PROPOSED

**Species at Risk Act**
Recovery Strategy Series

# Recovery Strategy for the Oregon Lupine (*Lupinus oreganus*) in Canada

## Oregon Lupine

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**2013**

Canada

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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 SAR Public Registry [1].

**Cover illustration**: Oregon Lupine, photograph courtesy Oregon Department of Agriculture (with permission)

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[1] http://www.registrelep.gc.ca/default_e.cfm

# 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:

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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 five years after the publication of the final document on the SAR Public Registry.

The Minister of the Environment and the Minister responsible for the Parks Canada Agency is the competent minister for the recovery of the Oregon Lupine and has prepared this strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the provincial government of British Columbia, Environment Canada, and the Garry Oak Ecosystems Recovery Team.

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 Oregon Lupine 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.

The recovery of Oregon Lupine will be coordinated with the recovery of at-risk species inhabiting maritime meadows associated with Garry Oak ecosystems (Parks Canada Agency 2006).

# Acknowledgments

Thank you to Todd Kohler and Carrina Maslovat for collecting and compiling the species and habitat information used in preparing this recovery strategy. The Garry Oak Ecosystems Recovery Team is the recovery team for the Oregon Lupine and was involved in the development of this recovery strategy. Thank you to Keystone Wildlife Research for administrative support and to Matt Fairbarns for providing valuable technical advice. Additional revision to this document has been made based on comments and edits provided by the Province of British Columbia, and Environment Canada.

# Executive Summary

Oregon Lupine (*Lupinus oreganus* Heller) was assessed as Extirpated in 2008 by the Committee on the Status of endangered Wildlife in Canada (COSEWIC) and in 2011 the Canadian population was listed as Extirpated on Schedule 1 of Canada's *Species at Risk Act* (SARA).

Oregon Lupine is a long-lived, showy, perennial plant restricted to western North America. In Canada, Oregon Lupine was known from the Victoria, British Columbia area.

Several key factors limit the recovery of Oregon Lupine: habitat specificity, limited mechanisms for reproduction, weak competitive ability, and limited genetic pool for seed source. Further reintroduced populations would face a number of threats: invasive alien plants, disruption of historic disturbance regimes (fire suppression), recreation and maintenance activities, hybridization, and insect herbivory.

In the short term, population and distribution objectives for Oregon Lupine are to determine the feasibility of reintroducing populations. Broad strategies to be taken to address the threats to the recovery of the Oregon Lupine are presented in section 6 Broad Strategies and General Approaches to Meet Objectives.

Critical habitat cannot be identified at this time as Oregon Lupine is currently extirpated from Canada and habitat studies are required to identify suitable habitat for reintroduction.

An action plan for Oregon Lupine will be completed by 2018.

# Recovery Feasibility Summary

The recovery of the Oregon Lupine 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. Although there are currently no populations in Canada, populations in the U.S. produce seeds and are capable of reproduction. Plants have been grown in cultivation in Canada and could be used in combination with additional material from the U.S to create a population in Canada.

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

   Yes. Although much of the Garry Oak maritime meadow habitat has been destroyed, over 40 maritime meadow complexes still exist to be studied and ranked for their suitability of supporting reintroduction of Oregon Lupine.

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

   Yes. The primary threats (Encroachment by native and invasive alien plants, and recreation and maintenance activities) can be mitigated through stewardship and public education. Further, careful selection of sites for new Canadian populations of Oregon Lupine will help mitigate other threats such as the potential negative effects associated with insect herbivory and hybridization.

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

   Yes. Although more remains to be understood, there has been a large amount of applicable research on Oregon Lupine in the United States. This research has focused on restoration, seed germination, propagation, and reintroduction techniques, as well as genetic diversity and pollination. Further, plants have been propagated in Canada and the Conservation Research Program from the Institute for Applied Ecology is studying Oregon Lupine and climate change using a common garden design including a site at Horticulture Centre of the Pacific on Quayle Road in Victoria. Techniques to mitigate the encroachment of woody native and invasive alien species are widely practiced for Garry Oak Ecosystem restoration.

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# 1. COSEWIC[1] Species Assessment Information

**Date of Assessment:** November 2008

**Common Name (population):** Oregon Lupine

**Scientific Name:** *Lupinus oreganus*

**COSEWIC Status:** Extirpated

**Reason for Designation:** The species has only been recorded from Oak Bay, Victoria, BC, where it was first collected in 1924. The last record of its existence in Canada is a collection made from the same area in 1929. The species has not been recorded since its last collection in the region in spite of extensive botanical surveys within southeastern Vancouver Island over the last several decades.

**Canadian Occurrence**: British Columbia

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

# 2. Species Status Information

The Canadian population of Oregon Lupine (*Lupinus oreganus*) was assessed as Extirpated in 2008 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and in February 2011 the population was listed as Extirpated under Canada's *Species at Risk Act* (SARA). Provincial, state, and global conservation ranks for Oregon Lupine in other jurisdictions are provided in Table 1.

**Table 1. Conservation ranks for Oregon Lupine. Sources: B.C. Conservation Data Centre 2012; NatureServe 2012.**

| Location | Rank* | Rank description |
|---|---|---|
| **Global** | G5T2 | Secure (variety *kincaidii* is globally imperilled) |
| **Canada** | XT | Extirpated |
| British Columbia | SX | Extirpated |
| **United States** | N2 | Imperilled |
| Washington | S1 | Critically imperilled |
| Oregon | S2 | Imperilled |

*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).

[1] COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

# 3. Species Information

## 3.1. Species Description

Oregon Lupine is a herbaceous perennial of the legume family (Fabaceae). The plants are 40 to 80 centimetres tall, with single to multiple unbranched flowering stems and basal leaves that remain after flowering. The yellowish to bluish or purple flowers are 9-12 millimetres long, aromatic, and have a distinctly ruffled upper petal. The leaves are on long stalks and tend to a deep green with an upper surface that is often hairless (COSEWIC 2008). Individual plants are able to spread extensively underground and individual clones can be several centuries old and quite large with many flowering stems (COSEWIC 2008; Wilson *et al*. 2003).

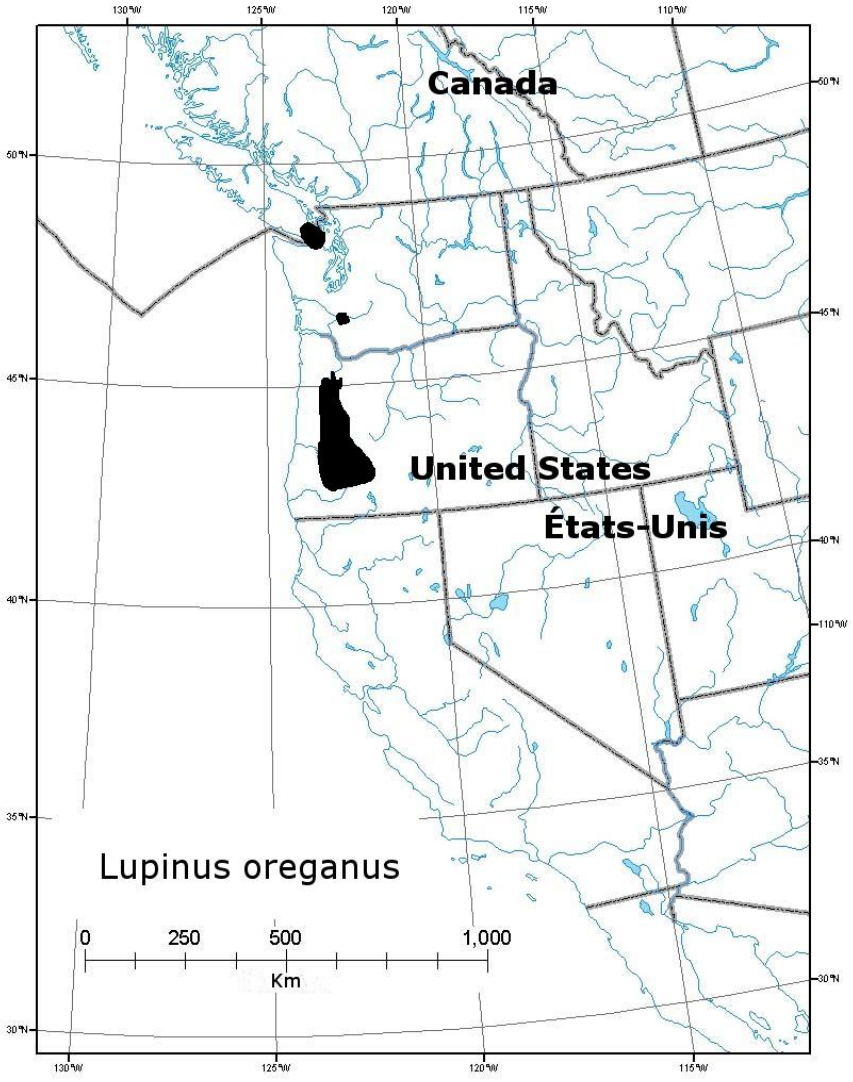


**Figure 1. Global Range of *Lupinus oreganus* (both var. *kincaidii* and var. *oreganus*) (reproduced from COSEWIC 2008 with permission of Environment Canada).**

## 3.2. Population and Distribution

Globally, Oregon Lupine is known from dry upland prairies west of the Cascades from Douglas County, Oregon to Lewis County, Washington, and into southern British Columbia (Figure 1). Within this narrow range, Oregon Lupine (Kincaid's Lupine in the U.S.) is known from only 57 sites totalling approximately 395 hectares (Kuykendall and Kaye 1993; Wilson *et al.* 2003). Most of the known Oregon Lupine populations (current and historic) are in the Willamette Valley of Oregon.

The seven herbarium specimens collected in Canada between 1924 and 1929 indicate that Oregon Lupine was found in the vicinity of Victoria and Oak Bay, British Columbia (Figure 2; COSEWIC 2008). However, it has been over eighty years since Oregon Lupine was last recorded in Canada and it is impossible to determine the number of historic Canadian populations from the limited information in herbarium records. The closest contemporary population is over 260 kilometres to the south in Lewis County, Washington, U.S.

## 3.3. Needs of Oregon Lupine

In the U.S., the Oregon Lupine is primarily restricted to undisturbed remnant upland prairie habitat. There are no comprehensive descriptions of the habitat used by historic populations in B.C.; but B.C. herbarium label descriptions ("grassy flat") suggest the plants were found in maritime meadows of Garry Oak and associated ecosystems in the dry Coastal Douglas-fir zone.

Maritime meadows are low elevation (<30 metres above sea level), herb-dominated ecosystems confined to within 3 kilometres of the shoreline and in B.C. they are found along the coast of southeast Vancouver Island and a subset of islands in the Strait of Georgia, Haro Strait, and the Strait of Juan de Fuca (Parks Canada Agency 2006). Soils in such sites are typically low in nitrates, moderately infertile, acidic, and of postglacial origin (MacDougall *et al.* 2004). These maritime meadows occur within the Coastal Douglas-fir Biogeoclimatic Zone which is characterized by a summer-dry sub-Mediterranean climate that is presumed necessary for Oregon Lupine survival in Canada.

In the United States, Oregon Lupine is a species of prairie, or open areas, and is unable to survive prolonged periods of shade (Wilson *et al.* 2003). In general, it will not tolerate decreases in available light that result from increased canopy closure as prairies (and meadows) gradually transform into shrubland or woodlands in the absence of disturbance. However, southern populations in Douglas County, Oregon, are known from more shaded habitat (canopy cover of 50 to 80 percent) than more northerly populations (U.S. FWS. 2006). In its U.S. habitat this species is found on 48 types of well drained, heavier soils, typically Ultic Haploxerolls, Ultic Argixerolls, and Xeric Palehumults (U.S. FWS. 2006).

A number of factors limit the recovery of Oregon Lupine in Canada:

- Dependence on habitats within Garry Oak and associated ecosystems, most of which have been lost or damaged by habitat conversion (i.e., 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.

- A lack of special structures to aid in the long-distance dispersal of seeds limits the potential for local rescue effects or establishment in unoccupied habitat areas.
- Ecosystem fragmentation may limit Oregon Lupine in some sites which may be too small and/or distant for effective pollination and/or gene transfer among populations.
- Extremely small population sizes, may constrain the species' genetic diversity, and increase its vulnerability to extirpation due to random effects on population size.

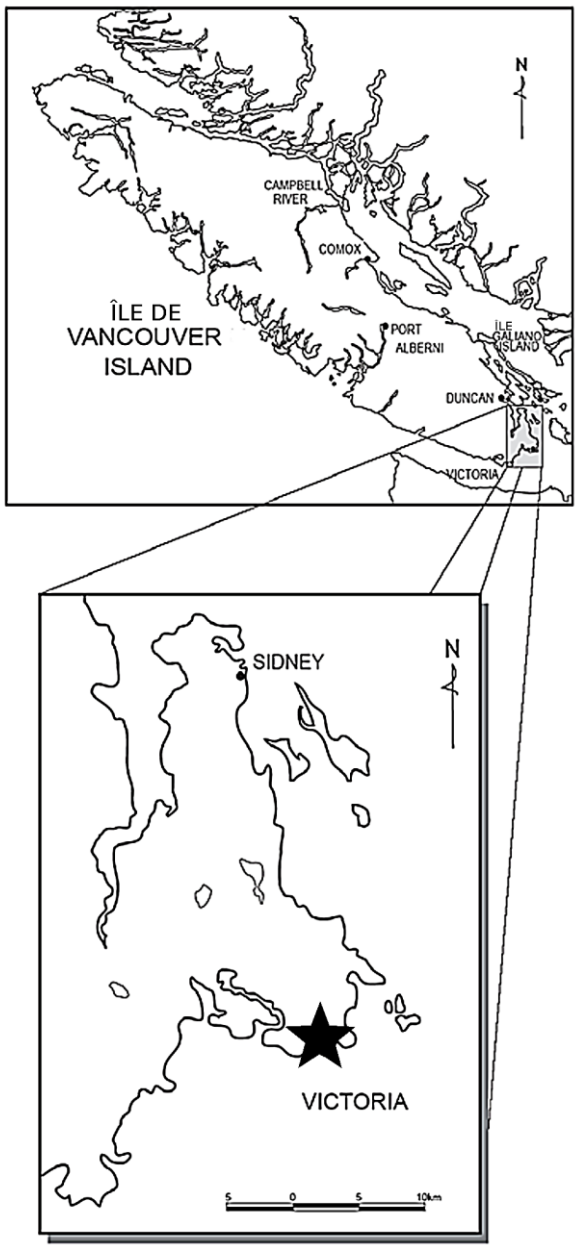


**Figure 2. Distribution of Oregon Lupine in Canada. Star indicates the general location of historical Canadian population(s). The exact number of historic populations cannot be determined (reproduced from COSEWIC 2008 with permission of Environment Canada).**

# 4. Threats

## 4.1. Threat Assessment

There are no extant populations in Canada and threats outlined in Table 2 are those that would threaten reintroduced populations in Canada. The identification and ranking of these threats is based, in part, on current threats to extant populations in the United States and current threats common to maritime meadow species in Canada (U.S. FWS. 2006; Parks Canada Agency. 2006).

**Table 2. Threat Assessment Table.**

| Threat | Level of Concern[1] | Extent | Occurrence | Frequency | Severity[2] | Causal Certainty[3] |
|---|---|---|---|---|---|---|
| **Alien, invasive or introduced species** | | | | | | |
| Encroachment by invasive alien plants | High | Widespread | Anticipated | Continuous | High | Medium |
| **Disturbance or harm** | | | | | | |
| Recreational and maintenance activities | High | Localized | Anticipated | Continuous/ Seasonal | Medium/ Low | Medium |
| Herbivory | Unknown | Widespread | Anticipated | Recurrent | Unknown | Medium |
| Habitat Restoration activities. | Medium | Widespread | Anticipated | Recurrent | Unknown | Medium |
| **Changes in ecological dynamics or ecological processes** | | | | | | |
| Fire suppression | High | Widespread | Anticipated | Continuous | High | High |
| Hybridization with other *Lupinus* species | Unknown | Widespread | Anticipated | Continuous | Unknown | Unknown |
| **Habitat loss or degradation** | | | | | | |
| Habitat conversion | Low | Widespread | Historic and anticipated | Recurrent | High | High |
| **Climate change and natural disasters** | | | | | | |
| Climate Change | Unknown | Widespread | Anticipated | Seasonal | 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. Alien, invasive or introduced species

One of the most serious and immediate threats to future populations of Oregon Lupine is the encroachment of invasive alien plants. Invasive alien shrubs shade herbaceous plants, alter meadow nutrient cycling, and compete for space, light, moisture, and nutrients (Fuchs 2001; MacDougall 2002). Invasive alien shrubs also alter ecosystem structure and can limit pollinator movements and seed dispersal (Parks Canada Agency 2006). Invasive alien grasses and forbs out-compete many native forbs and create dense thatch that can lead to poor reproductive success, reduced seed set and germination, reduced fitness and dispersal, and prevent establishment of seedlings (Maslovat pers. obs. 2010). Invasive alien plants may have contributed to the decline of the historic populations.

Invasive alien plants are a persistent threat facing populations of Oregon Lupine in the United States (U.S. FWS 2006). Consequently, this threat is considered a high level of concern for potentially reintroduced populations in Canada. However, this threat can be managed using various treatments including prescribed fire, mowing, and herbicide (e.g., Wilson *et al.* 2003; Stanley *et al.* 2011).

### 4.2.2. Disturbance or harm

#### *Recreational and maintenance activities*

Recreational and maintenance activities may cause harm to reintroduced populations of Oregon Lupine, in particular because plants will likely be introduced to public lands. People and their dogs use all municipal and regional parks in this urban area extensively and trampling damages plants, compacts soil, and can spread invasive alien plants.

Many of the municipal and regional parks in Victoria and Oak Bay are mown regularly for aesthetic reasons and to reduce the risk of fire (Kohler pers. obs. 2010). Mowing during the growing season can damage the foliage, flowers, and unripe seed (Erhart 2000) and encourages further trampling in mown areas. Pesticide application may harm populations.

While these threats are relatively recent and likely did not contribute to the decline of historic populations, they will need to be mitigated for reintroduced populations. Destructive recreation and maintenance activities are a serious threat to U.S. populations (U.S. FWS 2006) and this threat is considered a high level of concern for potentially reintroduced populations in Canada.

#### *Herbivory*

In recent years there have been changes in patterns of herbivory throughout maritime meadows. Notably an increase in the density of native herbivores such as the Columbian Black-tailed Deer (*Odocoileus hemionus columbianus*) and growing populations of introduced herbivores such as the Canada Goose and Black Slug (*Arion rufus*) may pose a threat to introduced populations of Oregon Lupine.

In the U.S., Oregon Lupine is vulnerable to seed, fruit, and flower predation by insects, which may limit the production of seeds (U.S. FWS 2006). Oregon Lupine seed production appears to be significantly limited by predation and other insect-related damage (Gisler 2004). While Oregon Lupine leaves in the Royal BC Museum herbarium collection show evidence of herbivory by insects, possibly by butterfly larvae (Kaye 2000), it is unknown whether herbivory posed a significant threat to historic populations.

Although herbivory is a natural process, small plant populations with limited gene pools and other stressors may be more vulnerable. It is also unknown what level of threat herbivory poses to reintroduced populations. Changes in herbivory patterns may result in positive or negative effects depending on the palatability of Oregon Lupine and competing vegetation; therefore, the level of concern for this threat is not known.

#### *Habitat Restoration activities*

While not mentioned in the COSEWIC status report the restoration activities required to maintain maritime meadow habitat pose a real threat to introduced Oregon Lupine populations. These populations will be established in an ecosystem requiring widespread restoration activities to mitigate changes in ecological dynamics. These restoration activities may include cutting and pulling of invasive plant species, prescribed burns, or herbicide application all of which may threaten introduced Oregon Lupine populations. However, potential negative effects of recovery activities 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. This threat is of medium concern.

### 4.2.3. Changes in ecological dynamics or ecological processes

#### *Fire Suppression*

Fire suppression has allowed 83% of upland prairie sites in the Oregon Lupine's United States range to succeed to shrub land or forest (U.S. FWS 2006). Fires were common in Canadian Garry Oak and associated ecosystems prior to European settlement (Fuchs 2001; MacDougal *et al.* 2004). A result of widespread fire suppression since settlement has been increased competition for light, moisture, and nutrients from encroaching woody plants (Fuchs 2001; MacDougall 2002). 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 can leave nutrients trapped in organic matter and unavailable for use, allow organic matter to build up and cover the ground limiting light and bare mineral soil for germination, and enable longer lived woody species to invade and suppress herbaceous species.

Oregon Lupine is known to be shade-intolerant (Wilson *et al.* 2003) and the increased cover of tall woody vegetation has reduced the availability of suitable habitat. Further, increased shrub and tree cover also limits the movement of pollinators, affecting pollination dynamics and effectively increasing fragmentation (Parks Canada Agency 2006).

Despite fire suppression, fires still occasionally occur, and when they do they cause more damage because increased abundance of woody vegetation provides more fuel for hotter fires (Parks Canada Agency 2006).

The large scale changes in ecosystem dynamics brought about by fire suppression threaten future populations of Oregon Lupine and are of great concern; however, these changes can be mitigated. For example, prescribed fire in association with mowing before or after the growing season has increased both leaf and flower production in Oregon Lupine (U.S. FWS 2006).

#### *Hybridization*

Species within the lupine family can readily hybridize (Wheeler *et al.* 2005; Fairbarns pers. comm. 2010; Klinkenberg pers. comm. 2010). For example, hybridization between Oregon Lupine and Longspur Lupine (*Lupinus arbustus*), a southern BC native, has been detected at Baskett Slough National Wildlife Refuge (Liston *et al.* 1995). While hybridization with Longspur Lupine itself is not a threat to Oregon Lupine in B.C., this example shows that hybridization is a real threat and a variety of lupines are present within and near the former range of Oregon Lupine in B.C (including the rare Dense Flowered and Prairie Lupines (*L. densiflorus* and *L. lepidus*)). A precautionary approach should be taken when considering re-introduction sites since it is unknown whether this species will experience genetic exchange with other lupine species. This threat level, therefore, remains unknown.

### 4.2.4. Habitat loss or degradation

While it is impossible to confirm due to the limited habitat descriptions on herbarium labels, the historic occurrences of Oregon Lupine in Canada were likely destroyed by habitat loss. Level sites with maritime meadows in Victoria and Oak Bay have been a focus for agriculture and urban development; surveys along a 500 metre coastal strip of Victoria and Oak Bay indicate that only 5% of coastal habitat is undeveloped and only 1% of level, maritime meadow remains in a natural state (COSEWIC 2008). A large portion of suitable habitat has been destroyed and reintroduced populations may be fragmented. However, direct habitat loss is unlikely to impact future populations in Canada because they should only be intentionally planted in areas that will not be developed and this threat is of low concern to contemporary populations.

### 4.2.5. Climate Change

Climate change is not listed specifically in the COSEWIC status report; however, the status report does mention climatic requirements of Oregon Lupine (COSEWIC 2008) 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). How climate change will affect introduced Oregon Lupine populations is ultimately unknown. Current habitat may become unsuitable and additional habitat may become suitable so as populations are introduced climate change will be considered in site selection. Climate change is considered to be a ‘low’ level of concern; however, its ultimate severity is unknown.

# 5. Population and Distribution Objectives

There are no comprehensive descriptions of the habitat used by historic populations of Oregon Lupine in Canada; however, herbarium labels suggest the plants were found in maritime meadows 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 extirpation. Encroachment of woody vegetation, invasive alien plants, and the effects of recreational activities continue to affect potential habitat (COSEWIC 2008). Given the permanent loss of most of the original habitat, it is likely impossible to recover the species to its natural area of occupancy or to its original probability of persistence.

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 Oregon Lupine, 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 a short-term objective that focuses on the feasibility of establishing new populations:

**Objective 1**: Establish new populations if determined to be feasible and biologically appropriate for Oregon Lupine.

# 6. Broad Strategies and General Approaches to Meet Objectives

Broad strategies and approaches to meet the population and distribution objectives for Oregon Lupine include the following:

- Population restoration: locate habitat and establish new population(s) to recover the Canadian population of the species;
- Stewardship: engage landowners to understand the species' needs and support recovery activities for the species; and
- Public education and outreach: engage and seek collaboration with the public in recovery of this species.
- Research: address critical knowledge gaps;

## 6.1. Strategic Direction for Recovery

**Table 3. Recovery Planning Table.**

| Threat or Limitation | Priority[2] | Broad Strategy to Recovery | General Description of Research and Management Approaches |
|---|---|---|---|
| Limitations: Habitat specificity and limited dispersal<br><br>Limitation: low genetic diversity<br><br>Habitat loss or degradation | High | Population Restoration | • Determine appropriate population targets and amount of genetic diversity needed for successful recovery.<br>• Determine the feasibility of population establishment:<br>  • Survey maritime meadows in Canada and identify potential sites for reintroduction of Oregon Lupine.<br>  • Rank and select potential habitat to determine site(s) for an experimental population.<br>  • Identify source populations for reintroduction efforts.<br>  • Test techniques for reintroduction and management by establishing and monitoring experimental populations in an adaptive manner. |
| Insect herbivory<br><br>Hybridization<br><br>Limitation: habitat fragmentation | Medium | Research | • Determine the significance of insect herbivory to reintroduced populations in Canada.<br>• Determine the risk of hybridization with other Lupinus species (via greenhouse experiments) in order to inform site selection.<br>• Investigate pollination mechanism and limitations. |
| Encroachment by invasive alien and native woody plants<br><br>Recreational and maintenance activities | High<br><br>Low | Stewardship<br><br>Public education and outreach | • Engage the cooperation of landowners with potential habitat for Oregon Lupine.<br>• Develop a restoration and management plan for each reintroduction site to support landowners and land managers in stewardship activities.<br>• Increase public awareness of Oregon Lupine and associated species at risk |

## 6.2. Narrative to Support the Recovery Planning Table

The remaining maritime meadow habitat in Victoria and Oak Bay has been heavily altered by development, encroachment of native and invasive alien woody species, and invasive alien grasses and shrubs. The recovery of this species will rely on habitat surveys and stewardship to locate, restore, and maintain suitable habitat (see GOERT 2011 for information on Garry Oak Ecosystem restoration). Further Oregon Lupine has symbiotic associations with nitrogen fixing bacteria and mychorrhizal fungi and reintroduction may be more successful if soils are inoculated small amounts of soil from existing populations of Oregon Lupine (Wilson *et al.* 2003). Alternatively mychorrhizal fungi in U.S populations could be isolated and identified in order to look for Canadian sources of the same fungi to avoid soil transfer. Successful habitat restoration will rely on data from populations in the United States to complement the spotty information recorded in Canadian herbarium records. However, even if additional habitat is made available, Oregon Lupine has no traits to promote long distance seed dispersal (Wilson *et al.* 2003) and natural reestablishment is unlikely.

[2] "Priority" reflects the degree to which the approach contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.

Seeds or plants will need to be brought from the United States to enable recovery of this species in Canada. Unfortunately, extant U.S. populations appear to be limited by low genetic diversity and are likely suffering from inbreeding depression (U.S. Fish and Wildlife Service 2006). Conservation of Oregon Lupine will likely require the out crossing of populations by planting new individuals from different sources and increasing pollinator connectivity (Severns 2003).

In addition, the ramifications of introducing a rhizomatous perennial with the ability to hybridize with other lupine species into ecosystems containing other rare lupines must be considered (Liston *et al.* 1995). Precautions could include establishing an experimental population on a small island that possesses suitable habitat but lacks other rare species, in particular other rare lupine species (Fairbarns pers. comm. 2010).

# 7. Critical Habitat

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 the Oregon Lupine is not identified in this recovery strategy because there is insufficient information on suitable Oregon Lupine habitat in Canada. Critical habitat may be identified in a recovery strategy update or in an action plan if an extant population of Oregon Lupine is found in British Columbia. The schedule of studies (Section 7.2; Table 4) outlines the activities required to identify critical habitat necessary to support the population and distribution objectives of the species.

## 7.2. Schedule of studies to identify critical habitat

**Table 4. Schedule of studies to identify critical habitat.**

| Description of Activity | Outcome/Rationale | Timeline |
|---|---|---|
| Habitat suitability mapping | • Survey for suitable habitat. Efforts should focus on maritime meadows in the municipalities of Oak Bay and Victoria (but should not be limited to them), including small islands off southeast Vancouver Island.<br>• Rank (e.g., for habitat suitability, feasibility, and appropriateness) sites for experimental reintroduction.<br>• Determine appropriate amount and configuration of habitat required for reintroduced populations. | 2017 |
| Reintroduce individuals | • Develop a translocation plan and establish experimental population(s) to test the suitability of proposed sites (identified by habitat suitability mapping). | 2019 |
| Monitor experimental population | • If small-scale reintroduction is successful, determine the potential for establishing a self-sustaining population(s). | 2019-2024 |
| Use information from experimental translocation to develop full-scale approach | • Use analysis to determine the amount and configuration of habitat required to support population and distribution objectives. | 2028 |

# 8. Measuring progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

**Objective 1:** Establish new populations if determined to be feasible and biologically appropriate for Oregon Lupine.

- By 2018, sites have been identified for establishment of experimental Oregon Lupine population(s).
- By 2022, one or more (re)introduction experiments are underway at suitable site(s).

# 9. Statement on Action Plans

One or more action plans will be completed by 2018.

# 10. References

Barbour, M. G, J. H. Burk, W. D. Pitts, F. S. Gilliam, and M. W. Schwartz. 1999. Terrestrial Plant Ecology: Third Edition. Benjamin/Cummings, an imprint of Addison Wesley Longman, Inc., Menlo Park, California. xiv + 649 pp.

B.C. Conservation Data Centre. 2012. Species Summary: Lupinus oreganus var. kincaidii. B.C. Ministry of Environment. Website: http://a100.gov.bc.ca/pub/eswp/ [accessed April 2012].

Brook, B.W., L.W. Traill, and J.A. Bradshaw. 2006. Minimum viable population sizes and global extinction risk are unrelated. Ecology Letters 9:375-382.

COSEWIC. 2008. COSEWIC Assessment and Status Report on the Oregon Lupine Lupinus oreganus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 23 pp.

Erhart, T. 2000. Population Dynamics and Conservation Biology of Lupinus sulphureus ssp. kincaidii (Fabaceae). Senior Thesis. Oregon State University, Corvallis, Oregon.

Fairbarns, M., pers. comm. 2010. *Email correspondence to T. Kohler.* Feb/March 2010. Species at Risk Botanist, Aruncus Consulting, Victoria, British Columbia.

Flather, C.H., G.D. Hayward, S.R. Beissinger, and P.A. Stephens. 2011. Minimum viable populations: is there a 'magic number' for conservation practitioners? Trends in Ecology and Evolution 26:307-316.

Fuchs, M.A. 2001. Towards a Recovery Strategy for Garry Oak and Associated Ecosystems in Canada: Ecological Assessment and Literature Review. Technical Report EC/GB-00- 030. Environment Canada, Canadian Wildlife Service, Pacific and Yukon Region. xi + 107 pp.

Garnett, S.T., and K.K. Zander. 2011. Minimum viable population limitations ignore evolutionary history. Trends in Ecology and Evolution 26(12): 618-619.

Gisler, S.D. 2004. Developing Biogeographically Based Population Introduction Protocols for At Risk Willamette Valley Plant Species. U.S. Fish and Wildlife Service, Portland, Oregon. 230 pp.

GOERT. 2011. Restoring British Columbia's Garry Oak Ecosystems: Principles and Practices. Garry Oak Ecosystems Recovery Team. Victoria, B.C. Web site: http://www.goert.ca/gardeners_restoration/restoration.php [Accessed January 2013].

Government of Canada. 2009. Species at Risk Act Policies: Overarching Policy Framework [Draft]. Pp ii+ 38pp. in Species at Risk Act Policies and Guidelines Series, Environment Canada. Web site: http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=1916 [accessed June 2010].

Jamieson, I.G., and F. W. Allendorf. 2012. How does the 50/500 rule apply to MVPs? Trends in Ecology and Evolution, Online, 1566: 1-7.

Kaye, T.N. 2000. Notes on the geographic distribution and taxonomy of lupinus sulphureus ssp. kincaidii (Fabaceae). Botanical Electrical News. No. 243. Web site: http://www.ou.edu/cas/botany-micro/ben/ben243.html [accessed March 2010].

Kaye, T.N. and K. Kuykendall. 1993. Status Report for Lupinus sulphureus ssp. kincaidii. Oregon Department of Agriculture, Salem, and U.S. Fish and Wildlife Service, Portland, Oregon. 71 pp.

Klinkenberg, Rose. pers. comm. 2010. *Email correspondence to T. Kohler*. February 2010. Ecologist/Botanist, Richmond, British Columbia.

Kuykendall, K. and T.N. Kaye. 1993. Lupinus sulphureus ssp. kincaidii Survey and Reproduction Studies. U.S. Bureau of Land Management, Roseburg District, Roseburg, Oregon and Oregon Department of Agriculture, Salem, Oregon. 44 pp.

Lea, T. 2006. Historical Garry Oak Ecosystems of Vancouver Island, British Columbia, pre-European Contact to the Present. Davidsonia 17:34-50.

Liston, A., K. St. Hilaire, and M.V. Wilson. 1995. Genetic diversity in populations of Lupinus sulphureus ssp. kincaidii, host plant of Fender's blue butterfly. Madroño 42: 309-322.

MacDougall, A.S. 2002. Fine-scale fire effects in Quercus garryana grassland. in: Burton, P.J. (ed.) Garry Oak Ecosystem Restoration: Progress and Prognosis. Proceedings of the Third Annual Meeting of the B.C. Chapter of the Society for Ecological Restoration, University of Victoria, B.C.

MacDougall, A.S., B.R. Beckwith, and C.Y. Maslovat. 2004. Defining conservation strategies with historical perspectives: a case study from a degraded oak grassland ecosystem. Conservation Biology 18: 455-465.

NatureServe. 2012. NatureServe Explorer: An Online Encyclopedia of Life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Web site: http://www.natureserve.org/efxplorer [accessed: April 2012].

Parks Canada Agency. 2006. Recovery Strategy for Multi-Species at Risk in Maritime Meadows Associated with Garry Oak Ecosystems in Canada. xii + 93 pp, in Government of Canada. Species at Risk Act Recovery Strategy Series, Ottawa, Ontario.

Reed, D.H. 2005. Relationship between population size and fitness. Conservation Biology 19:563-568.

Rodenhuis, D.R., K.E. Bennett, A.T. Werner, T.Q. Murdock, and D. Bronaugh. 2007. Hydro-climatology and future climate impacts in British Columbia. Pacific Climate Impacts Consortium, University of Victoria, Victoria, B.C. 132 pp.

Severns, P.M. 2003. Propagation of a long-lived and threatened prairie plant, Lupinus sulphureus ssp. kincaidii. Restoration Ecology 11(3): 334-342.

Stanley, A.G., T.N. Kaye, and P.W. Dunwiddie. 2011. Multiple treatment combinations and seed addition to increase abundance and diversity of native plants in the Pacific Northwest. Ecological Restoration 29(1-2): 35-44.

Traill, L.W., C.J.A. Bradshaw, and B.W. Brook. 2007. Minimum viable population size: A meta-analysis of 30 years of published estimates. Biological Conservation 139:159-166.

Traill, L.W., B.W. Brook, R.R. Frankham, and C.J.A. Bradshaw. 2009. Pragmatic population viability targets in a rapidly changing world. Biological Conservation 143:28-34.

U.S. FWS. 2006. Recovery Outline for Lupinus sulphureus ssp. kincaidii (Kincaid's Lupine). U.S. Fish and Wildlife Service, Portland, Oregon. 23 pp.

Wheeler, E.J., R. L. Edward, and G.A. Allen. 2005. Morphological and molecular evidence concerning the relationship of Lupinus polyphyllus and L. wyethii (Fabaceae). Madroño 52(2):107-133.

Wilson, M.V., T. Erhart, P.C. Hammond, T.N. Kaye, K. Kuykendall, A. Liston, A.F. Robinson Jr., C.B. Schultz, and P.M. Severns. 2003. Biology of Kincaid's lupine (Lupinus sulphureus ssp. kincaidii [Smith] Phillips), a threatened species of western Oregon native prairies. U.S. Natural Areas Journal 23:72-83.

# 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 and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[3] goals and targets.

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

However, actions to assist in the recovery of Oregon Lupine could negatively affect other species at risk in the Garry Oak Ecosystems (Table 5). Any on-site activity has the potential to affect other species at risk through trampling or the inadvertent translocation of invasive alien plant seeds; therefore, care must be taken to avoid indirect effects. Further, some actions such as removal of invasive alien plants or encroaching woody species can result in significant disturbance. If fire is identified as being a necessary component of restoration care must be taken to ensure that the natural disturbance is contained and that the fire does not inadvertently promote the growth of an invasive alien plant.

Oregon Lupine itself may have effects on other species. In particular, Garry Oak ecosystems with rare *Lupinus* species ( e.g., *Lupinus densiflorus* and *Lupinus lepidus*) should be avoided as reintroduction sites until the risk of hybridization has been determined. *L. lepidus* has been extirpated from the historical range of Oregon Lupine but may be reintroduced in the future. It would be prudent to observe how Oregon Lupine behaves in an experimental population to ensure it does not out-compete other native species or negatively impact native plant communities. After potential sites are identified, a more thorough assessment of the effects of reintroducing Oregon Lupine to Canada area will be possible.

[3] http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

**Table 5. Partial list of species at risk and vulnerable species that could be affected by recovery activities. Sources: B.C. Conservation Data Centre 2012, NatureServe 2012.**

| Scientific Name | Common Name | Provincial List | Conservation Rank | COSEWIC Status |
|---|---|---|---|---|
| *Coenonympha california insulana* (*Coenonympha tullia insulana*) | Common Ringlet, *insulana* subspecies | Red | G5T3T4S1 | Not Assessed |
| *Entosthodon fascicularis* | Banded Cord-moss | Blue | G4G5 S2S3 | Special Concern |
| *Syntrichia laevipila* (*Tortula laevipila* var. *laevipila* and *T. laevipila* var. *meridionalis*) | Twisted Oak Moss | Blue | GNR S2S3 | Special Concern |
| *Contia tenuis* | Sharp-tailed Snake | Red | G5S1 | Endangered |
| *Pituophis catenifer catenifer* | Pacific Gopher Snake (Gopher Snake, *catenifer* subspecies) | Red | G5T5SX | Extirpated |
| *Allium amplectens* | Slimleaf Onion | Blue | G4S3 | Not Assessed |
| *Allium geyeri* var. *tenerum* | Geyer's Onion | Blue | G4G5T3T5S2S3 | Not Assessed |
| *Alopecurus carolinianus* | Carolina Meadow-foxtail | Red | G5S2 | Not Assessed |
| *Balsamorhiza deltoidea* | Deltoid Balsamroot | Red | G5S1 | Endangered |
| *Callitriche marginata* | Winged Water-starwort | Red | G4S2S3 | Not Assessed |
| *Carex tumulicola* | Foothill Sedge | Red | G4S2 | Endangered |
| *Castilleja levisecta* | Golden Paintbrush | Red | G1S1 | Endangered |
| *Castilleja victoriae* | Victoria Owl-clover | Red | G1S1 | Endangered |
| *Centaurium muehlenbergii* | Muhlenberg's Centaury | Red | G5?S1 | Endangered |
| *Crassula connata* var. *connata* | Erect Pygmyweed | Red | G5TNRS2 | Candidate |
| *Heterocodon rariflorum* | Heterocodon | Blue | G5S3 | Not Assessed |
| *Idahoa scapigera* | Scalepod | Red | G5S2 | Not Assessed |
| *Isoetes nuttallii* | Nuttall's Quillwort | Blue | G4? | Not Assessed |
| *Juncus kelloggii* | Kellogg's Rush | Red | G3?S1 | Endangered |
| *Limnanthes macounii* | Macoun's Meadowfoam | Red | G2S2 | Threatened |
| *Lomatium dissectum* var. *dissectum* | Fern-leaved Desert-parsley | Red | G4T4S1 | Not Assessed |
| *Lotus formosissimus* | Seaside Birds-foot Lotus (Seaside Bird's-foot Trefoil) | Red | G4S1 | Endangered |
| *Lotus unifoliolatus* var. *unifoliolatus* | Spanish-clover | Blue | G5T5 S3 | Not Assessed |
| *Lupinus densiflorus* var. *densiflorus* | Dense-flowered Lupine | Red | G5T4 S1 | Endangered |
| *Microseris bigelovii* | Coast Microseris | Red | G4S1 | Endangered |
| *Orthocarpus bracteosus* | Rosy Owl-clover | Red | G3? S1 | Endangered |
| *Piperia elegans* | Elegant Rein Orchid | Yellow | G4S3S4 | Not Assessed |
| *Plagiobothrys tenellus* | Slender Popcornflower | Red | G4G5S1 | Threatened |
| *Psilocarphus elatior* | Tall Woolly-heads | Red | G4QS1 | Endangered |
| *Polygonum paronychia* | Black Knotweed | Blue | G5S3 | Not Assessed |
| *Psilocarphus tenellus* var. *tenellus* | Slender Woolly-heads | Blue | G4T4S3 | Not at Risk |
| *Ranunculus alismifolius* var. *alismifolius* | Water-plantain Buttercup | Red | G5T5S1 | Endangered |
| *Ranunculus californicus* | California Buttercup | Red | G5S1 | Endangered |

| Scientific Name | Common Name | Provincial List | Conservation Rank | COSEWIC Status |
|---|---|---|---|---|
| *Sanicula arctopoides* | Bear's-foot Sanicle (Snake-root Sanicle) | Red | G5S1 | Endangered |
| *Sanicula bipinnatifida* | Purple Sanicle | Red | G5S2 | Endangered |
| *Sericocarpus rigidus* (*Aster curtus*) | White-top Aster | Red | G3S2 | Special Concern |
| *Silene scouleri* ssp. *grandis* | Coastal Scouler's Catchfly (Scouler's Campion) | Red | G5TNR S1 | Endangered |
| *Trifolium depauperatum* var. *depauperatum* | Poverty Clover | Blue | G5T5?S3 | Not Assessed |
| *Trifolium dichotomum* | Macrae's Clover | Blue | G4?S2S3 | Not Assessed |
| *Triphysaria versicolor* ssp. *versicolor* | Bearded Owl-clover | Red | G5T5S1 | Endangered |
| *Triteleia howellii* | Howell's Triteleia | Red | G3G4S1 | Endangered |
| *Viola praemorsa* ssp. *praemorsa* | Yellow Montane Violet | Red | G5T3T5S2 | Endangered |

Potential negative effects of recovery 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 Oregon Lupine and its habitat, both natural components of biodiversity in Canada. Activities required to meet recovery objectives are unlikely to result in any important negative environmental effects as they are limited to conducting habitat mapping and inventory, habitat rehabilitation, research activities, fostering stewardship, increasing public awareness, and improving knowledge on habitat requirements and population threats. In addition, it is likely that habitat restoration for Oregon Lupine 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.