

Recovery Strategy for the Dense-flowered Lupine (*Lupinus densiflorus*) in Canada

Dense-flowered Lupine



2011



Parks
Canada

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Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is “*to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity.*”

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an Endangered, Threatened, or Extirpated species is arrested or reversed and threats are removed or reduced to improve the likelihood of the species’ persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/approach/act/default_e.cfm) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What’s next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (<http://www.sararegistry.gc.ca/>).

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Additional copies can be downloaded from the SARA Public Registry (<http://www.sararegistry.gc.ca/>).

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DECLARATION

Under the *Accord for the Protection of Species at Risk* (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada. The *Species at Risk Act* (S.C. 2002, c.29) (SARA) requires that federal competent ministers prepare recovery strategies for listed Extirpated, Endangered, and Threatened species.

The Minister of the Environment presents this document as the recovery strategy for the Dense-flowered Lupine, as required under SARA. It has been prepared in cooperation with the jurisdictions responsible for the species, as described in the Preface. The Minister invites other jurisdictions and organizations that may be involved in recovering the species to use this recovery strategy as advice to guide their actions.

The goals, objectives, and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives.

This recovery strategy will be the basis for one or more action plans that will provide further details regarding specific recovery measures to be taken to support protection and recovery of the species. Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the actions identified in this strategy. In the spirit of the *Accord for the Protection of Species at Risk*, all Canadians are invited to join in supporting and implementing this strategy for the benefit of the species and of Canadian society as a whole. The Minister of the Environment will report on progress within five years.

ACKNOWLEDGMENTS

Parks Canada Agency would like to thank the following organizations and individuals: The Canadian Wildlife Service of Environment Canada funded the preparation of the first draft of this report; the initial draft was prepared by Matt Fairbarns. The Garry Oak Ecosystems Recovery Team is the recovery team for the Dense-flowered Lupine and was involved in the development of this recovery strategy. Further revision was the result of comments and edits provided by a number of organizations: Department of National Defence, Canada Coast Guard, the Province of British Columbia, and Environment Canada.

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

In accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan, and Program Proposals* (2004), a strategic environmental assessment (SEA) is conducted on all *Species at Risk Act* recovery strategies. 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 their intended benefits. Environmental effects, including impacts to non-target species and the environment, were considered during recovery planning. The SEA is incorporated directly into the strategy and also summarized below.

The greatest potential for environmental effects comes from fieldwork activities aimed at habitat restoration; however, these effects can be mitigated or eliminated at the project level phase through proper field procedures and/or strong involvement of Parks Canada Agency and the Garry Oak Ecosystem Recovery Team (see section 2.6: “Effects on Other Species”). 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 Dense-flowered Lupine, a natural component of biodiversity. Activities required to meet recovery objectives are unlikely to result in any important negative environmental effects, as they are limited to habitat rehabilitation, research activities, fostering stewardship, increasing public awareness, improving knowledge of habitat requirements and population threats, and conducting habitat/species mapping, inventory, and restoration. In addition, it is likely that habitat restoration for Dense-flowered 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.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* [Subsection 2(1)].

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry:

http://www.sararegistry.gc.ca/sar/recovery/residence_e.cfm.

PREFACE

This recovery strategy addresses the recovery of Dense-flowered Lupine (*Lupinus densiflorus*). In Canada, this species only occurs in British Columbia.

Parks Canada Agency led the preparation of this recovery strategy, which involved the Garry Oak Ecosystems Recovery Team in cooperation with the provincial government of British Columbia and Environment Canada, Canadian Wildlife Service.

Dense-flowered Lupine is a species of maritime meadows in 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 Maritime Meadows Associated with Garry Oak Ecosystems in Canada* (Parks Canada Agency 2006).

EXECUTIVE SUMMARY

Dense-flowered Lupine is an annual plant restricted to western North America. Within its range, Dense-flowered Lupine is restricted to dry to moist grassy openings, clay cliffs, and eroding grassy banks and benches above the seashore.

The Canadian populations, along with a small number of populations on nearby islands in Puget Sound, constitute a disjunct element within the species that appears to be evolutionarily distinct and may comprise a variety (*scopulorum*) not occurring elsewhere. While the *scopulorum* variety has not been assessed individually, Dense-flowered Lupine was assessed as Endangered—the highest risk category—by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2005). In 2006 the species was listed as Endangered on Schedule 1 of the federal *Species at Risk Act* (SARA).

The total Canadian population is small and fluctuates considerably depending on climatic conditions. This small population is also subject to continued risks from habitat loss and degradation due to activities such as trampling and soil disturbance, competition with invasive alien plants, land development, mowing, and fire suppression.

While there are significant knowledge gaps relating to the species, there is sufficient information to conclude that recovery is feasible. To this end, the population and distribution objectives are to attain at least four viable, self-sustaining populations of Dense-flowered Lupine (the number known historically) distributed throughout its historical extent of occurrence in Canada.

Critical habitat for the recovery of Dense-flowered Lupine is identified in this recovery strategy. 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.

Further recovery actions for Dense-flowered Lupine will be incorporated into one or more action plans by June 2016

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1 BACKGROUND

1.1 Species Assessment Information from COSEWIC

Date of Assessment: May 2005

Common Name (population): Dense-flowered Lupine

Scientific Name: *Lupinus densiflorus*

COSEWIC Status: Endangered

Reason for designation: An annual with a highly restricted distribution known from three Canadian locations. The total population size is small and fluctuates considerably depending on climatic conditions. These populations are subject to continued risks from habitat loss and degradation due to activities such as urban development, trampling, mowing, and competition with invasive exotic plants.

Canadian Occurrence: BC

COSEWIC Status History: Designated Endangered in May 2005.

1.2 Description

Dense-flowered Lupine is an annual, tap-rooted plant that is usually branched and grows 20-30 cm in height (Figure 1). The stems are usually hollow and cylindrical at the base, and sparsely to copiously soft-hairy with long, brownish hairs. The leaves are palmately compound and occur basally and alternately along the stem but tend to cluster near the top. Further details can be found in the COSEWIC status report (COSEWIC 2005).

1.3 Populations and Distribution

Dense-flowered Lupine occurs from Vancouver Island and coastal Puget Sound, south to Baja California (Figure 2). Canadian plants are sometimes (e.g., Hitchcock *et al.* 1961) recognized as belonging to the *scopulorum* variety, which is restricted to the area of Victoria, British Columbia, and adjacent islands of Washington State. These populations are disjunct from the main range of the species (Figure 2).

Conservation ranks are provided in Table 1. The proposed *scopulorum* variety, though much more rare, has not been ranked separately.

In Canada, populations of Dense-flowered Lupine occur in maritime meadows in the vicinity of Victoria, British Columbia (Figure 3, Table 2).

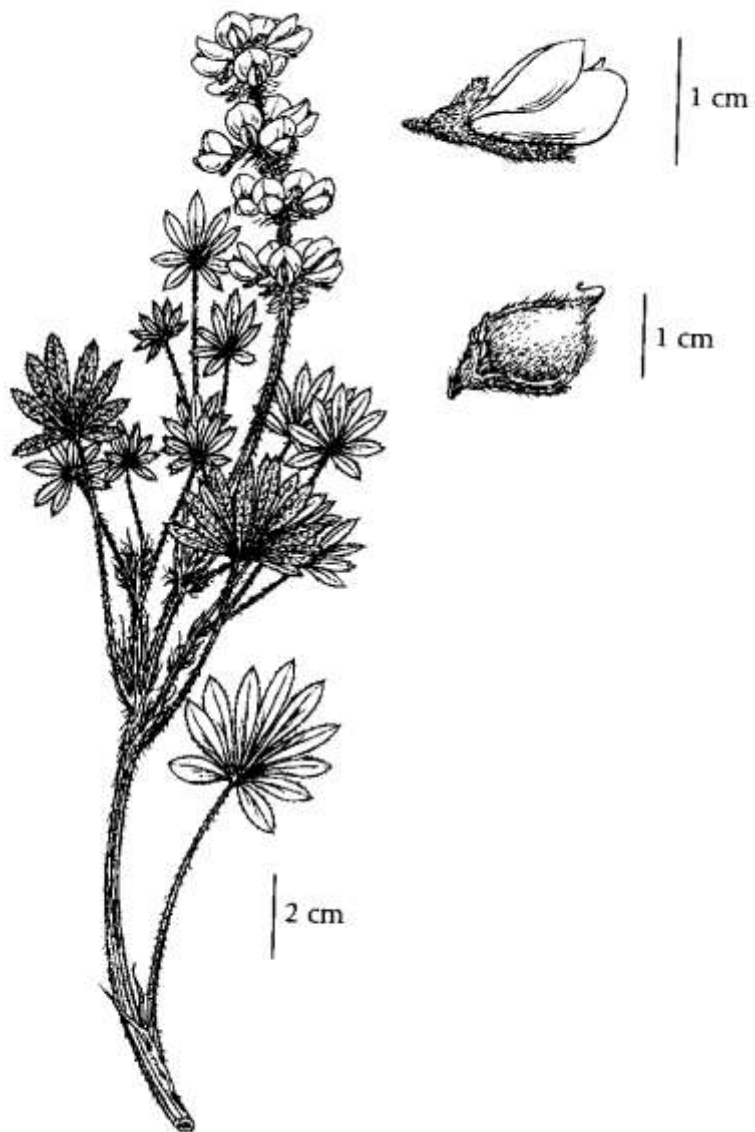


Figure 1. Illustration of Dense-flowered Lupine. Plant habit (left), flower (top right) and seedpod (bottom right). Line drawing by Ronald in Taylor (1974).



Figure 2. Distribution of Dense-flowered Lupine in North America (from COSEWIC 2005). The proposed *scopulorum* variety is restricted to a small area near Victoria, well separated from the range of other varieties of the species.

Table 1. Conservation ranks for Dense-flowered Lupine. Sources: BC Conservation Data Centre 2010, NatureServe 2010.

Location	Rank	Rank Description
British Columbia	S1	Critically imperilled
Washington	S3?	Vulnerable?
Oregon	SNR	Not ranked
California	SNR	Not ranked
Global	G5T4	Secure

? denotes an inexact rank

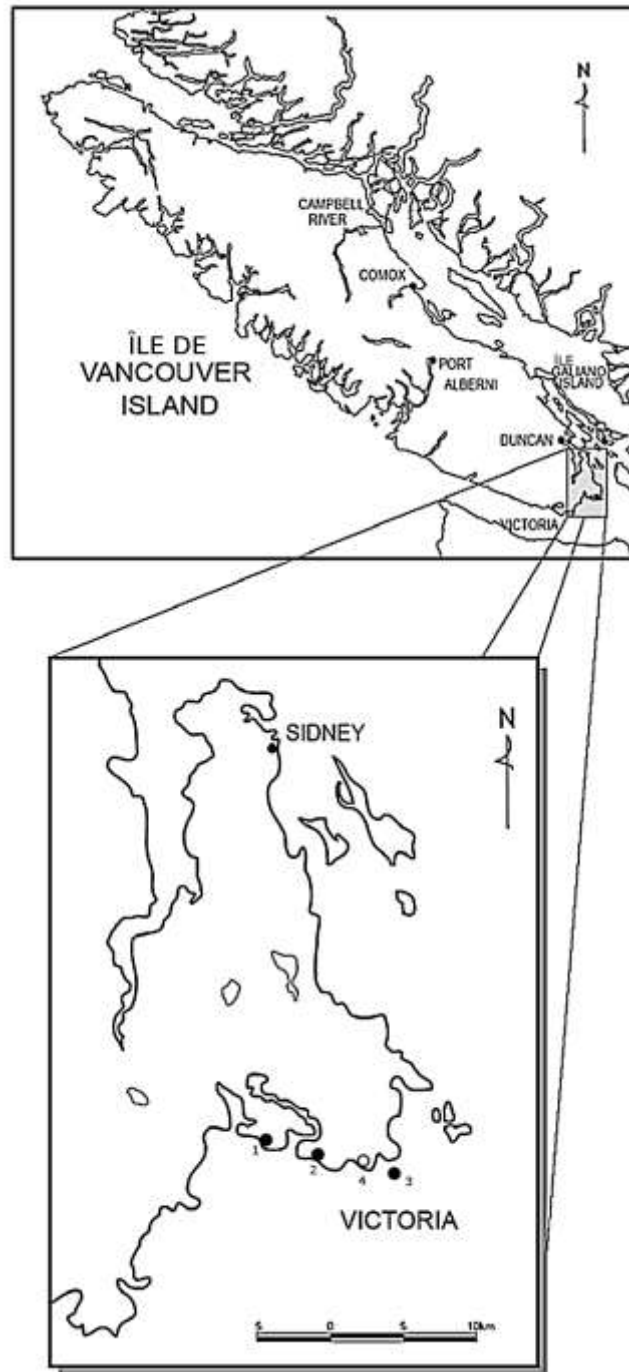


Figure 3. Distribution of Dense-flowered Lupine in Canada (from COSEWIC 2005). Numbers refer to population numbers in Table 2. Closed circles: extant populations; open circle: extirpated population.

The extent of occurrence in Canada is approximately 2 km² (Fairbarns unpublished data 2005). The average number of mature individuals in the Canadian population is likely in the low 1000's, but the population varies greatly in size from year to year and survey effort has been inconsistent (Table 2). The Canadian extent of occurrence, area of occupancy, and population size represent less than 1% of the corresponding global values for the species. The status report does not treat the proposed *scopulorum* variety separately, but based on reports from Atkinson and Sharpe (1993) the Canadian extent of occurrence would constitute approximately 40% of the global extent of occurrence (M. Fairbarns, unpublished data 2005).

Table 2. Populations of Dense-flowered Lupine in Canada[†].

Population^{††}	Status and Description[†]
1. Macaulay Point	~ 2,984 flowering plants occupying discontinuous areas of suitable habitat in a < 4 ha block (Miskelly 2008, 2009).
2. Dallas Bluffs (Finlayson and Holland Points)	~ 300 flowering plants occupying discontinuous areas of suitable habitat in a < 3 ha block (M. Fairbarns pers. obs. May 2005).
3. Trial Island	~ 500 flowering plants occupying < 1 ha (M Fairbarns pers. obs. May 2005).
4. Clover Point	Extirpated; last observed in 1954; site has been heavily altered by construction activities.

[†]Counts presented in this table are not population estimates. These numbers represent the most recent survey data for a given population and due to high annual variation these numbers can not be interpreted as the average population size.

^{††}Populations numbered as in COSEWIC status report.

1.4 Needs of the Dense-flowered Lupine

1.4.1 Habitat and Biological Needs

In British Columbia, Dense-flowered Lupine is restricted to the Southern Gulf Islands and Nanaimo Lowlands Ecosctions where it occurs in the Coastal Douglas-fir Biogeoclimatic Zone (BC Ministry of Environment n.d.; BC Ministry of Forests 2003). It occurs in dry to moist grassy openings, clay cliffs, and eroding grassy banks and benches above the seashore. The sites are either level or steep and face southeast to southwest. The soils are deep and remain moist through the winter but are very dry by mid-summer. The plant communities are dominated by low-growing forbs and grasses with little or no bryophyte cover. The sites are open and sunny with few trees, shrubs, or even dense and taller growing herbaceous plants.

This species is dependent on various ecosystem processes to reduce competition with other species and provide safe sites for seed germination and seedling growth. These processes include natural erosion of clay banks, periodic exposure to harsh marine conditions (wind and salt spray), an annual cycle of summer drought, and occasional wildfire. In general, these processes serve to keep perennial species from dominating, allowing space for Dense-flowered Lupine germination and growth. Many of these processes have been altered by human activities within the last few hundred years.

While southern (California) populations of Dense-flowered Lupine are self-pollinated, the Canadian plants have a different flower structure and are pollinated by bumblebees.

1.4.2 Limiting Factors

Dense-flowered Lupine does not reproduce vegetatively; therefore, dispersal of the species is dependent on seeds. It is an annual species, so populations are replenished either by recruitment from a local seed bank and/or by dispersal from other populations. Long-distance dispersal between populations is probably a rare event, so banked seeds are essential to the persistence of populations.

Three-year demographic studies reported after the COSEWIC status report was prepared provide new information on demographic characteristics (Fairbarns 2005a). The number of seedlings that survived to produce fruiting plants varied considerably (20-91%), both among locations and between years. Mortality was concentrated during the seedling stage and the major factors were invertebrate herbivory and fungal attack. Fruiting plants produced an average of 26.5 ripe seeds. There was little damage to seeds while they were still on the plant, but there were only about 10-20% as many seedlings as seeds produced in the previous year. The rest of the seeds may enter deep dormancy or be attacked by soil fungi or invertebrates. In a two year study the number of flowering individuals varied among three study plots from a decrease of 71% to an increase of 239%. Long-term fluctuations are probably much greater.

Dense-flowered Lupine populations appear limited by poor dispersal, high seedling mortality, and extreme population fluctuations.

1.5 Threats

1.5.1 Threat classification

Table 3. Threat classification table.

1 Trampling		Threat Information		
Threat Category	Accidental Mortality	Extent	Widespread (Esp. Macaulay and Dallas Bluffs)	
			Local	Range-wide
General Threat	Recreational use	Occurrence	Current	Current
		Frequency	Continuous	Continuous
Specific Threat	Walking on individual plants, crushing them.	Causal Certainty	Medium	Medium
		Severity	High	High
Stress	Increased mortality (all age classes); reduced establishment; reduced population size.	Level of Concern	High	

2 Soil Disturbance		Threat Information		
Threat Category	Habitat Loss or Degradation	Extent	Widespread (Esp. Macaulay and Dallas Bluffs)	
			Local	Range-wide
General Threat	Off trail recreational use	Occurrence	Current	Current
		Frequency	Continuous	Continuous
Specific Threat	Increased erosion from expanded trail network	Causal Certainty	Medium	Medium
		Severity	High	High
Stress	Reduced germination and establishment; reduced population size and viability; small population size	Level of Concern	High	
3 Invasive alien plants		Threat Information		
Threat Category	Alien, Invasive, or Introduced Species/Genome	Extent	Widespread	
			Local	Range-wide
General Threat	Scotch Broom (<i>Cytisus scoparius</i>), English Ivy (<i>Hedera helix</i>), Gorse (<i>Ulex europaeus</i>), Orchard Grass (<i>Dactylis glomerata</i>), Sweet Vernal Grass (<i>Anthoxanthum odoratum</i>), Perennial Ryegrass (<i>Lolium perenne</i>), Barren Brome (<i>Bromus sterilis</i>), and Soft Brome (<i>B. hordeaceus</i>)	Occurrence	Current	Current
		Frequency	Continuous	Continuous
Specific Threat	Resource competition; alteration of habitat characteristics (light, moisture and nutrient availability); loss of Dense-flowered Lupine	Causal Certainty	Medium	Medium
		Severity	High	High
Stress	Reduced productivity; Reduced growth; Reduced germination/establishment	Level of Concern	High	

4 Land Development		Threat Information		
Threat Category	Habitat Loss or Degradation	Extent	Widespread	
			Local	Range-wide
General Threat	Land development (e.g., park infrastructure, bank stabilization)	Occurrence	Anticipated	Historic
		Frequency	Recurrent	Recurrent
Specific Threat	Habitat conversion	Causal Certainty	High	High
		Severity	High	High
Stress	Local extinctions Reduced population size and viability	Level of Concern	Medium	
5 Fire Suppression		Threat Information		
Threat Category	Changes in Ecological Dynamics or Natural Processes	Extent	Widespread	
			Local	Range-wide
General Threat	Fire suppression	Occurrence	Current	Current
		Frequency	Recurrent	Recurrent
Specific Threat	Plant competition, encroachment of forests , shrublands, and tall herbaceous perennials	Causal Certainty	Medium	Medium
		Severity	Medium	Medium
Stress	Reduced population size and viability; reduced productivity; reduced growth; reduced germination/establishment	Level of Concern	Medium	
6 Mowing		Threat Information		
Threat Category	Habitat Loss or Degradation	Extent	Localized	
			Local	Range-wide
General Threat	Lawn production	Occurrence	Unknown	
		Frequency	Seasonal	
Specific Threat	Habitat conversion	Causal Certainty	Medium	
		Severity	Medium	
Stress	Increased (juvenile and adult) mortality; reduced productivity; poor reproductive success	Level of Concern	Low	

1.5.2 Description of threats

Except where otherwise stated, this section is adapted from COSEWIC 2005. Threats are listed in the order they appear in Table 3).

Trampling and Soil Disturbance

Trampling and elevated levels of soil instability pose one of the greatest threats to Dense-flowered Lupine. The Macaulay Point and Dallas Bluffs populations occur mainly along the coastlines of heavily used municipal parks and many plants are trampled and killed each year. Trampling also poses an indirect threat at both locations because the informal network of trails has accelerated soil erosion, exceeding the species' needs and destroying significant amounts of habitat through small landslides. Based on information presented in the COSEWIC status report and field work (Fairbarns 2010a), this threat is believed to be of high severity and concern.

Invasive alien plants

Invasions of alien herbaceous plant species pose as great a threat as trampling and soil disturbance. All three populations are threatened by the encroachment of alien shrubs and grasses, most notably Scotch Broom (*Cytisus scoparius*), English Ivy (*Hedera helix*), Gorse (*Ulex europaeus*), Orchard Grass (*Dactylis glomerata*), Sweet Vernal Grass (*Anthoxanthum odoratum*), Perennial Ryegrass (*Lolium perenne*), Barren Brome (*Bromus sterilis*), and Soft Brome (*B. hordeaceus*). Based on information presented in the COSEWIC status report and field work (Fairbarns 2010a), this threat is believed to be of high severity and concern.

Land Development

Land conversion poses a significant threat to Dense-flowered Lupine. A portion of the Macaulay Point population was destroyed in 2003 when an existing road was upgraded. The Clover Point population has also been lost, apparently when a sewage pumping station was developed or the seawall was improved.

The developments described above continue a century-long trend that has seen the loss of more than 95% of Garry Oak ecosystems in the Victoria area (Lea 2002). Because the habitat of Dense-flowered Lupine is closely associated with Garry Oak ecosystems, the historical loss of Garry Oak ecosystems probably reflects a similar decline in habitat suitable for survival and recovery of this species.

While this threat has the potential for severe population level effects through land conversion, it is of medium concern as the species occurs on public land and land managers are aware of the species.

Fire Suppression

Aboriginal people may have burned some Dense-flowered Lupine sites on a regular basis to improve production of food plants and increase habitat suitability for game species (Turner 1999). There is no information about whether Dense-flowered Lupine was harvested by Aboriginal people, but burning activity would have maintained suitable habitat for this species. Fire has been suppressed throughout the Canadian extent of occurrence for over a century and this has favoured encroachment by forests, shrublands, and tall herbaceous perennials within which the lupine cannot grow.

This threat has the potential for large population level effects as it can result in habitat becoming unsuitable. However, two out of the three populations currently have habitat stewardship activities underway to reduce encroachment of shrubs. This threat is of medium concern.

Mowing

The majority of the Trial Island population has been regularly mown to reduce the risk of fire. At one time, mowing began before most of the plants could produce mature fruit. Over the past decade, mowing has usually been deferred until the majority of the seed has been dispersed (McNeill pers. comm. 2005). The site was not mowed at all in 2004 and aspen along the meadow fringe had sent numerous suckers into the meadow by mid-summer. It therefore appears that properly timed mowing is beneficial to populations on deep, stable soils susceptible to woody plant encroachment. Elsewhere, mowing may have detrimental effects on Dense-flowered Lupine and/or co-occurring species at risk. Mowing on Trial island was resumed in 2005 to stop aspen encroachment.

While this threat has the potential to severely reduce plant growth and reproduction in a given population, it is not occurring range wide and mowing practices have been altered to benefit the species making this threat currently of low concern.

1.6 Knowledge Gaps

Further information is needed on seedbank longevity and minimum viable population size. Techniques for population establishment/augmentation still need to be developed. Taxonomic studies are required to determine whether the Canadian/Puget Sound populations constitute a distinct taxonomic element within the species. Knowledge gaps relating to critical habitat identification are listed in section 2.5.4.

2 RECOVERY

2.1 Recovery Feasibility

Recovery is biologically and technically feasible for this species (Table 4).

Table 4. Technical and Biological Feasibility of Recovery. Criteria from Government of Canada (2009).

Criteria	Feasibility
1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.	Yes. All existing populations produce seeds and plants have been successfully reared in cultivation to produce abundant seed.
2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.	Yes. While Dense-flowered Lupine requires specialized habitat conditions, there are many areas of unoccupied habitat that appear capable of sustaining populations in their current condition or after invasive alien plants populations have been reduced.
3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.	Yes. Threats can be mitigated through the strategies outlined in Table 5.
4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.	Yes. Over the short term, recovery techniques consist primarily of threat mitigation techniques. Over the long term, techniques for population establishment/augmentation are likely to be developed (some component techniques such as seed collection, propagation, seed storage, and habitat management techniques have already been successfully tested).

2.2 Population and Distribution Objectives

This species was likely always rare in Canada and recovery in this case constitutes a reversal of the population decline and recovery of the known number of historical populations. In the absence of demographic information with which to confirm current population trends or to define the minimum viable population, the setting of specific population and distribution objectives is an uncertain process reflecting the best interpretation of available data. This does not, however, preclude the setting of interim population and distribution targets. The population and distribution objectives for Dense-flowered Lupine are as follows:

1. Recover and maintain all three known extant populations at no less than their minimum viable population size (note: minimum viable population size to be determined). In the absence of population viability analyses, an average of 2,500¹

¹ In the absence of demographic information to define the minimum viable population, the setting of specific population and distribution objectives is an uncertain process reflecting the best interpretation of available data. Population viability assessments have been performed for a number of species and while the range of values is

mature individuals may be used as an interim target for each of the Canadian populations.

2. Establish at least one population within the historical extent of occurrence in Canada, to compensate for the loss of the Clover Point population, and maintain it at no less than the minimum viable population size. Given that the Dense-flowered Lupine habitat at the one extirpated site (Clover Point) is destroyed, a new site will need to be identified (see section 2.3 below)².

2.3 Broad Strategies and General Approaches to Meet Objectives

The recovery objectives for Dense-flowered Lupine will be met through the following broad strategies (explored in greater detail in Table 5):

- Habitat and species protection: protect existing populations and their habitat from destruction (e.g., from land development) through regulation;
- Stewardship: use stewardship to control the damaging effects of trampling and soil disturbance, invasive alien plants, fire suppression, and mowing;
- Research: address knowledge gaps relating to critical habitat of Dense-flowered Lupine, seedbank longevity, and the taxonomic status of the proposed variety *scopulorum*;
- Mapping and inventory: map and inventory existing populations and other suitable sites;
- Population restoration: develop and test population establishment/augmentation techniques to establish populations on other suitable sites; and
- Public education and outreach: provide public education and outreach to increase interest in the protection and stewardship of the species.

large, minimum viable population estimates are generally on the order of thousands of individuals (Brook *et al.* 2006, Traill *et al.* 2007). Most populations are far below 2,500 mature individuals which provides ample room for recovery; however, it should be noted that 2,500 individuals is less than the minimum viable population size of most plant species that have been investigated using population viability analysis techniques (Traill *et al.* 2007). N.B. it is not the goal of this strategy to alter the status of Dense-flowered Lupine and achieving a population of 2,500 for each population will not result in a change of status for Dense-flowered Lupine as the species will still meet other COSEWIC criteria for the status of Endangered.

²The establishment of one more population will bring the number of extant populations up to the number of historically documented populations. Establishment of more than one additional population may be justified as populations were likely lost before they were documented. The total number of new populations to establish will be assessed as recovery proceeds.

Table 5. Broad Recovery Strategies for Dense-flowered Lupine.

Priority	Obj. No.	Broad Strategy	Threat	General Description
Urgent	1	Habitat and species protection	<ul style="list-style-type: none"> • Land development 	<ul style="list-style-type: none"> • Develop list of priority sites for creation of a new population. • Establish protection mechanisms/instruments for critical habitat.
Urgent	1	Stewardship	<ul style="list-style-type: none"> • Trampling and soil disturbance • Invasive alien plants • Fire suppression • Mowing 	<ul style="list-style-type: none"> • Prepare Best Management Practices for species in maritime meadows, including Dense-flowered Lupine, to support land managers in stewardship activities. • Engage the cooperation of all involved land managers in habitat stewardship.
Urgent	1, 2	Research	<ul style="list-style-type: none"> • Trampling and soil disturbance • Invasive alien plants • Fire suppression 	<ul style="list-style-type: none"> • Describe habitat for Dense-flowered Lupine and refine critical habitat attributes (see Section 2.5 for detail). • Determine appropriate restoration and adaptive management protocols using existing techniques (including the use of fire) for populations of Dense-flowered Lupine and their habitat. • Develop population establishment/augmentation techniques and priorities to establish one experimental population. • Determine minimum viable population size.
Necessary	2	Mapping and inventory	<ul style="list-style-type: none"> • Land development • Trampling and soil disturbance • Invasive alien plants 	<ul style="list-style-type: none"> • Identify and prioritize areas for inventory. • Assess maritime meadows throughout the extent of occurrence to prioritize sites for establishment of one new population.
Necessary	1, 2	Population restoration	<ul style="list-style-type: none"> • Trampling and soil disturbance • Invasive alien plants • Fire suppression • Mowing 	<ul style="list-style-type: none"> • Develop and implement a population restoration plan for locations with existing populations (including a monitoring component). • Conduct trials for Dense-flowered Lupine population establishment. • Develop and implement a translocation plan establishing one new population of Dense-flowered Lupine.
Beneficial	1,2	Public education and outreach	<ul style="list-style-type: none"> • Trampling and soil disturbance • Invasive alien plants 	<ul style="list-style-type: none"> • Increase public awareness of the existence and conservation value of Dense-flowered Lupine and associated species at risk. • Develop priorities to deliver public education and outreach concerning species at risk, their habitats and their management (e.g., to naturalist and outdoor recreation clubs, schools, First Nations, local governments, land owners, land managers, and stakeholders).

2.3.1 Narrative to support Recovery Planning Table

Public support, stewardship, and research will be critical to the recovery of Dense-flowered Lupine. Landscape level changes in land use have, and are continuing to alter the habitat and processes this species depends on. The intensive public use of some of the locations means that public support and involvement will be required to effect changes away from the current damaging land use, to practices that are compatible with Dense-flowered Lupine (such as reducing trampling and the resulting plant death and erosive habitat losses).

The identification and protection of critical habitat alone will not be sufficient for Dense-flowered Lupine recovery. The habitat processes which allow Dense-flowered Lupine to survive have been altered by human activity (e.g., across the region fire is strictly controlled, alien plants have been introduced, and mowing is common place). Protection must be coupled with active stewardship that reintroduces or mimics missing habitat processes (e.g., wildfire) and mitigates new pressures (e.g., trampling).

Strategies to conserve Dense-flowered Lupine habitat include monitoring and controlling the abundance of invasive weeds, controlling shrub encroachment, protecting sites from development, and reducing trampling and soil disturbance to curb plant mortality and habitat erosion. Some of these activities have already been implemented at some sites.

Further habitat stewardship could be accomplished by developing and implementing best management practices including trail re-alignment at Macaulay Point and Dallas Bluffs. The abundance and species composition of invasive weeds could be monitored and weed control measures could be taken when necessary to steward habitat at occupied sites and potential locations for establishing populations.

It is important to note that additional habitat may be needed to expand existing populations to a sustainable level. It will help recovery of this species if habitat which is adjacent to Dense-flowered Lupine patches and that matches the critical habitat attributes is managed according to best management practices for critical habitat. Similarly, the recovery of this species will be assisted if, within the range of Dense-flowered Lupine, habitat which matches the critical habitat attributes, or could be easily restored to match critical habitat attributes, is conserved for potential use in the creation of a new population.

Research is essential to provide knowledge regarding appropriate stewardship activities, restoration targets, and levels of disturbance that Dense-flowered Lupine needs to survive. As more is learned this information will need to be incorporated into recovery actions in an adaptive manner.

2.4 Performance Measures

Progress towards recovering Dense-flowered Lupine in Canada will be assessed using the following measures:

- The total Canadian population has been maintained at, or increased from 2010 levels (assuming a natural range of annual variability).

- All three populations extant in 2010 are maintained.
- Four (or more) suitable meadow areas are identified or conserved by 2015 for establishment of a new population of Dense-flowered Lupine.

2.5 Critical Habitat

Areas of critical habitat for Dense-flowered Lupine are identified in this recovery strategy. Critical habitat is defined in the *Species at Risk Act* as “the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in a 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)).

2.5.1 Information used to identify critical habitat

The habitat of Dense-flowered Lupine plants is generally characterized as dry to moist, low elevation grassy openings (Douglas *et al.* 1999). To further characterize habitat of Dense-flowered Lupine, site and vegetation data were collected at each extant location (Fairbarns 2008, 2010a). Common characteristics were then selected as critical habitat attributes (see section 2.5.2).

The Dense-flowered Lupine depends directly on openings to provide certain habitat attributes. These openings must be large enough that the Dense-flowered Lupine plants are not sheltered by surrounding vegetation. The minimum size of openings can be determined based on the height of vegetation likely to grow in the area and cast shade on the Dense-flowered Lupine (e.g., Spittlehouse *et al.* 2004).

Populations of Dense-flowered Lupine are prone to large annual fluctuations (Fairbarns 2005a; COSEWIC 2005). Such fluctuations mean that critical habitat cannot be identified based on data from any single year: a long term data set is required to ensure the full range of population fluctuation is captured. Recent studies (Fairbarns 2008, 2010a; Miskelly 2008, 2009) can be used to identify a minimum baseline of critical habitat required by Dense-flowered Lupine populations; however, it is expected that these datasets do not represent the maximum extent of annual variation in these populations and therefore do not represent the total habitat required for the survival of extant Dense-flowered Lupine populations. For these reasons, to accommodate expected population fluctuations, critical habitat is identified as a set of attributes that occur within specified geographical boundaries. It is expected that continued monitoring which documents annual fluctuations in population extent will provide data which more confidently characterizes the habitat needed by this species. The studies referred to above have been used to guide the location of boundaries within which critical habitat is found.

To maintain the population at current numbers or greater, all habitat required by each patch of plants in each current population is required. To account for a natural range of annual variability in each population the amount of habitat identified as critical to each patch needs to be based on the maximum patch extent. While some habitat may not be used every year, the presence of

plants in one year indicates that the habitat may be critical for storing seeds and boosting seed production in favourable years.

2.5.2 Identification of the species' critical habitat

The critical habitat identified here is necessary, but not sufficient, to support either of the population and distribution objectives for Dense-flowered Lupine in Canada. Within the geographical boundaries identified in Figure 4, Figure 5, Figure 6, and Figure 7, critical habitat for the survival of current populations is the minimum opening supporting each patch of Dense-flowered Lupine plants in each population: the size of this opening is calculated using all available data regarding the maximum patch extent such that full meadow conditions prevail across all areas where Dense-flowered lupine is, or has, grown. In total, as of December 2010, studies have identified approximately 0.9 ha of habitat which is critical to Dense-flowered Lupine survival.

Critical habitat attributes are as follows:

- Sunny areas with short or sparse vegetation (trees are absent and the cover of shrubs is never substantial).
- One to fifteen metres above sea level, with variable slopes (on steeper slopes the habitat is generally found on southeast to southwest aspects).
- Glaciomarine clay, silt or loam with a depth of 5 to >50 cm.
- Soils tend to be moist in the early growing season (October to March), but are well to rapidly drained which, combined with the full exposure and southern aspects, make these sites very dry by mid-summer.
- Coarse material (e.g., wood or garbage) covering the soil is rarely abundant.

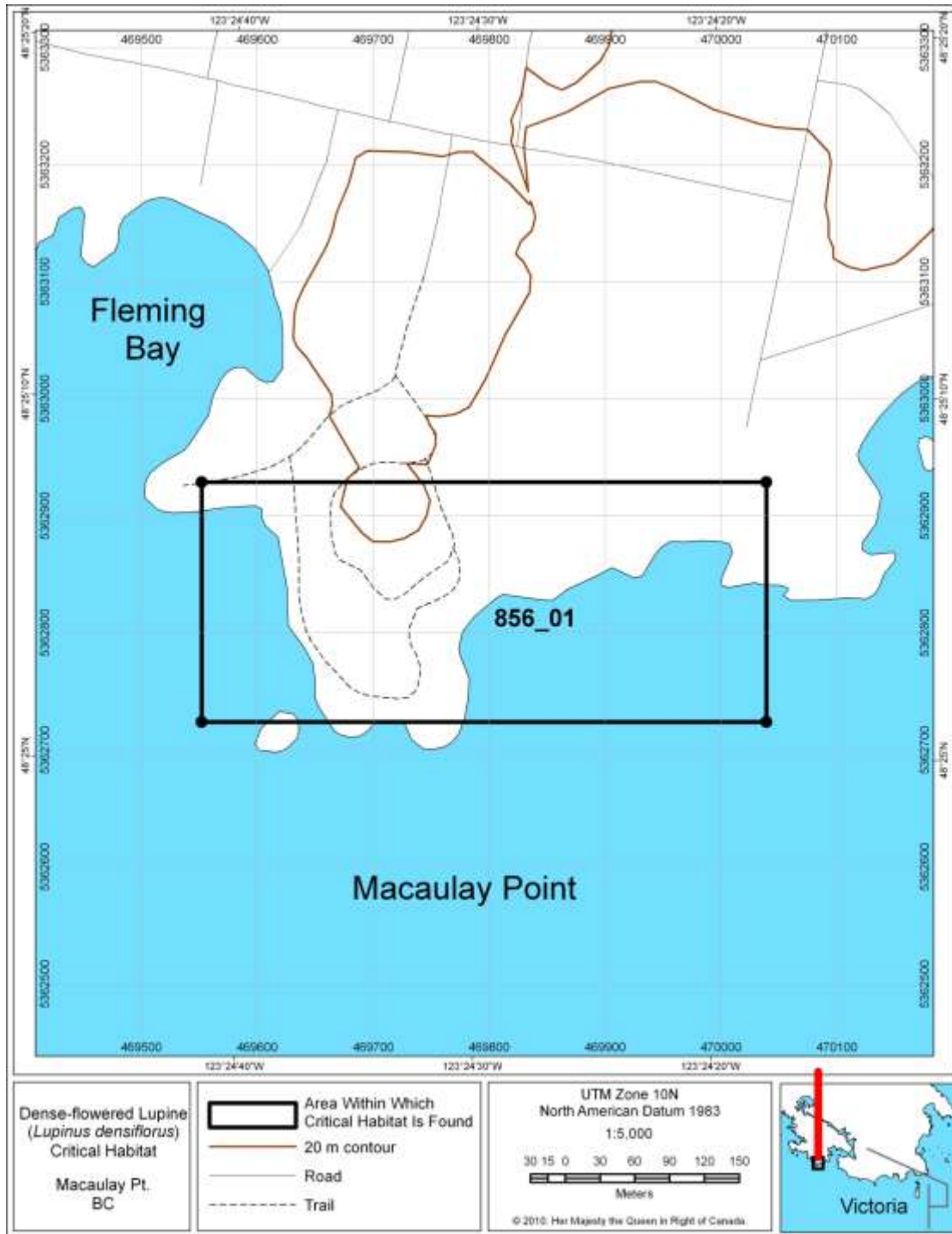


Figure 4. Area (~ 10.0 ha) within which critical habitat for Dense-flowered Lupine is found at Macaulay Point. This area includes properties managed by the Capital Regional District and the Department of National Defence (CFB Esquimalt and the Township of Esquimalt). As of December 2010 approximately 0.18 ha of critical habitat has been identified within this area.

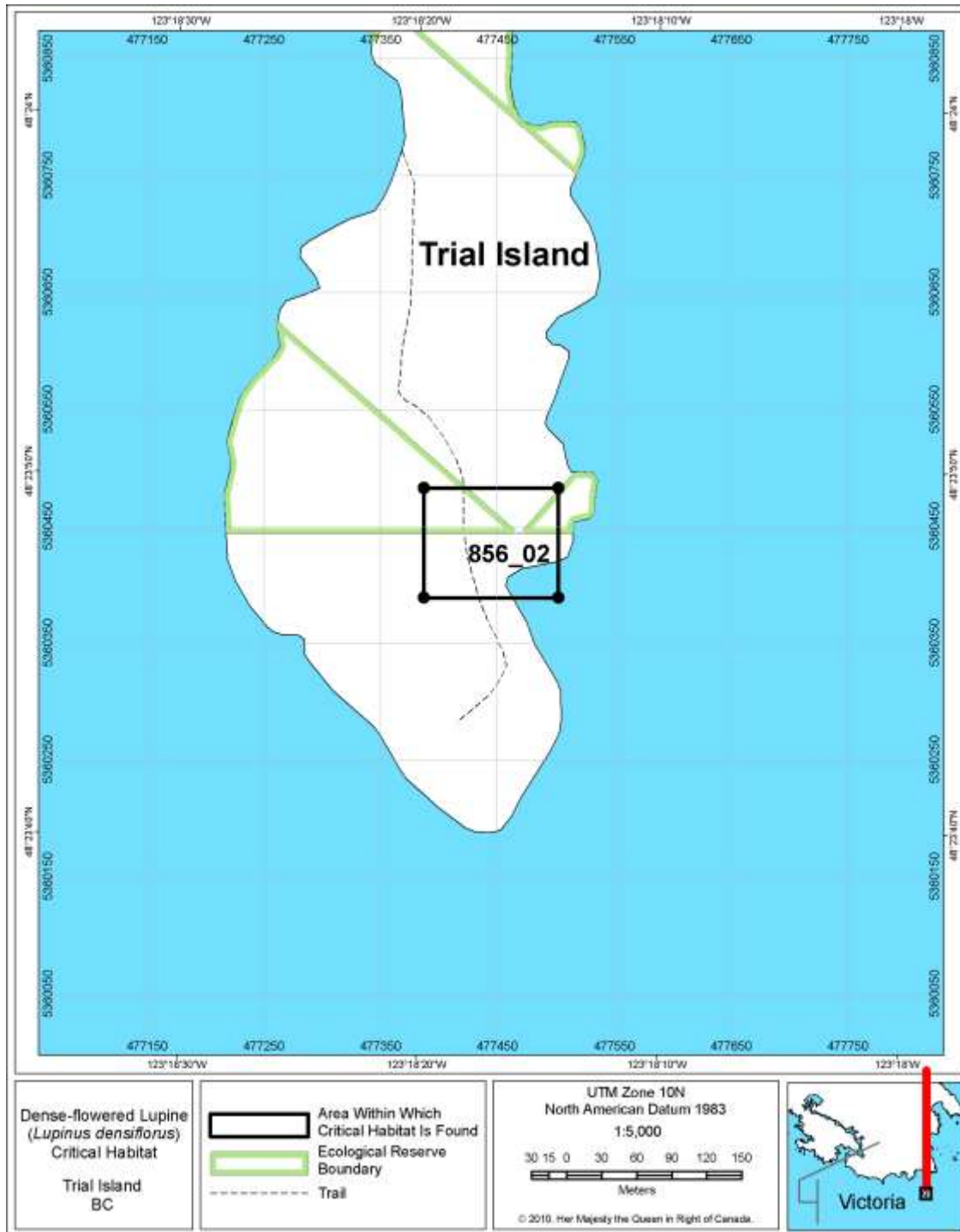


Figure 5. Area (~ 1.0 ha) within which critical habitat for Dense-flowered Lupine is found at Trial Island. This area includes properties managed by the Canadian Coast Guard, and the Province of British Columbia. As of December 2010 approximately 0.31 ha of critical habitat has been identified within this area.

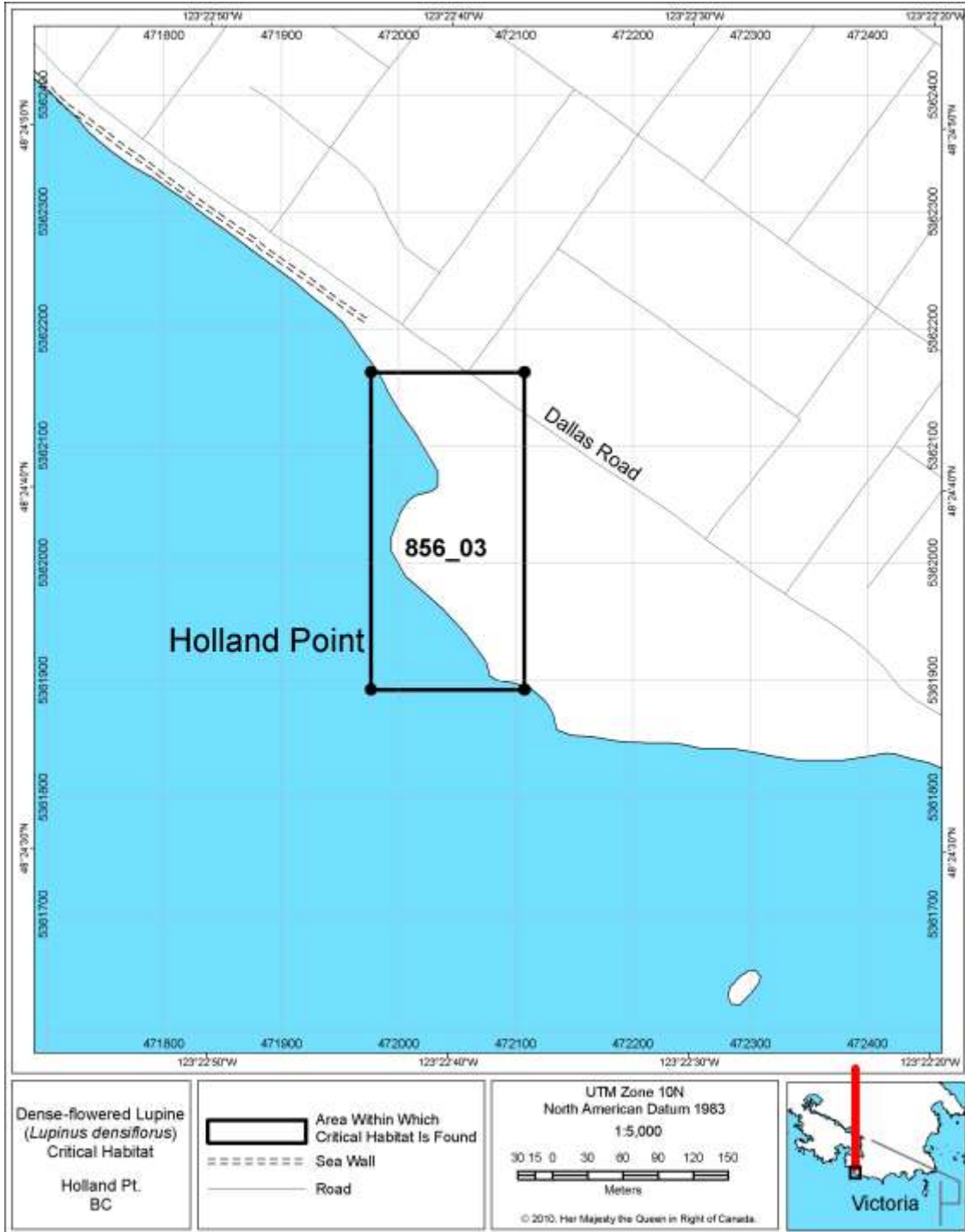


Figure 6. Area (~ 3.5 ha) within which critical habitat for Dense-flowered Lupine is found at Holland Point (Dallas Bluffs). This area is managed by the City of Victoria. As of December 2010 approximately 0.13 ha of critical habitat has been identified within this area.

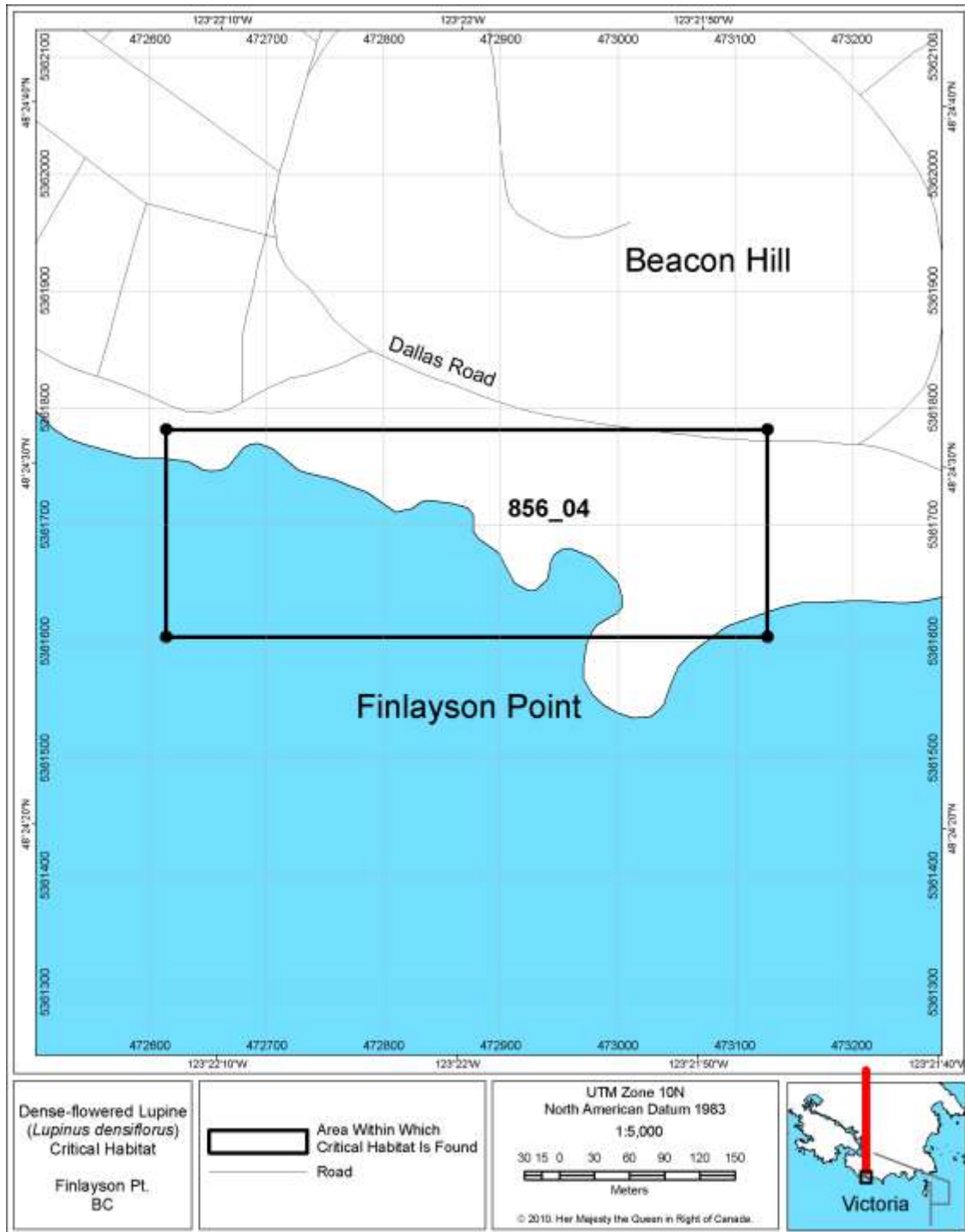


Figure 7. Area (~ 9.0 ha) within which critical habitat for Dense-flowered Lupine is found at Finlayson Point (Dallas Bluffs). This area is managed by the City of Victoria. As of December 2010 approximately 0.29 ha of critical habitat has been identified within this area.

2.5.3 Examples of activities likely to result in destruction of critical habitat

Examples of activities likely to destroy critical habitat are provided below (Table 6). Destruction of critical habitat will result if any part of the critical habitat is degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. It is important to note that some activities have the potential to destroy critical habitat from outside the critical habitat.

Table 6. Examples of activities likely to result in the destruction of critical habitat.

Activity	Effect of activity on critical habitat	Most likely sites
Damaging recreational use (e.g., intensive walking, cycling, and animal exercising activities)	Soil compaction and loss of vegetation leading to changes in hydrology (such as decreased infiltration and increased runoff). Habitat is likely to be directly lost due to increased erosion and plants may become stressed and die due to impaired ability of the habitat to provide a suitable moisture regime. In addition, this activity is likely to introduce or spread alien plant species. Alien plant species compete with Dense-flowered Lupine and alter the availability of light, water, and nutrients in the habitat, such that the habitat would not provide the necessary habitat conditions required by Dense-flowered Lupine.	Macaulay Point, Finlayson Point, and Holland Point
Landscaping (e.g., planting / development and maintenance or modification of existing structures, roads or trails)	This activity can cause direct land conversion, soil compaction and associated hydrological effects (see recreational use), shading (e.g., by introduced plants or nearby structures), altered moisture regime (e.g., impounded drainage, or reduced water flow to the plants through ditching, or diversion of subsurface water by built structures), and introduction of alien species (e.g., intentional plantings or accidental introductions such as facilitated by unclean machinery; see recreational use for effect of invasive species). Some landscape / construction activities may destroy critical habitat even if they occur outside of the critical habitat. For example tall buildings may still cast shade on the plants. Also, some activities such as road or trail construction, ditching, or irrigation may alter hydrological regimes within the critical habitat area.	Macaulay Point, Finlayson Point, and Holland Point (e.g., road maintenance, park facility or coastline protection structures)
Dumping of waste (e.g., poorly planned invasive alien plant removal efforts, illegal dumping of garden waste and household items)	Increased cover of coarse debris reduces the ability of the habitat to support germination and growth and is likely to introduce invasive alien plants (see recreational use for effect of invasive species).	All

2.5.4 Schedule of studies to identify critical habitat

To identify sufficient critical habitat for the survival of existing populations, additional monitoring of existing populations is required to refine the maximum patch extent.

In addition, further study is needed to verify whether the known habitat characteristics can be used to predict suitable unoccupied habitat for recovery. Once suitable habitat can be identified, an analysis of the population dynamics is required to determine the total amount and configuration of habitat that is required to support a viable Canadian population. To achieve the above, the following studies are required for the identification of critical habitat to expand or reintroduce populations of Dense-flowered Lupine as per population and distribution objectives:

1. Identify high quality unoccupied sites and conduct surveys to determine whether they possess the known habitat characteristics required by Dense-flowered Lupine. Survey efforts should focus on maritime meadows within the extent of occurrence (Esquimalt, Victoria, Oak Bay, Trial Islands, and small islands and islets in Haro Strait). Suggested completion date 2013.
2. Test the suitability of high quality unoccupied sites identified in (#1) by attempting to establish, maintain, and monitor a small number of Dense-flowered Lupine individuals in an experimental manner. Suggested completion date 2014/2015.
3. If #2 is successful, test the potential for establishing new self sustaining populations or expanding existing populations through introduction of larger numbers of seeds or seedlings into suitable habitats and monitoring over many years. Seed bank viability must be determined to facilitate restoration and introductions. Suggested completion date 2016 onward³.
4. Towards a full identification of critical habitat: undertake analyses to determine the amount and configuration of habitat needed to achieve the population and distribution objectives. Suggested completion date 2020 (completion date assumes successful and timely completion of previous steps).

2.6 Effects on Other Species

A number of other rare species (Table 7) have been reported in the vicinity of one or more populations of Dense-flowered Lupine.

It is impossible to discuss all possible interactions associated with recovery. Actions to assist in the recovery of Dense-flowered Lupine will likely benefit other species at risk. For example, increased public education and awareness may limit harmful recreational activities in locations with species at risk and invasive alien plant management may restore habitat for other plant species at risk.

³ Following the conclusion of step 3, additional critical habitat can be identified, but full identification will not be possible until step four.

However, actions to assist in the recovery of Dense-flowered Lupine may negatively affect other species at risk. For example, trampling or other disturbance due to on-site recovery activities (e.g., surveys, research, and landscape management) poses a threat to rare species that occur in or near sites with Dense-flowered Lupine. If not planned and implemented carefully, recovery activities may have a negative effect on other species at risk.

Table 7. Co-occurring Rare Species (S-ranks assigned by as per BC Conservation Data Centre 2010.

Species	Common name	Conservation Rank	COSEWIC Status
Butterflies			
<i>Coenonympha tullia insulana</i>	Island Ringlet	G5T3T4 S1	Not assessed
Plants			
<i>Castilleja victoriae</i>	Victoria Owl-clover	G1 S1	Not assessed
<i>Castilleja levisecta</i>	Golden Paintbrush	G1 S1	Endangered
<i>Entosthodon fascicularis</i>	Banded Cordmoss	G4G5 S2S3	Special Concern
<i>Isoetes nuttallii</i>	Nuttall's Quillwort	G4? S3	Not assessed
<i>Leymus triticoides</i>	Creeping Wildrye	G4G5 S1	Not assessed
<i>Limnanthes macounii</i>	Macoun's Meadowfoam	G2 S2	Threatened
<i>Lotus formosissimus</i>	Seaside Bird's-foot Trefoil	G4 S1	Endangered
<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	Spanish-clover	G5T5 S3	Not assessed
<i>Lupinus oreganus</i> var. <i>kincaidii</i>	Kincaid's Lupine	G5T2 SX	Extirpated
<i>Orthocarpus bracteosus</i>	Rosy Owl-clover	G3? S1	Endangered
<i>Polygonum paronychia</i>	Black Knotweed	G5 S3	Not assessed
<i>Ranunculus californicus</i>	California Buttercup	G5 S1	Endangered
<i>Sanicula arctopoides</i>	Bear's-foot Sanicle	G5 S1	Endangered
<i>Sanicula bipinnatifida</i>	Purple Sanicle	G5 S2	Threatened
<i>Sericocarpus rigidus</i>	White-top Aster	G3 S2	Special Concern
<i>Silene scouleri</i> ssp. <i>grandis</i>	Coastal Scouler's Catchfly	G5TNR S1	Endangered

Parks Canada Agency and partners such as the Garry Oak Ecosystems Recovery Team are guiding recovery actions for this and other species in the area to ensure that recovery actions for one species do not unduly hinder the recovery of another.

2.7 Recommended Approach for Recovery Implementation

Recovery of Dense-flowered Lupine will be coordinated with other maritime meadow species as outlined in the multi-species strategy for maritime meadows in Garry Oak Ecosystems (Parks Canada Agency 2006). Parks Canada Agency and partners such as the Garry Oak Ecosystems Recovery Team will coordinate this approach.

2.8 Statement on Action Plans

One or more action plans will be completed by June 2016.

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