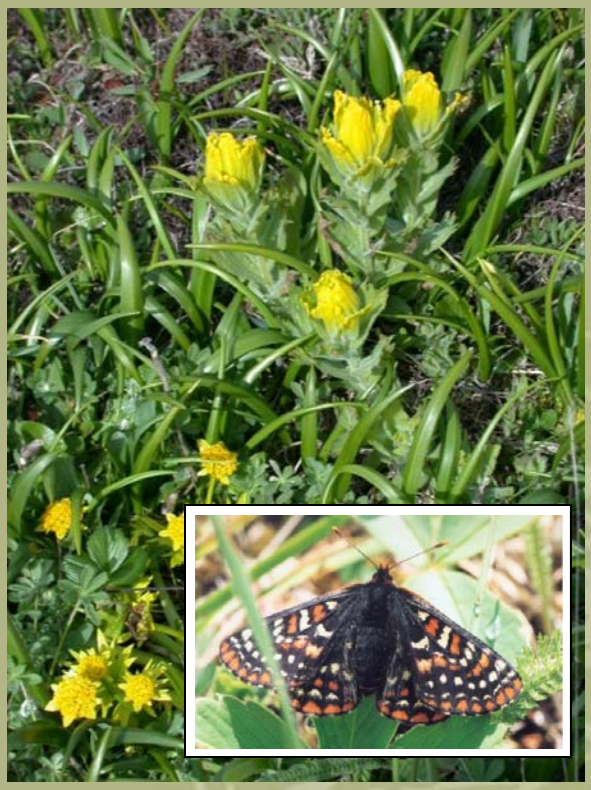
PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for Multi-Species at Risk in Maritime Meadows associated with Garry Oak Ecosystems in Canada

Island marble
Taylor's checkerspot
Bearded-owl clover
Bear's-foot sanicle
Coastal Scouler's catchfly
Golden paintbrush
Prairie lupine
Purple sanicle
Seaside birds-foot lotus



September 2005

Parks Canada Parcs Canada

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/the_act/default_e.cfm) spell out 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/) and the web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

Recovery Strategy for Multi-Species at Risk in Maritime Meadows associated with Gary Oak Ecosystems in Canada

September 2005





Garry Oak Ecosystems Recovery Team



Recommended citation:

Parks Canada Agency. 2005. Recovery Strategy for Multi-species at Risk in Maritime Meadows Associated with Garry Oak Ecosystems in Canada (proposed). In *Species at Risk Act* Recovery Strategy Series. Ottawa: Parks Canada Agency. 98 pps.

Additional copies:

You can download additional copies from the SARA Public Registry (http://www.sararegistry.gc.ca/)

National Library of Canada cataloguing in publication data

Main entry under title:
Recovery Strategy for Multi-Species at Risk in Maritime Meadows associated with Gary Oak Ecosystems in Canada

National Library input to come

Cover photos:

Golden Paintbrush & Bear's-foot Sanicle © Matt Fairbarns
Taylor's checkerspot © J.Miskelly

Également disponible en français sous le titre :
Programme national de rétablissement multi-espèces visant les espèces en péril des prés maritimes associés aux chênaies de Garry au Canada

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ISBN *To come*
Cat. no. *To come*

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RESPONSIBLE JURISDICTIONS

The species addressed within the Maritime Meadows Recovery Strategy occur exclusively within the Province of British Columbia in Canada. The Maritime Meadows Recovery Strategy was developed by the Parks Canada Agency on behalf of the Competent Minister (the Minister of the Environment) in partnership with the Government of British Columbia.

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ACKNOWLEDGMENTS

This document is adapted from a pre-consultation draft prepared by Carrina Maslovat and Matt Fairbarns on behalf of the GOERT Plants at Risk Recovery Implementation Group. Background information for both the island marble and Taylor's checkerspot strategies was prepared by Crispin Guppy, Norbert Kondla and Lee Shaeffer with funding provided by the BC Ministry of Water, Land and Air Protection. Members of the Invertebrates at Risk Recovery Implementation Group of the Garry Oak Ecosystems Recovery Team, Ann Potter (Washington Department of Fish and Wildlife), Dan Grosboll (Washington Department of Fish and Wildlife), James Miskelly (University of Victoria), and Scott Hoffman-Black (Xerces Society) reviewed drafts of the island marble and Taylor's checkerspot strategies. Members of the Invertebrates at Risk Recovery Implementation Group of the Garry Oak Ecosystems Recovery Team also reviewed drafts of this strategy. The BC Conservation Data Centre, James Miskelly, Wayne Hallstrom, Brenda Beckwith, Nancy Turner, and Vince Nealis supplied information.

Jenifer Penny and Marta Donovan (BC Conservation Data Centre), Trudy Chatwin (BC Ministry of Environment), Hans Roemer (consultant), Adolf Ceska (consultant) and Tracy Fleming (Capital Regional District Parks) supplied information pertaining to plants in this strategy. Staff from a wide range of jurisdictions (refer to Record of Experts Consulted) provided details of ongoing actions, policies and procedures. Herbaria throughout the range of Garry oak and associated ecosystems provided distribution information (refer to Record of Consultation). Members of the Plants at Risk Recovery Implementation Group of the Garry Oak Ecosystems Recovery Team including Hans Roemer, Marilyn Fuchs and Mike Miller reviewed drafts of this strategy. Ted Lea, Brenda Costanzo and Kari Nelson provided support and contract management for the development of this recovery strategy.

This strategy was funded by the Nature Conservancy of Canada and the Habitat Conservation Trust Fund. The Habitat Conservation Trust Fund was created by an act of the legislature to preserve, restore, and enhance key areas of habitat for fish and wildlife throughout British Columbia. Anglers, hunters, trappers and guides contribute to the projects of the Trust Fund through license surcharges. Tax-deductible donations to assist in the work of the Trust Fund are also welcomed.

PREFACE

The national recovery strategy for maritime meadow species at risk addresses the recovery of one extirpated butterfly; the island marble *(Euchloe ausonides insulanus*), one endangered butterfly; the Taylor's checkerspot (*Euphydryas editha taylori*); and seven endangered or threatened plant species: bearded owl-clover (*Triphysaria versicolor* spp. *versicolor*), bear's-foot sanicle (*Sanicula arctopoides*), coastal Scouler's catchfly (*Silene scouleri* ssp. *grandis*), golden paintbrush (*Castilleja levisecta*), prairie lupine (*Lupinus lepidus* var. *lepidus*), purple sanicle (*Sanicula bipinnatifida*) and seaside birds-foot lotus (*Lotus formosissimus*).

In Canada, these species occur (or occurred) primarily in Garry oak and associated ecosystems and are largely restricted to low elevation, marine-influenced habitats. Although the range of all species extends into the United States, many of the species are widely disjunct from the US populations.

The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered or threatened species. The Garry Oak Ecosystems Recovery Team, Province of British Columbia and the Parks Canada Agency led the development of this *Recovery Strategy.* The proposed strategy meets SARA requirements in terms of content and process (Sections 39-41). It was developed in cooperation or consultation with numerous individuals and agencies: the Garry Oak Ecosystems Recovery Team, Province of British Columbia, Environment Canada; numerous aboriginal groups within the range of the species were informed of the strategy and opportunity for involvement; numerous environmental non-government groups such as The Land Conservancy and Nature Conservancy of Canada; industry stakeholders such as Weyerhaeuser, and BC Hydro; and landowners such as the Department of National Defence. Almost 1700 individuals and agencies were contacted directly and informed about this recovery program and the opportunity for involvement.

In accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals* (the Directive), a strategic environmental assessment (SEA) was conducted on this Recovery Strategy. The purpose of an SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making. The strategy has no significant adverse effects, and presents an overall benefit to the environment.

STRATEGIC ENVIRONMENTAL ASSESSMENT

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

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly in the strategy itself, but are also summarized below.

There are no obvious adverse environmental effects of the proposed recovery strategy. Implementation of direction contained within this recovery strategy should result in positive environmental effects. In this strategy, the appropriate species (i.e. those in greatest danger of irreversible damage) are targeted for action. Threats to species and habitat are identified to the degree possible and related knowledge gaps are acknowledged. The state of knowledge of habitat critical for the survival and recovery of these species is provided and a specific course of action for definition of these spaces is outlined. Recovery objectives relate back to the specified threats and information gaps. It follows that acting upon the objectives will help to mitigate the effects of threats and improve upon knowledge gaps, thereby resulting in positive impacts to the subject species populations.

The compatibility of this recovery strategy and other plans is facilitated through the multi-stakeholder committee structure of the Garry Oak Ecosystems Recovery Team. It is reasonable to assume that successful stakeholder participation allows for this recovery strategy and relevant plans to be mutually influenced, thereby resulting in some degree of compatibility and positive cumulative effects.

EXECUTIVE SUMMARY

The national recovery strategy for maritime meadow species at risk addresses the recovery of two extirpated butterfly and seven endangered or threatened plant species: island marble *(Euchloe ausonides insulanus*), Taylor's checkerspot (*Euphydryas editha taylori*), bearded owl-clover (*Triphysaria versicolor* spp. *versicolor*), bear's-foot sanicle (*Sanicula arctopoides*), coastal Scouler's catchfly (*Silene scouleri* ssp. *grandis*), golden paintbrush (*Castilleja levisecta*), prairie lupine (*Lupinus lepidus* var. *lepidus*), purple sanicle (*Sanicula bipinnatifida*) and seaside birds-foot lotus (*Lotus formosissimus*). The maritime meadow recovery strategy is designed to fit under the umbrella recovery strategy for Garry oak and associated ecosystems drafted by the Garry Oak Ecosystems Recovery Team (GOERT 2002).

In Canada, these species occur (or occurred) primarily in Garry oak and associated ecosystems and are largely restricted to low elevation, marine-influenced habitats. Although the range of all species extends into the United States, many of the species are widely disjunct from the US populations. Mild winters with frequent coastal fogs and cool, dry summers characterize maritime meadow ecosystems. These ecosystems are naturally fragmented, occurring along shorelines and small islands. However, urbanization has intensified the natural fragmentation and remnant habitats and species at risk face a diverse array of threats.

Stewardship Approach

For successful implementation in protecting species at risk there will be a strong need to engage in stewardship on a variety of land tenures, and in particular on private land and on Indian Reserves. Stewardship involves the voluntary cooperation of landowners to protect Species at Risk and the ecosystems they rely on. It is recognized in the Preamble to the federal *Species at Risk Act* (SARA) that "stewardship activities contributing to the conservation of wildlife species and their habitat should be supported" and that "all Canadians have a role to play in the conservation of wildlife in this country, including the prevention of wildlife species from becoming extirpated or extinct." It is recognized in the Bilateral Agreement on Species at Risk, between British Columbia and Canada that:

"Stewardship by land and water owners and users is fundamental to preventing species from becoming at risk and in protecting and recovering species that are at risk" and that "Cooperative, voluntary measures are the first approach to securing the protection and recovery of species at risk."

Threats

Maritime meadows are greatly diminished from their former abundance due to habitat destruction; some remaining patches continue to be threatened by urban development and high recreational demands are placed on remnant patches. Maritime meadow species at risk are threatened by the invasion of exotic shrubs, grasses and forbs. Habitat fragmentation limits the dispersal of seeds and pollinators, causes genetic isolation, and limits the availability of foodplants for butterflies. Historically these ecosystems were fire-maintained. Fire suppression has changed vegetation composition, density and structure, and altered nutrient cycling and increased fuel loading, thus limiting the possibility of re-introducing fire as a management tool.

Demographic collapse, caused by a combination of environmental and genetic factors may limit the persistence of species at risk. Other human activities including mowing, changes to hydrology, re-introduction of fire, maintenance activities, ecosystem restoration, pesticide and herbicide spraying and cultivation of non-native plants can negatively affect maritime meadow species at risk. Herbivory, livestock grazing, climate change, marine pollution and invasive invertebrates and vertebrates are also potential threats.

Recovery Goals and Objectives

The long-term goals for recovery for all of these species include maintaining existing populations and developing appropriate management strategies to mitigate the identified threats. For most species, translocations[1] may also be required to ensure the long-term viability of the species and restore distributions to natural historic ranges. This could include augmenting existing populations, establishing populations at historic sites or introducing populations to new locations.

The following short-term objectives (5-10 year) for meeting the long-term goals are listed in decreasing order of priority for recovery, although importance may vary from species to species:

1. Establish protection[2] for existing populations through stewardship and other mechanisms.
2. Engage the cooperation of landowners in habitat protection
3. Identify life history, dispersal and habitat constraints and methods for mitigating them.
4. Determine the causes of extirpation, and/or population decrease or loss.
5. Develop and implement a habitat monitoring and restoration plan for locations with confirmed records or, in the case of extirpated species, for sites needed for recovery.
6. Identify and prioritize sites for inventories and conduct surveys to determine whether there are any undocumented populations.
7. Identify potential habitat to establish new populations, as outlined in species-specific goals
8. Develop priorities to establish new populations and one experimental population per species (if appropriate based on above research).

[1] Translocation is defined here as "deliberate moving of plant or butterfly propagules from one location to another in order to help conserve the species."
[2] This may involve protection in any form including stewardship agreements and conservation covenants on private lands, land use designations on crown lands, and protection in federal, provincial and local government protected areas.

Strategic Approaches

The recovery actions and approaches developed in this recovery strategy address the above objectives and identify ways to mitigate threats. Recovery actions fall under seven strategic approaches, listed roughly in descending order of importance, although importance may vary from species to species:

1. Habitat protection[2]
2. Habitat stewardship
3. Research
4. Mapping and inventory
5. Habitat restoration
6. Public education and outreach
7. Experimental population trials

This work builds on the ongoing recovery efforts undertaken by a range of agencies, organizations, and landowners.

Social and economic considerations

Recovery of species at risk and restoration of imperiled habitats associated with Garry oak ecosystems will contribute to biodiversity, health and functioning of the environment and enhance opportunities for appreciation of such special places and species thereby contributing to overall social value in southwestern British Columbia. The natural beauty of Garry oak ecosystems in the lower mainland, Gulf Islands and Vancouver Island are an important resource for British Columbians that provide for a robust tourism and recreation industry. Protecting these natural spaces, biodiversity and recreation values has enormous value to the local economy. Recovery actions could potentially affect the following socioeconomic sectors: recreation; private land development; operations and maintenance activities. The expected magnitude of these effects is expected to be low in almost all cases

Knowledge Gaps

Research is required to address specific knowledge gaps. The following knowledge gaps are listed in descending order of priority for recovery, although importance may vary from species to species:

1. Effects of invasive species and the response of invasive species, species at risk and habitat to management
2. Detailed characteristics and delineation of suitable habitat
3. Species-specific demographic and dispersal information
4. Accurate species distributions and total numbers of populations
5. Trophic and other ecological interactions
6. *Ex situ* germination/ propagation methodologies for plants and captive breeding/rearing techniques for butterflies
7. Genetic studies

Further studies will help refine restoration targets and recovery actions.

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INTRODUCTION

This strategy has been developed to address the recovery of seven plant and two butterfly species and their associated habitats (Table 1). These species are all characterized by one or more of the following: total population decline, small distributions with decline or fluctuation, loss of habitat, declining small population sizes or very small populations or restricted distribution (COSEWIC 2003b). Unless recovery actions are initiated, these species may become extinct or extirpated from Canada.

This recovery strategy is compatible with the federal *Species at Risk Act*. The strategy has been prepared using COSEWIC (Committee on the Status of Endangered Wildlife in Canada) status reports and is designed to guide the development of an Action Plan.

All of the species addressed in this strategy live almost exclusively within Garry oak and associated ecosystems. This strategy addresses both the specific needs of the target species as well as the plant communities and ecosystems where the species occur. The strategy constitutes one component of the recovery program for Garry oak and associated ecosystems as outlined in the *Recovery Strategy for Garry Oak and Associated Ecosystems and their Associated Species at Risk in Canada: 2001-2006* (GOERT 2002). In particular, this strategy expands upon Strategic Approach D: "Protection and recovery of species at risk" of the umbrella GOERT strategy. This habitat-based, multi-species strategy for maritime meadow species is nested in the larger ecosystem-level recovery planning addressed by GOERT. It includes species-level planning as well as planning for the common habitat of the maritime meadow species.

The first section of this recovery strategy provides general background information common to all species, including common habitat elements, key characteristics of the species and the rationale for taking a multi-species approach to recovery. Section B addresses common threats and the identification of critical habitat. Section B also includes recovery goals, objectives and approaches for all species and for maritime meadow ecosystems. Section C describes each species, including their distribution, habitat and biologically limiting factors.

All nomenclature for plants follows the *Illustrated Flora of British Columbia* by Douglas et al. (1998a, b; 1999a, b; 2000; 2001a, b; 2002). The nomenclature for butterflies follows *Butterflies of British Columbia* by Guppy and Shepard (2001), which includes a subspecific reference for the island marble (*Euchloe ausinoides* ssp. *insulanus*) and differs from the nomenclature (*Euchloe ausinoides*) used by COSEWIC and SARA.

1.1 Stewardship Approach

For successful implementation in protecting species at risk there will be a strong need to engage in stewardship on a variety of land tenures, and in particular on private land and on Indian Reserves. Stewardship involves the voluntary cooperation of landowners to protect Species at Risk and the ecosystems they rely on. It is recognized in the Preamble to the federal *Species at Risk Act* (SARA) that "stewardship activities contributing to the conservation of wildlife species and their habitat should be supported" and that "all Canadians have a role to play in the conservation of wildlife in this country, including the prevention of wildlife species from

becoming extirpated or extinct." It is recognized in the Bilateral Agreement on Species at Risk, between British Columbia and Canada that:

> "Stewardship by land and water owners and users is fundamental to preventing species from becoming at risk and in protecting and recovering species that are at risk" and that "Cooperative, voluntary measures are the first approach to securing the protection and recovery of species at risk."

1.2 Stewardship Approach for Private Lands

Since many species of risk occur only or predominantly on private lands, including some of the species in this strategy, stewardship efforts will be the key to their conservation and recovery. It is recognized that to successfully protect many species at risk in British Columbia there will have to be voluntary initiatives by landowners to help maintain areas of natural ecosystems that support these species of risk. This stewardship approach will cover many different kinds of activities, such as: following guidelines or best management practices to support species at risk; voluntarily protecting important areas of habitat on private property; conservation covenants on property titles; ecogifting part or all of their property to protect certain ecosystems or species at risk; or to sell their property for conservation. For example, both government and non-governmental organizations have had good success in conserving lands in the Province. This could be aided by the B.C. Trust for Public Lands.

Table 1. Species addressed in this recovery strategy

Species	SARA Status (Schedule1)	COSEWIC Status	Date Designated	BC CDC Rank[3]
Island marble *Euchloe ausonides insulanus*	Extirpated	Extirpated	May 2000	G1T1 SX
Taylor's checkerspot *Euphydryas editha taylori*	Endangered	Endangered	Nov 2000	G1T1 SH
Bearded owl-clover *Triphysaria versicolor* ssp. *versicolor*	Endangered	Endangered	May 2000	G5T5 S1
Bear's-foot sanicle *Sanicula arctopoides*	Endangered	Endangered	May 2001	G5 S1
Coastal Scouler's catchfly *Silene scouleri* ssp. *grandis*	Consultations Phase	Endangered	May 2003	G5TNR S1
Golden paintbrush *Castilleja levisecta*	Endangered	Endangered	May 2000	G1 S1
Prairie lupine *Lupinus lepidus* var. *lepidus*	Endangered	Endangered	May 2000	G5 S1
Purple sanicle *Sanicula bipinnatifida*	Threatened	Threatened	May 2001	G5 S2
Seaside birds-foot lotus *Lotus formosissimus*	Endangered	Endangered	May 2000	G5 S1

COSEWIC uses the following definitions:

EXTINCT: A species that no longer exists.
EXTIRPATED: A species that no longer exists in the wild in Canada, but occurs elsewhere.
ENDANGERED: A species facing imminent extirpation or extinction.

[3] BC Conservation Data Centre ranking
G=Global Conservation Status
S= Subnational (Provincial) Conservation Status
T= designates a rank associated with a subspecies or variety
X= Presumed extirpated; not located despite intensive searches of historical sites and appropriate habitat and there is virtually no likelihood that it will be discovered
H= Historical occurrence; despite no recent evidence that the element is extant, there is some expectation that it may be discovered
1 = critically imperiled , 2 = imperiled, 3 = vulnerable to extirpation or extinction, 4 = apparently secure, 5 = demonstrably widespread, abundant, and secure, NR = unranked/Rank not yet assessed (BC Conservation Data Centre 2004).

1.3 Habitat area covered by the recovery strategy

All of the species covered in this recovery strategy are limited in their Canadian distribution to areas within the range of Garry oak and associated ecosystems. All of the Canadian occurrences of species covered in this recovery strategy are at the northern limit of their distribution and their ranges extend south into the United States. The Canadian populations of some of the species addressed in this strategy are widely disjunct from their main ranges in the United States (Table 2).

Table 2. Canadian population size and global percentages

Species	Percentage of global population in Canada	Estimated Total Population[4]
Island marble	Less than 1%	0
Taylor's checkerspot	Less than 1%	~ 15
Bearded owl-clover	Less than 1%	8,300-9,000
Bear's-foot sanicle	Less than 1%	~7,500
Coastal Scouler's catchfly	Less than 1%	400-540
Golden paintbrush	15%	~10,500
Prairie lupine	Less than 1%	~115
Purple sanicle	Less than 1%	~4,000
Seaside birds-foot lotus	Less than 1%	400-600

The restricted Canadian range of these species is characterized by mild winters and dry, cool summers. In the winter, relatively warm, low-pressure systems dominate. January, the coldest month, has a daily mean temperature of 4.6^{o} C and a mean daily minimum of 2.5^{o} C[5] (Environment Canada 2003). December, the wettest month, receives an average of 108 mm of precipitation, including very little snow (Environment Canada 2003). In the summer, a large semi-permanent high-pressure area extends over the northeastern Pacific. May, June, July and August each bring less than 25 mm of mean monthly precipitation (Environment Canada 2003). The scarcity of snow and rarity of hard frosts allows the vegetation to remain green throughout the winter. Strong moisture deficits turn the ground vegetation brown in mid-summer.

While all of the species addressed in this strategy occur in maritime meadows, some of them also occur in associated ecosystems. These ecosystems include: rocky coastal bluffs, mesic open deciduous or coniferous woodlands, open shrubby areas and vernal pool margins. This strategy deals with all sites in Canada where each of these species occur. Recovery of the butterfly species covered in this strategy may require consideration of actions on a broader suite of habitat types in order to effect recovery and will be guided by the recovery goals and needs of each species.

[4] Population totals are rough estimates only. Population counts were taken in different years and in some cases counted different things (e.g. some counts included all plants whereas other counts were only of flowering individuals).

[5] All figures are 1898-1988 climatic normals for Victoria Gonzales Heights, a coastal station 69 m above sea level and close to many maritime meadows that contain species at risk. Actual climatic regimes of many maritime meadows are even milder because they are at lower elevations closer to the ocean.

The term "maritime meadow" is an informal designation and there is no classification of such ecosystems in British Columbia. Maritime meadows are low-elevation (< 30 m), herb-dominated ecosystems largely confined to coastal situations (within 3 km of the shoreline) along southeastern Vancouver Island and a subset of islands in the Straight of Georgia, Haro Strait and the Strait of Juan de Fuca. Summer temperatures are greatly moderated by proximity to the ocean. Coastal fogs bring heavy dew in the late summer and early fall, stimulating germination and breaking shoot dormancy in many perennials even as inland areas remain dry and brown. Coastal fogs and the proximity to shoreline also tend to moderate winter frosts (particularly at night), retard the accumulation of heat and may slow down the development of plants, particularly in the late spring (Fairbarns pers. obs. 2004). Maritime meadows may be largely free of woody vegetation for a variety of reasons, including strong summer moisture deficits (particularly on wind-exposed sites and/or those with thin, coarse-textured soils), salt spray and a long history of First Nations burning. These forces may act alone or in concert, consequently some maritime meadows are subject to forest ingrowth while others remain open despite fire suppression.

Maritime meadows only occupy a small portion of coastal habitats, even where the natural vegetation remains. Cool north- and east-facing slopes and sheltered pockets of deep soils allow establishment of forest species while shallow, outcropping rock provides too little moisture to sustain maritime meadow species. There are no rigorous estimates of their former extent, but maritime meadows likely occupied less than 2,000 ha of heavily-fragmented habitat even in the early 18th century prior to European colonization. Since then, the area of maritime meadow habitats has declined substantially on southeast Vancouver Island.Early settlers drastically altered Garry oak and associated ecosystems by introducing grazing, cultivation and exotic plants (MacDougall et al. 2004) and fire suppression has favoured forest encroachment and ingrowth of woody species on sites that were formerly maintained by First Nations burning (c.f. Fuchs 2001). The future of remaining areas of maritime meadow is also at risk because they occur on high value shoreline property in a densely-populated, fast-growing region. From 1991-2001, the population in the Capital Region increased by 8.6% with the fastest growing areas in the Western Communities (16.6%) and the Gulf Islands (18.1%) (CRD 2002).Growth in the Capital Region is forecast to increase by 28.9% in 2026 from 1996 population levels (CRD 2001). Trends in Garry oak forests and woodlands, which have declined by 95% as a result of European settlement, provide a useful reference point for the decline of maritime meadows (Lea 2002). Maritime meadows have probably declined at least as much, since they are subject to even more intense development pressure due to the habitats' slope and aspect, which was desirable for agriculture and grazing, and their proximity to the ocean. It appears quite likely that less than 200 ha of maritime meadow remain relatively intact.

Maritime meadow ecosystems with over 5% cover of California oatgrass (*Danthonia californica*), Roemer's fescue (*Festuca idahoensis* ssp. *roemeri*) and/or native elements of red fescue (*Festuca rubra*) have been described for the adjacent Puget Trough in Washington State but other maritime meadow ecosystems in the area have not been classified (Chappell 2004b). Many of the maritime meadow communities in Canada fall into the unclassified group, so it would be premature to cross-reference Canadian maritime meadows with Washington State plant communities. Accordingly, it is not possible to assess the global extent or conservation of maritime meadow communities.

While there is no classification of maritime meadows in Canada, certain patterns are worthy of comment. The most drought-prone sites, referred to as dry maritime meadows in this strategy, tend to be well-drained and have quite low vegetation. They tend to support many low-growing species that are out-competed on more productive sites. Mesic maritime meadows warm up more slowly in the spring and dry out more slowly as the summer drought develops. They tend to support more productive vegetation and often have a substantial component of robust invasive grasses. Moist maritime meadows develop where water tends to pond slightly during the winter. They are transitional to vernal seeps and their vegetation tends be dominated by small plants that wither quickly with the onset of summer drought. Excluded from this classification are meadows composed of tall grasses and herbs occurring in areas with brief or non-existent summer moisture deficits. Such communities, which are transitional to coastal marshes, tend to have a quite different vegetation composition from the maritime meadow types described above. Furthermore, the rare species addressed in this recovery strategy are not known from such ecosystems.

As mentioned above, many of the 'maritime meadow' plant species addressed in this recovery strategy also occur on closely related ecosystems (refer to Table 3 for key habitat characteristics). Bearded owl-clover tends to occur in moist meadows or along the margins of vernal pools and seeps. Such habitats are described by Miller (in prep.). Coastal Scouler's catchfly, purple sanicle and seaside birds-foot lotus are most abundant in maritime meadows but also occur in mesic, open Garry oak woodlands (c.f. Douglas and Smith in prep.). Seaside birds-foot lotus also occasionally occurs in mesic, open coniferous forests but these populations probably established in maritime meadows, and the conifer canopy has developed as a result of subsequent forest ingrowth. Prairie lupine formerly occurred in maritime meadows but is recently known only from higher elevation grassland habitat. Such sites are superficially similar to maritime meadows but have a greatly different vegetation composition, which has not yet been formally described. In addition to maritime meadows, Taylor's checkerspot habitat can also include areas cleared by humans including powerline right of ways. The single remaining population of island marble on San Juan Island in the United States occurs in a mix of disturbed grassland, sand dunes and shorelines.

Table 3. Key habitat characteristics of species at risk in maritime meadows

	Environmental Attribute			
	Climate	**Distance from coast (km)**	**Elevation (m)**	**Slope/aspect**
Island marble	sub-Mediterranean	0-3.5	unknown	unknown
Taylor's checkerspot	sub-Med	0-5.0	1-250 (600)[6]	Nearly level to very strong slopes facing southwest to northwest
Bearded owl-clover	sub-Med	0-3.0	1-10	Nearly level
Bear's-foot sanicle	sub-Med	0-0.1	1-20	Nearly level to moderate southeast to southwest slopes
Coastal Scouler's catchfly	sub-Med	0-2.5	1-20 (- 225[7])	Nearly level to gentle slopes with various aspects
Golden paintbrush	sub-Med	0-3.0	1-20 (-60[8])	Nearly level
Prairie lupine	sub-Med	0-10[9]	1-400	Nearly level to moderate slopes with various aspects
Purple sanicle	sub-Med	0-2.5	1-250	Nearly level to very strong southeast to southwest slopes
Seaside birds-foot lotus	sub-Med	0-0.1	1-25	Nearly level to moderate southeast to southwest slopes
	Meso slope position	**Drainage**	**Soil moisture -summer-**	**Soil moisture -winter-**
Island marble	unknown	unknown	unknown	unknown
Taylor's checkerspot	Crest, upper slope, middle slope, level	Rapidly to poorly	unknown	unknown
Bearded owl-clover	depression	imperfectly to poorly	subarid	peraquic
Bear's-foot sanicle	level, middle slope (lower slope, toe)	well to rapidly	subarid to arid	humid to subhumid
Coastal Scouler's catchfly	level (upper slope, middle slope	well to rapidly	subarid	perhumid to subaquic
Golden paintbrush	level	moderately well to well	subarid	subaquic to perhumid
Prairie lupine	crest, upper slope, middle slope, level	rapidly to well	semiarid	humid
Purple sanicle	level, upper slope, middle slope	moderately well to well	semiarid to subarid	humid to perhumid
Seaside birds-foot lotus	level, lower slope	moderately well to well	semiarid to subarid	perhumid to subaquic

[6] One population in Clallum County occurs at 600m elevation but 250m is a more typical upper elevation
[7] upper elevation comes from an anomalous population on Mount Tzouhalem, now extirpated
[8] assumes Cedar Hill record came from Cedar Hill and not Mount Douglas (as has been reported elsewhere)
[9] assumes Koksilah River population occurred in the vicinity of/downstream of mouth of Grant Creek

	Environmental Attribute			
	Soil nutrient regime	**Minimum soil depth**	**Maximum soil depth/Root-restricting layer**	**Coarse frag. content**
Island marble	unknown	unknown	unknown	unknown
Taylor's checkerspot	unknown	unknown	Variable- no root restricting layer in gravelly Puget Prairies	unknown
Bearded owl-clover	unknown	unknown	Usually less than 10 cm - no root restricting layer in sites with moderate to severe exposure to wind and/or salt spray	unknown
Bear's-foot sanicle	unknown	unknown	Usually less than 50 cm soil - no root restricting layer in sites with moderate to severe exposure to wind and/or salt spray	Unknown
Coastal Scouler's catchfly	unknown	unknown	Usually less than 50 cm soil - no root restricting layer in sites with moderate to severe exposure to wind and/or	unknown
Golden paintbrush	unknown	unknown	Usually less than 50 cm soil - no root restricting layer in sites with moderate to severe exposure to wind and/or salt spray	unknown
Prairie lupine	unknown	unknown	Usually less than 50 cm soil - no root restricting layer in sites with moderate to severe exposure to wind and/or salt spray	unknown
Purple sanicle	unknown	unknown	Usually less than 50 cm soil - no root restricting layer in sites with moderate to severe exposure to wind and/or salt spray	unknown
Seaside birds-foot lotus	unknown	unknown	Usually less than 50 cm soil - no root restricting layer in sites with moderate to severe exposure to wind and/or salt spray	unknown

	Environmental Attribute		
	Mineral soil texture	**Humus form**	**Vegetation**
Island marble	unknown	unknown	unknown
Taylor's checkerspot	unknown	unknown	Rock bluff, dry meadow, mesic meadow, wet meadow, deciduous woodland, dry or mesic openings in coniferous forest
Bearded owl-clover	unknown	unknown	Wet meadow, vernal pool margin
Bear's-foot sanicle	unknown	unknown	Dry meadow
Coastal Scouler's catchfly	unknown	unknown	Dry meadow, mesic meadow, mesic open deciduous woodland
Golden paintbrush	unknown	unknown	Dry meadow, mesic meadow
Prairie lupine	unknown	unknown	Dry meadow, rock bluff, open shrubland
Purple sanicle	unknown	unknown	Dry meadow, mesic meadow, mesic open deciduous woodland
Seaside birds-foot lotus	unknown	unknown	Dry meadow, mesic meadow, mesic open deciduous or conif. woodland

1.4 Key characteristics of the group of species

1.4.1 Ecology of the species

All of the species are at the northern limits of their distribution in Canada and many are disjunct. Species at the edge of their distribution may be genetically and/or morphologically distinct and protecting these peripheral populations may be important for long-term survival of the species. Although Canada has a small percentage of the current global range of each species (except for Golden paintbrush), the habitat in Canada is an important and significant part of the species' range. Future climatic changes (review in Fuchs 2001) may make preservation of species at the northern limit of their distribution especially important for species recovery.

In most cases, the ecological significance of these species is not known. Both bearded owl-clover and golden paintbrush are root parasites (hemiparasites). The association between these and related hemiparasites and their hosts is a relatively random process and a broad range of species may be parasitized (Atsatt and Strong 1970). There is no evidence that either of these species have a significant effect on populations of their host species or significantly regulate vegetation composition where they occur. None of the species addressed in this recovery strategy are known to be keystone species, ecologically dominant species, or a significant prey item or pest.

All of the species covered in this recovery strategy prefer open habitat. Each of the plant species is relatively shade-intolerant. The larval and nectar foodplants of both butterfly species require open meadows, and the butterflies inhabit these same meadow conditions. This habitat requirement makes all species particularly vulnerable to invasion by exotic shrubs and

encroachment by native woody species due to the suppression of prior disturbance regimes that formerly limited woody invasion. Species adapted to regular disturbance regimes may be less able to compete with highly competitive woody and herbaceous species when disturbances are suppressed.

All of the species have mechanisms to address summer drought periods; five of the seven plants are dormant in the summer and the other two plant species can withstand heavy droughts. Both butterfly species diapause (enter a state of halted development) during summer drought.

All of the plant species have relatively limited dispersal mechanisms that limit their ability to disperse to suitable re-establishment habitat. Both sanicle species have hooked prickles on the seed that can attach to passing animals but the animal vectors do not preferentially select habitats suitable for the plants. Both seaside birds-foot lotus and prairie lupine have seedpods that twist explosively when ripe. However, in highly fragmented ecosystems, these mechanisms may not be sufficient for effective dispersal into unoccupied habitat.

Additional species may be added to this strategy over time. Some of these characteristics may not apply to other species at risk found in maritime meadows.

1.4.2 Economic/cultural value

Some maritime meadows contain large numbers of rare species. Some of the species at risk in this recovery strategy are showy and highly recognized as components of Garry oak and associated ecosystems. Protecting and appropriately restoring these rare ecosystems will help preserve biodiversity and prevent the loss of Canada's natural heritage. GOERT has identified all of these species as components of integrated recovery efforts for Garry oak and associated ecosystems (GOERT 2002).

There are few references to Aboriginal use of any of the species addressed in this recovery strategy (Moerman 1998; Turner pers. comm. 2004). The Miwok people of California and Nevada states used purple sanicle root as a cure-all and an infusion of the leaves as a remedy for snakebite (Moerman 1998). Although other species in some of the same genera as the species in this recovery strategy (*Castilleja* spp. *Lupinus* spp., *Silene* spp.) have been used for food, medicinal or ceremonial use, with the exception of purple sanicle there are no records of First Nations' use of the species in this recovery strategy.

None of the species in this recovery strategy are used commercially.

1.5 Rationale for taking a multi-species approach to recovery

To date, multi-species recovery strategies have been uncommon for species at risk in Canada. However, the federal *Species at Risk Act* permits ecosystem-level recovery planning and the Recovery of Nationally Endangered Wildlife (RENEW) recognizes the importance of a multi-species approach in dealing with multiple species at risk in a limited geographic area. The Garry Oak Ecosystems Recovery Team has used an ecosystem-level approach in the development of the *Recovery Strategy for Garry Oak and Associated Ecosystems and their Associated Species at Risk in Canada: 2001-2006* (GOERT 2002).

The complex ecology of British Columbia's Garry oak and associated ecosystems, and the large number of species at risk (both nationally and provincially-listed species) in maritime meadow ecosystems, are key factors in deciding upon a multi-species approach to recovery. A multi-species approach makes efficient use of limited recovery funds, as well as ecological and human resources. In addition, a multi-species approach is the most efficient one for addressing broad-scale recovery issues including communication planning, reintroduction possibilities, shared stewardship actions, education programs, landscape linkages, etc. (GOERT 2002).

All of the species included in this recovery strategy have a number of features that allow a multi-species approach to be effective. Most occurrences of these species are in highly specialized maritime meadows and many locations support more than one of the species covered in this recovery strategy. Species found in similar habitats also have similar adaptations to habitat conditions that influence potential management options.

A multi-species approach is the most effective one for addressing any conflicting needs between species and for developing appropriate protection and management strategies. A multi-species approach can address both species-specific threats and threats to habitat at the ecosystem level. A focus on habitat will accommodate range shifts and population expansions that cannot be included in a single species approach. Large-scale threats such as climate change and invasive species are best addressed at a broad scale. In the subsequent more detailed recovery action planning stage, specific needs of individual species covered by this recovery strategy can also be addressed and critical habitat proposed that will help ensure survival and effect recovery of a species at risk.

MULTI-SPECIES RECOVERY

1.6 Common Limitations and Threats

There is a broad range of threats that directly affect maritime meadow species at risk and/or their habitats. The threats and the degree of threat affecting each species are listed in Table 4. The ranking of threats applies to confirmed populations although additional threats will likely also affect translocated populations. For both butterfly species, the importance of each threat relates to the potential effects of known extant, newly found, or reestablished populations (Miskelly and Heron, pers. comm.). In 2004 a population of Taylor's Checkerspot was confirmed on Denman Island. This population is on private lands and unknown before 2004 (Heron, pers. comm.). A matrix outlining the degree of each threat affecting each plant species at each confirmed location is included in a background document (Fairbarns and Maslovat 2005). The following threats are ranked roughly in descending order of importance for recovery although this may vary between species.

Table 4. Threats to habitat (H) and direct threats to the survival (D) of species at risk in maritime meadows (For each species, threats are ranked as low, moderate, high or ? (unknown). Empty cells indicate the threat is not particularly relevant for that species.

IM=island marble, TC=Taylor's checkerspot, BOC= bearded owl-clover, BFS=bear's-foot sanicle CSC=coastal Scouler's catchfly GP=golden paintbrush, PL=prairie lupine, PS=purple sanicle, SBL=seaside birds-foot lotus.

THREATS	EFFECT	IM	TC	BOC	BFS	CSC	GP	PL	PS	SBL
1. Habitat destruction	D, H	High	High	High	High	High	High	High	High	High
2. Invasive plants										
• Invasive shrubs	D, H	High	High	High	Low	High	High	High	Mod.	High
• Invasive grasses and forbs	D, H	Mod.	Mod.	High	Mod.	Mod.	High	Mod.	High	High
3. Habitat fragmentation	D	High	High	Mod.	High	High	High	High	High	High
4. Changes in native vegetation composition from altered fire regimes	D, H	High	High	Low	Mod.	Mod.	Mod.	High	Mod.	Mod.
5. Recreation	D	Mod.	Mod.	High	Mod.	Low	Mod.	?	High	Low
6. Demographic collapse	D	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	High	Low	Low
7. Mowing	D, H	Mod.	Low	Low	Low		High			
8. Changes to hydrology	H			High	Low	Low	Low		Low	Mod.
9. Climate change	D, H	?	?	?	?	?	?	?	?	?
10. Re-introduction of fire	D, H	High	Mod.	?	?	?	?		?	?
11. Livestock grazing	D, H	High	Low							
12. Cutting or handpulling of invasive plants	D, H	Low	Low	Mod.	Low	Mod.	Mod.	Low	Mod.	Mod.
13. Maintenance activities	D			Mod.	Mod.	Mod.	Mod.		Low	

THREATS	EFFECT	IM	TC	BOC	BFS	CSC	GP	PL	PS	SBL
14. Herbivory	D			Low	Low	Low	Low		Mod.	Mod.
15. Pesticides	D	Mod.	Mod.							
16. Landscaping with non-native plants	D	Low	Low	Mod.					Low	
17. Marine pollution	D? H?			Low	Low	Low	Low		Low	Low
18. Invasive invertebrates	D							?		
19. Invasive vertebrates	D, H									?

1.6.1 Habitat destruction

Habitat destruction is listed as a primary threat for all of the plant species covered in this recovery strategy (Ryan and Douglas 1995; Ryan and Douglas 1996a, 1996b; Penny *et al*. 1998; Donovan and Douglas 2001; Penny and Douglas 2001; Fairbarns and Wilkinson 2003) and for Taylor's checkerspot (Shepard 2000c).

Although agricultural and urban development has likely eliminated both recorded and unrecorded populations of species addressed in this strategy in addition to maritime meadow habitat, most remaining patches of maritime meadows lie within protected areas or on federal lands (refer to Tables 11-17).

1.6.2 Invasive plants

Invasive species (exotic shrubs, grasses and forbs) are a prominent threat to Garry oak and associated ecosystems and to all of the species at risk in this recovery strategy (Fuchs 2001; GOERT 2002). Some invasive plants may increase nitrogen availability, thus changing ecosystem function (Maron and Connors 1996; Adair and Groves 1998; Levine et al. 2003), pre-empt safe-sites for germinants (Brown and Rice 2000; Ryan and Douglas 1996a; Ryan and Douglas 1996b), alter litter layers (Facelli and Pickett 1991; Bergelson 1990), change the availability of soil moisture during different seasons and at different soil depths (Harris and Wilson 1970; Smith 1994), alter soil structure and composition (Levine et al. 2003), increase fire intensity by increased fuel loading (D'Antonio and Vitousek 1992) and compete with native plants for water, light and nutrients (Fuchs 2001; MacDougall, 2002).

Invasive plant species affect butterflies by competing with native larval and adult foodplants, preventing access to nectar plants and by changing the physical structure of the habitat (GOERT 2002; Vaughan and Black 2002a; 2002b).

For threats associated with different management activities, refer to Threats 7 (Mowing), 10 (Reintroduction of fire) and 12 (Cutting or hand-pulling of invasive plants).

1.6.3 Habitat fragmentation

Maritime meadow habitat is naturally fragmented, occurring on separate small islands and in pockets of Garry oak and associated ecosystems. However, recent habitat loss has accentuated the fragmentation by eliminating suitable habitat and the adjacent matrix. Habitat fragmentation may harm the long-term survival of a species by limiting restoration activities (e.g. preventing the reintroduction of fire in urban areas) and limiting dispersal of plants at risk and their pollinators (thereby potentially decreasing reproductive capability). Habitat fragmentation also creates dispersal barriers for seeds and butterflies, potentially limiting genetic diversity and decreasing the possibility of rescue effect (refer to Fuchs 2001 for a more comprehensive overview). Fragmented butterfly habitats may not support a wide enough range of habitat conditions to ensure that phenologically suitable foodplants are available to feed emerging larvae (refer to Fuchs 2001).

1.6.4 Changes in native vegetation composition from altered fire regimes

Although prior to European settlement many Garry oak and associated ecosystems had frequent, low-intensity burns initiated by First Nations (review in Fuchs 2001; Beckwith 2002), it is unclear how ubiquitous the use of fire was in maritime meadows. In areas with large First Nations populations (e.g. Vancouver Island), human-initiated burns probably played a significant role in maintaining meadows. Following European settlement, both cultural and natural fires were actively suppressed (Fuchs 2001; MacDougal et al. 2004). Fire suppression allows the establishment and encroachment of native woody species in areas that were formerly open (Fuchs 2001), increases the buildup of aboveground biomass (grass and dead litter) and decreases the amount of exposed mineral soil providing safe sites for germination and establishment.

Plant communities that are dominated by herbaceous rather than woody species have more fine roots in the soil that produce organic matter as the roots decay root material. Low-intensity fires do not greatly reduce the organic component of the top layers of soil but do burn surface organic materials, releasing nutrients in forms available to plants. In ecosystems where the main inputs of organic matter come from herbaceous or deciduous woody plants rather than coniferous trees, the Ah horizon has a relatively neutral pH in sharp contrast to the acidic soils under Douglas-fir forests (Broersma 1973).

Woody plant encroachment may occur more rapidly on wetter portions of the landscape than in areas that experience deep, prolonged summer drought (GOERT 2002; Vaughan and Black 2002a; 2002b). Encroachment restricts native meadows to areas that are prone to drying out and plants experience premature senescence during times of drought. Premature senescence would reduce the number of larval and nectar plants available for butterfly species Hellmann (2002), Cappuccino and Kareiva (1985). As the phenology of remaining plants is temporally compressed, this can cause starvation of butterflies if foodplants dry out. The Helliwell Park population of Taylor's checkerspot may have been extirpated because the moister areas of the original grasslands, which previously contained late-season foodplants, have undergone encroachment by conifers.

The suppression of fires also influences the plant community in relation to exotic species invasion. Although some exotic species are favoured by fire (refer to Threat 2), regular fires can also reduce exotic herbaceous vegetation since many highly competitive exotic plants decrease under a regime of frequent burning (Tilman 1988 in MacDougall 2002; MacDougall pers. comm. 2004).

1.6.5 Recreational activities

Trampling from people and dogs can damage vegetation and all butterfly life stages. Bicycling, horseback riding and off-road vehicles can compact soil and damage both butterfly and plant species. Recreational use of horses may have been a factor in the recent extirpation of Taylor's checkerspot from at least two locations in Washington State (Vaughan and Black 2002b). Although light trampling may benefit some low-growing plant species (e.g. bearded owl-clover, bear's-foot sanicle) by reducing competition and suppressing tall exotic herbs (Penny et al. 1998), some species such as seaside birds-foot lotus are only found in locations with limited public access and are likely sensitive to trampling (Ryan and Douglas 1996a). The effect of dogs, especially in off-leash areas such as Macaulay Point, and the potential effects of escaped beach fires is not known.

Trial Island Ecological Reserve and Oak Bay Islands Ecological Reserve require permits to land marine craft, but there is no effective BC Parks management presence for enforcement. Municipal and Regional parks are both used extensively by the public and their pets, a trend that will continue to increase as Victoria's population increases. Some recent initiatives to control off-leash dogs in some jurisdictions have met with public opposition and have not been successful.

1.6.6 Demographic collapse

All of the species in this recovery strategy are limited to a small number of populations that have been genetically isolated from other populations. Genetic isolation can drive local adaptation, which is generally beneficial but can make a species less able to adapt to environmental changes. Genetic isolation can also lead to a limited gene pool, inbreeding depression and genetic drift (Primack 1993 in Donovan and Douglas 2000). Over time, these factors in combination with environmental limitations present at the periphery of a species range, can result in low seed set, low seedling vigour, low flowering rates, low resilience and low recruitment.

Habitat fragmentation and limited dispersal can also lead to demographic collapse and low seed set.

1.6.7 Mowing

Interactions between the autecology of the individual species and the timing of mowing will determine the effect of mowing on species at risk. For example, mowing may partically mimic some aspect of fire and may control shrub encroachment into meadows. Mowing may have a positive effect on low-growing species such as bear's-foot sanicle. However, mowing may have contributed to the extirpation of golden paintbrush from Beacon Hill Park (Hook pers. comm. 2004). Mowing at appropriate times should have minimal negative effects on reintroduced populations of Taylor's checkerspot larvae and pupae, which remain near the ground. However,

mowing will likely negatively affect re-established island marble larvae, which are found 15-80 cm above the ground (Guppy pers. comm. 2003; Miskelly pers. obs. 2004).

In some parks including Glencoe Cove Municipal Park in Saanich and Beacon Hill Park in the municipality of Victoria, specific areas are either not mowed or are mowed late in the year (after mid-August) to minimize adverse effects to plants at risk (Daly pers. comm. 2004; Raeroer pers. comm. 2004).

1.6.8 Changes to hydrology

Increased drainage, artificial ponding and elimination/diminution of water sources, notably vernal pools, can alter maritime meadows and degrade habitat. Irrigation common in urban areas and landscaped areas may encourage less stress-tolerant species, favouring exotic plant species. Landscaping adjacent to one bear's-foot sanicle population is heavily irrigated and may be affecting populations and limiting suitable habitat where the species may have once existed (Donovan and Douglas 2000).

1.6.9 Climate change

Climatic change may cause warmer summers and more compressed spring periods than existed formerly. These effects may combine with hydrological changes to cause the gradual disappearance of relict populations that no longer enjoy the climatic conditions that favoured their establishment.

1.6.10 Re-introduction of fire

Further research is needed to determine whether reintroducing fire is a viable restoration option. Increased fuel loading will cause fires to be hotter and more catastrophic than the more frequent, cooler fires that would have occurred prior to fire suppression.

The direct response of species at risk to controlled burns is not known but hot fires will likely kill invertebrates (Nicolai 1991, Swengel 1996 and Siemann et al. 1997 in Fuchs 2001). Individual species autecology and the timing of the burn will determine the degree of effect. Taylor's checkerspot pupae and larvae generally remain near the ground in cold or rainy weather and after they enter summer diapause (resting phase) (Guppy pers. obs. of Mill Bay population 2003; Hellman pers. comm. 2005; Ross pers. comm. 2004). The direct affect of a cool surface burn, completed at the appropriate time of the year, on the larvae or pupae of Taylor's checkerspot is not known. Guppy (pers. comm. 2004) suggests that burns may directly kill many eggs, larvae or pupae of the island marble; eggs and larvae are found on the foodplants (15-80cm above the ground) (Miskelly pers. obs. 2004), which are vulnerable to fire and pupae are above the soil surface but attached to objects near the ground. Fires, at least in the short-term, may also eliminate or limit larval foodplants of both butterfly species.

Although frequent burns appear to suppress adult exotic grasses such as Kentucky bluegrass (*Poa pratensis*) and orchardgrass (*Dactylis glomerata*) (MacDougall 2002), many exotic species, including Scotch broom and common velvet-grass (*Holcus lanatus*) are favoured by fire and

readily colonize any post-burn mineral soil that is exposed. While Scotch broom can increase after a single fire, it is not favoured by repeated burns. The presence of these exotic species, can in turn increase the flammability of ecosystems (D'Antonio and Vitousek 1992).

1.6.11 Threats with livestock grazing

Livestock were formerly grazed on Discovery, Trial, Chatham, Strongtide, VanTreight, and Griffin Islands. Intensive grazing coupled with cultivation and the introduction of exotic species dramatically altered Garry oak ecosystems, including maritime meadows (MacDougall et al. 2004). Grazing likely shifted the species composition, vegetation structure and nutrient cycling of these ecosystems (Hatch et al. 1999; Bartolome et al. 2004). Feral goats continue to graze Brown Ridge on Saturna Island. Site-specific consideration of the impacts of livestock grazing on maritime meadows will be needed before altering particular management regimes, as grazing can suppress shrub invasion (hence reduce other threats to the species of concern).

Livestock grazing tips the competitive balance of communities in favor of unpalatable species and, if grazed at the wrong time of year (i.e. spring), may decimate palatable species such as seaside birds-foot lotus. Grazing favours sod-forming grasses and overgrazing can also play a major role in the establishment and eventual dominance of exotic forage species (Saenz and Sawyer 1986 in Fuchs 2001) (refer to Threat 2). Grazing tramples butterfly larvae and may eliminate larval foodplants. Depending on the timing of grazing, island marble eggs and larvae may be consumed. Therefore, if grazing is to be ongoing in these ecosystems, knowledge of the phenology of plants and invertebrates (in particular lepidopterans) will be required to minimize damage to important life cycle stages.

1.6.12 Cutting and hand pulling of invasive plants

Managing invasive species may also affect species at risk. Habitat restoration for both butterfly species, which feed on exotic host plants, should focus on reintroductions of native foodplants rather than retaining exotic host plants such as ribwort plantain (*Plantago lanceolata*) for Taylor's checkerspot and introduced weedy mustards for island marble.

The issue of providing suitable habitat for butterfly species through maintenance or encouragement of exotic host plants was considered. Such actions may be further considered in the development of a recovery action plan.

Hand pulling, or cutting invasive shrubs and piling and removal of slash material may trample plant species at risk. These activities may also damage all butterfly life stages and their foodplants. Many invasive plants are particularly adapted to colonize disturbed soils and the soil disturbance associated with invasive species removal may increase invasion by seedlings (Knops et al. 1995; Kotanen 2004). Ineffective control techniques (e.g. cutting young broom at stem level) may also threaten populations.

Other invasive species management tools include mowing (Threat 7) and prescribed burning (Threat 10).

1.6.13 Maintenance activities

Maintenance activities around radio towers (e.g. Seacoast Communications lease on Trial Island, on Department of National Defence lands and in parks) can damage species at risk. Potential threats include mowing (Threat 7), herbicide application, trampling, placement of heavy wires across the ground, stockpiling of materials and garbage, facility maintenance and transport of heavy materials and equipment from dock to facilities (Penny and Douglas 2001).

1.6.14 Herbivory

The concentration of native grazers and their herbivory patterns have changed with increased urbanization and habitat loss. Roosevelt elk (*Cervus elaphus roosevelti*), which were formerly more common in Garry oak and associated ecosystems, are now rarely encountered only in less populated areas of Vancouver Island. Columbian black-tailed deer (*Odocoileus hemionus columbianus*) are now more densely concentrated on a smaller landbase than formerly. Development, decreased hunting, and fewer carnivores than formerly in populated areas have increased the density of deer populations. An increased food supply from agriculture, irrigation, and exotic plants provide a food source for deer later in the season than formerly available. In some areas, dogs may discourage ungulate populations. Deer do not live on Trial Island and are rare on Alpha and Griffin Island.

Ungulates browsing on shrubs, formerly associated with frequent low-intensity fires, favours the persistence of meadow species. Shrubs that survive fire are browsed sufficiently to shift the competitive balance further in favour of meadow species. Tall, palatable forbs with elevated meristems (growing tips) suffer greatly from grazing. Unpalatable species, low-growing forbs and grasses (which do not have elevated meristems) gain a competitive advantage. Changing herbivory patterns may cause positive or negative effects to species at risk depending on the palatability of the species (or their foodplants) and the palatability of competing vegetation. The effect of native invertebrate predators is not known. Insect seed predators, especially pre-dispersal seed predators that can destroy seed production from entire inflorescences, may seriously affect reproductive capabilities (Bigger 1999). Threat 11 discusses threats associated with livestock grazing.

1.6.15 Pesticides

Invasion by exotic gypsy moth has led to aerial spraying of *Bacillus thuringiensis* ssp. *kurtaski* (*Btk*) for control. *Btk* is lethal to most butterfly and moth larvae, and Taylor's checkerspot and island marble larvae are actively feeding during the early spring when *Btk* is likely scheduled for application (Wagner and Miller, 1995; Nealis pers. comm. 2003). *Btk* at toxic concentrations can drift for over two miles from target spray areas (Whaley et al. 1998). Refer to GOERT (2002) for approaches for dealing with this threat (p.36).

1.6.16 Cultivation of non-native plants

Cultivation of non-native plants (e.g. lawns and horticultural plants) adjacent to occurrences of species at risk may introduce new invasive species, increase herbicide use, alter moisture regimes, and decrease native foodplants for butterflies. Horticultural plants may also escape from cultivation and become naturalized further adding to the problem of invasive species. Planting and maintenance of lawns and ornamental horticultural plants next to occurrences of bear's-foot sanicle in Saxe Point Park may have eliminated suitable habitat for this species (Matt Fairbarns, pers. obs.).

1.6.17 Marine pollution

The Strait of Juan de Fuca is the most active shipping lane on the Pacific Coast north of San Francisco. The threat of oil tanker collisions and oil spills is prominent. In December 2003, a freighter was only 3 minutes of running aground on Trial Island (Victoria Times-Colonist 2003), a site for 5 of the 7 plant species in this strategy and one of the former locations for Taylor's checkerspot.

Much of the maritime meadow habitat occurs next to the intertidal zone and is affected by saltspray during storm events and may be vulnerable to marine pollution. More research is needed to determine the current and potential effects of diffuse marine pollution and a catastrophic point source spill on species at risk.

1.6.18 Invasive invertebrates

The effect on nutrient cycling and ecosystem productivity by introduced earthworms requires further research (Fuchs 2001). Likewise, the effect of herbivory by the introduced black slug (*Arion rufus*) and seed predation by introduced insects on the species addressed in this recovery strategy is not known.

1.6.19 Invasive alien invertebrates

There has been minimal research on the effect of introduced vertebrates on species at risk in Garry oak ecosystems (GOERT 2002). Rabbits (*Sylvilagus floridanus* and *Oryctolagus cuniculus*) and rats (*Rattus* sp.) are found in maritime meadows and likely eat vegetation and seeds. Introduced birds such as the European starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*) feed on invertebrates and may affect butterflies at risk. The effect of opossums (*Didelphis virginiana*) in Garry oak ecosystems on Denman and Hornby Islands has not been investigated.

1.7 Critical Habitat

No critical habitat, as defined under the federal Species at Risk Act [s2], is proposed for identification at this time.

While much is known about the habitat needs of the species included within this recovery strategy, more definitive work must be completed before any specific sites can be formally proposed as critical habitat. It is expected that critical habitat will be proposed within one or

more recovery action plans following: 1) consultation and development of stewardship options with affected landowners and organizations and 2) completion of outstanding work required to quantify specific habitat and area requirements for these species. A schedule of studies outlining work necessary to identify critical habitat is found below (Section 2.2.4).

Following completion of key work such as development and implementation of a landowner contact program, it is anticipated that proposed critical habitat may include habitat currently occupied by one or more species addressed within this recovery strategy. A more complete definition of proposed critical habitat that also incorporates potential habitat will be addressed at a later date, through the Recovery Action Plan.

A description of the biotic and abiotic features of each species' habitat is included in each of the species-specific sections. A summary table of habitat attributes is included in **section 1.1 Habitat area covered by the recovery strategy**.

1.7.1 Occupied habitat

Proposed critical habitat should include occupied habitat, and surrounding buffers of appropriate potential habitat to allow dispersal and prevent invasion of invasive species. In order to accurately define the boundaries of each location on the ground for designation of critical habitat, further studies are needed, as detailed below (section 2.2.4). All confirmed locations supporting a viable or potential viable population of each species will form essential components of any proposed critical habitat. Island marble has been extirpated from Canada, so the only habitat occupied by this species occurs in the United States.

1.7.2 Potential habitat

Proposed critical habitat should include surrounding buffers of appropriate potential habitat to allow dispersal and prevent invasion of invasive species. In order to accurately define the boundaries of each location on the ground for designation of critical habitat, further studies are needed as detailed below (section 2.2.4).

The present distribution of each species is insufficient for full recovery of the species as defined under the species-specific recovery goals in section 2.4.2. Additional habitat needed by these species in order to maintain a self-sustaining and viable population level, is required to meet the needs of each species, and this will likely include extant maritime meadow ecosystems that remain in a near natural state. However, further research and research trials are required to determine the feasibility of translocations before critical habitat can be proposed for designation. Potential habitat may require extensive restoration and mitigation of adverse effects before it is suitable. Native foodplants may need to be introduced in sufficient quantity for habitat to support viable populations of both the island marble and Taylor's checkerspot.

1.7.3 Examples of activities that are likely to result in destruction of any critical habitat identified in the future

Examples of activities that would be expected to result in the destruction of proposed critical habitat include:

- Residential development
- Recreational activities (bicycling, horseback riding, off-road vehicles, dog-walking)
- Hydrological alterations (draining or ditching)
- Livestock grazing
- Maintenance activities (mowing, trail building, installment of structures, chemical use)

1.7.4 Schedule of studies to determine critical habitat

Further research in the following areas is required to define critical habitat for all seven plant and two invertebrate species:

1. Document microhabitat conditions where populations now exist as well as the conditions that prevailed for locations of extirpated populations (i.e. critical abiotic and biotic features of habitat including: soil texture, soil depth, slope, aspect, hydrologic regime for the entire growing period, species composition, etc.). Particular attention should be paid to locations in Canada with robust populations and care should be taken not to extrapolate from conditions prevailing at remote locations where there may be major differences in the flora and macroclimate that invalidate comparisons. Suggested completion date: 2008.

2. Work with landowners and land managers to develop mechanisms to protect and manage areas of important habitat for these species to ensure their survival and recovery. Suggested completion date: 2008

3. For each population of species in which micro-catchment drainage patterns (small internal drainages in which most or all of the populations occur) determines viability of habitat, map the entire microcatchment area. Suggested completion date: 2010.

4. Determine the suitability of contemporary habitat in locations where populations have been extirpated. Suggested completion date: 2010.

5. Identify high quality unoccupied sites and conduct phenologically appropriate surveys to determine whether they possess the key hydrological and biotic attributes that prevail where the species occurs. Suggested completion date: 2010.

6. Test the suitability of high quality unoccupied sites identified in (4) by attempting to establish, maintain and monitor an experimental population in one of the locations. Suggested completion date: 2010.

7. Identify and prioritize high quality unsurveyed sites and conduct phenologically appropriate surveys to determine the presence/absence of undocumented populations of extirpated species. Suggested completion date: 2009.

1.8 Recovery feasibility

For all species of plants and invertebrates in this strategy recovery is biologically and technically feasible.

It is difficult to fully ascertain the potential for recovery of maritime meadow species because there are significant information gaps. Further studies and trials are needed to determine whether there are insurmountable barriers to the maintaining or enhancing existing populations, the re-establishment of extirpated populations, and the establishment of new populations. For this reason, the ecological and technical feasibility of recovery may have to be re-evaluated once further research is conducted. For extirpated (or extremely rare) species where re-introductions are required for recovery, access to sufficient numbers of individuals without further threatening extant populations may be the limiting factor in the species recovery.

Table 5. Feasibility of recovery for all species

IM=island marble, TC=Taylor's checkerspot, BOC= bearded owl-clover, BFS=bear's-foot sanicle, CSC=coastal Scouler's catchfly, GP=golden paintbrush, PL=prairie lupine, PS=purple sanicle, SBL=seaside birds-foot lotus.

Recovery Criteria	IM	TC	BOC	BFS	CSC	GP	PL	PS	SBL
1. Are individuals capable of reproduction available to support recovery?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Is habitat available for recovery or could it be made available through recovery actions?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4. Do the necessary recovery techniques exist and are they demonstrated to be effective?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1.8.1 Biological Feasibility

Biological feasibility, defined here as the ability of a species to recover based solely on the inherent reproductive capability and the known biological needs of the species, is possible for all species. All of the plant species in this recovery strategy reproduce sexually and both butterfly species are likely capable of producing egg masses large enough for small populations to rebound within a short period of time. Source populations for translocations in the United States will be required for the recovery of island marble, Taylor's checkerspot and prairie lupine. Populations of both butterfly species are also limited in the United States and may require genetic studies to determine the appropriateness of translocation.

Historical and contemporary records indicate all of the species in this recovery strategy have always had small numbers of naturally fragmented Canadian populations (details of known number of populations and population sizes are given in the species-specific sections). Species with low numbers of populations may have been stable or viable in the past. However, given the scarcity of historical records, it is difficult to determine whether low numbers of populations indicates historic rarity of the species or whether the species were previously more widespread in

maritime meadows prior to European settlement and former locations have since been extirpated. However, all of the species have fewer numbers of populations due to habitat loss, suppression of ecological processes, invasive alien species and direct human effects rather than natural processes.

Although for most species the size of extant populations is relatively stable (e.g. bear's-foot sanicle, coastal Scouler's catchfly, golden paintbrush, purple sanicle, seaside birds-foot lotus), populations of some species show extreme year-to-year natural fluctuations in population size (e.g. bearded owl-clover, prairie lupine).

Securing Quality Habitat

While there have been declines in habitat quality and extent, there is no compelling evidence that sufficient habitat securement for recovery is impossible. Although some populations of plants at risk occur on private land, many of the populations occur in protected areas (Refer to Tables 11-17 for population information and land status of plant populations).

There is currently one known location of Taylor's checkerspot on Denman Island. This location was confirmed in May 2005 in a fifteen-year old clear-cut. This population has likely colonized the site from a surrounding meadow habitat. There are no known habitats currently occupied by island marble. However, there is the potential for future surveys to find undocumented populations. Unless large new populations are found, recovery of extirpated species will rely on the ability to define the key habitat features necessary to sustain a population and on the success of translocations. In some cases, this may require translocation to sites not formerly occupied. For example, the only protected site that historically supported a population of the island marble is the heavily used Beacon Hill Park in the municipality of Victoria. This site may not be appropriate for reintroductions unless extensive measures are put in place to limit threats, as the introduced individuals may not survive.

Possibility of Restoring Habitat

Although many of the sites that historically supported maritime meadow populations remain protected in some capacity, the habitat may no longer be suitable. Recovery will require more thorough studies to determine which habitat attributes are required for each species in order to determine goals and techniques for restoration. Habitat restoration for the two butterfly species will need to ensure an adequate, continued and accessible supply of larval and nectar plants that matures over a wide range of phenology to support each species.

Feasibility of Removing or Mitigating Threats

Although in some cases the specific threats are unknown or not fully understood, threats can likely be addressed through site-specific restoration plans and research aimed towards uncovering, clarifying or mitigating new threats.

1.8.2 Technical Feasibility

Feasibility of Translocations

Currently, a small pilot project is underway for experimental translocation of seeds to a small area of disturbed soil on Trial Island of three of the plant species (golden paintbrush, purple sanicle, and bear's-foot sanicle) collected in adjacent habitat. Captive breeding and a rearing program for Taylor's checkerspot is being developed by Oregon Zoo (Miskelly pers. comm. 2004; Potter pers. comm. 2005) (Refer to Actions Completed or Underway). Captive rearing has not been completed for the island marble, and there is very little information on the life history of this species. If future translocation attempts are not successful, the degree of recovery (as defined by the species-specific goals) will need to be re-evaluated.

1.9 Multiple Species Recovery

This section provides goals and objectives for protecting and managing maritime meadow ecosystems to ensure adequate protection and management of the habitat for species at risk. Species-specific goals and objectives and the strategic approaches recommended to achieve them are detailed in this section.

1.9.1 Maritime meadow ecosystems goals and objectives

In order to prevent further declines, protect using stewardship and other mechanisms, moderate to high quality maritime meadow ecosystems, in association with moderate to high quality adjacent matrix. The connectivity of maritime meadow habitat should be maintained to allow dispersal, movement of pollinators, and limit invasion by exotic species. Most areas with maritime meadow habitat have not been identified or mapped, and this will be required in order to identify potential habitat for translocations and to re-establish new populations.

Recovery goal for maritime meadow ecosystems

Protect[10] and restore moderate to high quality maritime meadow ecosystems and the adjacent matrix habitat throughout the geographic range.

Recovery objectives for maritime meadow ecosystems

1. Protect[10] using stewardship and other mechanisms, moderate to high quality locations with maritime meadow habitat in 5-10 years.

2. Engage the cooperation of owners or managers of land critical for species conservation and recovery within 5 years.

3. Determine habitat responses to restoration and to refine restoration targets in 5-10 years.

[10] This may involve protection in any form including voluntary stewardship agreements and conservation covenants on private lands, land use designations on crown lands, and protection in municipal parks and other types of land tenures.

4. Develop and implement appropriate management plans for maritime meadows and buffers to address invasive species and restore ecosystem processes in 5-10 years.

1.9.2 Species specific recovery goals, objectives and broad strategies

Each of the species addressed in this recovery strategy has a different autecology and different constraints for recovery. Before the feasibility of reintroductions for extirpated butterfly species can be more accurately assessed, it is necessary to increase the survey effort to determine whether remnant populations have been overlooked. This consideration is important to establish protection for these populations and to avoid further threats to any possible small overlooked populations through contamination of the local gene pool.

Specific numerical targets for each plant species are based on the number of historical populations, the number of populations required to distribute the species throughout its former range and the number of populations required to provide robustness to withstand stochastic events and environmental variability (Table 6). In order to create new populations of all of the plant species, translocations will be required. A draft policy document to guide translocations is currently being developed (Maslovat in prep.).

Species specific recovery goals

Recovery goals have been developed by evaluating the number of historic populations and by assessing COSEWIC criteria. For most species, minimum population sizes are to be determined by future viability analysis. COSEWIC Criteria established COSEWIC's Assessment Process and Criteria (COSEWIC 2003b).

Table 6. Recovery goals for maritime meadow species at risk

Species	COSEWIC Criteria[11]	Recovery Goals
Island marble	None given	To attain viable, self-sustaining populations of island marble within the species' historic range in Canada.
Taylor's checkerspot	B1 and B2c; C2a	To attain viable self-sustaining populations of Taylor's checkerspot with the species' historic range in Canada.

[11](Taken from COSEWIC 2003b) **B=Small Distribution, and Decline or Fluctuation**
1. Extent of occurrence <5,000 km^2 for endangered, <20,000 km^2 for threatened OR
2. Area of occupancy <500km^2 for endangered, <2,000 km^2 for threatened
For either of the above, specify at least two of a-c:
a. Either severely fragmented or known to exist at ≤5 locations for endangered, ≤10 locations for threatened
b. Continuing decline observed, inferred or projected in ii) area of occupancy
c. Extreme fluctuations in any of the following: > 1 order of magnitude for endangered; > 1 order of magnitude for threatened) i) extent of occurrence; ii) area of occupancy; iii) number of locations or populations; iv) number of mature individuals.

C= Small Total Population Size and Decline
Number of mature individuals <2,500 for endangered, <10,000 for threatened
2. Continuing decline observed, projected, or inferred, in numbers of mature individuals. a) fragmentation

D= Very Small Population or Restricted Distribution
1. # of mature individuals <250 for endangered, <1,000 for threatened

Species	COSEWIC Criteria[11]	Recovery Goals
Bearded owl-clover	B1a + B1b*ii* and B2a + B2b*ii*	To attain viable self-sustaining populations of bearded owl-clover distributed throughout its historic range in Canada with a minimum of at least eight populations by: • Maintaining or enhancing all seven existing populations/ subpopulations at no less than their current levels of abundance and increasing smaller ones. • Establishing one experimental population with an average annual population size of at least 300 flowering individuals
Bear's-foot sanicle	B1a +B1b*ii* and B2a + B2b*ii*	To attain viable self-sustaining populations of bear's-foot sanicle distributed throughout its historic range in Canada with a minimum of at least ten viable populations by: • Maintaining all eight existing populations/ subpopulations at no less than their current levels of abundance. • Restoring at least two extirpated populations or establishing at least two new populations
Coastal Scouler's catchfly	B1a + B1b*ii* and B2a + B2bii	To attain viable self-sustaining populations of coastal Scouler's catchfly distributed throughout its historic range in Canada with a minimum of at least eight populations by: • Maintaining both extant populations/ subpopulations at no less than their current levels of abundance. • Establishing at least six additional populations
Golden paintbrush	B1a + B1b*ii* and B2a + B2b*ii*	To attain viable and self-sustaining populations of golden paintbrush distributed throughout its historic range in Canada with a minimum of at least nine populations by: • Maintaining both existing populations at their current levels of abundance. • Establishing at least seven new populations
Prairie lupine	B1a + B1b*ii* and B2a + B2b*ii* and D1	To attain viable and self-sustaining populations of prairie lupine distributed throughout its historic range in Canada by: • Managing and enhancing the single extant population • Establishing additional populations with numbers to be determined by future research
Purple sanicle	B1a + B1b*ii* and B2a + B2b*ii*	To attain viable and self-sustaining populations of purple sanicle throughout its historic range in Canada with a minimum of at least ten populations by: • Maintaining all extant populations/ subpopulations at no less than their current levels of abundance. • Managing at least eight of the smaller, existing populations (including at least one in the southern Gulf Islands) such that their numbers increase
Seaside birds-foot lotus	B1a + B1b*ii* and B2a + B2b*ii*	To attain viable and self-sustaining populations of seaside birds-foot lotus throughout its historic range with a minimum of at least six populations by: • Maintaining all five extant populations/subpopulations, increasing small populations and conserving larger populations at their current levels of abundance. • Establishing one additional population containing at least 100 flowering individuals per year

Species specific objectives

The following objectives (Table 7) are required to meet the above species-specific goals. They have been drafted to be completed in a five to ten year time frame. The objectives are roughly ranked in descending order of priority although this may vary between species.

Table 7. Species-specific recovery objectives

IM=island marble, TC=Taylor's checkerspot, BOC= bearded owl-clover, BFS=bear's-foot sanicle, CSC=coastal Scouler's catchfly, GP=golden paintbrush, PL=prairie lupine, PS=purple sanicle, SBL=seaside birds-foot lotus.

General Objectives[12]	IM	TC	BOC	BFS	CSC	GP	PL	PS	SBL
1. Establish protection[13] for existing known populations	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10
2. Engage the cooperation of all involved landowners and land managers in habitat protection	<5	<5	< 5	<5	<5	<5	<5	<5	<5
3. Identify life history, dispersal and habitat constraints and methods for mitigating them	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10
4. Determine the causes of extirpation, and/or population decrease or loss	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10
5. Develop and implement a habitat monitoring and restoration plan for locations with confirmed records, or in the case of extirpated species, for sites designated as potential habitat	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10
6. Identify and prioritize sites for inventories and conduct surveys to determine whether there are any undocumented populations (i.e. to determine necessity of re-introductions)	5-10	5-10	5	5	5	N/A	5	5	5
7. Identify critical habitat required to establish new populations, as outlined in species-specific goals	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10
8. Develop techniques and priorities to establish new populations and one experimental population per species (if appropriate based on above research)	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10

[12] Numbers in table indicate the number of years required to complete the objective. For extirpated populations, the timeframes indicated in O.1 and O.2 will apply to any newly found populations.
[13] This may involve protection in any form including stewardship agreements and conservation covenants on private lands, land use designations on crown lands, and protection in municipal parks and other types of land tenures.

Research and management activities required to meet recovery objectives

Recovery activities have been grouped in seven broad approaches to address the threats and meet the recovery objectives (Table 8). These are roughly ranked in descending order with the most urgent activities listed first, although this may vary between species.

1. **Habitat and species protection:** A primary focus of this recovery strategy is to prevent further loss and fragmentation of maritime meadow habitats. Habitat with known occurrences of species at risk should be protected and any new occurrences as they are discovered should become priorities for protection. Protection will include protection of private lands through acquisition and through conservation covenants and other voluntary stewardship agreements.

2. **Habitat stewardship:** Involving landowners/land managers in effective management of maritime meadows habitat will be key to the recovery of species at risk. This will include developing proactive communication with different landowners/land managers and involving them in the recovery planning process. It is also necessary to determine the legislation, regulations and policy that apply to different public landowners. Landowners/land managers should also be encouraged to collaborate with researchers, participate in and support restoration and monitoring projects.

3. **Research:** Identifying habitat attributes and native butterfly food plants is essential for the delineation of critical habitat. Demographic research is required to assess recovery potential and to assess and monitor the viability of populations. Genetic research will be required to inform the establishment of experimental populations. Research is also required to determine the effects of threats such as: climate change, the re-introduction of fire, invasive species, herbivory and predation.

4. **Mapping and inventory:** Inventory to identify the complete range and extent of maritime meadow species at risk will help to clarify habitat characteristics and aid in the delineation of critical habitat. Inventory may find undocumented populations of some species and will minimize the risk of genetic contamination with experimental population trials.

5. **Habitat restoration:** Effective, informed restoration is critical to restore ecosystem processes, restore habitat for species at risk and mitigate threats.

6. **Public outreach and education:** Developing and distributing information about maritime meadows and their species at risk will help minimize the threats associated with public use of these habitats. Involving the public may also help with identifying undocumented populations, especially for the butterfly species. Workshops and presentations at community meetings are effective tools for educating landowners.

7. **Experimental population trials**: Establishing new populations utilizing adaptive management for some of the maritime meadows species at risk will help meet long-term species specific goals. Such experiments will also further our understanding of the biology and ecology of species at risk.

Table 8. Strategies to effect recovery

Priority	Obj. No.	Broad Approach/ Strategy	Threat[14]	General Description
Urgent	1. 2. 7.	Habitat and species protection	1. 3. 5. 6.	Develop priorities for acquisition or protection (e.g. covenants and other stewardship agreements) of sites in conjunction with the Conservation Planning and Site Protection RIG of GOERT.
Urgent	1. 2.	Habitat stewardship	1. 10. 2. 11. 4. 12. 5. 13. 7. 15. 8. 16.	Identify which private and public landowners have populations of species at risk and/or maritime meadow ecosystems that occur on their lands. Contact landowners through the public outreach program through GOERT or other organizations for stewardship to protect the species.
Necessary	3. 4. 5. 7. 8.	Research	2. 4. 5. 6. 7. 8. 10. 12. 14. 18. 19.	Determine priorities for research and conduct research where necessary to determine specific information gaps: • determine habitat attributes for each species • determine whether there are bottlenecks affecting pollination/reproduction, dispersal, seed/egg production, recruitment, recruit survival • determine which larval and nectar food plants are required by Lepidopterans and the required distribution and abundance of food plants • determine appropriate restoration and adaptive management for each species and their habitat including threats such as invasive species, woody species encroachment as well as restoring ecological processes, etc. • determine taxonomic variation with respect to US populations if required
Necessary	3. 4. 5. 6. 7. 8.	Mapping and inventory	2. 8. 3. 10. 4. 11. 6. 12. 7. 14.	Determine habitat attributes for species at risk

[14] Threats are as follows: 1. Habitat destruction. 2. Invasive plants. 3. Habitat fragmentation. 4. Changes in native vegetation composition from altered fire regimes. 5. Recreation. 6. Demographic collapse. 7. Mowing. 8. Changes to hydrology. 9. Climate change. 10. Effects of re-introducing fire. 11. Livestock grazing. 12. Cutting or hand pulling of invasive plants. 13. Maintenance activities. 14. Herbivory. 15. Pesticides. 16. Landscaping of non-native plants. 17. Marine pollution. 18. Invasive invertebrates. 19. Invasive vertebrates.

Priority	Obj. No.	Broad Approach/ Strategy	Threat[14]	General Description
Necessary	2. 3. 4. 5. 6. 7. 8.	Mapping and inventory	1. 2. 3. 4. 5. 8.	Assess existing meadows to prioritize for other activities including acquisition, restoration, translocation of species at risk, etc. Conduct inventories for new species at risk in maritime meadow habitats.
Necessary	1. 3. 4. 5. 7.	Habitat restoration	2. 6. 3. 7. 4. 10.	Determine the need for and feasibility of restoration and, if appropriate, develop and conduct trials for maritime meadow restoration
Beneficial	3. 4. 5. 6.	Public education and outreach	2. 10. 3. 12. 5. 13. 7. 15. 8. 16.	Develop priorities in conjunction with GOERT's Public Education and Extension Specialist and other organizations, 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)
Beneficial	1. 3. 4. 5. 7. 8.	Experimental population trials	1. 3. 6. 9.	Determine the need for establishing new populations, and if appropriate, determine locations for translocations.

1.9.3 Knowledge gaps common to all or most species

There are many knowledge gaps common to all or most species. The following knowledge gaps are ranked roughly in descending order of importance for recovery although this may vary between species (Summary in Table 9).

1. **Effects of invasive species and responses of invasive species, species at risk and habitat to management:** This includes the effect of woody encroachment due to altered disturbance regimes; responses of species at risk and their habitat to management, restoration and invasive species control; lack of targets for restoration activities; traditional landscape management, and the use of fire, and species-specific responses to the re-introduction of fire regimes.

2. **Detailed characteristics and delineation of suitable habitat**, particularly for extirpated populations: This includes the range of habitat suitable for each species (e.g. soil characteristics, microhabitat, etc.), minimum habitat patch sizes, matrix composition, and the effectiveness of buffers and linkages at allowing dispersal of species between habitat patches; soil processes including the role and identification of mycorrhizae, soil fauna and the effect of introduced species (including earthworms); specific native and introduced larval and nectar food plants for island marble and Taylor's checkerspot.

3. **Species-specific demographic and dispersal information:** This includes defining where demographic bottlenecks for each species occur (ie. seed or egg production, dispersal, recruitment, recruitment survivorship, etc.) and the effect of limited gene pools on reproductive capacity.

4. **Accurate species distributions and total numbers of populations:** Not all historical locations have been inventoried to determine if populations still persist. Systematic surveys are required to determine accurate species distribution and population information and to ensure all populations are protected and appropriately managed.

5. **Trophic and other ecological interactions:** This includes the role of species at risk in their respective habitats including the degree and effect of interactions with native and introduced herbivores, pests and diseases and pollination in maritime meadows.

6. ***Ex situ* germination/ propagation methodologies for plants and captive breeding/rearing techniques for butterflies:** Although most of the species in this recovery strategy have been propagated *ex situ*, they have not been subjected to rigorous propagation or captive breeding studies. There is limited information about re-establishing these species in the wild.

7. **Nature of genetic differences between US and Canadian populations of prairie lupine, Taylor's checkerspot and island marble:** Although the taxonomy of most species is well defined, genetic studies are required to clarify taxonomy for prairie lupine and the island marble. Genetic studies are also required to compare Canadian populations of species at risk to their US counterparts since many populations are widely disjunct and may be genetically distinct. This information will provide an important foundation for identifying donor populations for translocation attempts.

Table 9. Knowledge gaps common to all or most species

IM=island marble, TC=Taylor's checkerspot, BOC= bearded owl-clover, BFS=bear's-foot sanicle, CSC=coastal Scouler's catchfly, GP=golden paintbrush, PL=prairie lupine, PS=purple sanicle, SBL=seaside birds-foot lotus. √ Means this is a knowledge gap for this species. "K" indicates there is some knowledge in the area, ± indicates limited studies.

Knowledge gaps	IM	TC	BOC	BFS	CSC	GP	PL	PS	SBL
1. Effects of invasive species and the response of invasive species, species at risk and habitat to management	√	√	√	√	√	√	√	√	√
2. Detailed characteristics and delineation of suitable habitat	√	√	√	√	√	√	√	√	In prog.
3. Species-specific demographic and dispersal information	√	√	√	K	K	K	√	K	K
4. Accurate species distributions and total numbers of populations		√	√	√	K	√	√	√	K
5. Trophic and other ecological interactions	√	√	√	√	√	√	√	√	√
6. *Ex situ* germination/ propagation methodologies for plants and captive breeding/rearing techniques for butterflies	√	√	±	K	K	K	±	±	K
7. Genetic studies	√	√	√	√	√	K	√	√	√

1.9.4 Management effects on other species/ecological processes

Garry oak and associated ecosystems are home to a large number of at risk taxa including 3 mosses, 71 plants, 1 earthworm, 3 dragonflies/damselflies, 5 true bugs, 2 flies, 13 butterflies, 2 reptiles, 14 birds and 3 mammals (list available online at www.goert.ca) (GOERT 2004). Because of the large number of taxa at risk and the high concentrations of rare species at some locations, it is not possible to describe all of the possible positive and negative effects associated with recovery. These management effects must be addressed at a later stage either in the Recovery Action Plan, or during on-site evaluations. A comprehensive list of co-occurring plant species is included below (Table 10). In addition, potential effects on vertebrate and invertebrate species at risk are discussed.

There are potential negative interactions between the butterfly and plant species addressed in this recovery strategy. Island marbles feed on introduced mustard (*Brassica* and *Sisymbrium* spp.) as well as *Lepidium* spp. (including *Lepidium virginicum*). Restoration should focus on the planting of the native species. Historic populations of Taylor's checkerspot on Alpha and Trial Islands may have used golden paintbrush (*Castilleja levisecta*) as a food plant, although this has not been confirmed (Miskelly pers. comm. 2004). Taylor's checkerspot larvae have also been found on *Tryphysaria pusilla* and may feed on other owl-clover species (Potter pers. comm. 2005). Invasive species management should be coordinated with butterfly life cycles.

The provincially red-listed Coastal Vesper Sparrows *affinis* subspecies (*Pooecetes gramineus affinis*), the endangered Horned Lark *strigata* subspecies (*Eromophila alpestris strigata*), and the Georgia depression population of Western Meadowlarks (*Sturnella neglecta*) are known to use

native grasslands and open habitat with short, sparse vegetation. Garry oak and associated ecosystems may be necessary for their recovery (Beauchesne 2002; Beauchesne et al. 2002; COSEWIC 2003a). Although there is no current overlap of confirmed sites, Coastal Vesper Sparrows and Western Meadowlarks may benefit from recovery actions outlined in this strategy. Control of invasive species may be beneficial provided it is not done during breeding season at confirmed locations of these species: early May to late June for Vesper Sparrows and early April to end of July for Meadowlarks (Beauchesne 2002; Beauchesne et al. 2002). Consideration of the use of shrubs for breeding purposes is necessary in invasive species control (i.e. potentially replacing invasive broom with native ocean spray, Nootka rose and saskatoon). This should be approached with caution as potential for some shrub species to affect the plant species at risk, in particular the Nootka rose which is rhizomatous.

Portions of Garry oak and associated ecosystems may be designated as critical habitat for the Horned Lark *strigata* subspecies, since little other potential habitat remains intact. Ongoing communication between GOERT, its relevant Recovery Implementation Groups, and the Horned Lark *strigata* subspecies & Vesper sparrow *affinis* subspecies Recovery Team will need to continue.

Although both Great Blue Heron (*Ardea herodias fanninni*) and Peregrine Falcon (*Falco peregrinus anatum*) are found at locations that roughly overlap with maritime meadow species at risk, there are no anticipated negative effects to either of these species associated with recovery of the rare plants and butterflies.

Given the large number of co-occurring plants at risk in maritime meadow ecosystems, it is not possible to discuss all possible interactions associated with recovery.

Recovery of the species covered in this recovery strategy 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.
- Management of invasive species may restore habitat for other plant species at risk.

However, recovery of the species covered in this recovery strategy may negatively affect other plants at risk. For example:

- If not planned and implemented very carefully, large-scale management actions, such as invasive species removal, may have a negative effect on other plants at risk (e.g. through trampling, increased herbivory and inadvertent dispersal of alien species during disposal).
- All on-site activities (surveys, research and management) to aid recovery pose a threat from trampling to co-occurring rare species that occur in or near maritime meadow ecosystems, unless care is taken to avoid damage.

Table 10. Co-occurring plant species at risk

Status: E =endangered, T =threatened, SC =Special Concern, P =proposed for COSEWIC listing, S-ranks assigned by as per BC Conservation Data Centre

Species	Common name	Subnational (Provincial Rank)	COSEWIC Status
Agrostis pallens	dune bentgrass	S3	
Allium amplectens	slimleaf onion	S3	
Allium geyeri var. *tenerum*	Geyer's onion	S2	
Alopecurus carolinianus	Carolina meadow-foxtail	S2	
Anagallis minima	chaffweed	S2S3	
Balsamorhiza deltoidea	deltoid balsamroot	S1	E
Callitriche marginata	winged water-starwort	S1	P
Carex tumulicola	foothill sedge	S1	P
Castilleja ambigua ssp. *ambigua*	paintbrush owl-clover	S2	
Centaurium muehlenbergii	Muhlenberg's centaury	S1	P
Clarkia amoena	farewell-to-spring	S2S3	
Clarkia purpurea ssp. *quadrivulnera*	twiggy godetia	S1	
Claytonia rubra ssp. *depressa*	redstem springbeauty	S3	
Crassula aquatica	pigmyweed	S3	
Crassula connata var. *connata*	erect pigmyweed	S2	
Epilobium densiflorum	dense spike-primrose	S1	E
Helenium autumnale	mountain sneezeweed	S2S3	
Heterocodon rariflorum	heterocodon	S3	
Idahoa scapigera	scalepod	S2	
Isoetes nuttallii	Nuttall's quillwort	S3	
Juncus kelloggii	Kellogg's rush	S1	E
Limnanthes macounii	Macoun's meadow-foam	S3	SC
Lomatium dissectum	fern-leaved desert-parsley	S1	
Lotus unifoliolatus var. *unifoliolatus*	Spanish clover	S2S3	
Lupinus densiflorus var. *densiflorus*	dense-flowered lupine	S1	E
Meconella oregana	white meconella	S2	E
Microseris bigelovii	coast microseris	S1	P
Orthocarpus bracteosus	rosy owl-clover	S1	E
Plagiobothrys tenellus	slender popcornflower	S2	

Species	Common name	Subnational (Provincial Rank)	COSEWIC Status
Piperia elegans	elegant rein orchid	S2S3	
Psilocarphus elatior	tall woolly-heads	S1	E
Ranunculus alismifolius	water-plantain buttercup	S1	E
Ranunculus californicus	California buttercup	S1	
Romanzoffia tracyi	Tracy's romanzoffia	S3	
Rupertia physodes	California-tea	S3	
Sagina decumbens ssp. *occidentalis*	western pearlwort	S3	
Seriocarpus rigidus	white-top aster	S2	T
Sidalcea hendersonii	Henderson's checker-mallow	S3	
Spergularia macrotheca var. *macrotheca*	beach sand-spurry	S2S3	
Trifolium depauperatum var. *depauperatum*	poverty clover	S3	
Triteleia howellii	Howells' triteleia	S1	E
Viola howellii	Howell's violet	S2S3	
Viola praemorsa ssp. *praemorsa*	yellow montane violet	S2	T

1.9.5 Examples of recovery actions already completed or underway

The following recovery actions apply to one or more of the species at risk and are linked to the broad strategies for recovery activities (Section V. 2.). A more comprehensive list of recovery actions has been compiled in a background document (Fairbarns and Maslovat 2005).

Relevant recovery strategies

- Miller, M. In prep. *National Multi-Species Recovery Strategy for Plants at Risk in Vernal Pools and Other Ephemeral Wet Areas Associated with Garry Oak Ecosystems*.
- Douglas, G.W. and S. Smith. In prep. *National Multi-species Recovery Strategy for Woodland Species Associated with Garry Oak Ecosystems*.

Habitat protection

- GOERT's Conservation Planning and Site Protection RIG has developed a list of sites for which it is a priority to raise local securement and protection. CRD Parks Best Management Practices for marking, building and maintaining trails in open, rocky areas (Maslovat 2003).

Habitat stewardship

- GOERT Invertebrates at Risk Recovery Implementation Group public lectures held on Saltspring Island and Hornby Island to inform local landowners about butterflies at risk in the Garry oak ecosystems.

Demographic and genetic research

- GOERT has supported, initiated and/or continued research regarding
  - rare butterfly ecology
  - butterfly diversity in relation to fragmentation, climate change, habitat loss, and exotic shrub invasion
  - fire history
  - indigenous ecological management
  - effects of mammalian herbivores and exotic plants on plant diversity
  - restoration strategies.
  - Research on demographic and phenological patterns of several plants at risk (Fairbarns in. prep. a-e.).

Mapping and inventory

- Identification of critical components of suitable butterfly habitat and potential sites for native habitat restoration (in progress, Miskelly pers. comm. 2004).
- Inventory of the major Gulf Islands and Saanich Inlet for Taylor's checkerspot and island marble (Guppy and Fischer 2001).
- Identification of critical components of suitable seaside birds-foot lotus habitat (in progress, Fairbarns 2005)

Habitat restoration

- Research in Helliwell Provincial Park on Hornby Island to determine quality of checkerspot habitat and response to restoration (in progress, Miskelly pers. comm. 2004).
- Draft Invasive Species Management Plan for all DND properties (Smith pers. comm. 2004)
- CRD Parks Mill Hill Regional Park Restoration Plan (CRD Parks 2003)
- Volunteer removal of invasive shrubs and vines from Harling Point in Victoria supported by Parks Canada, the municipality of Oak Bay and the Chinese Benevolent Society.

Public outreach and education

- GOERT's *Species at Risk in Garry Oak and Associated Ecosystems in British Columbia* stewardship manual (GOERT 2003).
- CRD Parks draft communications plan for the Sooke Hills Wilderness Area and Mount Wells Regional Park (Groves pers. comm. 2004).
- Garry Oak Ecosystems Invertebrates at Risk RIG public presentations to inform local landowners about the butterflies at risk in the Garry oak ecosystems (Heron pers. comm. 2004).

Experimental population trials

- Preparation of a draft reintroduction plan for *Castilleja levisecta* (golden paintbrush) that can inform reintroduction procedures in Canada for all maritime meadow species (Caplow 2001).
- A captive rearing program for Taylor's checkerspot is being developed at Oregon Zoo (Potter pers. comm. 20054).
- Staff from the City of Victoria Parks Department are testing methods for propagating golden paintbrush (Hook pers. comm. 2004).

1.9.6 Statement of when Recovery Action Plan (RAP) will be completed

A draft action plan should be completed by March 2010.

1.9.7 Socioeconomic considerations

Recovery of species at risk and restoration of imperiled habitats associated with Garry oak ecosystems will contribute to biodiversity, health and functioning of the environment and enhance opportunities for appreciation of such special places and species thereby contributing to overall social value in southwestern British Columbia. The natural beauty of Garry oak ecosystems in the lower mainland, Gulf Islands and Vancouver Island are an important resource for British Columbians that provide for a robust tourism and recreation industry. Protecting these natural spaces, biodiversity, opportunities for nature appreciation, spiritual renewal and other recreation values has enormous value to the local economy.

Some activities occurring in and around maritime meadows can impact sensitive species at risk. Deleterious impacts on species at risk and the integrity of these spaces may occur through activities that:

- modify or damage ecological processes important for maintenance of these sites,
- directly or indirectly introduce species, native or non-native, that alter the biotic or abiotic environment in a manner detrimental to processes important for the perpetuation of Maritime Meadows,
- directly damage or destroy an individual species at risk (such as through trampling or wheeled activities), or
- modify or destroy maritime meadows (such as through complete terra-forming).

Recovery actions could potentially affect the following socioeconomic sectors: recreation; private land development; operations and maintenance activities. The expected magnitude of these effects is expected to be low in almost all cases

Maritime meadows are rare on the landscape: the overall land area required for physical protection of these sites is relatively small within the region. Effective mitigation of potentially detrimental activities can be accomplished through careful planning and environmental assessment of proposed developments and site activities and sensitive routing of travel corridors and recreational activities with minimal negative economic consequences in most instances.

Recovery of maritime meadows and their associated species at risk will require intelligent planning for any development, and determination of appropriate uses for sensitive locations. Managers of public lands such as parks can provide appropriate opportunities for site access and manage site infrastructure in a manner that helps maintain and improve maritime meadows under their stewardship.

1.9.8 Evaluation and measure of success

Performance measures that can be used to evaluate the success of recovery include:

- Number of high priority sites protected. This may involve protection in any form including stewardship agreements and conservation covenants on private lands, land use designations on crown lands, and protection in municipal parks and other types of land tenures.
- Change or maintenance in provincial or national rank of species at risk covered in this recovery strategy
- Creation of a ranking system to prioritize maritime meadow sites for acquisition and protection under stewardship agreements
- Creation of economic or other incentives for private landowners to protect maritime meadows
- Number of communication and outreach plans developed for maritime meadows
- Creation of prairie lupine and coastal Scouler's catchfly species at risk stewardship manual insert sheets
- Number of management plans developed for each specific maritime meadow location
- Number of sites with appropriate management for maritime meadows implemented
- Evidence of long-term viability of species at sites where stewardship and protection are in place
- Refinement of critical habitat description (based on research to address knowledge gaps)
- Creation of a translocation Decision Support Tool (or Best Management Practices) or equivalent
- Creation of a seedbank program and a captive rearing program
- Number of new locations for species (where additional surveys are recommended in the objectives) through surveys and reports from the public
- Number of participants at the Garry oak ecosystems butterfly blitz
- Number of landowners given informational materials and best management practice guidelines for maritime meadow species at risk on their property.
- Number of visitors to the invertebrates at risk website and the Garry oak ecosystems recovery team website.
- Number of locations in which habitat is improved by carefully removing invasive species
- Information sharing with the US counterparts managing recovery in the United States.
- Listing of maritime meadow species at risk under the BC *Wildlife Act*
- Number of municipalities that use the BC Community Charter to enact bylaws, agreements etc. to protect maritime meadow species at risk under the BC Community Charter

SPECIES DESCRIPTIONS

1.10 Island marble Euchloe ausonides insulanus

Common Name: island marble.

Scientific Name: *Euchloe ausonides insulanus* Guppy & Shepard.

Status: Extirpated.

Reason for designation: This butterfly was formerly found on two islands off the west coast, but has not been seen in Canada since 1908. It is presumed to have been extirpated by 1910.

Canadian Occurrence: British Columbia.

Status history: Extirpated by 1910. Designated Extirpated in April 1999. Status confirmed in May 2000. Last assessment based on an existing status report.

1.10.1 The species

Euchloe ausonides subspecies *insulanus* is a well-delineated taxon as described in the COSEWIC Status report (Shepard 2000b). The species was recognized as a separate subspecies as described in Guppy and Shepard (2001).

The island marble is a white and greyish black butterfly with a marbled texture to the underside of the hindwings and black markings at the tips of the forewings. The veins on the hindwings are emphasized as yellowish lines, giving the species a marbled appearance. The sexes are similar but the females have darker yellowish marbling on the hindwings, and a yellow ground colour, compared to the white of the males. The body is covered with whitish-yellow hairs giving it a fuzzy appearance.

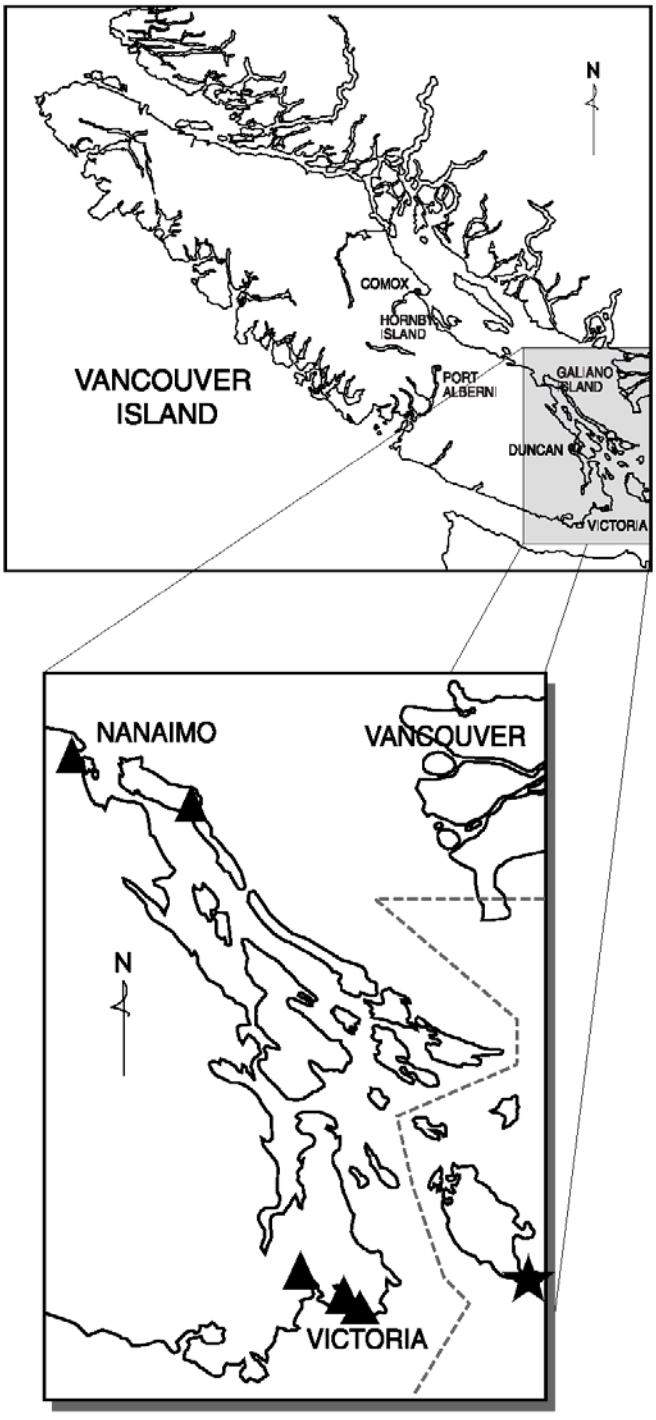


Figure 1. Approximate global and Canadian distribution of island marble

(Extant populations shown as stars, extirpated populations as triangles)

1.10.2 Distribution

The subspecies *Euchloe ausonides insulanus* is isolated from the rest of the species' range. The species as a whole is found from Alaska south to California and Colorado and east to Ontario and Minnesota.

The current global range of the subspecies, *insulanus* consists of one known population in Washington State (S1), identified in 1998 at San Juan Island Historical Park, American Camp, San Juan Island, Washington (Figure 1) (J. Fleckenstein per. comm. 2002). Other than this single population, the subspecies *insulanus* has not been documented in the United States. The subspecies has been extirpated from British Columbia (Hinchliff 1994, 1996; Layberry et al. 1998).

1.10.3 Population and distribution trend

The island marble is known from 14 historical records in Canada suggesting the existence of five naturally fragmented populations distributed among the Greater Victoria area (Langford, Beacon Hill Park and James Bay), and Nanaimo (Wellington) on Vancouver Island and Gabriola Island (Figure 1). The earliest record, from the 1860s, was a specimen labeled simply 'Vancouver;' this was most likely a reference to Vancouver Island. The species is presumed extirpated by about 1910, with the last record in Canada being in 1908 on Gabriola Island. Recent survey efforts have not located any new populations of this species in Canada.

Extirpation of the island marble in Garry oak ecosystems in Canada occurred prior to substantial habitat loss of these ecosystems. It is suspected that grazing by sheep and/or cattle prior to, or during World War I eliminated the larval foodplant (suspected to be hairy rockcress [*Arabis hirsuta*]) and acted as the primary cause leading to extirpation of this species from British Columbia (Shepard 2000b). The overall reasons for extirpation are unknown.

There is no published estimate of global abundance for the population on San Juan Island. At least 20 individuals were observed in 2002, (Fleckenstein pers.comm. 2002; Miskelly pers. comm.2004), and at least 100 in 2003 (Pyle pers. comm.2003), but no population estimate was completed. There is no indication of the former total number of individuals in Canada.

1.10.4 Biotic and abiotic features of habitat

Since the island marble has not been recorded in Canada since 1908, habitat requirements are based on information from the San Juan Island population in the United States and current descriptions of sites with historic records.

The San Juan Island population lives in a large (> 100 ha) open area that contains three distinct habitats: mesic, disturbed grassland; sand dunes; and shorelines. The area primarily faces west and is devoid of large trees. The areas used by the butterflies are not steep: slopes range from flat to up to 50% (Miskelly pers. obs. 2004). Introduced mustards (Brassicaceae) are patchy but abundant in the grassland and sand dunes, while native foodplants are abundant along the shorelines. Native and introduced weedy mustards (Brassicaceae) usually reach their highest densities in moderately disturbed areas. The mustard plants in the grasslands grow in areas

disturbed by burrowing mammals (Fleckenstein pers. comm. 2002; Miskelly pers. comm. 2004; Pyle pers. comm. 2003). There are no similar habitats of this scale in Canada.

The extant population on San Juan Island, Washington, oviposits on the introduced European weeds field mustard (*Brassica campestris*) and tumble mustard (*Sisymbria altissimum*), and the native tall pepper-grass (*Lepidium virginicum*), family Brassicaceae (Fleckenstein pers. comm. 2002; Miskelly pers. comm. 2004; Pyle pers. comm. 2003). This is consistent with documented use of weedy introduced Brassicaceae by larvae of other subspecies of *Euchloe ausonides* (Opler 1975). Field mustard grows in more mesic habitat than native rockcress (*Arabis*) species, and is therefore less susceptible to early dessication.

In Canada, it is likely that the island marble was associated with open grassland successional stages of Garry oak and associated ecosystems. Larval foodplants in British Columbia were likely rockcress (*Arabis* spp.), perhaps *A. hirsuta* (Shepard 2000a; 2000b), as well as tall pepper-grass (*Lepidium virginicum*). Rockcress (*Arabis* spp.) is the major foodplant for subspecies *mayi* in the southern interior of BC. However there is no historical record of the larval foodplants or the habitats used.

1.10.5 Spatial requirements

The amount of habitat needed to sustain a viable population is unknown. It is likely that a moderately large habitat patch or close proximity to other patches is required for long term survival. A patch of 50 to 100 hectares of high quality habitat may be required, based on an estimate of a 100 ha area inhabited by the extant population on San Juan Island although further research is required to determine minimum habitat sizes. There are very few habitat patches of this size that remain in British Columbia.

1.10.6 Annual cycle

Eggs hatch from late May to late June and larvae feed until pupation, which occurs between late-June and late-July.

High mortality results if the larval food plants desiccate prior to pupation. The amount of spring and early summer rain affects the date of food plant senescence, and hence larval success in reaching pupation.

1.10.7 Ecological niche

There has been no research on the ecological role of this butterfly. The adults may be minor pollinators of flowers. The larvae are minor herbivores of Brassicaceae family and feed on flowers and fruits. Adults, larvae and pupae may serve as prey for insectivorous birds, small mammals, and predatory insects (Family Braconidae). Eggs, larvae and pupae are likely to also function as hosts for insect parasitoids (van Nouhys and Hanski, 2004).

1.10.8 Biologically limiting factors

There is minimal knowledge of the biologically limiting factors for the island marble. Flight and dispersal capabilities have not been studied. Observations on the behaviour of subspecies *mayi*, suggest that individual adults may move significant distances during their lifespan. In California, near the ocean, adults of *E. ausonides* have been documented moving up to one kilometre (Scott 1975a; 1975b).

The larvae of island marbles are actively feeding during late May and June, the later part of the period in which *Btk* is scheduled for application in the historic range of the species in British Columbia (Nealis pers. comm. 2003).

1.11 Taylor's checkerspot *Euphydryas editha taylori*

Common Name: Taylor's checkerspot.

Scientific Name: *Euphydryas editha taylori* (W. H. Edwards).

Status: Endangered.

Reason for designation: This butterfly has undergone significant range-wide reductions in population size. Until recently, it persisted at one site in Canada in coastal grasslands. Much of its habitat has been destroyed, and introduced invasive plants have eliminated its larval host plant in most of the remaining site.

Canadian Occurrence: British Columbia.

Status history: Designated Endangered in November 2000. Assessment based on a new status report.

1.11.1 The species

Taylor's checkerspot is a medium-size butterfly. The upper wing surfaces have distinct alternate black and orange bands. Wing undersides show a pattern of orange, white, red, pale cream and black-checkered bands outlined with black. Checkered bands are parallel to the black thorax and abdomen. The front wings have rounded tips. Males are slightly smaller than females.

Caterpillars are black with orange bands. Eggs are pale yellow and transparent. *Euphydryas editha taylori* is a well-delineated taxon as described in the COSEWIC Status report (Shepard 2000c).

1.11.2 Distribution

The current global range consists of fifteen known populations in Clallum County and the south Puget Sound (Washington) (S1), and the Willamette Valley (Oregon) (S1) (Figure 2).

In Canada, Taylor's checkerspot is known historically from 22 naturally fragmented populations: fifteen sites in the greater Victoria area, three sites from Mill Bay to Duncan, three sites on Hornby Island and one near Courtenay (Figure 2). Records date from 1887 to 1995. The species is currently listed as Endangered (2000), although recent surveys in 2001 and 2003 of the last known sites confirmed the species is likely extirpated from Canada (Miskelly 2003). However, in 2005, 15 individuals were found on Denman Island, near Courtenay on Vancouver Island (Jennifer Heron, pers. comm., 2005).

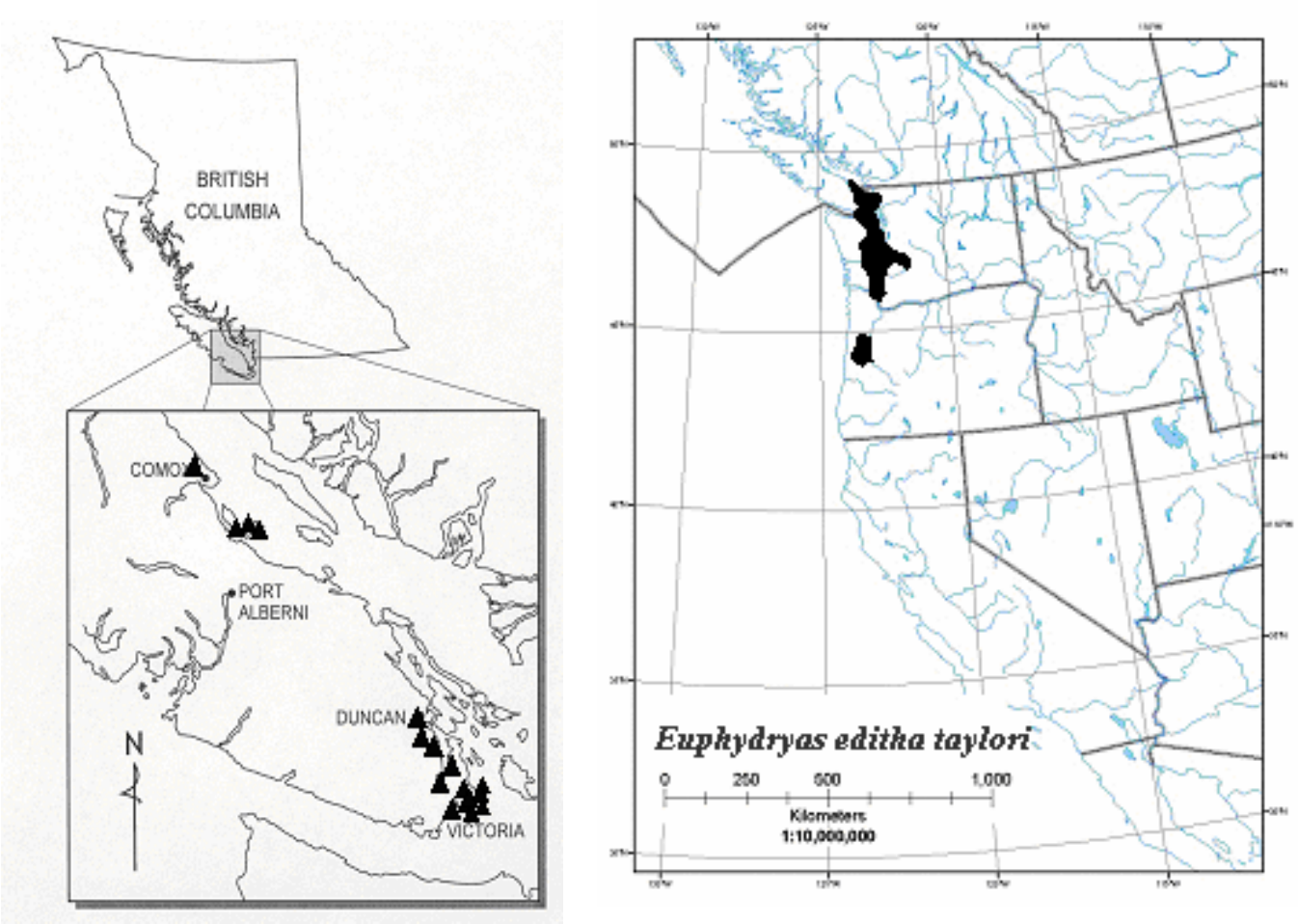


Figure 2. Global and Canadian distribution of Taylor's checkerspot

(Extirpated populations shown as triangles)

1.11.3 Population and distribution trend

Many of the populations in the Victoria area persisted until the 1950s except the Beacon Hill Park population, which was likely extirpated by the early 1930s. In 1989, only one population remained, which was in a powerline right-of-way 3 km southwest of Mill Bay (Shepard 2000c), which was also extirpated by 1995 (Shepard 2000a). In 1995, several populations were found on Hornby Island, were known to be extant in 1996 (Shepard 1995; Shepard 2000b; 2000c), but were thought to be extirpated by 2001 (Guppy and Fischer 2001).

Although trends are not documented specifically for Taylor's checkerspot habitat, Garry oak and associated ecosystems have declined substantially. Fire suppression and conifer encroachment

into areas of water seepage and deeper soil, coupled with drought, may have extirpated the Helliwell Park population on Hornby Island.

In Washington State, population sizes are unknown. The two populations in Oregon state are estimated at 1000 (Vaughan and Black 2002b) and 500 (Black pers. comm. 2004). Historic Canadian populations numbered 1100 at Hornby Island (1996) and 1000 at Mill Bay (1989) (Shepard 2000c) but there is no indication of the former total number of individuals in Canada.

1.11.4 Biotic and abiotic features of habitat

Habitat descriptions for the Taylor's checkerspot are based on observations of the last known occupied locations cccc and current descriptions of sites with historic records. There are no completed habitat studies for this butterfly in Canada, although research is underway at the University of Victoria (Eastman et al. 2002).

Taylor's checkerspot requires non-forested habitats (Shepard 2000b; 2000c). Native ecosystem habitats are not necessarily required; areas cleared by human activities, such as powerline rights-of-way, can be suitable habitat (Vaughan and Black 2002b; Shepard 2000b; 2000c). Recent surveys in Washington have found thriving populations in new locations uncharacteristic of historic populations, including a site at 600m elevation in habitat that was formerly logged and burned with sheer cliffs interspersed with the native species oceanspray (*Holodiscus discolor*), ceanothus (*Ceanothus* sp.) and currants (*Ribes* spp.) (Miskelly pers. comm. 2004).

Foodplants of extant populations in the United States are ribwort plantain (*Plantago lanceolata*), harsh paintbrush (*Castilleja hispida*), large-flowered blue-eyed Mary (*Collinsia grandiflora*), sea blush (*Plectritis congesta*) and one record of dwarf owl-clover (*Triphysaria pusilla*) (Grosboll pers.comm. 2004, Potter pers. comm. 2003;2005). Taylor's checkerspot larvae may also use sea plantian (*Plantago maritima*), golden paintbrush (*Castilleja levisecta*), and possibly other owl-clover species (Murphy et al. 1983; Pelham, pers. comm. 2003).

It is unknown whether any populations in British Columbia used anything other than ribwort plantain (*Plantago lanceolata*) as a primary or secondary foodplant (Shepard 2000b; 2000c; Danby 1890). It is speculated that Taylor's checkerspot populations in British Columbia could have used the same, additional foodplants as those used by butterflies in Washington.

Nectar is not required for reproduction, but egg production in subspecies *E. editha bayensis* is dependent on available nectar sources, with up to double the number of eggs laid when nectar was abundant (Murphy et al. 1983). Important nectar sources for extant populations of Taylor's checkerspot in the United States include common camas (*Camassia quamash*), strawberries (*Fragaria* spp.), spring gold (*Lomatium utriculatum*), and sea blush (*Plectritis congesta*) (Potter pers. comm. 2003; Grosboll pers. comm. 2003; Ross pers. comm. 2003). Nectar plants for former British Columbia populations are not known.

This species is particularly vulnerable to invasion by exotic shrubs, which decreases the availability and amount of foodplants. Scotch broom (*Cytisus scoparius*) invasion of human-cleared habitat resulted in the extirpation of the population near Mill Bay, BC (Shepard 2000b; 2000c). Invasion was implicated in the extirpation of at least one Washington population, and

may threaten one remaining population in Oregon (Vaughan and Black 2002b). The Bright Angel Provincial Park population, south of Duncan, British Columbia, was extirpated by subdivision development adjacent to the park, combined with increased native shrub growth within the park (Guppy, pers. comm. 2003).

1.11.5 Spatial requirements

In order to ensure long-term survival of a population, the required patch size is estimated to be 5 to 20 hectares of high quality habitat (abundant ribwort plantain [*Plantago lanceolata*] or harsh paintbrush [*Castilleja hispida*] and nectar sources). These figures are based on estimates of the areas occupied by historic populations (Guppy pers. comm. 2003). Several extant populations occupy areas of less than one hectare (Miskelly pers. obs. 2004).

1.11.6 Annual cycle

The related subspecies, *Euphydryas editha bayensis,* typically lays an initial mass of 130-180 eggs, with each female laying several batches of eggs of successively smaller numbers (Murphy et al. 1983). This is consistent with the size of clusters of first instar larvae observed at the Taylor's checkerspot site southwest of Mill Bay (Guppy pers. comm. 2003). The larvae hatch from eggs in May or early June and feed until they are in the late third instar and enter diapause. Techniques of captive oviposition of checkerspots, with or without captive mating, are well known and easily implemented (eg. Murphy et al. 1983). In 1988/89, Guppy (pers. comm. 2003) successfully reared Taylor's checkerspot larvae, collected as second instar from near Mill Bay, BC. In 2004, Taylor's checkerspot rearing experiments were conducted using 20-40 larvae collected in Thurston and Clallum County, Oregon. A more rigorous rearing program for Taylor's checkerspot is scheduled to begin in 2005 (Potter pers. comm. 2005). There may be significant phenological differences between populations in Canada and the United States that suggest some degree of genetic divergence (Guppy pers. comm. to Miskelly 2004).

1.11.7 Ecological niche

There has been no research on the ecological role of this butterfly. The adults, when at high densities, may be significant pollinators of native spring flowers. The larvae are major herbivores of ribwort plantain when at high densities, and can completely strip off all leaves on plants in some patches (Guppy pers. comm. 2003). There is no evidence that this herbivory adversely affects the viability of plantain populations. Adults, larvae and pupae may serve as prey for insectivorous birds, small mammals, and predatory insects. However they contain iridoid glycosides (sequestered from their larval foodplants), and hence are not palatable to most predators. Eggs, larvae and pupae are likely to also function as hosts for insect parasitoids (van Nouhys and Hanski 2004).

1.11.8 Biologically limiting factors

Dispersal capabilities of Taylor's checkerspot have not been studied. Adults of subspecies *E. editha bayensis* and *E. editha wrighti* only move 200 to 300 feet under favourable environmental conditions even within patches of suitable habitat, but may disperse more widely under stress of drought or high densities, and have difficulty establishing new populations even when

transplanted (Ehrlich 1961; Ehrlich et al. 1980; Harrison 1989; Murphy and White 1984). *E. editha taylori* appears to be less limited in dispersal abilities, and has been observed crossing forested areas and other barriers (Potter pers.comm. 2003; Vaughn pers. comm. 2003; Black pers. comm. 2004). Metapopulations of subspecies *bayensis* rely on a large, stable central population as a source to establish and stabilize peripheral populations (Harrison 1989). If new populations are re-established in Canada, distance between patches of suitable habitat may have a strong influence on dispersal potential. In some instances, populations of subspecies *bayensis* are very close to another and share very few individuals and did not rescue one another from extirpation (Hellmann et al. 2003, McLaughlin et al. 2002).

Larval starvation results when the foodplants, especially plantain, desiccate due to summer drought prior to the larvae entering diapause (Vaughan and Black 2002b). This is believed to be the main cause of mortality in this species. The effects of weather on larval success in reaching diapause, and on survival through diapause, has been demonstrated to be a key variable in determining adult population size and population persistence in the Californian subspecies *bayensis* (McLaughlin et al. 2002). Viable populations of other subspecies in California are around 1000 individuals (Ehrlich 1961; Hellmann et al. 2003) with smaller populations having greater susceptibility to extirpation by droughts or other stochastic events. However, even populations that numbered around 1000 individuals have become extirpated (Hellman pers. comm. 2005). Climate change is expected to increase rates of extinction for Taylor's checkerspot (McLaughlin et al. 2002) by limiting the variability of foodplants phenology.

Taylor's checkerspot larvae are actively feeding during the early spring when *Btk* is normally applied to control forest pests (Wagner and Miller 1995; Nealis pers. comm. 2003).

1.12 Bearded owl-clover *Triphysaria versicolor* ssp. *versicolor*

Assessment Summary – May 2000

Common name: bearded owl-clover

Scientific name: *Triphysaria versicolor* ssp. *versicolor*

Status: Endangered

Reason for designation: Disjunct with highly specific habitat requirements, few populations in restricted range, subject to development, risks from recreational activities and competition with exotic plants.

Occurence: British Columbia

Status history: Designated Endangered in April 1998. Status re-examined and confirmed in May 2000. May 2000 assessment based on new quantitative criteria applied to information from the existing 1998 status report.

1.12.1 The species

Triphysaria versicolor Fisch. & C. Meyer ssp. *versicolor* is a well-delineated taxon as described in the status report (Penny et al. 1996). *T. versicolor* ssp. *faucibarbatus,* the only other taxon within the species, is restricted to California (Chuang and Heckard 1993).
Bearded owl-clover is a small (10-50 cm) annual herbaceous plant with tiny hairs on the leaves and stems. The leaves are pinnately divided onto linear segments. The inflorescence, a terminal spike, has white or pink flowers and leaf-like bracts. The club-shaped corollas distinguish bearded owl-clover from narrow-leaved owl-clover (*Castilleja attenuatus*). It can be distinguished from dwarf owl-clover (*T. pusilla*), which is a smaller plant with more finely dissected leaf segments (Douglas et al. 2000; Penny et al. 2000). Bearded owl-clover is a root-parasite (hemiparasite) that appears to parasitize a broad range of host species.

1.12.2 Distribution

Bearded owl-clover ranges from southern Vancouver Island, south along the Pacific coast to southern California (figure 3). The species is absent from Washington State and northern Oregon; the Canadian populations are disjunct, by about 500 km, from the next nearest populations in Lane County (Oregon). In the United States, bearded owl-clover is ranked SNR in California and Oregon, the only two states where it occurs (NatureServe 2004).

In Canada, the historical extent of occurrence covered approximately 95 km^2 and the current extent of occurrence is under 15 km^2. The COSEWIC status report estimates the area of occupancy to be 379 m^2 although since this report two newly documented populations (combined area under 200 m^2) place the total area of occupancy in Canada under 600 m^2.

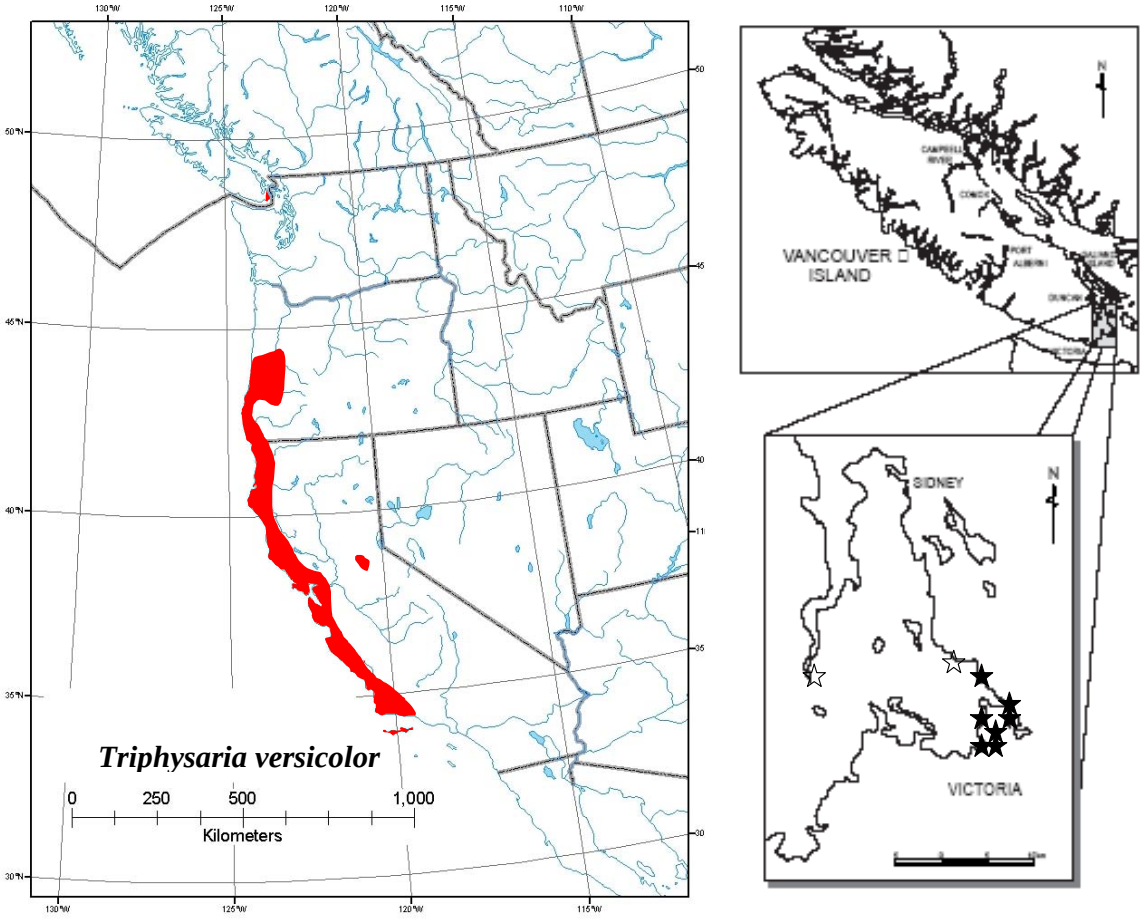


Figure 3. Global and Canadian distribution of bearded owl-clover

(Global distribution on left; Canadian distribution on right with open stars showing extirpated populations and solid stars showing locations of one or more extant populations)

1.12.3 Population and distribution trend

There are seven extant populations and one that has been extirpated. This has been confirmed using the description of populations from the BC Conservation Data Centre criterion for recognizing distinct populations (those separated by less than 1,000 m as subpopulations) in addition to subsequent surveys. The COSEWIC status report describes eight extant 'populations' and two or three other populations (the record from Mount Finlayson may have been based on a misidentification) which have not been reported for more than 80 years (Penny et al. 1996).

The COSEWIC status report estimates a total population size of between 4,000 and 5,000 plants (Penny et al. 1996). Subsequent surveys (Table 11) of some populations indicated that their numbers may be higher, at least in favourable years.

Table 11. Population information for bearded owl-clover in Canada

Population	Land Tenure	Data from Status Report			Subsequent Data		
		Date	Observer	# Plants	Date	Observer	# Plants
Cedar Hill	unknown	1897	Henry	unknown	No further information		
Mount Finlayson	unknown	1908	Newcombe	unknown	No further information		
Islands south of Victoria	unknown	1915	Higgins	unknown	May be from the populations recently described from Mary Tod and/or Strongtide Islands		
Ten Mile Point	private property	1996	Penny	61	2002	Penny	> 1,900
Cattle Point	Municipality of Oak Bay (designated as an urban park)	1996	Penny	1,300	Mapped in 2003 but not counted		
Victoria Golf Club	private property	1996	Penny	300	2004	Fairbarns	250-400
Harling Point	private property designated a National Historic Site	1996	Penny	67	2002	Fairbarns	270
Glencoe Cove	Municipality of Saanich (designated as an urban park)	1996	Penny	2,500	2001	Penny	4,100
Mary Tod Island	Municipality of Oak Bay (designated as an urban park)	Population unknown when status report written			2001	Douglas	6
Strongtide Island	Songhees Indian Reserve	Population unknown when status report written			2003	Fairbarns	500-1,000

1.12.4 Biotic and abiotic features of habitat

Bearded owl-clover grows in maritime meadows and seepages. It is largely restricted to low sites <10 m above sea level and within 30 m of the shoreline. It occurs in rocky areas and moderately shallow soils and its habitat is often maintained open by a combination of salt spray, wind, summer drought and winter seepage, which combine to prevent trees, shrubs and more robust herbs from becoming established. It occurs in vegetation dominated by grasses and forbs. The sites have not been ploughed in the past but often contain large amounts of invasive alien pasture grasses including orchard-grass (*Dactylis glomerata*), barren brome (*Bromus sterilis*), soft brome (*B. hordeaceus*), sweet vernalgrass (*Anthoxanthum odoratum*), hedgehog dogtail (*Cynosurus echinatus*) and common velvet-grass (*Holcus lanatus*). The meadow soils are fresh or wet throughout the winter months but dry to the permanent wilting point by mid-summer.

1.12.5 Annual cycle

Bearded owl-clover is an annual plant. Unpublished notes (M. Fairbarns 2003 and 2004) have documented the annual cycle.

Unpublished notes (M. Fairbarns 2003 and 2004) from Harling Point, Victoria Golf Club, Glencoe Cove and Strongtide Island reveal the following cycle. Germination begins in January. At least some seedlings, bearing nothing but cotyledons, are found as late as mid-March. True leaves are evident on rapidly growing plants by as early as February. Most plants are dead by late June. Flowering begins in April and may continue until late May. Fruit development begins in late April and seed dispersal in some plants continues into July.

1.13 Bear's-foot sanicle *Sanicula arctopoides*

Assessment Summary – May 2001

Common name: bear's-foot sanicle

Scientific name: *Sanicula arctopoides*

Status: Endangered

Reason for Designation: Highly restricted geographically with only five populations present within a major urban centre and on adjacent small islands where habitat losses continue and major risks are posed by exotic plants.

Occurrence: British Columbia

Status history: Designated Endangered in May 2001.

1.13.1 The species

Sanicula arctopoides Hooker and Arn. Is a well-delineated taxon as described in the status report (Donovan and Douglas 2000). Kartesz (1994) does not recognize any intraspecific taxa within this species.

Bear's foot sanicle is a tap rooted perennial with prostrate or ascending branches (5-30 cm long). Basal leaves form a rosette and are irregularly toothed, somewhat succulent and often yellowish. Stem leaves are reduced. The inflorescence is several to many compact umbels with bright yellow corollas surrounded by a distinct involucel. The seeds are egg-shaped schizocarps with hooked prickles. Bear's foot sanicle is distinguished from other sanicle species by its prostrate growth habit and conspicuous involucels (Douglas et al. 1998a; Donovan and Douglas 2001).

1.13.2 Distribution

Bear's-foot sanicle ranges from southern Vancouver Island, south along the Pacific coast to central California (figure 4). The Canadian populations are disjunct, by about 150 km, from the next nearest populations on the west coast of central Washington State. The species is ranked S1 in Washington and SNR in California and Oregon (Natureserve 2004).

In Canada, bear's-foot sanicle is restricted to a small area in and near Victoria, British Columbia. The historical and current range encompassed a narrow coastal fringe about 100 km long but only about 50 m wide, hence the extent of occurrence never exceeded about 5 km^2. The COSEWIC status report estimates the area of occupancy to be 3,614 m^2. The combined area of populations subsequently documented at Rocky Point and on Discovery and Mary Tod Islands

covers less than 200 m^2. The extirpated populations at Chain Island, Cadboro Bay, Clover Point, Beacon Hill and Foul Bay are unlikely to have covered more than 1,000 m^2. From this data, the current area of occupancy in Canada is estimated at 3,814 m^2, down from a historic value of as much as 4,814 m^2.

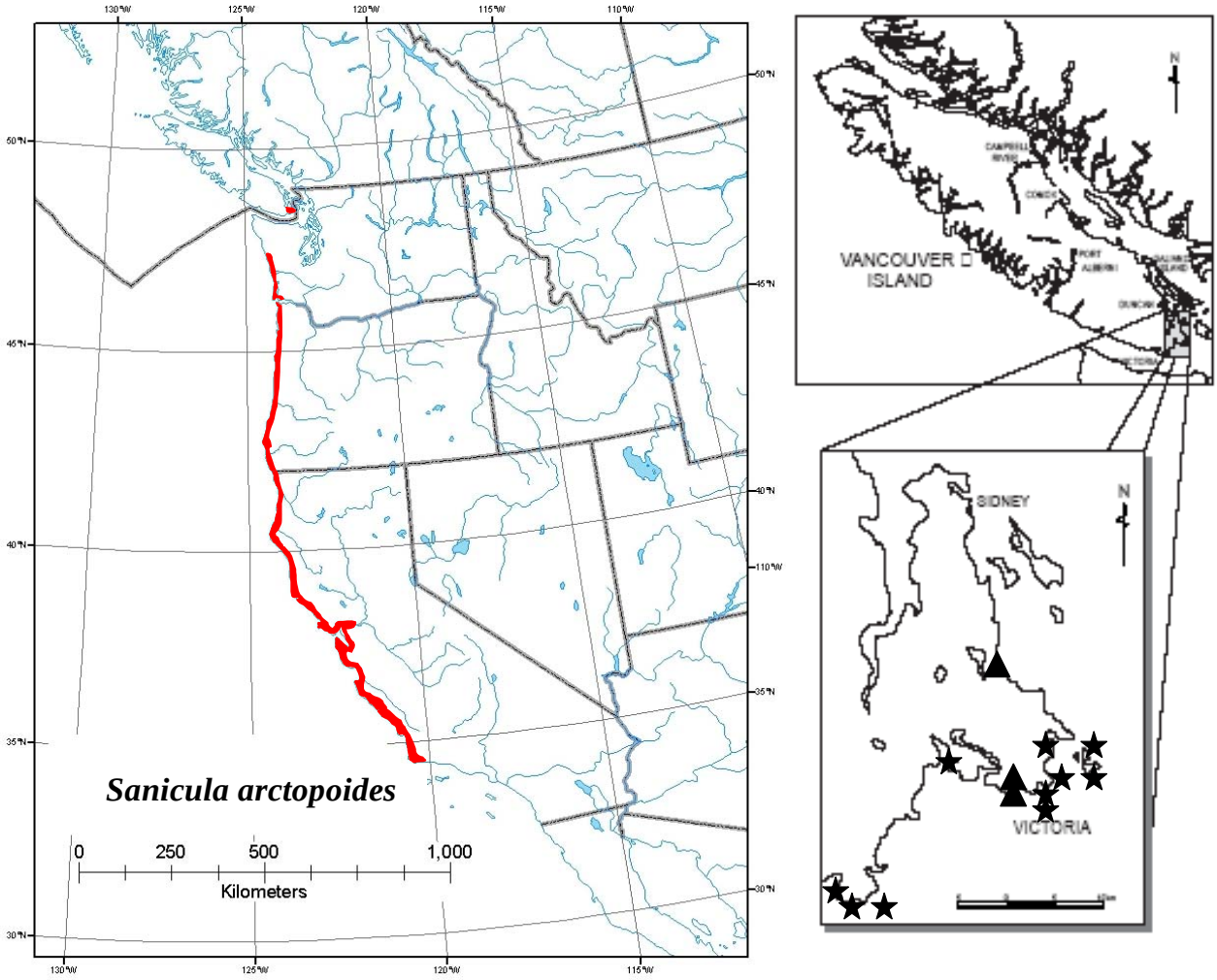


Figure 4. Global and Canadian distribution of bear's-foot sanicle

(Global distribution on left; Canadian distribution on right with extant populations shown as stars, extirpated populations as triangles)

1.13.3 Population and distribution trend

The COSEWIC status report describes five extant populations, one population with an 'unknown' status, and four extirpated populations (Donovan and Douglas 2000). Four new populations have been documented since this report and another extirpated population at Cattle Point has been confirmed. There are now nine known, extant populations of bear's-foot sanicle and it appears that 3-4 populations have become extirpated (Table 12).

Table 12. Population information for bear's-foot sanicle in Canada

Population	Land Tenure	Data from Status Report			Subsequent Data		
		Date	Observer	# Plants	Date	Observer	# Plants
Alpha Islet	Provincial ecological reserve	1999	Donovan & Douglas	52	no subsequent data		
Trial Island	Population occurs on provincial lands designated as an ecological reserve, provincial lands leased to a radio-communications corporation, and federal lands managed by Canada Coast Guard	1999	Donovan & Penny	6,015	no subsequent data		
Harling Point	Private property designated a National Historic Site	1999	Donovan & Douglas	81	2002	Fairbarns	50-70 in flower
Saxe Point	Municipality of Esquimalt (designated as a an urban park)	1999	Donovan	1,145	no subsequent data		
Bentinck Island	Federal lands managed by Department of National Defence	1999	Donovan & Penny	71	2002	Fairbarns	3
Discovery Island	Provincial Park		not reported		2002	Fairbarns	12
Mary Tod Island	Municipality of Oak Bay (zoned for park use)		"		2001	Douglas	~ 100
Swordfish Island	Federal lands managed by Department of National Defence		"		2003	Fairbarns	6
Church Point	Federal lands managed by Department of National Defence		"		2002-3	Fairbarns	10
Cattle Point	Municipality of Oak Bay (designated as an urban park)		Not reported		2003	Fairbarns	extirpated

Population	Land Tenure	Data from Status Report			Subsequent Data		
		Date	Observer		Date	Observer	
Foul Bay	Unknown	1942	Hardy	extirpated	May be same as Harling Point population (see above)		
Cadboro Bay	Unknown	1913	Taylor	"	no subsequent data		
Clover Point	City of Victoria (designated as an urban park)	1913	Macoun	"	"		
Beacon Hill	City of Victoria (designated as an urban park)	1938	Eastham	"	"		
Chain Island	Provincial ecological reserve	1897	Anderson	unknown	2002	Fairbarns	Extirpated

There is no indication of the past total number of plants in Canada. The COSEWIC status report estimates a total population size of 7,364 plants, although this includes both flowering and non-flowering individuals. The newly documented occurrences add slightly to the total estimated population. Unfortunately, there is no accurate estimate of the reproductive population, the criterion that COSEWIC uses to rank species.

1.13.4 Biotic and abiotic features of habitat

The habitat of bear's-foot sanicle consists of dry maritime meadows. The following information on ecosystem structure is from the COSEWIC status report supplemented by recent vegetation sampling (Fairbarns pers. obs. 2004). These meadows are less than 10 m above sea level. Their soils are over 15 cm deep and remain moist throughout the winter months but dry to the permanent wilting point by late spring. The sites have never been ploughed or hayed, but some have been lightly grazed by livestock and most probably burned in the past.

Trees are not present due to wind exposure, salt spray and the extreme droughty nature of the shallow soils. The same environmental stresses usually preclude the presence of shrubs, although small amounts of salal (*Gaultheria shallon*), Nootka rose (*Rosa nutkana*) and/or the alien Scotch broom (*Cytisus scoparius*) are occasionally present.

The herb layer is typically dominated by a mix of native and introduced species. The leading native species are forbs (Puget Sound gumweed [*Grindelia integrifolia*], thrift [*Armeria maritima*], field chickweed [*Cerastium arvense*], small-flowered birds-foot trefoil [*Lotus micranthus*], Spanish clover [*Lotus unifoliolatus*], white triteleia [*Triteleia hyacinthina*], slender plantain [*Plantago elongata*], dwarf owl-clover [*Triphysaria pusilla*]), although a small component of native graminoids (California oatgrass [*Danthonia californica*], many-flowered wood-rush [*Luzula multiflora*], beach bluegrass [*Poa confinis*]) may be present.

Introduced grasses (rip-gut brome [*Bromus rigidus*], soft brome [*B. hordeaceus*], hedgehog dogtail [*Cynosurus echinatus*], red fescue [*Festuca rubra*], early hairgrass [*Aira praecox*], fescues [*Vulpia* spp.]) and forbs (hairy cat's ear [*Hypochaeris radicata*], ribwort plantain

[*Plantago lanceolata*], small-flowered catchfly [*Silene gallica*], small hop-clover [*Trifolium dubium*]) are often present, and any of these may dominate at a given site.

Mosses and lichens are usually sparse in extent, but *Dicranum scoparium, Racomitrium canescens, Homalothecium* sp. and *Cladonia portentosa* are often present.

1.13.5 Annual cycle

The COSEWIC status report provides little information on the annual cycle of bear's-foot sanicle although subsequent research has added pertinent information (Fairbarns in. prep. c.).

Germination occurs in January or February depending on weather events and site characteristics. Seedling mortality is low initially, with most juveniles developing 1-3 true leaves before the onset of the summer drought. Most populations are so dense that the survival of individual plants over the summer dormant season can't be determined. The dense nature of populations of this monocarpic perennial species suggests that survivorship through the first drought season is relatively high.

Established plants re-sprout after the summer/fall drought. Fresh rosettes appear as early as September if there are late summer rains which moisten the soil. In typical years shoot dormancy does not break until October or early November. Plants grow slowly through the winter and begin to die back by May. Most shoots are dead by June although a few large non-reproductive rosettes may not die back completely until early July.

Flower buds are usually evident by mid-February and flowering peaks in March or early April. Green fruit are evident by mid-May and fruit ripen in June. Fruit are shed slowly and many plants retain up to 20% of their fruit until October. Most of the barbed fruit are dispersed when animals brush against the plants but some fruit are dispersed when the dead shoots they are attached to snap off and tumble away.

1.14 Coastal Scouler's catchfly *Silene scouleri* ssp. *grandis*

Assessment summary – May 2003

Common name: coastal Scouler's catchfly

Scientific name: *Silene scouleri* ssp. *grandis*

Status: Endangered

Reason for designation: This is a species of highly restricted geographical occurrence in Canada with fewer than 350 plants comprising three remaining populations present on very small islands. Along with other historical population extirpations, a Vancouver Island population has recently been extirpated. These islands are located within an area of active shipping and recreational activities where invasive plants and human activities present ongoing risks.

Occurrence: British Columbia

Status history: Designated Endangered in May 2003. Assessment based on a new status report.

1.14.1 The species

Silene scouleri and its close relatives form a taxonomically difficult complex (Morton pers. comm. 2002). Most authors recognize *S. scouleri* Hooker ssp. *grandis* Hitchcock and Maguire at the subspecies or variety level.

Coastal Scouler's catchfly is an erect (15-80 cm), taprooted perennial from a branched caudex. Basal leaves form rosettes and stem leaves are opposite, reducing in size up the stem. Leaves are hairy, unstalked and have no teeth or stipules. The flowers are greenish-white to purple and form a spike. The united sepals form a prominently nerved tube. Pimply seeds are contained in dry capsules (Douglas et al. 1998b; Fairbarns and Wilkinson 2003).

1.14.2 Distribution

Coastal Scouler's catchfly occurs in a small area of southeastern Vancouver Island and nearby areas of Washington (figure 5). The northern populations are disjunct by about 550 km from the main range of the species, along coastal areas from southern Oregon to the San Francisco Basin.

In Canada, coastal Scouler's catchfly is restricted to two small islands near Victoria, BC. The historical extent of occurrence encompassed approximately 600 km^2 although the current extent of occurrence is about 0.6 km^2. The COSEWIC status report (2002) estimates the area of occupancy to be 1.58 ha yet subsequent surveys revise this figure to 2.0 ha (Fairbarns pers. obs. 2004).

Coastal Scouler's catchfly has not been ranked globally or in the states of California, Oregon and Washington (NatureServe 2004). The species is absent from central and southern Washington State as well as northern and central Oregon. This raises the possibility that the Canadian populations (together with nearby populations in north-central Washington State) may have become genetically distinct from populations in the main range of the species.

1.14.3 Population and distribution trend

The COSEWIC status report describes two extant populations and at least six further populations that have become extirpated although there may have been up to four further populations. (Table 13).

The COSEWIC status report estimated a total population size of between 278 and 328 mature (flowering) plants. Surveys in 2004 revealed the existence of a further 18 flowering plants on Trial Island. The total past Canadian population is unlikely to have exceeded 5,000 individuals.

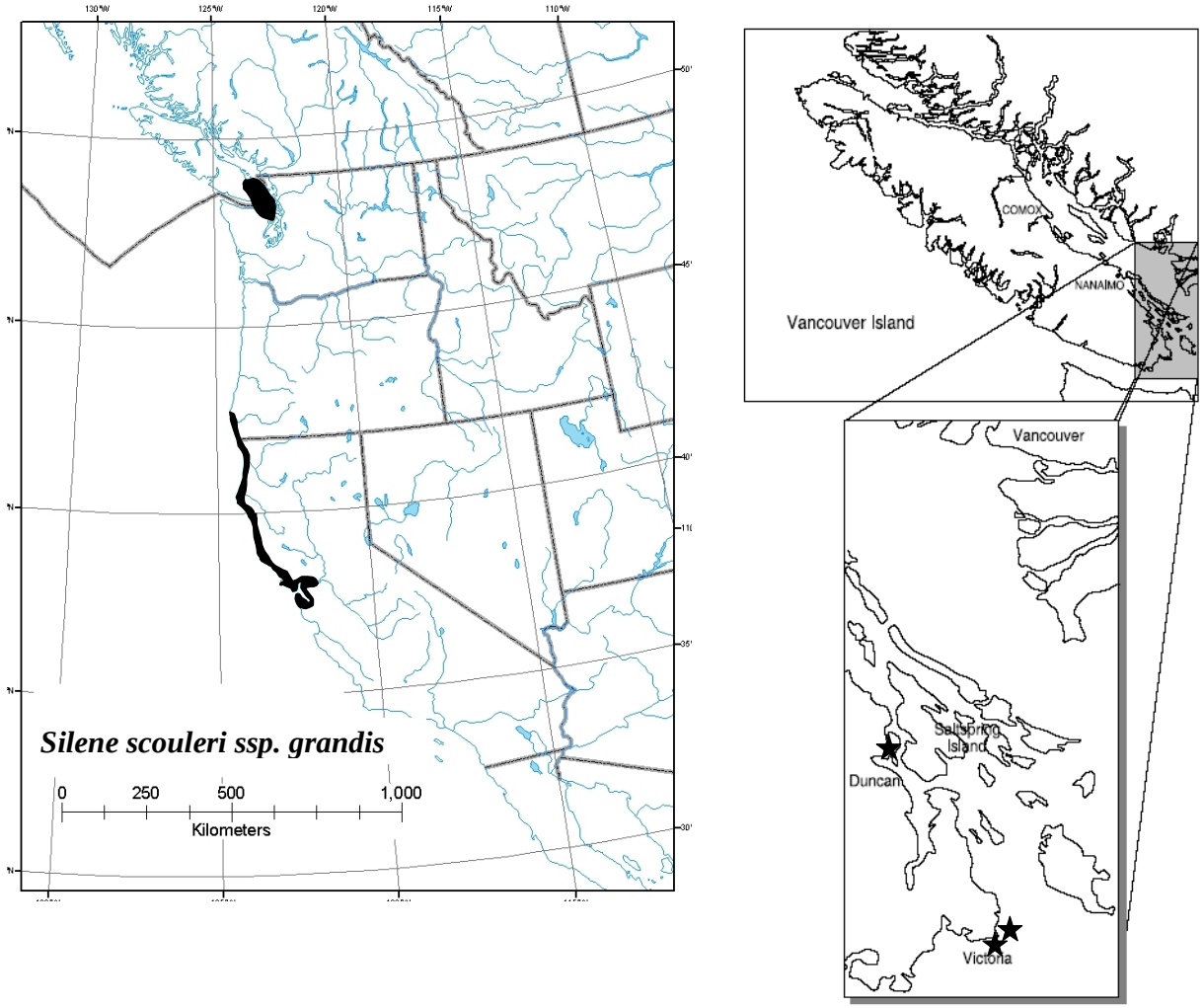


Figure 5. Global and Canadian distribution of coastal Scouler's catchfly

(Global distribution on left; Canadian distribution on right; triangles show extirpated populations and stars show extant populations)

1.14.4 Biotic and abiotic features of habitat

The habitat of coastal Scouler's catchfly consists of mesic maritime meadows. The COSEWIC status report provides information on ecosystem structure supplemented by recent vegetation sampling (Fairbarns pers. obs. 2004). Suitable meadows are less than 30 m above sea level although the Mount Tzuhalem population occurred at about 250 m and the elevation of the extirpated Mount Douglas population was also higher. The meadow soils are moist throughout the winter months but dry almost to the permanent wilting point by late summer. Most plants are rooted in soil over 15 cm deep, and those plants that do occur on shallow soils wilt before flowering (except in the very wet summers). The sites have never been ploughed or hayed, but some have been lightly grazed by livestock and most probably burned in the past.

Trees are generally absent due to the wind exposure, salt spray and the droughty nature of the shallow soils. There was a very open canopy of Garry oak (*Quercus garryana*) at the Mount Tzuhalem site. Native shrubs are often sparse or absent although snowberry (*Symphoricarpos albus*) and Nootka rose (*Rosa nutkana*) are sometimes present. These two shrub species often form dense thickets at the edge of populations of coastal Scouler's catchfly and may advance into the populations in moist years, presenting a threat to the species. Wildfires and First Nations burning may have formerly constrained the advance of these low shrub thickets. Alien, invasive shrubs such as Scotch broom (*Cytisus scoparius*) and gorse (*Ulex europaeus*) (and to a lesser extent spurge laurel [*Daphne laureola*], English ivy [*Hedera helix*] and Himalayan blackberry [*Rubus discolor*]) are sometimes abundant and will probably invade all locations of coastal Scouler's catchfly in the absence of continuing control activities.

A mix of native and introduced species typically dominates the herb layer. The leading native species are forbs (strawberry [*Fragaria* spp.], bracken fern [*Pteridium aquilinum*], white-top aster [*Sericocarpus rigidus*], field chickweed [*Cerastium arvense*], yarrow [*Achillaea millefolium*], woolly eriophyllum [*Eriophyllum lanatum*], Puget Sound gumweed [*Grindelia integrifolia*], barestem desert-parsely [*Lomatium nudicaule*]), although native grasses (tufted hairgrass [*Deschampsia cespitosa*], blue wildrye [*Elymus glaucus*], red fescue [*Festuca rubra*]) are also present at some locations. Common camas (*Camassia quamash*) and broad leaved shootingstar [*Dodecatheon hendersonii*] are abundant in the spring at some locations. Introduced grasses (common velvetgrass [*Holcus lanatus*], Kentucky bluegrass [*Poa pratensis*], sweet vernalgrass [*Anthoxanthum odoratum*], hedgehog dogtail [*Cynosurus echinatus*]) are usually more abundant than introduced forbs (hairy cat's ear [*Hypochaeris radicata*], sheep sorrel [*Rumex acetosella*], ribwort plantain [*Plantago lanceolata*], common vetch [*Vicia sativa*]).

Table 13. Population information for coastal Scouler's catchfly in Canada

Population	Land Tenure	Data from Status Report			Subsequent Data		
		Date	Observer	# Plants	Date	Observer	# Plants
Trial Island	Population is largely restricted to a parcel of provincial land leased to a radio-communications corporation. A small portion of the population (< five plants) may extend slightly into adjoining provincial ecological reserve but this can only be determined by legal survey	2001	Fairbarns	5	2004	Fairbarns	23
Little Trial Island	Provincial land designated as an ecological reserve		Not reported		2004	Fairbarns	14
Alpha Islet	Provincial land designated as an ecological reserve	2001	Fairbarns	673	2003	Fairbarns	370-500
Mt. Tzuhalem	Provincial land designated as an ecological reserve		Extirpated		no subsequent data		
Ten Mile Point	Unknown		extirpated				
Uplands Park	Municipality of Oak Bay (designated as an urban park)		extirpated			"	
Beacon Hill	City of Victoria (designated as park)		extirpated			"	
Bare Island	Indian Reserve		extirpated				
Cedar Hill	Municipality of Saanich (designated as park)		extirpated			"	
Griffin Island	Provincial land designated as an ecological reserve	False report (likely collected from Alpha Islet population)				"	
'near Victoria'	unknown	Imprecise locations, may be the same as populations listed above					
Burnside Dist.	Unknown					"	
Oak Bay	unknown						

1.14.5 Annual cycle

Information in the COSEWIC status report has been updated by subsequent field studies of plants on Trial island (Fairbarns in. prep. e.).

Established plants send out new shoots in July, August and September after the summer drought is broken. The shoots grow slowly during the winter but in May and June reproductive shoots elongate. Some of the tall shoots wilt and die back during the summer drought in July and

August. Less stressed tall shoots develop flower buds, which begin to swell in late June and flower in July or early August. Most plants have ceased flowering by late August although plants on moister microsites may continue to develop flowers into September or October. Late forming flowers fail to produce viable fruit. Mature fruit on early flowers begin to dehisce in late August. Seeds gradually sift out of the dehisced capsules as shoots are shaken in the wind and late-maturing capsules may continue to shed seed well into November. Most dead shoots remain upright long after all seeds have been dispersed.

1.14.6 Biologically limiting factors

Germination occurs in March or April, when dense clusters of seedlings are sometimes found near the base of plants that bore seed in the previous year. Seedling mortality is high, with many seedlings wilting during brief dry periods when the upper soil layers dry out. Survivors grow slowly and do not flower in their first year. It is not clear how long plants take to flower in the wild but even in well-watered gardens most plants do not flower until they are three years old. Many shoots fail to elongate in any given year, and those that do often succumb to drought-induced wilt before flowers are produced. Reproductive shoots that survive until the summer drought is broken often fail to produce viable seed before cool autumn weather arrives and development ceases. Immature capsules rot during the winter. The potential for recovery of coastal Scouler's catchfly is limited by the failure of some populations to produce viable seed before growth ends with cool fall weather.

1.15 Golden paintbrush Castilleja levisecta

Assessment Summary – May 2000

Common name: Golden paintbrush

Scientific name: *Castilleja levisecta*

Status: Endangered

Reason for Designation: Highly restricted range with loss of nearly half of the historic populations and continued threats from spread of exotic plants

Occurrence: British Columbia

Status history: Designated Threatened in April 1995. Status re-examined and uplisted to Endangered in May 2000. May 2000 assessment based on new quantitative criteria applied to information from the existing 1995 status report

1.15.1 The species

Castilleja levisecta Hooker is a well-delineated taxon as described in the status report (Douglas and Ryan 1995).

Golden paintbrush is a multi-stemmed, erect (10-50cm) perennial herb from a woody stem-base. The glandular, hairy leaves are alternate and range from entire to 3-lobed further up the stem. The inflorescence is a terminal spike with golden-yellow bracts that conceal the inconspicuous flowers. The dry capsules have many tiny seeds (Douglas et al. 2000; Ryan and Douglas 1995).

1.15.2 Distribution

Golden paintbrush ranges from in and near Victoria on southern Vancouver Island and offshore islands to the southern Puget Basin (figure 6). It is ranked S1 in Washington and is extirpated from Oregon (SH) and southwest Washington (Natureserve 2004).

The historic and current range estimates the former area of occurrence at approximately 300 km^2 (BC Conservation Data Centre records 2004). The current extent of occurrence is approximately 2-3 km^2 and recent vegetation surveys show the current area of occupancy is actually about 50,000 – 60,000 m^2 (5-6 ha).

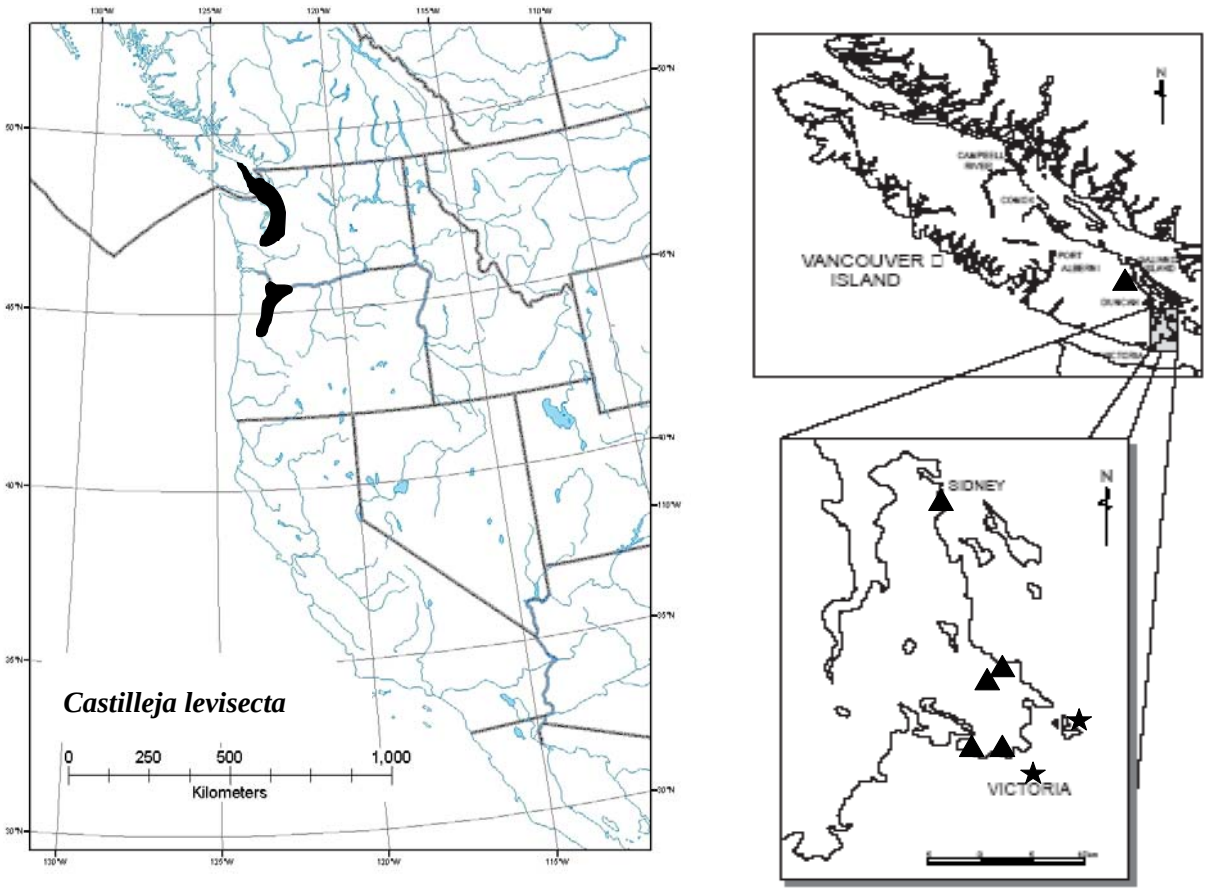


Figure 6. Global and Canadian distribution of golden paintbrush

(Global historic distribution on left; Canadian distribution on right with star indicating approximate location of extant populations and triangles indicating extirpated populations)

1.15.3 Population and distribution trend

The COSEWIC status report describes three extant 'populations' and seven other populations, which have been extirpated or for which there is no recent data (Table 14). One population cited in the status report has subsequently become extirpated leaving only two extant populations. The COSEWIC status report estimates a total population size of 3,563 plants. Records from 2002 estimate a total of 8,850 although there are differences of opinions regarding this estimate (BC Conservation Data Centre 2004).

Table 14. Population information for golden paintbrush in Canada

Population	Land Tenure	Data from Status Report			Subsequent Data		
		Date	Observer	# Plants	Date	Observer	# Plants
Alpha Islet	Provincial ecological reserve	1994	Cannings	1,000	2002 2004	Fairbarns Penny	2,400 4,000
Trial Island	Population occurs on all three land tenures on Trial Island. These consist of provincial lands designated as an ecological reserve, provincial lands leased to a radio-communications corporation, and federal lands managed by Canada Coast Guard	1992	Douglas	2,560	2002	Fairbarns	6,450
Beacon Hill Park	City of Victoria (designated as an urban park)	1991	Brayshaw	3	2004	Fairbarns	extirp.
Dallas Cliffs	City of Victoria (designated as an urban park)	1969	Clark	extirpated	This record refers to an extirpated subpopulation belonging to the Beacon Hill Park population		
Cedar Hill	Municipality of Saanich (apparently on municipal lands now designated as a an urban park)	1887	Macoun	extirpated	no subsequent data so presumed extirpated		
Lost Lake (Blenkinsop L.)	unknown	1945	Hardy	extirpated	"		
Foul Bay	unknown	1918	Carter	extirpated			
Patricia Bay Hwy	unknown	1954	Melburn	extirpated	" "		
Sidney	unknown	1927	Goddard	unknown			

Population	Land Tenure	Data from Status Report			Subsequent Data		
		Date	Observer	# Plants	Date	Observer	# Plants
Wellington	unknown	1898	Fletcher	unknown		"	
						"	
						"	

1.15.4 Biotic and abiotic features of habitat

The habitat of golden paintbrush consists of mesic maritime meadows. The COSEWIC status report provides information on ecosystem structure, which has been refined with further vegetation surveys (Fairbarns pers. obs. 2004, Chappell 2004a). These meadows are less than 30 m above sea level. Their soils are over 30 cm deep and remain moist throughout the winter months but dry to the permanent wilting point by late summer. The sites have never been ploughed or hayed, but may have been lightly grazed and probably burned in the past.

Trees are rarely present and their abundance and canopy cover is never great due to the combined effects of wind exposure, salt spray and/or the droughty nature of the shallow soils. Shrubs are usually absent or sparse although introduced species (Scotch broom [*Cytisus scoparius*], spurge laurel [*Daphne laureola*], gorse [*Ulex europaeus*]) are occasionally abundant. Native species (tall Oregon-grape [*Mahonia aquifoilium*], snowberry [*Symphoricarpos albus*]) are frequent but rarely abundant.

A mix of native and introduced species typically dominates the herb layer. The leading native species are forbs (common camas [*Camassia quamash*], great camas [*C. leichtlinii*], wild strawberry [*Fragaria virginiana*], barestem desert-parsely [*Lomatium nudicaule*], spring gold [*L. utriculatum*], bracken fern [*Pteridium aquilinum*], Pacific sanicle [*Sanicula crassicaulis*], white triteleia [*Triteleia hyacinthina*]), although a small component of native graminoids (tufted hairgrass [*Deschampsia cespitosa*], blue wildrye [*Elymus glaucus*]) may be present. Introduced grasses (sweet vernal grass [*Anthoxanthum odoratum*], red fescue [*Festuca rubra*], Kentucky bluegrass [*Poa pratensis*], barren fescue [*Vulpia bromoides*]) and forbs (hairy cat's ear [*Hypochaeris radicata*], ribwort plantain [*Plantago lanceolata*], common vetch [*Vicia sativa*]) are often present, and any of these may dominate at a given site.

Mosses and lichens are usually sparse in extent, but *Cladina portentosa* and *Dicranum scoparium* may be moderately abundant.

1.15.5 Annual cycle

The information in the COSEWIC status report has been updated by subsequent study of plants on Trial Island and casual observations of plants on Alpha Islet (Fairbarns in. prep. a.).

Established plants resprout after the summer/fall drought. Buds on the root-crown break dormancy as early as August if there are late summer rains that moisten the soil. The young

shoots may develop rapidly as long as temperatures remain high, and a small proportion of fresh shoots were observed flowering as early as mid-October in 2004.

In typical years, however, the soil doesn't become sufficiently moist to trigger bud break until mid-autumn, at which point cool temperatures retard shoot growth. Early shoot growth occurs just above the soil surface and the developing shoots have dense internodes and tiny leaves clustered close to the root crown, which are easily overlooked. Shoot elongation begins in late February or March and shoots usually reach full length by late April or early May. Flowering is coincident with the full development of vegetative growth in late April and early May. Green fruit are abundant in June and most fruit have ripened by late July. Seed dispersal begins in late August and continues until late November or early December.

Golden paintbrush is a root parasite (hemiparasite). The association between this species and related hemiparasites and their hosts is a relatively random process and a broad range of species may be parasitized (Atsatt and Strong 1970).

1.15.6 Biologically limiting factors

Seedlings with cotyledons still attached were not observed in natural environments in three years of study but seedlings were observed in March 2004 in an experimental area near the Trial Island plot. It appears either that germination or early juvenile survivorship is a rare event, only occurring in particularly favourable years. It is hard to determine whether low levels of recruitment are due to low germination rates or high levels of early mortality because the seedlings are extremely small and hard to distinguish from those of other species in the area. The potential for recovery of golden paintbrush appears to be limited by intermittent reproduction.

1.16 Prairie lupine *Lupinus lepidus* var. *lepidus*

Assessment Summary – May 2000

Common name: prairie lupine

Scientific name: *Lupinus lepidus* var. *lepidus*

Status: Endangered

Reason for designation: Endangered due to small distribution and declining populations. May be extirpated.

Occurrence: British Columbia

Status history: Designated Endangered in April 1996. Status re-examined and confirmed Endangered in May 2000.

May 2000 assessment based on new quantitative criteria applied to existing 1996 status report.

1.16.1 The species

The current taxonomy of prairie lupine is complicated and is not universally accepted. Refer to Douglas and Ryan (1996b) for a description of classification and nomenclature.

Lupinus lepidus var. *lepidus* is a tufted, perennial herb that grows 20-45 cm tall. Most of the silky leaves grow at the base of the plant with a few alternate leaves along the stem. The leaves are palmately compound, with 5-9 leaflets. The flower is a terminal raceme of pea-like flowers, each 10-13 mm long, ranging in colour from blue, white or purple. The hairy seedpods are 1-3 cm long and contain 2-4 seeds. Distinguishing features include the densely hairy stems and leaves and the woody stem-base (Douglas et al. 1999a; Ryan and Douglas 1996).

1.16.2 Distribution

Ryan and Douglas (1996b) consider the range of prairie lupine to extend from British Columbia south to Washington and Oregon. The distribution in the United States is difficult to determine because of taxonomic confusion and because it is not tracked as a rare species (SNR) in Washington and Oregon. The species is ranked S1 in Alaska but the identification of the specimen has been questioned (Ryan and Douglas 1996b). The species is relatively common in southern Puget Sound prairies (Thurston and Pierce Counties). Although the prairies themselves are highly fragmented and threatened, within the prairies, prairie lupine is common and is a characteristic species of the Roemer's fescue/white-topped aster (*Festuca idahoensis* var. *roemerii/Sericocarpus rigidus*) plant association (Chappell pers. comm. 2004).

In Canada, two prairie lupine populations have recently (BC CDC 2005) been re-confirmed on southeast Vancouver Island at Mt. Braden and Mt. MacDonald. The historical extent of occurrence is difficult to determine because of limited records (BC Conservation Data Centre 2004).

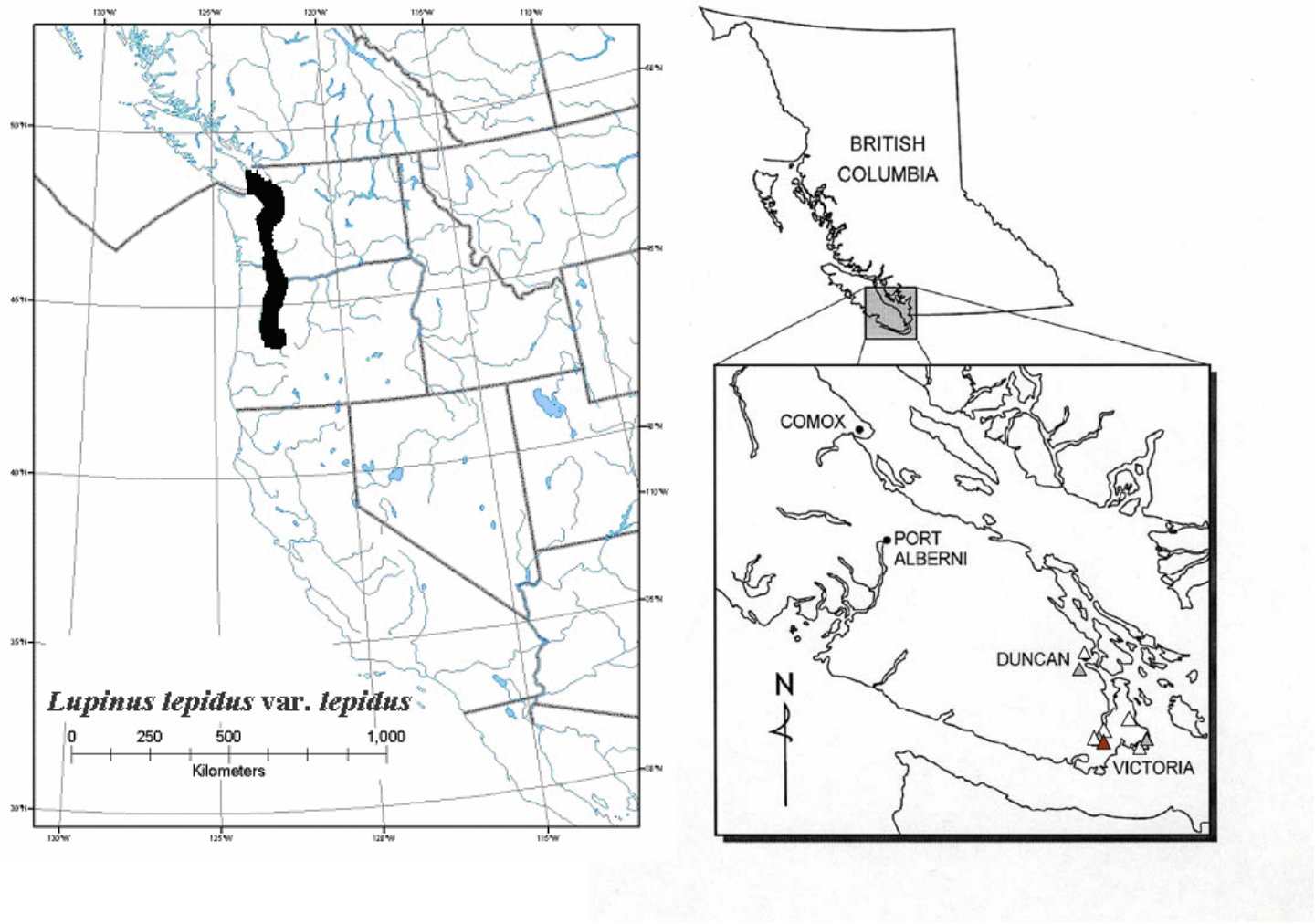


Figure 7. Global and Canadian distribution of prairie lupine

(Global distribution on left; Canadian on right with open triangles showing extirpated populations, grey triangles showing unverified populations and solid triangles showing location of recently extant population)

1.16.3 Population and distribution trend

The COSEWIC status report describes 7 extirpated or sites having poor location information. There is no indication of the past total number of plants in Canada.

Since the status report was written, two populations have been confirmed at Mount Braden (1996) in the Sooke Hills Wilderness Area and at Mount Wells Regional Park (2001) (Table 15). No plants were found in subsequent years at the Mount Braden population (Roemer pers. comm. 2004), until July 0f 2005 when 2 plants were seen. At Mount Wells, 7 plants were first observed in 2001 after a burn (BC Conservation Data Centre 2004). In 2003, the site was heavily vegetated with hairy manzanita [*Arctostaphylos columbiana*] and the alien Scotch broom [*Cytisus scoparius*] and only 2 plants (one of which flowered with 2 seeds in the seedpod) were found (Maslovat pers. obs. 2003). The plants were not found in 2004, although seed probably still exists in the seedbbank (Roemer pers. comm. 2004). In addition, in July of 2005, 113 plants were found on Mt. MacDonald where the plants had not been seen since 1913 (BC CDC database).

Table 15. Population information for prairie lupine in Canada

		Data from Status Report			Subsequent Data		
Population	**Land Tenure**	**Date**	**Observer**	**# Plants**	**Date**	**Observer**	**# Plants**
Langford Plains	unknown	1908	Macoun	Extirpated	No further information		
Mount MacDonald	Capital Regional District (CRD) Park Reserve, Sooke Hills Wilderness Area	1915	Newcombe	Unknown	No further information		
Observatory Hill	National Research Council Herzberg Institute of Astrophysics	1960	Hardy	Unknown	2003	Fairbarns	Likely Extirpated
Koksilah River Valley	unknown	1973	Brayshaw	Unknown	No further information		
Cattle Point	Municipality of Oak Bay (designated as an urban park)	1991	Brayshaw	Unknown	May have been based on misidentification (Fairbarns and Penny 2003)		
Beacon Hill	Municipality of Victoria (designated as an urban park)	1993	Ryan	Extirpated	No further information		
Somenos Lake	unknown[15]	1994	Douglas	Extirpated	No further information		

[15] Responsible jurisdiction is either the BC Ministry of Transportation or the Esquimalt & Northern Railroad since the site lies between the Trans Canada Highway and the rail line.

		Data from Status Report			Subsequent Data		
Population	**Land Tenure**	**Date**	**Observer**	**# Plants**	**Date**	**Observer**	**# Plants**
Mount Braden	CRD Park Reserve, Sooke Hills Wilderness Area	Population unknown when status report written			1996 1999 2005	Roemer	4 0 2
Mount Wells	CRD Park Reserve, Sooke Hills Wilderness Area	Population unknown when status report written			2001 2003 2004	Roemer Maslovat Roemer	7 2 (one flwr) Seedbank?
Mt. MacDonald	CRD Park Reserve, Sooke Hills Wilderness Area	Population last seen in 1913			2005	Roemer	113

1.16.4 Biotic and abiotic features of habitat

Prairie lupine has been documented from few sites in Canada, so precise habitat descriptions are difficult to determine (Ryan and Douglas 1996b). It tends to occur on very dry, exposed sites with well-drained, nutrient poor, rocky or gravelly soils (Ryan and Douglas 1996b). Prairie lupine populations occurred on level to sloping (20%) ground with elevations ranging from 30-360 metres. At Mount Wells (2001), it was observed in a recent burn area, in flat shallow (< 30 cm) soil. One former site was regularly mowed and another was in a disturbed area between the highway and a railroad (BC Conservation Data Centre 2004).

At Mount Wells, prairie lupine was found in association with resprouting hairy manzanita (*Arctostaphylos columbiana*), seedlings of red-flowering currant (*Ribes sanguineum*), gummy gooseberry (*Ribes lobbii*), oceanspray (*Holodiscus discolo*r), annual grasses and weeds. At Mount Braden, it was observed in patchy Roemer's fescue (*Festuca idahoensis* ssp. *roemeri*), *Rhacomitrium canescens* and lichens. At Somenos, it was found with *Rhacomitrium canescens* and large-leaved lupine (*Lupinus polyphyllus*) with the alien Scotch broom (*Cytisus scoparius*) on the edges of the population (BC Conservation Data Centre 2004).

In Washington, it appears to prefer water stressed sites that have low soil moisture in the summer (Ewing pers. comm. 2004).

1.16.5 Annual cycle

Prairie lupine is a perennial plant that appears to be short-lived. There is no published information about the phenology or demography of this species. Prairie lupine appears to have a long life in the seedbank (Douglas pers. comm. 2004).

1.16.6 Biologically limiting factors

Without periodic soil disturbance or fires, prairie lupine plants appear to decline over time (Ryan and Douglas 1996b). Adult plants may be dying either due to a lack of vigour in adult plants or due to competition (Ryan and Douglas 1996b).

Other *Lupinus* species are affected by seed predation (Grosboll pers. comm. 2004) and herbivory (Fagan and Bishop 2000; Fagan et al. 2001) but the effect on prairie lupine is not known. During planting trials in Seattle, Washington, prairie lupine seedlings decreased in size with the addition of mulch and fertilizer and were decimated by an unknown disease (Ewing 2002; Ewing pers. comm. 2004).

1.17 Purple sanicle *Sanicula bipinnatifida*

Assessment Summary – May 2001

Common name: purple sanicle

Scientific name: *Sanicula bipinnatifida*

Status: Threatened

Reason for designation: Geographically restricted species with small area of occupancy in Garry oak communities within a major urbanized region at risk from habitat loss and degradation and impact of exotic plants.

Occurrence: British Columbia

Status history: Designated Threatened in May 2001.

1.17.1 The species

Sanicula bipinnatifida Hooker is a well-delineated taxon as described in the status report (Penny and Douglas 2000). Kartesz (1994) does not recognize any infraspecific taxa within this species. Purple sanicle is an erect (10-60 cm tall), branching, taprooted perennial. The basal and lower stem leaves are pinnately divided with a toothed, winged leaf axis. The inflorescence is several to many compact umbels with purple corollas and an inconspicuous involucel. The seeds are egg-shaped schizocarps covered with hooked prickles. Purple sanicle can be distinguished from other sanicle species by its inconspicuous involucel and deep purple flowers (Douglas et al. 1998a; Penny and Douglas 2001).

1.17.2 Distribution

Purple sanicle ranges from southern Vancouver Island, south along the Pacific coast and interior valleys to Baja California (figure 8). The species is not ranked (SNR) in California, Oregon and Washington (Natureserve 2004). The Georgia Basin-Puget Sound populations appear to be disjunct, by about 100 km, from the main populations, which reach their northern limits along the Columbia River.

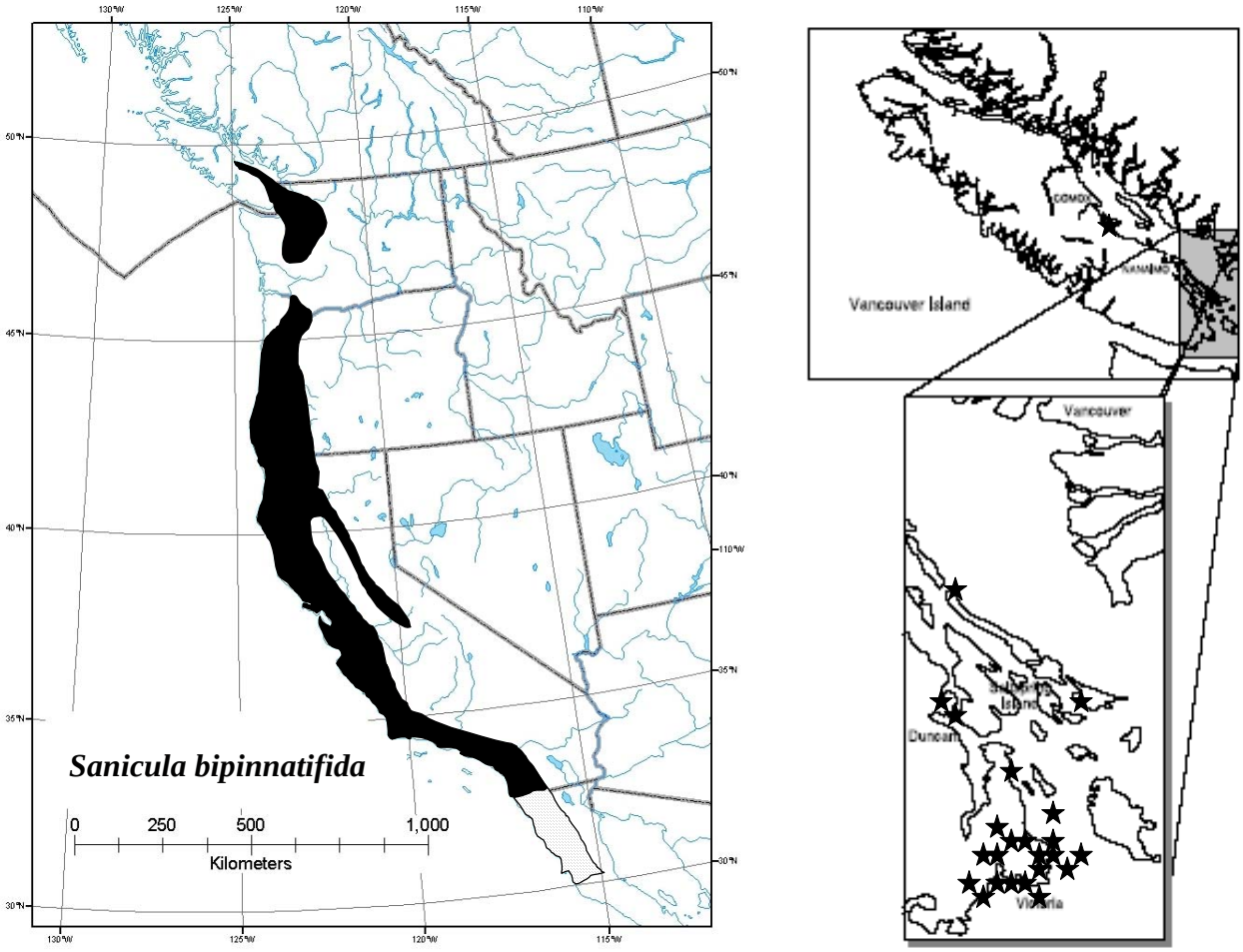


Figure 8. Global and Canadian distribution of purple sanicle

(Global distribution on left with uncertain distribution in Baja California; Canadian distribution on right with stars showing location of disjunct population of uncertain status)

In Canada, purple sanicle is restricted to a small area of southeast Vancouver Island and the southern Gulf Islands. \Based on the most recent records the extent of occurrence is estimated at approximately 3,500 km^2 and the Canadian area of occupancy 2 to 3ha (BC Conservation Data Centre records 2004; Fairbarns pers. obs. 2004).

1.17.3 Population and Distribution Trend

The COSEWIC status report describes fourteen extant 'populations', five that have become extirpated and seven with status unknown (Table 16) (Penny and Douglas 2000). Describing populations separated by less than 1,000 m as subpopulations (the default BC Conservation Data Centre criterion for recognizing distinct populations) in addition to

subsequent surveys confirm there are there are 20 populations presumed extant, and 5-6 which are presumed extirpated.

Table 16. Population information for purple sanicle in Canada

Population	Land tenure	Data from Status Report			Subsequent Data		
		Date	Observer	# Plants	Date	Observer	# Plants
Flora Islet	Provincial ecological reserve	1976	Pojar	unknown	no subsequent data		
Brown Ridge, Saturna Island	private property	1996	Janszen	140	no subsequent data		
East Point, Saturna Island	Federal land managed by Canada Coast Guard		extirpated		presumed extirpated		
Dionisio Park, Galiano Island	Provincial park	1993	Roemer	1	no subsequent data		
Little D'Arcy Is.	Private property	1977	A. Ceska	unknown	no subsequent data		
Alpha Islet	Provincial ecological reserve	1981	A. Ceska	unknown	2002	A. Ceska	11
Discovery Is.	Provincial park		not reported		2002	Fairbarns	5
Trial Island	Provincial land leased to a radio-communications corporation.		Not reported		2004	Fairbarns	about 40
Tzuhalem E.R.	Provincial ecological reserve	1999	Penny	94	no subsequent data		
Tzuhalem I.R.	Federal Indian Reserve	1999	Penny & Douglas	75	no subsequent data		
Sidney	unknown	1927	Goddard	unknown	presumed extirpated		
Cedar Hill	unknown	1897	Macoun	extirp.	synonymous with Mount Douglas?		
Mount Douglas (synonymous with Blenkinsop Rd. and Cedar Hill?)	Municipality of Saanich (designated as an urban park)	1953	Melburn	unknown	2004	Fairbarns	2
Cloverdale Dist.	Unknown	1919	Newcombe	extirp.	Presumed extirpated		
Ten Mile Point	unknown	1942	Eastham	unknown	presumed extirpated		
Blenkinsop Rd.	unknown	1939	unknown	unknown	synonymous with Mount Douglas?		
Glencoe Cove	Municipality of Saanich (designated as an urban park)	1999	Penny	6	no subsequent data		

Population	Land tenure	Data from Status Report			Subsequent Data		
		Date	Observer	# Plants	Date	Observer	# Plants
Rithet's Bog	Municipality of Saanich (designated as an urban park)	1999	Penny and Hartwell	24	2004	Ansell	~ 20
Uplands Park	Municipality of Oak Bay (designated as an urban park)	1983	Van Dieren	extirp.	2004	Fairbarns	Extirpated subpopn. From same popn. As Cattle Pt.
Cattle Point	Municipality of Oak Bay (designated as an urban park)	1999	Penny & Douglas	215	2004	Fairbarns	> 300
Holland Point	City of Victoria (designated as an urban park)	1999	Penny	63	no subsequent data		
Macaulay Point	Federal lands owned by Department of National Defence but leased to Municipality of Esquimalt for park use	1999	Penny & Donovan	1014	no subsequent data		
Golf Hill	Federal land owned by Department of National Defence	1976	A. Ceska	extirp.	Presumed extirpated same population as Macaulay Point <1 km away		
Near Francis King	private property	1999	Penny	13	1999 Roemer 12		
Thetis Lake	Capital Regional District land designated as park	2000	Ussery & Fleming	152	no subsequent data		
Mill Hill	Capital Regional District land designated as park	1999	Penny & Fleming	127	2003 2004	Roemer	309 533
Neild Road	private property	1999	Penny	630	no subsequent data		
Fort Rodd Hill National Historic Site	Federal land managed by Parks Canada Agency	1966	Ashlee	unknown	2002	Fairbarns	extirpated
Albert Head	Federal land owned by Department on National Defence	1999	Penny & Donovan	1,014	no subsequent data		

The newly recorded subpopulations add to the total estimated population but there is no accurate estimate of the reproductive population. The COSEWIC status report estimates a total population size of 3,692 plants, which includes both flowering and non-flowering individuals.

1.17.4 Biotic and abiotic features of habitat

The habitat of purple sanicle consists of mesic maritime meadows in addition to upland meadows. The information in the COSEWIC status report has been supplemented with information from recent vegetation sampling (Fairbarns pers. obs. 2004). These meadows are often less than 30 m above sea level although populations are known from elevations of 100-300 m at Mill Hill, Mount Tzuhalem and Brown Ridge as well as the extirpated population presumed to occur at Mount Douglas. Their soils are over 30 cm deep and remain moist throughout the winter months but dry to the permanent wilting point by early summer. The sites have never been ploughed or hayed, but several have been lightly grazed by livestock and most probably burned in the past.

Trees are sometimes present but their abundance and canopy cover is rarely great due to the combined effects of wind exposure, salt spray and/or the droughty nature of the shallow soils. Shrub cover varies considerably among sites, with the introduced species of Scotch broom (*Cytisus scoparius*), gorse (*Ulex europaeus*) and tree lupine (*Lupinus arboreus*) occasionally abundant.

A mix of native and introduced species typically dominates the herb layer. The leading native species are forbs (Puget Sound gumweed [*Grindelia integrifolia*], barestem desert-parsley [*Lomatium nudicaule*], bracken fern [*Pteridium aquilinum*]), although a small component of native graminoids (California brome [*Bromus carinatus*], California oatgrass [*Danthonia californica*]) may be present.

Introduced grasses (soft brome [*Bromus hordeaceus*], orchard grass [*Dactylis glomerata*], perennial ryegrass [*Lolium perenne*], barren brome [*Vulpia bromoides*]), and forbs (hairy cat's ear [*Hypochaeris radicata*], ribwort plantain [*Plantago lanceolata*], sheep sorrel [*Rumex acetosella*], small hop-clover [*Trifolium dubium*], common vetch [*Vicia sativa*]) are often present, and any of these may dominate at a given site.

Mosses and lichens are usually sparse in extent.

1.17.5 Annual cycle

Information in the COSEWIC status report has been supplemented by subsequent study of plants at Trial Island and Macaulay Point and observations from other Canadian sites (Fairbarns in. prep. d.).

Established plants resprout in January or February. Plants grow slowly through the late winter and early spring, then grow rapidly in April and early May. Shoots begin to wither and die back as the summer drought begins to take hold in mid-May and most shoots are dead by late June or early July.

Flower buds are usually evident by mid-April and flowering peaks in late April and early May. Green fruit are evident by late May and fruit ripen in June. Fruit are shed slowly and many plants retain up to 20% of their fruit until October. The barbed fruit are dispersed when animals brush against the plants.

1.17.6 Biologically limiting factors

Germination occurs between mid-February and mid-April. Initial seedling mortality may be quite high, with few plants developing true leaves. Only a small proportion of germinants survive the succeeding dormant season.

1.18 Seaside birds-foot lotus *Lotus formosissimus*

Assessment summary – May 2000

Common name: seaside birds-foot lotus

Scientific name: *Lotus formosissimus*

Status: Endangered

Reason for designation: Few remaining populations and the area of occupancy are declining because of competition from invasive alien plants and rabbits.

Occurrence: British Columbia

Status history: Designated Endangered in April 1996. Status re-examined and confirmed in May 2000. May 2000 assessment based on new quantitative criteria applied to information from the existing 1996 status report.

1.18.1 The species

Lotus formosissimus Greene is a well-delineated taxon as described in the status report (Ryan and Douglas 1996). Kartesz (1994) does not recognize any intraspecific taxa within this species. Seaside birds-foot lotus is a sprawling perennial (20-50 cm) from stolons or rhizomes. The alternate leaves are pinnately compound with 5 (usually) round to egg-shaped leaflets. The flowers are umbels of 3-9 pink and yellow pea-like flowers. Few seeds are found in the linear to oblong pods. Seaside birds-foot lotus can be distinguished from other *Lotus* species by the large membraneous stipules on the leaves, perennial habit, and by the yellow and pink colour of the flowers (Douglas et al. 1999a; Ryan and Douglas 1996a).

1.18.2 Distribution

Seaside birds-foot lotus ranges from southern Vancouver Island, south along the Pacific coast to central California (Figure 9). The species is not ranked (SNR) in Washington, Oregon and California (Natureserve 2004). The Canadian populations are disjunct, by about 160 km, from the next nearest populations on the west coast of central Washington State.

In Canada, the historical and current range of seaside birds-foot lotus encompassed approximately a narrow coastal fringe about 60 km long but only about 50 m deep, hence extent

of occurrence never exceeded about 3 km^2. The COSEWIC status report estimates the area of occupancy to be 155 m^2 although recent estimates place the total area of occupancy in Canada at under 200 m^2.

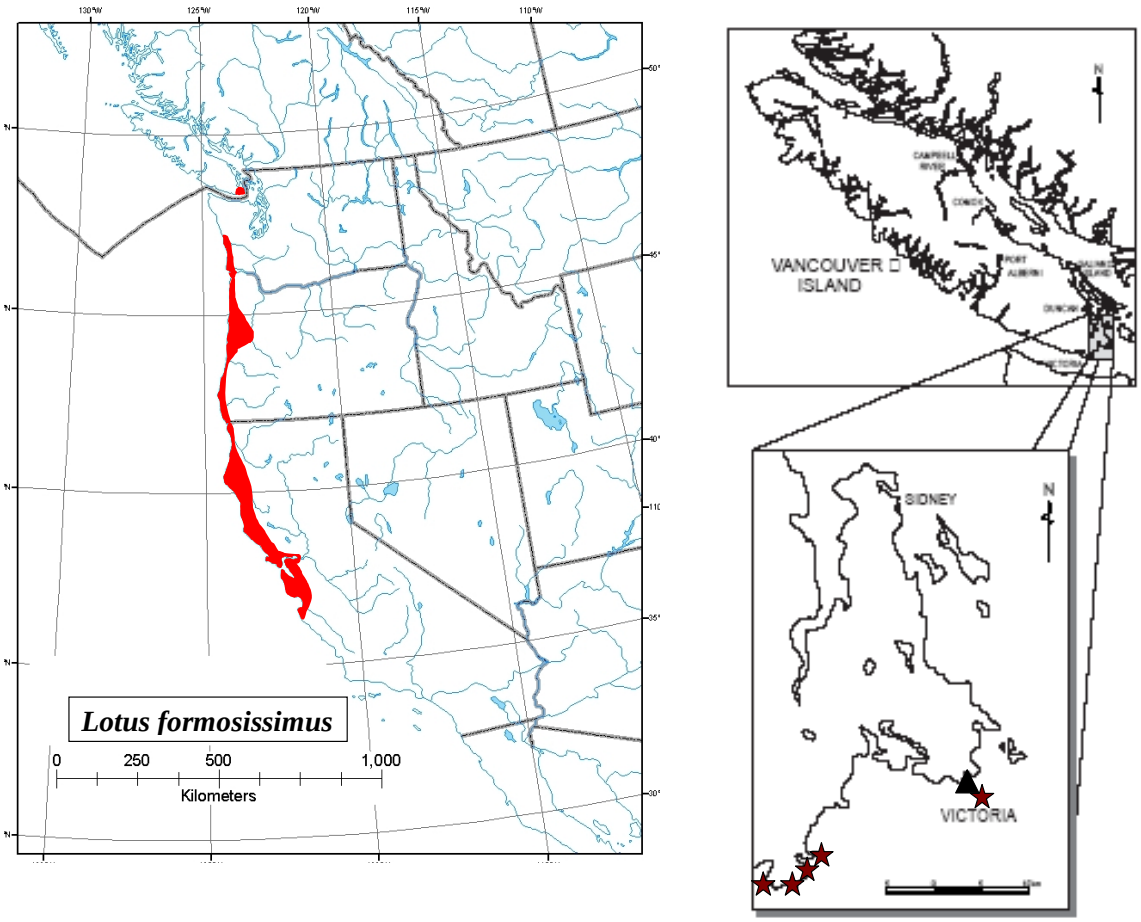


Figure 9. Global and Canadian distribution of seaside birds-foot lotus

(Global distribution on left with uncertain distribution in Baja California; Canadian distribution on right with stars showing location of disjunct population of uncertain status)

1.18.3 Population and distribution trend

The COSEWIC status report describes two extant populations, one historical population and two populations that were presumed extirpated. Subsequent, fieldwork has confirmed five populations of seaside birds-foot lotus in Canada and one presumed extirpated (BC Conservation Data Centre 2004).

The COSEWIC status report estimates a total population size of 193 plants. Subsequent surveys (Table 17) of some populations indicated that the total Canadian population number between 350 and 600 plants. The precise size of most populations cannot be determined without destructive sampling.

Table 17. Population information for seaside birds-foot lotus in Canada

Population	Land tenure	Data from Status Report			Subsequent Data		
		Date	Observer	# Plants	Date	Observer	# Plants
Trial Island	Population occurs on all three land tenures on Trial Island. These consist of provincial lands designated as an ecological reserve, provincial lands leased to a radio-communications corporation, and federal lands managed by Canada Coast Guard	1992	Douglas	28	2004	Fairbarns	100-200
William Head	Federal lands managed by Corrections Canada	1953	Hardy	presumed extirpated	2004	Fairbarns	7
Rocky Point	Federal lands managed by Department of National Defence	1993	Ryan	165	2004	Fairbarns	25
Bentinck Island	Federal lands managed by Department of National Defence	1977	Ceska	unknown	2002	Fairbarns	45-55
Church Point	Federal lands managed by Department of National Defence		Not reported		2002	Fairbarns	200-300
Foul Bay	unknown	1912	Macoun	unknown		extirpated	

1.18.4 Biotic and abiotic features of habitat

The habitat of seaside birds-foot lotus consists of mesic maritime meadows. The COSEWIC status report provides information on ecosystem structure, which has been supplemented with recent vegetation sampling (Fairbarns pers. obs. 2004). These meadows are less than 30 m above sea level. Their soils are over 20 cm deep and remain moist throughout the winter months but dry almost to the permanent wilting point by late summer. The sites have never been ploughed or hayed, but some have been lightly grazed and most probably burned frequently in the past.

A sparse canopy of Garry oak (*Quercus garryana*), logepole pine (*Pinus contorta*), arbutus (*Arbutus menziesii*) and/or Douglas-fir (*Pseudotsuga menziesii*) may be present but trees are generally absent due to wind exposure, salt spray and the droughty nature of the shallow soils. Native shrubs are usually sparse or absent although snowberry (*Symphoricarpos albus*), Nootka rose (*Rosa nutkana*) and salal (*Gaultheria shallon*) are sometimes present. These shrub species often form dense thickets at the edge of populations of seaside birds-foot lotus and may advance into the populations in moist years, presenting a threat to the species. Wildfires and First Nations burning may have formerly constrained the advance of these low shrub thickets at some sites. Alien, invasive shrubs such as Scotch broom (*Cytisus scoparius*), and to a lesser extent gorse [*Ulex europaeus*] and spurge laurel [*Daphne laureola*]) are sometimes abundant. These alien

species will probably invade the more sheltered locations of seaside birds-foot lotus in the absence of continuing control activities.

A mix of native and introduced species typically dominates the herb layer. The leading native species are forbs (small-flowered birds-foot trefoil [*Lotus micranthus*], Spanish clover [*L. unifoliolatus*], two-coloured lupine [*Lupinus bicolor*], long-spurred plectritis [*Plectritis macrocera*], dwarf owl-clover [*Triphysaria pusilla*]), although native graminoids (blue wildrye [*Elymus glaucus*], California oatgrass [*Danthonia californica*], long-stoloned sedge [*Carex inops*]) may be present.

Introduced grasses (common velvetgrass [*Holcus lanatus*], Kentucky bluegrass [*Poa pratensis*], sweet vernalgrass [*Anthoxanthum odoratum*], orchard grass [*Dactylis glomerata*], soft brome [*Bromus hordeaceus*], barren brome [*Vulpia bromoides*], hairgrass [*Aira* spp.]), are usually more abundant than introduced forbs (ribwort plantain [*Plantago lanceolata*], hairy cat's ear [*Hypochaeris radicata*], smooth cat's ear [*H. glabra*], hawkbit [*Leontodon* spp.], common vetch [*Vicia sativa*], and small hop-clover [*Trifolium dubium*]).

Mosses and lichens are usually sparse in extent, but *Dicranum scoparium* and *Cladonia portentosa* are occasionally abundant, especially where the seaside birds-foot lotus grows in the shelter of boulders and shallow outcrops.

1.18.5 Annual cycle

The COSEWIC status report provides information on the annual cycle of seaside birds-foot lotus, which has been supplemented from a subsequent study of plants on Trial and Bentinck Island and casual observations from other Canadian sites (Fairbarns in. prep. b.).

Germination occurs in March, April and May depending on weather events and site characteristics.

Established plants resprout after the summer/fall drought. Buds on the buried root-crown break dormancy as early as September if there are late summer rains that moisten the soil. Shoots may emerge from the soil by late September or early October.

In typical years, however, the soil doesn't become sufficiently moist to trigger bud break until mid-autumn, at which point cool temperatures retard shoot growth. Early shoot growth occurs underground or below the surface layer of moss and plant litter and shoots don't begin to emerge until late February or March.

Flowering peaks in May and June and most plants bear mature fruit by July. Seed dispersal begins in July, as plants begin to wither, and continues into August, well after most of the foliage has died back. Plants on dry microsites may die, flower, fruit and die-back earlier, but their fruit are often aborted or they bear smaller seeds with less endosperm.

Vegetative growth, flowering and fruiting may be slightly prolonged if unusual summer rainfall events delay the summer drought, but most plants are dormant between mid-August and December.

1.18.6 Biologically limiting factors

Seedling mortality is high, with few plants surviving their first dormant (summer) season. Survivors grow slowly and do not flower in their first year. It is not clear how long plants take to flower.

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APPENDIX A - RECORD OF EXPERTS CONSULTED

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Roxanne Bittman. March 2004. Email correspondence. California Natural Diversity Database, Department of Fish and Game, 1807-13th Street, Suite 202, Sacramento, CA 95814. Telephone: (916) 323-8970. Fax: (916) 324-0475. Email: rbittman@dfg.ca.gov

BC Conservation Data Center. 2004. BC Ministry of Water, Land and Air Protection, Victoria, BC. Telephone: (250) 356-0928 Email: cdcdata@victoria1.gov.bc.ca

Trudy Chatwin. September 2004. Telephone conversation. Rare and Endangered Species Biologist, BC Ministry of Water, Land and Air Protection. Nanaimo, BC. Telephone: (250) 751-3150. Email: Trudy.Chatwin@gems1.gov.bc.ca

Chris Chappell. March 2004. Email correspondence. Vegetation Ecologist, Washington Natural Heritage Program, Asset Management and Protection Division, Washington Department of Natural Resources, P.O. Box 47014, Olympia, WA. 98504-7014. Telephone: (360) 902-1671. Email: chris.chappell@wadnr.gov

Joe Daly. May 2004. Email to Michelle Gorman. City of Victoria Parks Department, Victoria, BC. Telephone: (250) 361-0600.

George Douglas. March 2004. Telephone conversation. Consultant. Deceased. 2005.David Ehret. May 2004. Telephone conversation. Research scientist, Agriculture and Agri-Food Canada. Intensive Crop Culture. Agassiz Research Centre. Telephone: (604) 796-2221. Email: ehretd@agr.gc.ca

Kern Ewing. March 2004. Telephone conversation. Professor, University of Washington, College of Forest Resources, Center for Urban Horticulture, Box 354115, Seattle, Washington, USA 98195. Telephone: (206) 543-4426. Email: kern@u.washington.edu

Dorothy Fabijan. February 2004. Email correspondence. Assistant Curator. Vascular Plant Herbarium. Department of Biological Sciences, University of Alberta, Edmonton, Alberta.T6G 2E9. Telephone: (780) 492-5523. Email: mailto:dfabijan@ualberta.ca

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Tracy Fleming. September 2004b. Telephone conversation. Environmental Protection Specialist. CRD Parks, Victoria, BC. Telephone: (250) 478-3344. Email: tfleming@crd.bc.ca

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Jessica Hellmann. January 2005. Assistant Professor, Department of Biological Sciences, University of Notre Dame. Telephone: (250) 631-7521. Email: hellmann.3@nd.edu

Jennifer Heron. 2005. Invertebrate Species At Risk Biologist. BC Ministry of Water, Land and Air Protection. 2204 Main Mall, Vancouver, BC V6T 1Z4. Telephone: 604-222-6759. Email: Jennifer.Heron@gov.bc.ca

Scott Hoffman-Black. May 2004. Email correspondence and April 2003 meeting with James Miskelly. Executive director, Xerces Society. 4828 SE Hawthorne Bldv. Portland, OR. Telephone: (503) 232-6639. Email: sblack@xerces.org

Fred Hook. October 2004. Email correspondence. Horticulturalist, City of Victoria, Parks Department. Victoria, BC. Telephone: (250) 361-0600. Email: fredh@city.victoria.bc.ca

Chris Junck. October 2004. Telephone conversation. Public Extension and Involvement, Garry Oak Ecosystems Recovery Team. Telephone (250) 383-3293. Email: Chris.Junck@goert.ca

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Aaron Liston. March 2004. Email correspondence. Professor, Department of Botany & Plant Pathology. Oregon State University. Corvallis, Oregon, 97331-2902. Email: listona@science.oregonstate.edu

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Michael Mancuso. March 2004. Telephone conversation. Botany Program Leader Idaho Conservation Data Center**.** 600 South Walnut, Box 25, Boise, ID 83707. Fax: (208) 334-2114.Telephone: (208) 287-2734. Email: mmancuso@idfg.state.id.us

Marshall, Wendy. June 2004. Telephone Conversation. Municipality of Esquimalt Parks, Victoria, BC. Telephone: (250) 414-7110 ext 2404. Email: marshalw@esquimalt.ca

Kate Miller. September 2004. Telephone conversation. Environment and Natural Resource Manager, Cowichan Tribes. Duncan, BC. Telephone (250) 748-3196.

James Miskelly. 2004. M. Sc. Candidate. University of Victoria, Victoria, BC. Telephone (250) 477-0490. Email: jmiskelly@telus.net

Morton, J.K. 2002. Letter to Matt Fairbarns. Professor Emeritus, University of Waterloo Department of Biology. February 21 2002. Draft materials for Flora of North America treatment of Silene.

Vince Nealis. 2003. Contact with Cris Guppy, Norbert Kondla or Lee Schaeffer, consultants. Pacific Forestry Centre, Canadian Forest Service. Victoria, BC. Telephone: (250) 363-0663. E-Mail: vnealis@pfc.cfs.nrcan.gc.ca

Ardice Neudorf. September 2004. Telephone conversation. Land Protection Specialist, Islands Trust. Victoria, BC. Telephone: (250) 405-5176 Email: aneudorf@islandstrust.bc.ca

Jonathan Pelham. November 2003. Contact with Cris Guppy, Norbert Kondla or Lee Schaeffer, consultants. Curatorial Associate, Burke Museum, University of Washington. Seattle, WA. Telephone: (206) 543-9853.

Adriane Pollard. September 2004. Telephone conversation. Municipality of Saanich. Telephone:475-1775. (250) Email: pollarda@saanich.ca

Ann Potter. June 2004. Meeting with James Miskelly. Wildlife Biologist, Wildlife Diversity Division. Washington Department of Fish and Wildlife. Olympia, Washington. Telephone: (360) 902-2496. Email: potteaep@dfw.wa.gov.

Robert Pyle. March to July 2003. Email correspondence and November 2004 meeting with James Miskelly. Private entomologist, Washington. tlpyle@willapabay.org

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Mary Stensvold. February 2004. Email correspondence. Regional Botanist. Alaska Region, USDA Forest Service. 204 Siginaka Way. Sitka, Alaska 99835. Email: mstensvold@fs.fed.us

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Danielle Smith. June 2004. Telephone conversation. Natural Resources Co-ordinator, Department of National Defence. Telephone: (250) 363-2313. Email: Smith.DS2@forces.gc.ca

Chris Trehearne. May 2004. Telephone conversation. William Head Penitentiary, Corrections Canada. Telephone: (250) 391-7000 ext. 7206.

Nancy Turner. 2004. Email correspondence. January 2004.Professor, School of Environmental Studies, P.O. Box 1700, University of Victoria, Victoria, BC, Telephone: (250) 721-6124. Fax: (250) 721-8985. Email: nturner@uvic.ca

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