Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Dense Spike-primrose (*Epilobium densiflorum*) in Canada

Dense Spike-primrose

2013

Canada

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PREFACE

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

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

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 Dense Spike-primrose and Canadian society as a whole.

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

Dense Spike-primrose is a species that inhabits vernal pools associated with Garry Oak ecosystems and recovery of this species will be integrated with the recovery of species in the Recovery Strategy for Multi-Species at Risk in Vernal Pools and Other Ephemeral Wet Areas in Garry Oak and Associated Ecosystems in Canada (Parks Canada Agency 2006).

RECOMMENDATION AND APPROVAL STATEMENT

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

Recommended by:

Helen Davies
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ACKNOWLEDGMENTS

Thank you to Matt Fairbarns for developing initial drafts of this recovery strategy. The Garry Oak Ecosystems Recovery Team (GOERT) is the recovery team for the Dense Spike-primrose and was involved in the development of this recovery strategy. Further revision was the result of comments and edits provided by a number of organizations: the Province of British Columbia, Parks Canada Agency, Department of National Defence, Natural Resources Canada, and Environment Canada.

EXECUTIVE SUMMARY

Dense Spike-primrose (*Epilobium densiflorum*) is listed as Endangered under Canada's *Species at Risk Act* (SARA). Dense Spike-primrose is an annual herb, which measures 15-100 cm in height with a hairy stem and small white to rose-purple flowers. It is restricted to western North America: from southern British Columbia to southern California east to Utah and Idaho. The species is listed as globally secure. Within its range, it is restricted to ephemerally wet areas associated with Garry Oak ecosystems.

There are historical records for 20 occurrences over a 2,000 km^2 range in Canada, but Dense Spike-primrose has been reduced to four extant occurrences over a 900 km^2 range. The entire Canadian population (all four occurrences) occupies a total of 10 ha and consists of approximately 102,120 plants.

Dense Spike-primrose grows on a mix of federal and non-federal lands where it faces threats from habitat destruction, invasive alien plants, demographic collapse (associated with small population sizes), mowing, off-road vehicle use, and fire suppression. In addition, several key factors limit the recovery of Dense Spike-primrose: habitat specificity, limited mechanisms for reproduction, weak competitive abilities, small area occupied, and fragmented populations. Broad strategies have been identified to address the threats to, and factors limiting, the survival and recovery of the species. These strategies include habitat and species protection, stewardship initiatives, research, inventories and monitoring, population restoration, as well as public education and outreach.

In the short term, population and distribution objectives for Dense Spike-primrose will focus on the maintenance of all extant Canadian populations and exploring the feasibility of establishing and/or augmenting populations to increase abundance and distribution. Broad strategies to be taken to address the threats to the survival and recovery of the Dense Spike-primrose are presented in section 6 Broad Strategies and General Approaches to Meet Objectives.

The critical habitat identified for Dense Spike-primrose in this recovery strategy is necessary, but not sufficient, to achieve the population and distribution objectives. Studies to identify additional critical habitat have been identified and include the completion of habitat assessments, and identification of sites suitable for establishment of new occurrences.

An action plan for Dense Spike-primrose will be completed by 2018.

RECOVERY FEASIBILITY SUMMARY

The recovery of the Dense Spike-primrose in Canada is deemed to be technically and biologically feasible based on the criteria identified in the *Species at Risk Act Policies, Overarching Policy Framework [Draft]* (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. All existing populations produce seeds and have survived to date which indicates some level of viable seed production.

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

   Yes. Sufficient suitable habitat is available to support the species. While Dense Spike-primrose requires specialized habitat conditions, there are many areas of unoccupied habitat which, either in their current condition or after invasive alien species populations have been reduced, appear capable of sustaining populations.

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

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

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

   Yes. Recovery techniques exist and are demonstrated to be effective. Over the short term, recovery techniques consist primarily of threat mitigation techniques such as invasive alien species removal. Over the long term, techniques for re-establishing extirpated populations are likely to be developed.

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1. Species Assessment Information

Date of Assessment: May 2005

Common Name (population): Dense Spike-primrose

Scientific Name: *Epilobium densiflorum*

COSEWIC Status: Endangered

Reason for Designation: An annual herb of a restricted habitat type within the Garry Oak ecosystem that has undergone significant declines in number of populations and is subject to continued habitat reduction due to development and the spread of invasive alien weeds. The four extant populations are fragmented, small, and have little chance of being repopulated from adjacent sites in Washington State should they become extirpated.

Canadian Occurrence: B.C.

COSEWIC Status History: Designated Endangered in May 2005.

2. Species Status Information

Dense Spike-primrose is ranked secure globally (G5) and critically imperilled (S1) in British Columbia, the only Canadian jurisdiction where it occurs (Table 1) (NatureServe 2010).

Table 1. Conservation status ranks for Dense Spike-primrose (NatureServe, 2010).

Location	Rank	Rank description
Global	G5	Secure
Canada	N2	Imperilled
British Columbia	S1	Critically imperilled
United States	NNR	Unranked
Washington	SNR	Unranked
Oregon	SNR	Unranked
California	SNR	Unranked
Idaho	SNR	Unranked
Montana	SNR	Unranked
Nevada	SNR	Unranked
Utah	S1	Critically imperilled
Arizona	SNR	Unranked

3. Species Information

3.1. Species Description

Dense Spike-primrose is an annual herb which measures 15-100 cm in height with white hairy stems and rose-purple flowers. A detailed description of the species is provided in the COSEWIC status report (COSEWIC 2005).

3.2. Population and Distribution

Dense Spike-primrose ranges from southeast Vancouver Island and the southern Gulf Islands southward on both sides of the Cascades from Washington to California (rarer on the immediate coast and in the Central Valley) and northern Baja California; east to western Montana (extirpated), Idaho, Utah, and Nevada (Figure 1). There are ambiguous records of a disjunct population in Gila County, Arizona (United States DA 2006).

In Canada, Dense Spike-primrose is restricted to the Southern Gulf Islands and Nanaimo Lowlands Ecosections, where it occurs in the Coastal Douglas-fir Biogeoclimatic Zone (B.C. Ministry of Environment n.d. and B.C. Ministry of Forests 2003). Two new populations have been reported in B.C. since the status report was submitted: one in the vicinity of Nanaimo and one at Rocky Point. The Nanaimo population was subsequently destroyed by construction activities (Ceska pers. comm. 2006a). The Rocky Point population remains extant and has turned out to be the largest documented population. The Canadian population is now distributed over four locations (Figure 2) and estimated to be approximately 102,120 plants over about 10 ha; the Rocky Point population accounts for 100,000 individuals (Miskelly pers. comm. 2011).

While not named in the COSEWIC status report, for the purposes of this recovery strategy, extant populations have been named as follows: Harewood Plains (i.e., population 1), Dunne Rd. (i.e., population 3), Thetis Lake Regional Park (i.e., population 4), and Rocky Point (not described in COSEWIC status report). Population 2 is presumed to be extirpated as it does not appear to have survived the habitat alterations described in the COSEWIC status report (COSEWIC 2005; Fairbarns pers. comm. 2011).

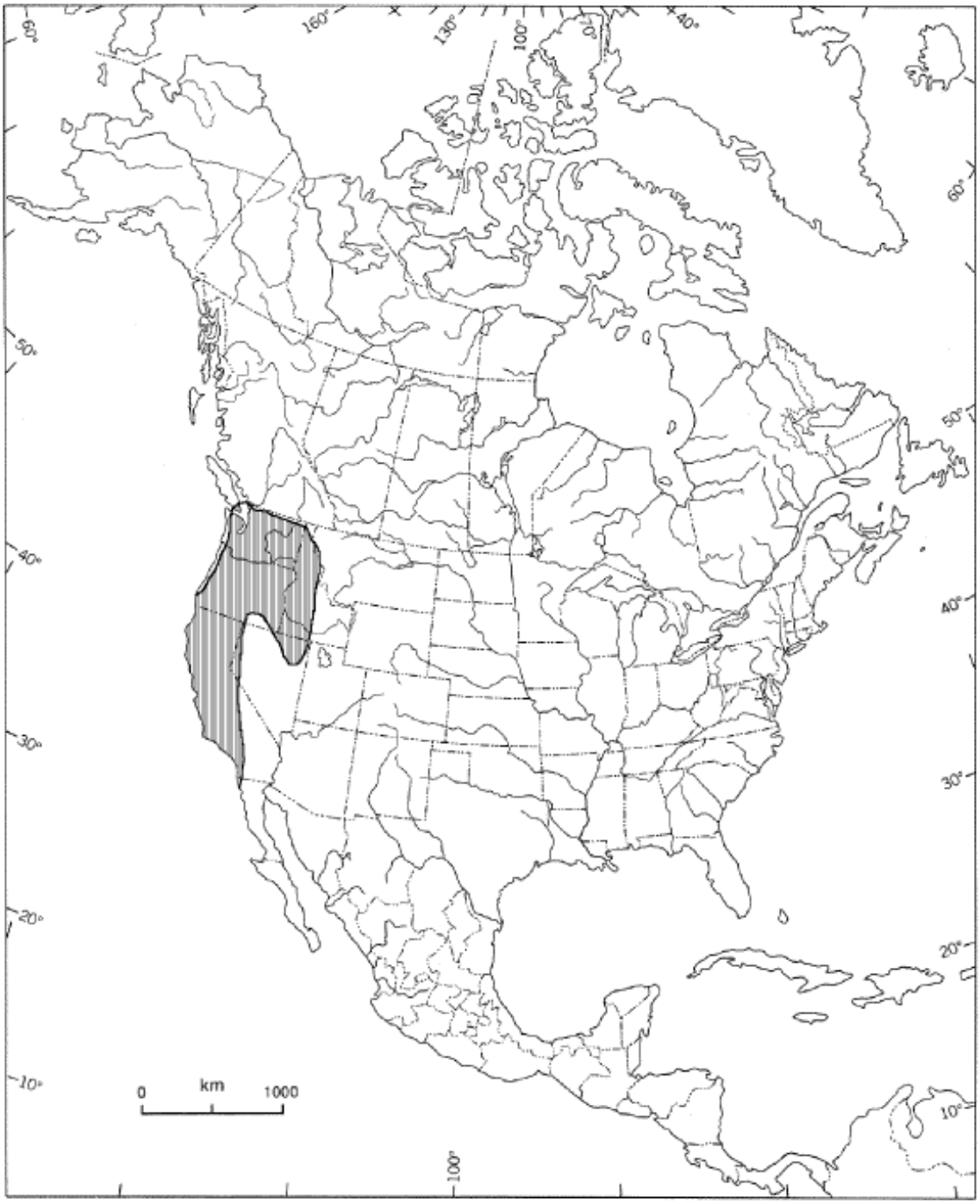

Figure 1. Global range of Dense Spike-primrose (from COSEWIC 2005).

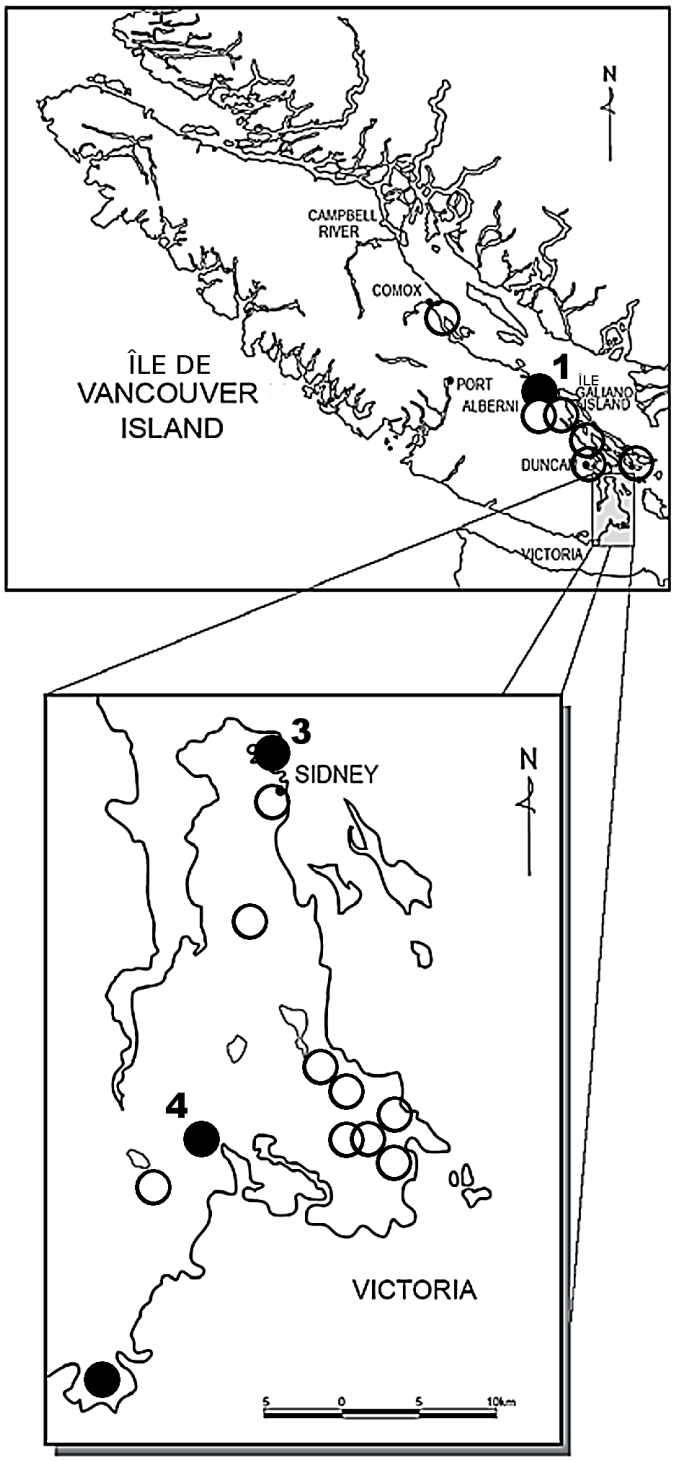

Figure 2. Distribution of Dense Spike-primrose in Canada (modified from COSEWIC 2005).The four extant populations are indicated with closed circles (numbering corresponds to population numbers in the status report, the new location is unnumbered). Open circles represent extirpated populations. Nearby locations may be represented by a single circle. Table 2 lists the location and status of the extant populations.

Table 2. Summary of Confirmed Extant Populations of Dense Spike-primrose.

Population Name[1]	Initial report
NEW. Rocky Point	First discovered in 2006 by Fairbarns (a few small plants). A few more plants found in 2008 by Miskelly and many were discovered in 2009 by Miskelly.
No.1 Harewood Plains	First reported in 1999 by Lomer[2]
No.3 Dunne Road (Canoe Bay)	First reported by Turner in 1966.
No.4 Thetis Lake Regional Park (Craigflower Meadow)	First reported by Melburn in 1958.

[1]Populations numbered as in COSEWIC status report and named after nearby features.
[2]Earlier records from the Nanaimo area may have come from the same population but the location information is too vague.

3.3. Needs of the Species

The status report does not provide detailed information on habitat needs and the following comments are based on a subsequent review of collection information. Twenty-seven Canadian herbarium records provide at least some information on habitat conditions. Collectively, these records provide a very mixed picture of habitat requirements, perhaps because some refer to small habitat patches where the species occurred (microsites) while others described the surrounding matrix vegetation. Since several of these populations have been lost and many were not described in sufficient detail to relocate them, future habitat studies will not be able to consider the full range of sites where the species formerly occurred. As well, many sites may have changed significantly due to increases in the abundance of invasive alien plants.

Generally, Dense Spike-primrose occurs in low elevation (under 100 m), open areas that are wet—often flooded—in the winter, moist in the spring, and very dry by mid-summer. The soils generally appear to be at least 10 cm deep and references to occurrences on rocks or in shallow soil probably overlooked the fact that the plants were rooting in pockets of deeper soil. Those microsites which were described in detail tended to be level or gently sloping and would have collected water in the winter. Slope aspect varies considerably, but this is of little significance because the slope angles are so slight.

Dense Spike-primrose habitat is also characterized by disturbances. There is abundant evidence that Dense Spike-primrose was well-adapted to moist, disturbed habitats before the arrival of a rich flora of invasive alien plants which have usurped such environments.

A number of factors may limit the recovery of Dense Spike-primrose in Canada including:

- A requirement for vernally moist depression habitats associated with Garry Oak and associated ecosystems, most of which have been lost or damaged by habitat conversion, forest encroachment, and/or a shift to dominance by invasive alien plants.
- Limited recruitment and limited dispersal ability which reduce the capacity for population replenishment by recruitment from a local seed bank or by dispersal from other populations.
- Apparently weak competitive ability, especially with respect to invasive alien species.
- Reproductive success sensitive to the timing of drought.

- The very small area occupied at most sites leaves it susceptible to chance events including those which operate at a small scale.
- The highly fragmented distribution is a likely constraint on genetic diversity and limit to the potential for local rescue effects.
- A general lack of knowledge impedes recovery. Unknown factors may limit the abundance and distribution of Dense Spike-primrose. For example, it is not known if Dense Spike-primrose is capable of banking dormant seeds in the soil for two or more years and there are no studies on its population processes.

4. Threats

4.1. Threat Assessment

Table 3. Threat Assessment Table.

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Habitat Loss or Degradation						
Agricultural, residential and industrial development	High	Widespread	Anticipated	One-time/ recurrent	High	High
Livestock grazing	Low	Widespread	Historic	Continuous	Low	Unknown
Changes in Ecological Dynamics or Natural Processes						
Fire suppression	High	Widespread	Historic and current	Continuous	High	Medium
Alien, Invasive, or Introduced Species						
Invasive alien plants	High	Widespread	Current	Continuous	High	Medium
Disturbance or Harm						
Mowing	Medium	Localized	Current	Seasonal (spring-fall)	High	Medium
Off-road vehicles	Low-medium	Localized	Current	Recurrent	High	Medium

[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

The following section is adapted from the threats section provided in the COSEWIC status report (2005) except where otherwise stated (Table 3).

4.2.1. Habitat Loss or Degradation

Habitat for Dense Spike-primrose has been destroyed by agricultural, residential, and industrial developments in the past. This is the most probable reason for the loss of many populations not seen for several years. The actual mechanisms may have included off-site activities that alter the hydrological regime necessary for Dense Spike-primrose and direct on-site habitat destruction.

Land conversion poses a significant threat to the Harewood Plains Dense Spike-primrose population; portions of the site have been repeatedly proposed for residential development. The Dunne Rd. population, which occurs in a roadside ditch, could be destroyed by road and ditch maintenance. The development proposals 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). Since the habitat of Dense Spike-primrose 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 the species. This threat is therefore considered to be a 'high' level of concern.

While the status report identifies livestock grazing as a possible contributor to past declines, the evidence it provides is equivocal. Further, none of the extant populations are currently grazed. Many areas of apparently suitable habitat in the region are grazed by livestock but the negative impacts of trampling and facilitated invasion by invasive alien plant species may be partially or completely offset by positive impacts, such as the control of encroaching woody vegetation, prevention of litter accumulation, and creation of bare soil sites suitable for germination. This threat is therefore considered to be a 'low' level of concern.

4.2.2. Changes in Ecological Dynamics or Natural Processes

Fire suppression has been identified as a threat to Dense Spike-primrose (COSEWIC 2005). First Nations used fire on a regular basis to maintain open areas for a variety of purposes in the local area (Turner 1999; Gedalof *et al.* 2006). The cessation of First Nations burning and suppression of all fires in the region has had a significant effect on resource availability to plants associated with Garry oak Ecosystems. Fire effects change in a wide variety of habitat characteristics including the amount of organic matter, nutrient cycling, soil moisture, and soil biota (Barbour *et al.* 1999). In general, when fire is a common occurrence, it maintains the availability of resources which would otherwise be limiting. For example, a lack of fire allows organic matter to build up and cover the ground, leaves nutrients trapped in organic matter and unavailable for use, and enables woody species to invade and suppress herbaceous species.

The significance of fire suppression as a threat to Dense Spike-primrose has not been examined in detail. However, in areas such as Thetis Lake Regional Park, Fairbarns (pers. comm. 2006) and Ceska (pers. comm. 2006b) have observed encroachment into the edges of Craigflower Meadow by species such as Red Alder (*Alnus rubra*). This encroachment will result in habitat changes such as increased shade, altered hydrology, and changes to floristic composition (Fairbarns pers. comm. 2006). Changes in ecological dynamics and natural processes have the potential to completely alter the habitat such that it is unsuitable for Dense Spike-primrose. This threat is of great concern because such alterations will lead to extirpation from the site.

4.2.3. Alien, Invasive, or Introduced Species

Habitat degradation through invasions of alien herbaceous plant species poses as great a threat as habitat destruction. All four extant populations are threatened by the encroachment of invasive alien grasses and shrubs–most commonly robust grasses such as Velvet Grass (*Holcus lanatus*), Kentucky Bluegrass (*Poa pratensis*), Sweet Vernal-grass (*Anthoxanthum odoratum*), Redtop (*Agrostis gigantea*), and Colonial Bentgrass (*A. capillaris*). Smaller stature, more drought

tolerant, invasive alien, annual grasses (e.g., Barren Brome (*Bromus sterilis*) and Soft Brome (*B. hordeaceus*)) occasionally dominate on sites most prone to spring drought. A wide variety of flood-tolerant, invasive alien forbs (e.g., docks and sorrels (*Rumex spp.*), Thistles (*Cirsium spp*.), Red Clover (*Trifolium pratense*), Common Dandelion (*Taraxacum officinale*), and English Plantain (*Plantago lanceolata*)) have been reported from one or more sites, but native graminoids are occasionally abundant. Shrubs, usually invasive alien, flood-tolerant species such as Evergreen Blackberry (*Rubus laciniatus*) and English Hawthorn (*Crataegus monogyna*), are occasionally present, but they tend to be confined to the margins of populations or exist as stunted individuals within wet meadows (as with English Hawthorn in Craigflower Meadow). Occasionally, sites may be characterized by a significant component of native species such as Common Camas (*Camassia quamash*), Scouler's Popcornflower (*Plagiobothrys scouleri*), and Yellow Monkey-flower (*Mimulus guttatus*).

Invasive alien species compete with Dense Spike-primrose for limited resources such as space, light, water, and nutrients. In addition, they have the potential to cause broad changes in habitat conditions. In combination, the effects of competition and habitat change are likely to have severe effects on the population of Dense Spike-primrose, which makes this threat of high concern.

4.2.4. Disturbance or Harm

Some populations of Dense Spike-primrose are regularly disturbed. The population at Dunne Road occurs on a road verge which is has been regularly mown. This removes upper portions of the flowering and fruiting plants, reducing seed production. Although not mentioned in the status report, one population (Harewood Plains) occurs in an area informally used by ATV enthusiasts. Their activities have caused direct damage to the population as well as habitat destruction through accelerated soil erosion and altered hydrological regimes. One of the extirpated populations may have been lost due to off-road vehicle activities (the site was heavily rutted when last visited). This threat is therefore considered to be of medium concern.

5. Population and Distribution Objectives

In Canada, Dense Spike-primrose is restricted to ephemerally wet areas associated with Garry Oak ecosystems and as such has a naturally, highly restricted range. Within this range, significant habitat loss since European settlement (Lea 2006) has likely resulted in population reductions. Encroachment by vegetation, development, and effects resulting from recreational activities continue to exacerbate the situation (COSEWIC 2005). Given the permanent loss of most of the original habitat, it is not possible to recover the species to its natural area of occupancy or to its original probability of persistence. Today there are four known Dense Spike-primrose populations in Canada (COSEWIC 2005).

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 Dense Spike-primrose, it is currently not possible to determine to what extent recovery is feasible and therefore it is not possible to establish quantitative long-term objectives. Recovery planning approaches (see Section 6) are designed to respond to knowledge gaps so that long-term, feasible, and quantitative recovery objectives regarding size and number of populations can be set in the future. At this time it is possible to set short-term objectives that focus on maintaining all four extant populations and exploring the feasibility of establishing and/or augmenting populations to increase abundance and distribution:

Objective 1: Maintain the four extant populations of Dense Spike-primrose.

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

6. Broad Strategies and General Approaches to Meet Objectives

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

- Habitat and species protection: protect populations and habitat from destruction by developing mechanisms/instruments for protection.
- Stewardship: prepare best management practices for Dense Spike-primrose and engage the cooperation of all involved landowners and managers in habitat stewardship.
- Research: address knowledge gaps related to understanding population decline and develop techniques and priorities to establish populations.
- Inventory and monitoring: conduct population and habitat inventories and monitor habitat and abundance of extant populations.
- Population restoration: restore extant populations and establish new population(s) to recover the Canadian population of the species.

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

6.1. Strategic Direction for Recovery

Table 4. Recovery Planning Table.

Threat or Limitation	Priority	Broad Strategy to Recovery	General Description of Research and Management Approaches
Site development	High	Habitat and species protection	• Establish protection for existing known populations. • Identify and prioritize areas for inventory and conduct population and habitat inventories.
Invasive alien plants Mowing Grazing Fire suppression	High	Stewardship	• Prepare Best (Beneficial) Management Practices for Dense Spike-primrose to support land owners and managers in stewardship activities. • Engage the cooperation of all involved land owners and managers in habitat stewardship.
	Medium	Inventory and monitoring	• Monitor habitat and abundance of extant populations annually to determine responses to changing habitat conditions in response to management activities.
	Low	Public education and outreach	• Increase public awareness of the existence and conservation value of Dense Spike-primrose and associated species at risk. • Deliver public education and outreach programs related to 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).
Knowledge gaps: population dynamics reproductive mechanisms	High	Research	• Determine whether there are bottlenecks affecting pollination/reproduction, dispersal, seed production, recruitment, survival. • Study seed viability, germination requirements and seed bank longevity. • Study seasonal development. • Determine long-term species-specific population thresholds and targets. • Determine total number of populations needed to achieve recovery and survival. • Develop techniques and priorities to establish populations. • Determine appropriate restoration and adaptive management techniques for Dense Spike-primrose and its habitat.
	Medium	Population restoration	• Develop and implement a population restoration plan for locations with existing populations. • Identify a list of priority sites for restoration or establishment of new population(s). • Increase the size and abundance of existing populations. • Conduct trials for Dense Spike-primrose population establishment.

Threat or Limitation	Priority	Broad Strategy to Recovery	General Description of Research and Management Approaches
Off-road vehicles	Low	Public education and outreach	• Increase public awareness of Dense Spike-primrose, its habitat, and conservation value. • Inform landowners and land managers of Dense Spike-primrose and its needs through education and outreach programs.

6.2. Narrative to Support the Recovery Planning Table

While habitat protection is essential for the short-term conservation of Dense Spike-primrose populations, effective stewardship will be needed for long-term persistence of the species (Table 4). Further, stewardship must be based on good information to be effective; however, little is known about this species and how to best steward it. Monitoring and research are therefore critical aspects to the effective recovery of this species. Monitoring is essential to learn how the species reacts to different stewardship activities and changing habitat conditions; it will enable stewardship activities to be adapted to best fit the species and habitat. To be efficient, stewardship will focus on key limiting factors; however, key bottlenecks remain to be determined through research into population dynamics. Research will also be essential to develop knowledge regarding new management methods and recovery targets for population size and number. As more is learned through research and monitoring, this information will need to be incorporated into recovery actions in an adaptive manner.

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

7. Critical Habitat

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

7.1. Identification of the Species' Critical Habitat

Critical habitat for the Dense Spike-primrose is identified in this recovery strategy to the extent possible, based on the best available information. It is recognized that the critical habitat

identified below is insufficient to achieve the populations and distribution objectives for the species. While habitat can be fully identified for one and partially identified for two known occurrences (Thetis Lake Regional Park, Rocky Point, and Harewood Plains, respectively), additional information is required to identify critical habitat at the remaining location (plants could not be located at Dunne Rd. during surveys for the preparation of the recovery strategy). Further, additional habitat will be needed for the creation of new populations. The schedule of studies (Section 7.2; Table 5) outlines the activities required to identify additional critical habitat necessary to support the population and distribution objectives of the species.

The Dense Spike-primrose likely requires high light to germinate. The area surrounding the seed bank must be clear of shading shrubs and trees; this area is the canopy opening required by the species. Canopy openings must be large enough that the Dense Spike-primrose 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 Spike-primrose (e.g., Spittlehouse *et al.* 2004). An additional consideration with regard to canopy opening is that when tall vegetation falls it will cover an area of ground for a distance equal to its height.

In addition to openings, specific hydrological characteristics are critical to the survival of this species. These hydrological characteristics are directly tied to rainfall (Graham 2004). Dense Spike-primrose grows in level to depressional meadows that collect water from the surrounding area, called the catchment area. Surface water flow and subsurface seepage from this catchment area is essential to the survival of the Dense Spike-primrose plants. This area has been mapped at Thetis Lake Regional Park and at some Rocky Point locations, but not at Harewood Plains (Fairbarns 2008 and 2010). These catchment areas are generally small and isolated within landscape scale catchments.

Critical habitat required for the survival of each plant or patch[2] of Dense Spike-primrose is composed of two habitat features: the minimum canopy opening and the catchment area. These features are always connected to a plant or patch and in all cases will overlap to some degree (no special status is applied to areas of overlapping critical habitat). The default minimum canopy opening required for light to reach the plants is the area defined by a 20 m distance surrounding each patch of plants (or plant) in all directions (20 m is generally the maximum height attained by trees in the soils surrounding Dense Spike-primrose). The catchment for each plant or patch of plants is delineated by following the upslope high point of land which divides water flowing towards the plants from water flowing away from the plants; these catchment areas are generally relatively small and isolated within landscape catchments.

Dense Spike-primrose is an annual herb and populations are likely prone to large annual fluctuations (Bush and Lancaster 2004). While some habitat areas (a minimum canopy opening and catchment) may not be used by growing individuals every year, the presence of plants in one year indicates that the habitat may be critical for storing seeds and boosting seed production in

[2] Patch is a term used to refer to a group of several plants in close proximity. A specific mapping scale and minimum separation distance have not been used to quantitatively define a patch; the identification of patches is based on survey work performed by a biologist familiar with the species. Lacking any detailed information on seed bank extent, the seed bank is assumed to be included within each patch: the only information pertaining to the spatial extent of the Dense Spike-primrose seed bank is derived from the physical characteristics of the seeds, and dispersal distance is probably very limited (COSEWIC 2005).

favourable years. All habitat used at any time by each patch of plants in each extant population is required to achieve the population and distribution objectives and is critical habitat; however, due to population fluctuations this habitat cannot be completely 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.

Within the geographical boundaries identified in Figure 3, critical habitat for the Thetis Lake Regional Park population is defined by the catchment area surrounding the last recorded location of the plants. In this case the catchment area exceeds the minimum canopy opening in all directions (Fairbarns 2008).

Within the geographical boundaries identified in Figure 4, critical habitat for the survival of the Rocky Point population is the minimum canopy openings and catchment areas associated with each recorded Dense Spike-primrose plant or patch location. The catchment areas are critical for the species survival, but have not been mapped for all recorded locations (Fairbarns 2010; Department of National Defence, unpublished data). It is worthy to note that some habitat at Rocky Point is artificially maintained.

Within the geographical boundaries identified in Figure 5, critical habitat for the survival of the Harewood Plains population is the minimum canopy openings and catchment areas surrounding recorded plant locations. The BC Conservation Data Centre maintains an occurrence record for this location (BC Conservation Data Centre 2010). The continued existence of plants and habitat at the location of this occurrence was verified extant within the last five years (Fairbarns pers. obs. 2009); therefore, the BC Conservation Data Centre record is accepted as the best available information regarding the location of the plants. In the absence of information regarding tree height around the plants the default minimum canopy opening of 20 m surrounding each occurrence polygon is also critical habitat. While the catchment areas have not been mapped they are defined above and identified as critical habitat.

A recent survey failed to locate the Dunne Rd. population and habitat was indicated to be in poor condition (Smith pers. comm. 2010). Further, spatial information for this occurrence is imprecise. Critical habitat is not identified for this location pending further studies.

Critical habitat attributes are as follows:

- Level or slightly depressed sites at below 100 m elevation.
- Significant amounts of exposed mineral soil, very little fine litter, coarse woody debris or rocks and cobbles.
- Poor drainage. In deeper soil sites there is a well-developed hardpan which creates a perched water table for much of the year. In the early growing season (April and May), the soil tends to remain saturated for extended periods, but standing water is rarely present.
- The sites are dry in summer and wet in winter and spring.
- Open sites with little tree or shrub cover.

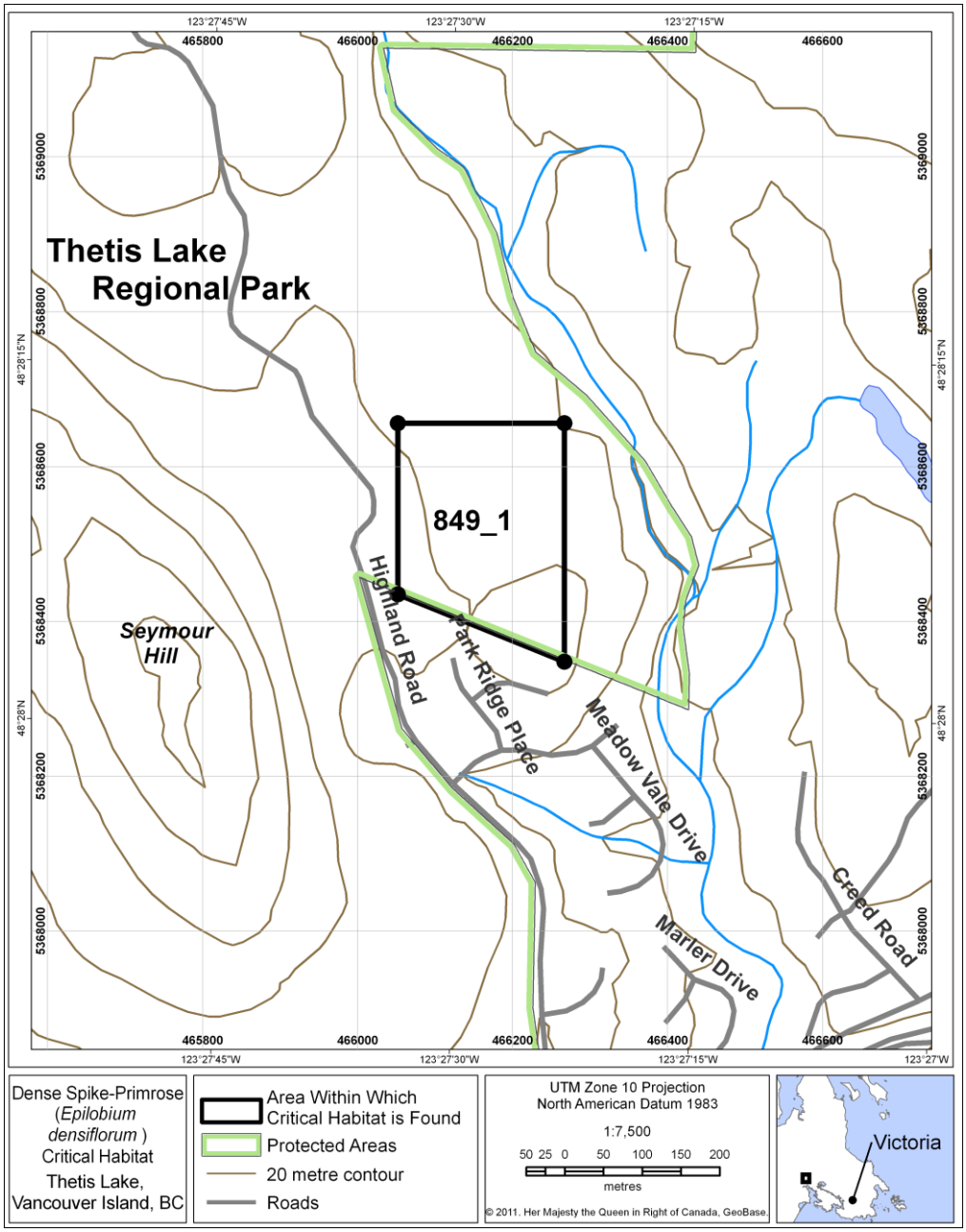

Figure 3: Area (~ 5.7 ha) within which critical habitat for Dense Spike-primrose is found at Thetis Lake Regional Park: this area is non-federal land. The area of critical habitat within this area is approximately 3.3 ha. The critical habitat parcel 849_1 is bounded by a polygon as follows: Commencing at a point with coordinates 466052, 5368656; thence east in a straight line to point 466267, 5368656; thence south in a straight line to the boundary of Thetis Lake Regional Park; thence northwest along the boundary to a point due south of the commencement point; thence in a straight line north to the commencement point. (UTM Zone 10, NAD 1983, North Azimuth).

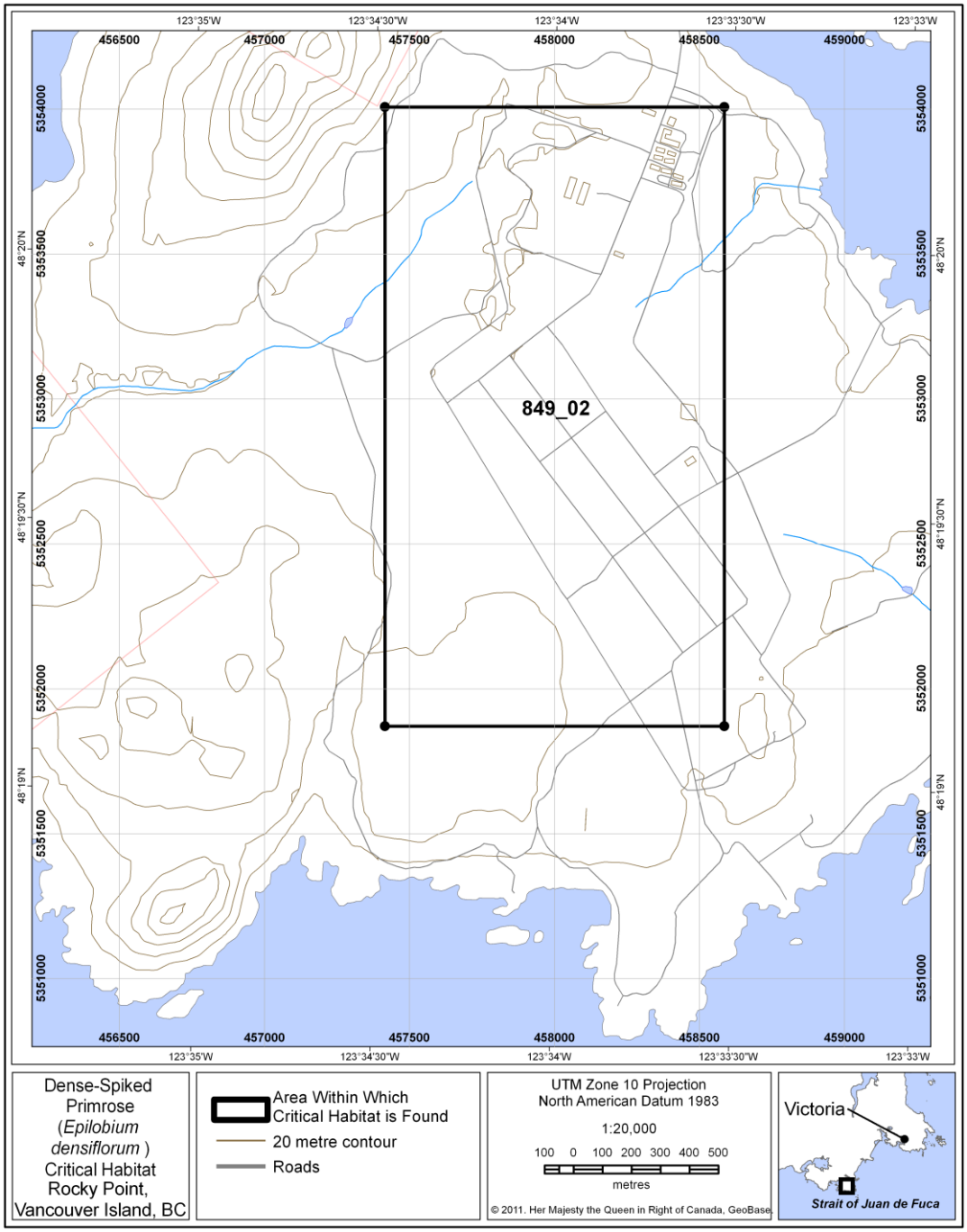

Figure 4: Area (~ 250 ha) within which critical habitat for Dense Spike-primrose is found at Rocky Point: this area is on federal land. The area of critical habitat within this area has not been completely mapped: the occupied area is approximately 1.2 ha, the catchment areas remain to be mapped. The critical habitat parcel 849_02 is bounded by a rectangle with the following corner coordinates: 457415, 5351871; 457415, 5354007; 458586, 5354007; and 458586, 5351871 (UM Zone 10, NAD 1983, North Azimuth).

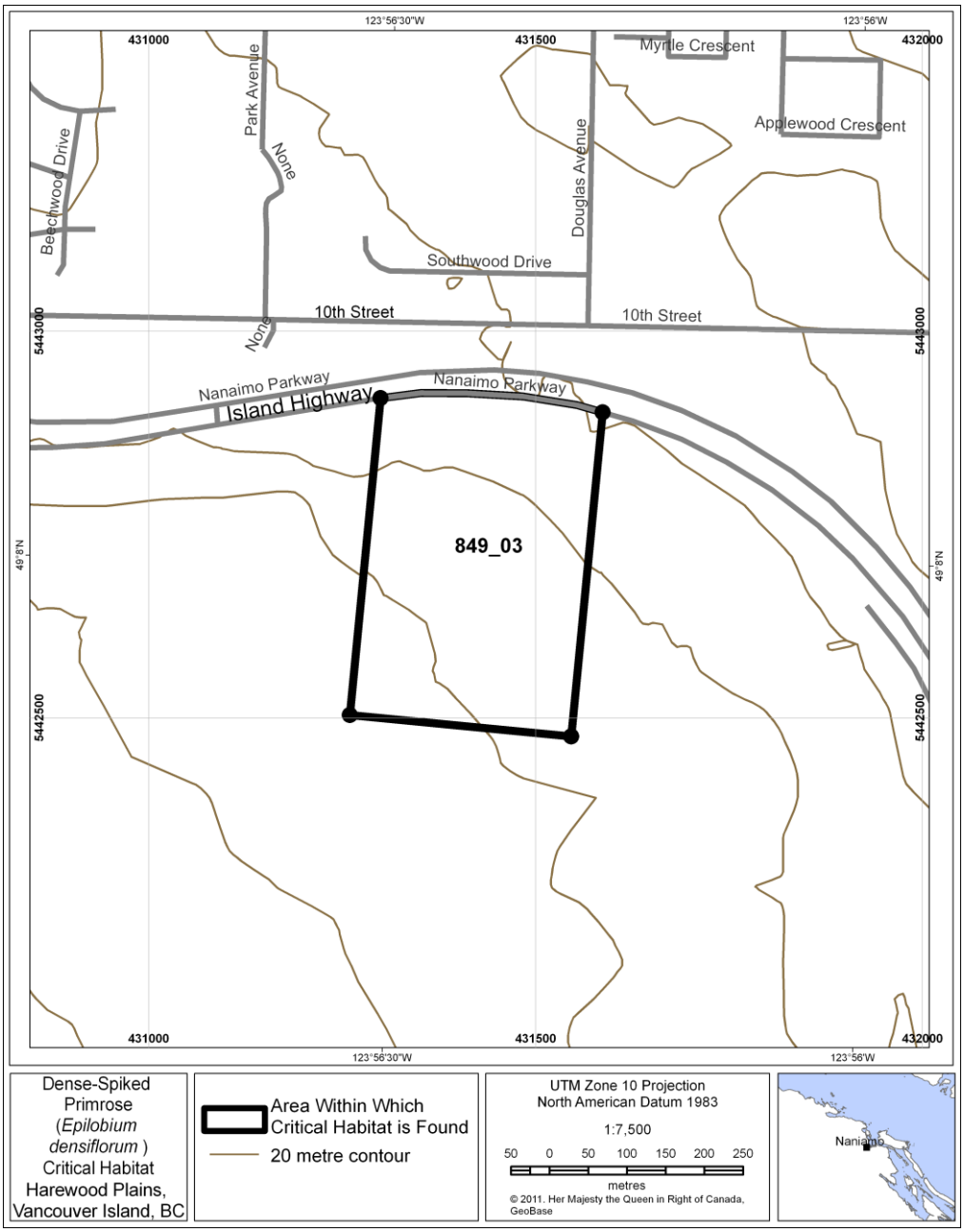

Figure 5: Area (~ 12 ha) within which critical habitat for Dense Spike-primrose is found at Harewood Plains. This area is on non-federal land. The area of critical habitat within this area has not been completely mapped: the occupied area is estimated to be approximately 1.7 ha, critical habitat features remain to be mapped. The critical habitat parcel 849_03 is bounded by a polygon as follows: Commencing at a point with coordinates 431260, 5442504; thence 5.53° in a straight line to the edge of the highway; thence east along the edge of the highway to a point at 431587, 5442895; thence 185.53° in a straight line to point 431546, 5442476; thence 275.53° in a straight line to the commencement point (UTM Zone 10, NAD 1983, North Azimuth).

7.2. Schedule of Studies to Identify Critical Habitat

Table 5. Schedule of Studies.

Description of Activity	Rationale	Timeline
1. Complete habitat assessments at all extant population locations.	Critical habitat remains to be identified at the Dunne Rd. population (if it is extant), and additional mapping is required at the Rocky Point and Harewood Plains populations. Habitat characteristics necessary for the survival of the species are identified. Critical habitat within the bounding boxes, including catchment areas, is mapped to assist site management.	Suggested completion date 2016.
2. Identify high quality, unoccupied sites and conduct surveys to determine whether they possess the key biophysical attributes that prevail where the Dense Spike-primrose occurs. Survey efforts should focus on vernal pools and ephemeral wet areas within the historic range.	Required to meet objectives for increasing existing and establishing new populations: habitat which may be suitable for the species must be found based on the best understanding of habitat requirements.	Suggested completion date 2017.
3. Test the suitability of high quality unoccupied sites identified in #2 by attempting to establish, maintain, and monitor Dense Spike-primrose individuals in an experimental manner.	Required to meet objectives for increasing existing and establishing new populations: habitat which may be suitable for the species must be tested to confirm its potential to support the species.	Suggested completion date 2018/2019.
4. If #3 is successful, test the potential for establishing new self-sustaining populations or expanding existing populations through introduction of seeds or seedlings into suitable habitats. Seed bank viability must be determined to facilitate restoration and introductions.	Required to meet objectives for increasing existing and establishing new populations: habitat which may be suitable for the species must be tested to confirm its potential to support the species.	Suggested completion date 2020 onward.
5. Undertake analyses to determine the amount and configuration of habitat needed to achieve the population and distribution objectives.	Required to ensure long term persistence: the total amount of critical habitat required to meet population and distribution objectives will be dependent on population dynamics, and the distribution and connectivity between habitat patches capable of supporting the species.	Completion date dependant on previous steps.

7.3. Activities Likely to Result in Destruction of Critical Habitat

Examples of activities likely to destroy critical habitat are provided below (Table 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
Recreational use (e.g., walking/ hiking, off road vehicle use, animal exercising)	Soil compaction leading to altered habitat attributes including alteration of hydrological regimes. Plants may become stressed and die or be unable to germinate due to impaired ability of the habitat to provide suitable soil moisture. In addition, these activities are likely to introduce or spread alien plant species. Alien plant species compete with Dense Spike-primrose and alter the availability of light, water, and nutrients in the habitat, such that the habitat would not provide the necessary habitat conditions required by Dense Spike-primrose.	Thetis Lake Regional Park population/ Harewood Plains population
Development (e.g., construction) or Landscaping (e.g., planting, trail building or maintenance).	This activity can cause direct land conversion, soil compaction and hydrological effects (see recreational use), altered moisture regime (e.g., impounded drainage, or reduced water flow to the plants through ditching, or diversion of subsurface water by built structures), and introduction of alien species (e.g., intentional plantings or accidental introductions such as facilitated by unclean machinery; see recreational use for effect of invasive alien plant species).	Harewood Plains population

8. Measuring Progress

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

Objective 1: Maintain the four extant populations of Dense Spike-primrose.

- By 2018 best management practices are developed and implemented at two or more sites.
- The populations remain extant.
- By 2023, all populations show a stable or increasing trend in population size[3].

[3] Note that populations are expected to fluctuate and require long term datasets to estimate (Bush and Lancaster 2004).

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

- By 2018, additional sites have been identified, for establishment or restoration of Dense Spike Primrose population(s).
- By 2023, one or more (re)introduction or augmentation experiments are underway at suitable site(s).

9. Statement on Action Plans

One or more action plans will be completed by 2018.

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APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

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

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

This recovery strategy will clearly benefit the environment by promoting the recovery of the Dense Spike-primrose. Activities to meet population and distribution objectives are unlikely to result in any important negative environmental effects, as they are limited to habitat protection and restoration, fostering stewardship and increasing public awareness, improving knowledge of habitat requirements and population threats, and conducting habitat/species mapping, inventory, and restoration.

The recovery strategy identifies current threats (Section 4) to the Dense Spike-primrose and its habitat. Population and distribution objectives clearly focus on resolving these threats and filling information gaps. The greatest potential for negative environmental effects comes from field activities aimed at habitat restoration, invasive alien species removal, and herbicide application (if required). For example, reintroduction attempts may spread invasive alien species, increase soil disturbance, or increase trampling in sensitive habitats where other rare species may live in close proximity to Dense Spike-primrose (e.g., Macoun's Meadowfoam (*Limnanthes macounii*) at Rocky Point; and Brook Spike-Primrose *(Epilobium torreyi*), Spanish-clover *(Lotus unifoliolatus*), and Needleleaf Navarretia (*Navarretia intertexta*) at Thetis Lake Regional Park). However, these effects can be mitigated or eliminated at the project implementation phase through proper field procedures and/or collaboration with key conservation partners such as the Garry Oak Ecosystems Recovery Team and appropriate government agencies.

Some recovery strategy activities, such as species establishment and habitat restoration, 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*. In summary, the SEA process has concluded that this recovery strategy will have several positive effects on the environment and other species. No important negative effects are expected.