PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for Multi-Species at Risk in Vernal Pools and other Ephemeral Wet Areas Associated with Garry Oak Ecosystems in Canada

Bog birds-foot trefoil
Tall woolly-heads (Pacific population)
Water plantain buttercup
Kellogg's rush
Rosy owl clover
Dwarf sandwort

August 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).

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RESPONSIBLE JURISDICTIONS

The species addressed within the Vernal Pools Strategy occur exclusively within the Province of British Columbia in Canada. The Vernal Pools 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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PREFACE

This multi-species Recovery Strategy addresses the recovery of six endangered plant species inhabiting vernal pools and other ephemeral wet areas: bog bird's-foot trefoil *(Lotus pinnatus*), tall woolly-heads (*Psilocarphus elatior*), *Juncus kelloggii* (*Juncus kelloggii*), *Ranunculus alismifolius* var. *alismifolius* (*water plantain-buttercup*), rosy-owl clover (*Orthocarpus bracteosus*), and dwarf sandwort (*Minuartia pusilla*). In Canada, these species occur (or occurred) primarily in Garry oak and associated ecosystems on Vancouver Island and nearby Gulf Islands where they are largely restricted to low elevation, coastal areas. Although the range of all species extends into the United States, many of the species are widely disjunct from the U.S. 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

This multi-species Recovery Strategy addresses the recovery of six endangered plant species inhabiting vernal pools and other ephemeral wet areas: bog bird's-foot trefoil *(Lotus pinnatus*), tall woolly-heads (*Psilocarphus elatior*), *Juncus kelloggii* (*Juncus kelloggii*), *Ranunculus alismifolius* var. *alismifolius* (*water plantain-buttercup*), rosy-owl clover (*Orthocarpus bracteosus*), and dwarf sandwort (*Minuartia pusilla*). In Canada, these species occur (or occurred) primarily in Garry oak and associated ecosystems on Vancouver Island and nearby Gulf Islands where they are largely restricted to low elevation, coastal areas. Although the range of all species extends into the United States, many of the species are widely disjunct from the U.S. populations. The Recovery Strategy comprises 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*.

Four main habitat types are distinguished in this strategy: vernal pools, vernal swales, vernal seeps, and seasonally wetted wetland margins. Vernal pools are spatially discrete, seasonally flooded depressions that form on top of impermeable layers such as hardpan, claypan, or bedrock. They occur under Mediterranean-type climatic conditions that provide for winter and early spring inundation, followed by complete or partial drying in summer. Vernal swales are similar to vernal pools, but are usually shallower with less defined boundaries and shorter inundation periods. Vernal seeps are shallow flows that occur where groundwater emerges on sloping terrain, usually on the lower slopes of hillsides. Seasonally wetted wetland margins are low-lying areas next to perennial streams, lakes, or marshes that experience temporary flooding during high water periods in the winter or spring, becoming dry again during the summer. These habitats are all naturally highly fragmented, occurring as small isolated patches along shorelines and on small islands. Urbanization has intensified their natural fragmentation, and species occurring within them 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

Vernal pools and associated habitats are likely greatly diminished from their former abundance due to habitat conversion. Remaining habitat patches continue to be threatened by urban development and recreational demands, as well as by the encroachment of invasive alien shrubs, grasses and forbs. Fire suppression has further altered vegetation composition, hydrologic regimes and nutrient cycling, and increased fuel loading. Activities such as wetland draining, ditching, mowing, biking, dog-walking, utility maintenance, and garbage dumping also pose potential threats. Finally, as most populations are small and cover small areas, they may be inherently at risk from stochastic demographic and environmental events.

Recovery feasibility

Further studies and trials will be needed to determine whether there are insurmountable barriers to the restoration of existing populations, the re-establishment of extirpated populations, and the establishment of new populations. However, following the precautionary nature of SARA, and to prevent undue extinctions or extirpations, the premise of this strategy is that recovery is technically and biologically feasible for all species.

Recovery goals and objectives

The long-term goals for recovery of each species include maintaining existing populations at current levels of abundance or greater, restoring species to their approximate historical area of occupancy and extent of occurrence through reintroductions or translocations, and ensuring long-term population viability.

The short-term (5-10 year) objectives for meeting the long-term goals are:

1. To establish protection[1] for existing populations through stewardship and other mechanisms.
2. To engage the cooperation of all implicated landholders in habitat protection.
3. To mitigate threats to habitat and survival from recreational activities, hydrologic alterations, and eutrophication.
4. To mitigate threats to habitat and survival from secondary succession and invasive species encroachment.
5. To restore to functioning condition a minimum of 10 historical (presently non-functional) vernal pools sites.
6. To identify and rank 5-10 potential recovery (translocation) sites for each species at risk.
7. To establish new populations (or subpopulations) of each species as per the recovery goal.

[1] 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.

8. To increase plant population sizes and/or population growth rates at extant sites as per the recovery goal.

9. To establish Vernal Pool Conservation Areas at Uplands Park, Trial Island, Rocky Point, and Harewood Plains.

10. To increase public awareness of the existence and conservation value of vernal pools and associated species at risk.

Strategic approaches

Broad strategies to address the threats and meet the recovery objectives include:

1. Habitat protection and stewardship
2. Landholder contact
3. Ecological research
4. Habitat restoration and site management
5. Population augmentation and establishment
6. Inventory and monitoring
7. Public outreach and education

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.

Following completion of key work such as development and implementation of a landowner contact program including stewardship activities, it is anticipated that proposed critical habitat may include habitat currently occupied by one or more species addressed within this recovery strategy, together with the adjacent upland areas that contribute directly to sustaining hydrologic functions within the primary habitat. A more complete definition of proposed critical habitat that also incorporates potential habitat will be addressed at a later date in the Recovery Action Plan stage. Based on current state of knowledge, potential critical habitat for recovery of these species may also include:

- Intact, naturally-occurring vernal pool, seep, or other ephemeral wet area greater than 1 m^2 on southeastern Vancouver Island and the Gulf Islands having the necessary ecological characteristics to serve as future recovery habitat for species at risk, along with assessment of a 20 m buffer zone around said feature.

- The associated watershed and hydrologic features, including upland habitat, that contribute to the filling and drying of the above vernal pool or ephemeral wet area, and that maintain suitable periods of inundation, water quality, and soil moisture for species at risk germination, growth and reproduction, and dispersal.

Examples of activities likely to result in the destruction of critical habitat identified in the future

Examples of types of activities that would be expected to result in the destruction of any critical habitat that may be proposed in a recovery action plan include residential development, recreational off-road vehicle use, garbage dumping, logging road construction, utility corridor maintenance, wetland draw-down, draining, ditching and dredging, and bicycle jump construction.

Existing and recommended approaches to habitat protection

Current levels of protection for sites in this strategy range from “none” to “effectively protected.” Potential approaches to habitat protection include stewardship agreements such as conservation covenants (a legal agreement by which a landowner voluntarily restricts or limits the types and amounts of development that may take place on the land to protect its natural features), direct land acquisition.

Schedule of studies to identify critical habitat

A formal definition of critical habitat will not be made until after a multi-step process to:

- determine the physical boundaries, biological attributes, and current ownership of occupied and potential habitat
- estimate the proportion of such habitat required to meet recovery targets
- identify threats to this habitat
- work with land owners and land managers to protect the species through stewardship and other mechanisms
- obtain peer review

The recommended completion date for these and other necessary steps is 2009.

Anticipated impacts on non-target species

This strategy recognizes the importance of the entire vernal pool community and also that of associated Garry oak ecosystems. By focusing on habitat protection, maintenance of hydrologic regimes, habitat restoration, and public outreach, it is expected that the approaches recommended here will benefit not only individual species at risk but the wider ecological community as well. A program of research to identify specific impacts on associated species at risk will be provided in the Recovery Action Plan.

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.

Some activities occurring in and around vernal pools and other ephemeral wet areas 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 hydrologic 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 the vernal pool complex,
- directly damage or destroy an individual species at risk (such as through trampling or wheeled activities), or
- modify or destroy vernal pools or other ephemeral wet areas (such as through in-filling)

Vernal pools and other ephemeral wet areas are rare on the landscape and the overall land area required for physical protection of these sites is relatively small. 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.

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

Knowledge gaps

To address current knowledge gaps, further information on the following is needed: species distributions and population status; vernal pool distribution and status; appropriate restoration targets for vernal pool communities; species demography and population dynamics; microsite attributes; optimal disturbance regimes; response of habitats and species (including non-plant species) to restoration activities; seed storage and propagation techniques; and impacts of climate change.

Evaluation and measures of success

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

- Stated targets for plant abundance, viability, and occupied range
- Formalization of critical habitat designations through a Recovery Action Plan
- Level of protection achieved for proposed critical habitat
- Knowledge gaps addressed
- Number of high priority sites protected by acquisition, conservation covenants, or other stewardship actions
- Number of vernal pool sites improved through restoration activities

Timeline for completion of recovery action plan (RAP)

It is recommended that a draft Recovery Action Plan be completed by October 2009.

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1. INTRODUCTION

1.1 Background

This multi-species Recovery Strategy has been developed to address the recovery of plants at risk in vernal pools and other temporally wet habitats on southern Vancouver Island and adjacent Gulf Islands. The strategy focuses on all Canadian locations of six species (Table 1): bog birds-foot trefoil (*Lotus pinnatus*), tall woolly-heads (*Psilocarphus elatior*, Pacific population), water-plantain buttercup (*Ranunculus alismifolius* var. *alismifolius*), Kellogg's rush (*Juncus kelloggii*), rosy owl-clover (*Orthocarpus bracteosus*), and dwarf sandwort (*Minuartia pusilla*). All six species have restricted distributions and/or small population sizes and are variously threatened by habitat loss, hydrologic alterations, and competition from invasive species (COSEWIC 2004). Unless recovery actions are initiated, these species may become extirpated from Canada. The present strategy was produced to conform to the Federal *Species at Risk Act* and is designed to guide the development of a Recovery Action Plan.

All of the species addressed in this document inhabit either vernal pools, wet meadows, or ephemeral seeps within Garry oak and associated ecosystems. Individual recovery goals are provided for each of the target species, along with general recommendations for recovery and management of the vernal pool ecosystem itself. The strategy comprises 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 comprises a component of Strategic Approach D: "Protection and recovery of species at risk" in the GOERT strategy (GOERT 2002).

This recovery strategy applies a habitat-based, multi-species approach within the broader ecosystem management framework laid out by GOERT (2002). Recovery actions that benefit the six identified species and the habitats they occupy are of immediate priority. Ultimately, the aim is to establish a general template for the recovery of all plants at risk in vernal pools. Accordingly, the overall recommendations are sufficiently general to allow for the incorporation of other species into future versions of this strategy, as resources permit or as dictated by changes in the COSEWIC status of selected species. The strategy is organized into three parts. The *Introduction* provides general background information common to all species, including common habitat elements as well as the rationale for taking a multi-species approach. The second section, *Multi-Species Recovery*, outlines the main threats to the habitat and to individual species, and suggests recovery goals for each species along with strategic approaches for meeting the recovery goals. The third section, *Species Information*, provides status and designation for each species along with descriptions of morphology, global and Canadian range, habitat preferences, and population trends, as far as these are known.

1.2 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."

1.3 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[2], together with their COSEWIC rank and global and provincial status.

Species	COSEWIC Status	Date Designated	Global and Provincial Rank[3]	% Of Global Range in Canada
Lotus pinnatus (bog birds-foot trefoil)	Endangered	May 2004	G4G5 S1 Red	<1
Psilocarphus elatior (tall woolly-heads) (Pacific population)	Endangered	May 2001	G4 S1 Red	<1
Juncus kelloggii (Kellogg's rush)	Endangered	May 2003	G3? S1 Red	<1
Ranunculus alismifolius var. *alismifolius* (water plantain-buttercup)	Endangered	May 2000	G5T5 S1 Red	<1
Orthocarpus bracteosus (rosy owl-clover)	Endangered	May 2004	G3? S1 Red	<1
Minuartia pusilla (dwarf sandwort)	Endangered	May 2004	G5 S1 Red	<1

1.4 Vernal Pools

Vernal pools are spatially discrete, seasonally flooded depressions that form on top of impermeable layers such as hardpan, claypan, or bedrock (Holland and Jain 1977, Zedler 1987). They occur under Mediterranean and sub-Mediterranean type climatic conditions that provide for winter and early spring inundation, followed by complete or partial drying in summer. Although primarily a feature of the California floristic province (Keeley and Zedler 1998, U.S. Fish and Wildlife Service 2003), vernal pools also occur in Oregon, Washington, and southern British Columbia, where they are largely restricted to southeastern Vancouver Island, the adjacent Gulf Islands, and the dry southern interior.

Vernal pools are a unique type of wetland ecosystem. Central to their distinctive ecology is that they are ephemeral, occurring temporarily and then disappearing until the next year. They are wet long enough to differ in character and species composition from the surrounding upland

[2] Taxonomy and nomenclature follows Douglas et al. (1998 - 2001).
[3] G=Global Conservation Status
S= Provincial Conservation Status
T= designates a rank associated with a subspecies or variety
1 = critically imperiled , 2 = imperiled, 3 = vulnerable to extirpation or extinction, 4 = apparently secure, 5 = demonstrably widespread, abundant, and secure.

habitats, while their prolonged annual dry phase prevents the establishment of species typical of more permanent wetlands (Keeley and Zedler 1998).

Vernal pools on Vancouver Island, as in California, begin to fill with rainwater in the fall and winter and exhibit four major phases: (1) the wetting phase, when pool soils become saturated, (2) the aquatic phase, when a perched water table develops and the vernal pool contains water (or alternates between being inundated and merely saturated), (3) a water-logged drying phase, when the pool begins losing water as a result of evaporation and loss to the surrounding soils but soil moisture remains high, and (4) the dry phase, when the pool and underlying soils are completely dry (Keeley and Zedler 1998). Many of the pools on Vancouver Island fill entirely from rain falling directly into the pool, but a few have a small watershed that contributes to their water inputs.

Vernal pools typically occur in landscapes that, on a broad scale, are level to gently sloping, but where complex micro-relief produces shallow, undrained depressions that retain water. Pools come in a variety of shapes and sizes, from less than 1 m^2 to a hectare or more. On Vancouver Island, landforms that support vernal pool complexes are typically low-lying meadows or coastal bluffs (Ward *et al.* 1998). The pools on Vancouver Island tend to be of two types: those formed by rock depressions and those forming on clay soils. Rock-bottomed pools are most common on rocky bluffs, while clay-based pools occur more often in low-lying meadows. Pools in the latter habitats are sometimes fed or connected by low drainage pathways called “swales.” Swales are themselves seasonal wetted areas that remain saturated for much of the wet season. However, they are usually not inundated long enough to develop strong vernal pool or wetland vegetation characteristics. Due to their connection to adjacent pools, swales are considered important parts of the vernal pool complex. An excellent example of such a complex can be found at Uplands Park, within the District of Oak Bay on Vancouver Island.

Two other types of ephemeral wet areas mentioned in conjunction with species in this recovery strategy are “vernal seeps” and “seasonally wetted wetland margins.” Vernal seeps are shallow flows that occur where groundwater emerges on sloping terrain, usually on the lower slopes of hillsides. Seeps differ from vernal pools in that they are not usually associated with prolonged inundation; however, like vernal pools, they tend to dry up by late spring or early summer and hence present plants with similar physiological challenges. Consequently, most of the native plant species found in vernal seeps are habitat specialists not generally found in drier habitats.

Seasonally wetted wetland margins are low-lying areas next to perennial streams, lakes, or marshes that experience temporary flooding during high water periods in the winter or spring, becoming dry again during the summer. An example of this habitat type is found at Somenos Marsh, near the urban centre of Duncan.

Vernal pools, vernal swales, vernal seeps, and seasonal wetland margins contribute significantly to the biodiversity of southeastern Vancouver Island and Gulf Islands, where they form one component in a larger mosaic of Garry oak woodlands, maritime meadows, coastal bluffs, grasslands, rock outcrops, and transitional forests that comprises Garry oak and associated ecosystems (Fuchs 2001). The Garry oak community supports the highest vascular plant species diversity of any terrestrial ecosystem in coastal British Columbia (Ward *et al.* 1998, Fuchs 2001). Many of these are “peripheral” species that reach the northern limits of their range in southern British Columbia (Douglas *et al.* 2002). In the last 150 years, agricultural development, urbanization, and fire suppression have combined to eliminate or highly modify most of the original Garry oak savanna from southern Vancouver Island and adjacent Gulf Islands. It is estimated that less than five percent remains in an undisturbed condition, making this one of the most imperiled natural communities in Canada (Fuchs 2001, Lea 2002). Currently, over 90 plant taxa are listed as being at risk in Garry oak and associated ecosystems in BC, including over 20 designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being at risk on a national scale. Of the latter, approximately 30 percent are associated primarily or exclusively with vernal pools or seeps (Douglas *et al.* 2002, Fuchs 2001).

The vernal pool plant community on southern Vancouver Island is dominated primarily by annual species, which may be better able to tolerate the cycles of extreme wetting and drying that characterize this habitat. Algal mats sometimes form a dense cover, especially in pools frequented by waterfowl. Litter cover is typically minimal, except on margins and in pools having abundant thatch-forming nonnatives like perennial ryegrass (*Lolium perenne*[*]) and creeping bentgrass (*Agrostis stolonifera**). Species composition is nevertheless highly variable from pool to pool, and is likely most closely related to pool size and depth, type of substrate (e.g., rock or clay), length of inundation, and the degree of encroachment by alien and native invasives. However, chance long-distance dispersal events have likely also had a role in determining current community composition. Typical vernal pool indicators on Vancouver Island and the Gulf Islands include Scouler's popcornflower (*Plagiobothrys scouleri*), water chickweed (*Montia fontana*), water-starwort (*Callitriche* spp.), Nuttall's quillwort (*Isoetes nuttallii*), Macoun's meadow-foam (*Limnanthes macounii*), lowland cudweed (*Gnaphalium palustre*), and tiny mousetail (*Myosurus minimus*).

Vernal pools were once widespread in California along the Pacific coast and Central Valley (Keeley and Zelder 1998) but most have been lost to urban expansion and agricultural development. It is estimated that only 3-10% of California vernal pools remain, and many vernal pool endemics are now legally protected (Witham *et al.* 1998). In British Columbia, hydrologic alterations resulting from wetland fills, draining, and housing construction have probably caused a similar decline in the amount and availability of vernal pool habitat during the last century. However, we have little specific information as to historical losses in the range and number of vernal pools in this region (H. Roemer, pers. comm. 2004).

Today, most of the remaining vernal pool/vernal seep habitat on Vancouver Island is confined to isolated coastal bluffs on the southeastern side of the island, and to small undeveloped islands adjacent to the coast. Soils on these bluffs develop slowly and tend to be concentrated in isolated micro-sites. This trait, combined with the characteristically thin organic layer, makes these areas highly sensitive to any type of use and development (McPhee *et al.* 2000). Likely the greatest impact on coastal bluffs in the past century has been the development of highly desirable ocean front property for tourism, commercial, recreational, and residential purposes.

The three remaining major "hot spots" of vernal pool plant species diversity in the region are at DND Rocky Point in the District of Metchosin, Uplands Park in the District of Oak Bay, and

[*] used hereon to designate species nonnative to British Columbia

Trial Island Ecological Reserve near Victoria (CDC HERB Database 2004). Nevertheless, vernal pools, swales, and seeps can be found scattered throughout the Gulf Islands and along the Vancouver Island coast as far north as Campbell River and Mitlenatch Island. Harewood Plains, near the City of Nanaimo, is an important vernal pool and seepage area that supports a number of red- and blue-listed plant species (Ceska 2003). Recovery for one of these species, bog bird's-foot trefoil, is addressed in the present strategy.

Broadly speaking, the overall goals and objectives set out in this recovery strategy apply in principle to all extant vernal pools, swales, and seeps on southeastern Vancouver Island and the Gulf Islands. However, the main focus is on the survival and recovery habitats of the six species, including those upland habitats required for their maintenance (Section 2.6, below). The present range of the six species extends collectively from Greater Victoria to Nanaimo, with additional occurrences on Gabriola Island and Ballenas Island (Table 2, Figs. 1-4). Bog bird's-foot trefoil occurs entirely in and around Nanaimo, with a single population on Gabriola Island. Tall woolly-heads is known from Oak Bay, Saanich, and Somenos Lake near Duncan. Water plantain-buttercup is restricted to Uplands Park and Ballenas Island, while Kellogg's rush is known only from Uplands Park. Dwarf sandwort and rosy owl-clover are known from single occurrences at Rocky Pt. and Trial Island, respectively (Table 2, Figs. 1-6).

The Vancouver Island/Gulf Island populations represent the northern extent of the geographic range of each species. Isolated peripheral populations often differ genetically and morphologically from central populations (Lesica and Allendorf 1995). The ability of a species to adapt to changing ecological conditions and, therefore, its long-term survival, may rest on the conservation of these potentially distinct ecotypes (Lesica and Allendorf 1995).

1.5 Rationale for multi-species approach to recovery

The Garry Oak Ecosystems Recovery Team (GOERT) was formed to develop an ecosystem-based recovery plan for *Quercus garryana* and associated ecosystems, with the overall objective of ensuring the continued survival of the species, habitats, and ecological functions that sustain this globally significant biome (GOERT 2002). Other recent national initiatives have also recognized the importance of incorporating both broad- and fine-scale approaches into species conservation planning (Rodger 1998, Hermanutez *et al.* 2001, South Okanagan-Similkameen Conservation Program 2001, Sydenham River Recovery Team 2003), as have parallel initiatives in the U.S. (e.g., U.S. Fish and Wildlife Service 1998b) The benefits of habitat protection and ecosystem-level planning for the recovery of species at risk, and for preventing species from becoming at risk, are recognized in the recently enacted federal *Species at Risk Act*.

The Recovery of Nationally Endangered Wildlife (RENEW) program identifies the co-occurrence of multiple species at risk within a limited geographical area as an important criterion in determining the appropriateness of ecosystem-level planning. Although the six species covered by this strategy differ with respect to life history, demography, and microsite preferences (specific ecological requirements are discussed in the individual species accounts, under *Species Information*), they all share a common dependence on habitats characterized by Mediterranean-like climatic cycles of winter/spring inundation and summer desiccation. Consequently, the factors threatening survival and/or habitat tend to be similar among species.

Table 2. Occurrence information for bog bird's-foot trefoil, tall woolly-heads (Pacific population), Kellogg's rush, water plantain-buttercup, rosy-owl clover, and dwarf sandwort.

Species	Population / Occurrence	Est. No. of Plants	Year Surveyed	Source	Land Tenure/ Jurisdiction
bog bird's-foot trefoil	Harewood Plains	1600 (22 sub-populations)	2003	Donovan 2004	Private
	Woodley Range	120-140	2003	Donovan 2004	BC Parks (ecological reserve)
	Gabriola Island	65-70	2003	Donovan 2004	Private
	Nanaimo, White Rapids Rd. (several patches)	40	2003	Donovan 2004	Private
	Nanaimo, Extension Rd. (several patches)	10	2003	Donovan 2004	Private
		20-35, now possibly extirpated	2003	Donovan 2004; A. Ceska, pers. comm. 2004	Private
	Nanaimo, Waddington Rd.	Presumed extirpated	1939	Donovan 2004	Unknown
	Nanaimo, Departure Bay Rd.	Presumed extirpated	1965	Donovan 2004	Unknown
tall woolly heads (Pacific pop.)	Christmas Hill	400+	2004	M. Miller, pers. obs.	District of Saanich (nature sanctuary)
	Uplands Park	10,000+ (17 subpopulations)	2003	Fairbarns and Penny 2003	District of Oak Bay (municipal park)
	Somenos Marsh	2,000,000+ (prior to recent dredging damage)	2004	Roemer 2004	District of North Cowichan and The Nature Trust of BC[1]
	Victoria, Cloverdale	Presumed extirpated	1887	Douglas *et al*. 2001a	Unknown
	Victoria, Cedar Hill	Presumed extirpated	1887	Douglas *et al.* 2001a	Unknown
	Ucluelet	Presumed extirpated	1909	Douglas *et al*. 2001a	Unknown

Species	Population / Occurrence	Est. No. of Plants	Year Surveyed	Source	Land Tenure/ Jurisdiction
tall woolly heads (Pacific pop.) (cont'd.)	Sidney, Roberts Bay	Presumed extirpated	1913	Douglas *et al*. 2001a	Unknown
	Sidney, Swartz Bay	Presumed extirpated	1931	Douglas *et al*. 2001a	Unknown
	Francis/King Park	Status unknown	1962	Douglas *et al.* 2001a	Capital Regional District (CRD) Park
	UVic	Extirpated	1976	A. Ceska, pers. comm.	University of Victoria
Kellogg's rush	Uplands Park	1000-1500	2003	A. Ceska, pers. comm.	District of Oak Bay (municipal park)
water plantain-buttercup	Cadboro Bay / Oak Bay	Extirpated (possibly numerous populations)	1918	RBCM Herbarium	Unknown
	Uplands Park	103	2005	M. Miller, pers. obs.	District of Oak Bay (municipal park)
		36	2005		
	Ballenas Island	11	2005	M. Miller, pers. obs.	Department of National Defence
		80			
rosy owl-clover	Trial Island	447	2002	M. Fairbarns, pers. comm.	BC Parks (ecological reserve)
		366	2003		
		47	2004		
		210-230	2005		
dwarf sandwort	Rocky Point	80-120	2005	M. Fairbarns, pers. comm.	Department of National Defence

[1] The tall woolly-heads population occurs in a narrow zone along Somenos Creek, just outside and paralleling the boundary of the Somenos Garry Oak Protected Area, on District of North Saanich land. The Protected Area is owned by The Nature Trust of British Columbia and is managed by the BC Ministry of Environment.

At present, there may be fewer than a hundred functioning vernal pool complexes remaining in southwestern BC (H. Roemer, pers. comm. 2004). A substantial proportion of these support occurrences of rare plants. Several of the sites addressed in this strategy, such as Uplands Park, provide habitat for COSEWIC-listed species not directly discussed here (e.g., Macoun's meadowfoam), and COSEWIC status reports have recently been prepared or are underway for several other species (e.g., Muhlenberg's centaury, winged water-starwort). Taking a multi-species approach to recovery planning will facilitate the inclusion of additional taxa with similar ecological requirements into future versions of this strategy, while encouraging the development of long-term objectives that potentially benefit all native vernal pool plant inhabitants.

2. RECOVERY

2.1 Common Limitations and Threats

Numerous factors have been identified as posing threats to plants at risk in vernal pools and other ephemeral wetlands on southeastern Vancouver Island (Table 3). In only some cases is there strong evidence linking a specific threat with recent population declines. The most obvious example is the loss of habitat and populations to urban development. However, at Harewood Plains, direct damage to bog bird's-foot trefoil plants from unauthorized all-terrain vehicle traffic has been well documented (Donovan 2004). At Somenos Marsh, a creek dredging operation has recently resulted in the destruction of a substantial segment of the tall woolly-heads population.

It is important to recognize the inherent complexity of vernal pool and related ecosystems and that, in most cases, population declines are likely a result of the cumulative impacts of many interacting anthropogenic stresses. Aside from direct habitat conversion, few of the identified threat factors have been diagnosed and tested empirically as driving declines for the individual species addressed in this strategy. However, many of these factors are cited in the literature as being key impacts for ephemeral wetlands in general (e.g., Witham *et al.* 1998).

2.1.1 Habitat Conversion

Widespread loss of natural wetland habitat has occurred on southeastern Vancouver Island, with the greatest habitat losses occurring in the past 150 years. Conversion to agricultural and pasture lands, and urban and residential development, have been the main factors responsible for the declining extent of wetlands (McPhee *et al.* 2000). Habitat conversion has been implicated in the loss of populations of bog bird's-foot trefoil, tall woolly-heads, rosy-owl clover and possibly water plantain-buttercup during the past century (Illingworth and Douglas 1998, Douglas *et al.* 2001a, Donovan 2004, Fairbarns 2004).

2.1.2 Environmental stochasticity and demographic failure

Most of the species addressed in this Recovery Strategy are represented in Canada by just a few individuals inhabiting a very small (<300 m^2) spatial area (Table 2). These small populations may be highly vulnerable to stochastic environmental events and processes (e.g., drought, disease, disturbance from waterfowl, etc.). Even under stable environmental conditions, random variation in demographic parameters (a phenomenon referred to as "demographic stochasticity") could propel these populations through fluctuations that include zero individuals, resulting in local extirpation (Menges 1998).

Some taxa may also be experiencing deleterious genetic effects such as inbreeding depression (i.e, a loss of vigour or fitness due to inbreeding), which is another hazard sometimes associated with small isolated populations (Huenneke 1991). Although genetic constraints are likely to be secondary to the demographic difficulties of small population size in a varying environment, inbreeding depression could theoretically contribute to decreased population growth rate and increased extinction probability (Schemske *et al.* 1994).

2.1.3 Alteration of hydrologic regimes

Both the timing and duration of the winter inundation phase are believed to have a marked effect on the floristic composition of vernal pools (Keeley and Zedler 1998). For example, some species initiate germination during the wetting phase (Zedler 1987; Bauder 1987a) whereas others require inundation (Keeley 1988). It is not uncommon that, as a result of annual variation in weather patterns, different species will dominate in different years within the same pool. Likewise, dryland species that normally would be excluded from pool basins due to their inability to tolerate inundation are sometimes able to colonize basins in low rainfall years (Zedler 1984, 1987). In California, pools deprived of sufficient moisture tend to be dominated by nonnative dry land plants, most notably grassland annuals (Bauder 1987b).

The timing of pool dry-down (e.g., early vs. late spring) may be an important factor constraining the ability of some pool species to persist locally, since rapid onset of drought conditions in shallow or otherwise drought-prone pools can result in truncated growing seasons and reduced seed production (M. Fairbarns, pers. comm. 2005). In such instances, the surrounding micro-catchment can play a crucial role in extending the growing/flowering season, by delivering late rains to the vernal pool, swale, or seep.

The timing of pool dry-down may also contribute to the exclusion of more typical wetland plants, as dry-down occurs just when air temperatures are rising rapidly. The transition period between inundation and drought appears to be too brief for establishment of many emergent wetland species (Keeley and Zedler 1998). Basin depth is likewise an important factor driving community composition, as deeper basins tend to retain water longer and hence favour different assemblages (Zedler 1987). Vernal pool plant species can tolerate lengthy periods of inundation, but they are not truly aquatic, so mortality increases with length of inundation and is often 100 percent when ponding exceeds six months (Bauder 1987b, 1992).

Consequently, hydrologic changes and erosion can cause significant changes in the pool flora (Bauder 1992). Irrigation common in urban and landscaped areas may encourage less stress-tolerant species, including exotic plant species. Trenching for public utilities, maintenance of fire access roads, fuel and chemical spills, and recreational activities can all cause damage to vernal pools and other ephemeral wetlands, particularly during the aquatic or drying phases when soils are most vulnerable and the organisms are growing or reproducing (U.S. Fish and Wildlife Service 1998a). Furthermore, although watershed contributions to pool filling may be minor relative to those from direct precipitation, water exchange between the vernal pool or seep and surrounding upland can play a major role in controlling water level relationships (Hanes and Stromberg 1998), thus maintaining overall landscape context may be vital to the long-term health of pools and seeps.

Ironically, ruderal species such as tall woolly-heads and bog bird’s-foot trefoil have now begun to colonize some of the older tire ruts at Uplands Park and Harewood Plains. It remains to be seen whether these artificial “pools” are capable of sustaining colonies of endangered plants over the long term, or whether they will eventually come to act as “sink” habitats for species at risk. Regardless, considerable effort will now be required to recover the landscape matrix and restore the natural flow of water through these areas.

Table 3. Present threats to the habitat (H) and direct threats to the survival (S) of species in the Recovery Strategy. BBT = bog bird's-foot trefoil, TW = tall woolly-heads, KR = Kellogg's rush, WP = water plantain-buttercup, RO = rosy owl-clover, DS = dwarf sandwort. For each species, threats in each of the two categories are ranked as Nil, Low, Moderate (Mod.), High, or ambiguous (?).

Threat	Impact	BBT	TW	KR	WP	RO	DS
1. Habitat conversion for urban/residential development	S, H	High	Mod.	Low	Low	Low	Low
2. Environmental stochasticity and/or demographic failure	S	Mod.	Mod.	High	High	High	High
3. Hydrologic disruptions							
a. irrigation	S, H	Low	Low	Low	Low	Nil	Nil
b. utility maintenance	S, H	Mod.	Low	Low	Low	Mod.	Low
c. vehicle traffic (utilities and fire-fighting)	S, H	Mod.	Mod.	Mod.	Mod.	Low	Low
d. park maintenance/ improvement (e.g., ditching, gravel deposition)	S, H	Low	Mod.	Mod.	Mod.	Low	Low
e. wetland draw-down	S, H	Low	High	Mod.	Mod.	Nil	Nil
f. loss of watershed integrity due to urban/agricultural development	H	Mod.	Mod.	Mod.	Mod.	Low	Low
g. logging road construction	H	Mod.	Low	Low	Low	Low	Low
h. drought	S	Mod.	Mod.	Mod.	Mod.	Mod.-High	Mod.-High
4. Recreational activities							
a. motorized off-roading	S, H	High	Low	Low	Low	Low	Low
b. mountain biking	S, H	Low	Mod.	High	High	Nil	Nil
c. foot and dog traffic	S	Mod.	Mod.?	Mod.-High?	Mod.-High?	Mod.	Low
d. dog excrement	S	Low	Mod.?	Mod.?	Mod.?	Low	Low
5. Secondary succession							
a. Encroachment by native trees and shrubs due to fire suppression	H	Mod.	Mod.	Mod.	Mod.	Low	Low
6. Invasive species							
a. encroachment by invasive nonnative grasses and shrubs	H	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.
b. thatch buildup	S, H	Mod.	Mod.	High?	High?	Mod.	Low
7. Eutrophication							
a. agricultural / residential runoff	S, H	Mod.	Mod.	Mod.	Mod.	Low	Low
b. nitrogen inputs from seabird guano	S, H	Low	Mod.	Low	Low	Low	Low
e. algal mats	S, H	Low	Mod.	Low	Low	Low	Low

Threat	Impact	BBT	TW	KR	WP	RO	DS
8. Marine pollution	S, H	Nil	Low	Nil	Low	Low	Low
9. Other							
a. mowing	S	Low	Low	Low	High?	Low	Nil
b. vertebrate/invertebrate herbivory	S	Mod.?	Low	Low	High?	Low	Low
c. seagull/geese digging	S	Low	Low	Low	Low	Mod.?	Mod.?
d. garbage dumping	S	Mod.	Low	Low	Low	Low	Low

The Somenos Marsh site near Duncan differs from most other habitats described in this strategy in that it lies adjacent to, and is sustained by, a permanent wetland. Best be described as a "seasonally wetted wetland margin" as opposed to a vernal swale or seep, this site hosts the largest confirmed tall woolly-heads population in Canada (Table 2). The basins draining into Somenos Marsh together occupy over 7000 ha. This watershed has undergone extensive land development and clearing, including dyking, forest harvesting, road construction, residential and commercial development, and agriculture (Williams and Radcliffe 2001). Over the past 20 years, in-filling of the lake and eutrophication have led to gradually increasing summer lake levels, raising concerns over impacts on agricultural production (mainly hay) as well as on fish and waterfowl habitat (Williams and Radcliffe 2001). As a way of enhancing wildlife values while accommodating agricultural objectives along the lake shore, a proposal has been made to reduce summer lake levels by improving drainage out of the lake (Williams and Radcliffe 2001). It is unclear at present how such a management action would affect the tall woolly-heads site. However, if spring lake levels were permanently lowered to the point where seasonal flooding of the upper shore no longer occurred, the present habitat would likely be eliminated along with the population (Douglas *et al.* 2001a). Recently, large piles of spoil from a dredging operation in Somenos Creek were deposited on the shore next to the Somenos Garry Oak Protected Area, resulting in the inadvertent destruction of an estimated 1/3 of the tall woolly-heads population (M. Fairbarns, pers. comm. 2004).

Individual and population-level responses to disruptions in hydrology per se have not been well documented for any of the six taxa covered by this strategy, either for BC or in the literature in general. However, germination rates in *Callitriche marginata*, a rare vernal pool plant that co-occurs with Kellogg's rush and water plantain-buttercup at Uplands Park, are known to be sensitive to the timing of the onset of fall flooding, as well as to the length of inundation (Bliss and Zedler 1998). In general, species restricted to open, seasonally ephemeral wetlands are highly specialized ecologically and may not be adapted to respond to major structural alterations to habitat (Hanes and Stromberg 1998). Successful management of these areas may require research into the way individuals and populations respond to changes to the hydrologic regime or to naturally-occurring hydrologic processes.

2.1.4 Recreational activities

Recreational activities such as all-terrain vehicle (ATV) off-roading, mountain biking, and dog-walking have variously been cited as posing a threat to the integrity of vernal pool systems (Clark *et al.* 1998, U.S. Fish and Wildlife Service 1998b, 2000, Douglas and Illingworth 1998, Donovan 2004). Traffic from off-road vehicles, which compacts the soil, creates deep and near-permanent ruts, dislodges and crushes vegetation, and generally fragments the habitat, appears to represent the most serious threat. However, dogs also churn up moist loose soil and trample plants where they are exercised, while traffic from bicycles and people can result in the creation of new trails, change the micro-topography of pool bottoms, and crush pool vegetation. The long-term impacts of these activities have not been quantified, although light trampling, along with mowing and grazing (Barry 1998), may actually benefit some low-growing plants by suppressing taller exotic herbs and reducing competition. Some species (e.g., bog bird's-foot trefoil) may also require a certain amount of soil disturbance for germination.

The impact of off-road vehicles at Harewood Plains has been noted above (Section 2.1.2). Despite efforts by the former landholder (Weyerhaeuser Canada) to block trail access with boulder placements and ditches, recreational users of ATV's, 4x4's and (to a lesser extent) dirt bikes continue to access the area on a regular basis (C. Thirkill, pers. comm. 2004). In addition to altering the local hydrologic regime, off-roading has disturbed and compacted the soil, facilitated the spread of invasive species, and directly endangered the survival of plants such as bog bird's-foot trefoil due to crushing (Donovan 2004).

Foot, bicycle, and dog traffic represents an ongoing impact at the heavily visited Uplands Park (including Cattle Point), particularly in spring when the vernal pool/swale plants are flowering and moist soil is easily compacted. Bicycling is prohibited within the park, but this rule is rarely enforced. Where trails come close to pools, soil compaction and heavy traffic have in some instances eliminated vegetation cover (Collier *et al.* 2004). In the spring of 2004, local mountain bikers built an unauthorized bike jump within metres of one of the water plantain-buttercup subpopulations. To construct the jumps, dirt and mud was excavated from a nearby depression, creating a crater sized hole in the meadow. Such activities threaten the habitat of species at risk both through direct mechanical damage and by permanently altering the local hydrologic regime.

Although dogs in Uplands Park are required to be on leashes throughout the spring months (April-June), this rule is also rarely enforced, and pets can be observed at all times of year running and chasing balls in the wet meadow containing known populations of Kellogg's rush, tall woolly-heads, and water plantain-buttercup as well as numerous other red-listed plants. A recent park use survey conducted during the spring months found that almost 50 percent of visitors to the main meadow were accompanied by dogs, whereas only 2 percent of the dogs were observed to be on leash at a given time (Collier *et al.* 2004). As most of the plants under consideration are small and fragile (fully mature individuals of Kellogg's rush and tall woolly-heads are often less than 4 cm tall), they are easily trampled or ripped up by dogs, and may also be vulnerable to being buried or crushed by dog scat. A recently completed draft stewardship plan for Uplands Park notes: "The frequent presence of commercial dog walking activity in the Park will be highly damaging to soil and vegetation under most conditions. Particularly because plant species at risk are concentrated in open meadows where dogs are brought for exercise there is an obvious conflict between the preservation of park values and the uncontrolled use of the Park by some dogs" (Collier *et al.* 2004).

At Trial Island, the rosy owl-clover site attracts some foot traffic from recreational boaters, as does the dwarf sandwort site at Rocky Point (Fairbarns 2004, Penny and Costanzo 2004).

Population-level impacts from these various disturbances have not been quantified, but merit further investigation.

2.1.5 Secondary succession due to fire suppression

Prior to European settlement on Vancouver Island, fire—both natural and human-initiated—is thought to have played an important role in maintaining Garry Oak savannas (Hebda and Aitkens 1993, MacDougall *et al.* 2004). Aboriginal peoples used regular burning to maintain the open stand structure favourable to camas (*Camassia* spp.) and other root crops (Turner 1999, Fuchs 2001). The frequent, low intensity fires scorched the grass and shrub layer but left the oak canopy largely intact. The process slowed the succession of shrubs (e.g., *Symphoricarpos albus, Rosa nutkana*) and conifers such as Douglas-fir (*Pseudotsuga menziesii*), allowing herbaceous meadow plants to flourish. Over the last 150 years, fire suppression has led to encroachment of woody shrubs and Douglas-fir into areas once dominated by Garry oak, dramatically altering local community structure (Fuchs 2001, MacDougall 2004).

Like the larger Garry oak ecosystems in which they are found, many vernal pool systems are thought to be fire-maintained and thus characteristic of early- to mid-seral stages (Witham *et al.* 1998). Fire suppression has been acknowledged as a threat to vernal pools and wetland prairies in Oregon (Wilson 1999, U.S. Fish and Wildlife Service 2000, Kaye *et al.* 2001). It is unclear what historical role fire played in creating and maintaining vernal pool habitat on Vancouver Island. However, most of the vernal pools under consideration are small enough (less than 20 m^2) to be easily affected by factors such as shading associated with woody plant encroachment.

At Uplands Park and other sites, fire suppression has already led to a decline in the vernal pool habitat, due to tree encroachment and a dramatic increase in the cover of shrubs such as native snowberry (*Symphoricarpos albus*) and nonnative Scotch broom (*Cytisus scoparius*), which now shade many vernally-moist microsites. The incursion of these species into adjacent habitats may have already begun to affect local hydrologic and light regimes, through alteration of drainage patterns, increased competition for water, increased shading, and thatch buildup. If unchecked, this process could result in feedback loops that accelerate the overall rate of secondary succession (Pollak and Kan 1998).

Few studies have addressed the problem of eutrophication in vernal pools. However, it is thought that extra nutrient loading in pools from agricultural or residential runoff favours the growth of other (non-specialist) aquatics that thrive in nutrient-rich conditions, and causes algal blooms that deplete the water of oxygen (U.S. Fish and Wildlife Service 1988b). Algal blooms sometimes form mats that cover plants and stunt their growth or prevent flowering (U.S. Fish and Wildlife Service 1998b).

2.1.6 Eutrophication

On Vancouver Island, eutrophication associated with guano contamination by waterfowl is a growing concern at several vernal pool sites. This process is clearly evident at Mitlenatch Island, a provincially-designated seabird preserve that hosts one of the largest nesting populations of glaucus-winged gulls (*Lárus glaucéscens*) in the Georgia Strait (Miller 2005). Records from bird counts indicate that the seagull population on Mitlenatch Island has been increasing at an exponential rate since the turn of the century, possibly coinciding with the appearance of garbage dumps, shellfish processing plants and sport fishing cleaning stations in the nearby coastal communities of Campbell River, Powell River, and Comox (Merilees 1992).

Recent signs of guano contamination have also been observed in vernal pools around Victoria and on adjacent Gulf Islands (Miller 2005), where resident Canada geese have been undergoing a similar exponential population increase since the 1960's (Campbell *et al.* 1990, Carsen 2000) and may now be having a similar negative impact on local water quality. Through their grazing, Canada geese also strip vegetation and churn soils. To date, none of the populations covered by this strategy appear to have been directly affected by Canada geese activity, although nutrient inputs from this source may have already compromised the integrity of potential habitats elsewhere.

Presumably, decomposing dog feces could also pose a contamination threat at heavily visited vernal pool/swale sites such as Uplands Park. Nutrient enrichment from this source might be sufficient to encourage algal blooms that in turn affect water oxygen/CO2 balance, light penetration, and other aspects of water quality, with potentially negative consequences for plant flowering, germination, and seedling survival rates (C. Björk, pers. comm. 2004). Unfortunately, this topic has received little attention to date in the vernal pool literature, and requires further study.

2.1.7 Marine Pollution

The Strait of Juan de Fuca is one of the most active shipping lanes in the Pacific Northwest. Petroleum tankers, freighters, cruise ships, and other marine traffic regularly pass within a few km of Vancouver Island. Trial Island, which is close to Cattle Point, hosts the lone Canadian occurrence of rosy owl-clover as well as numerous other federally listed plant species at risk (Plants at Risk Recovery Implementation Group 2005b). Many of these populations are located in low-lying pools or meadows adjacent to the shore.

Much of the vernal pool habitat on Vancouver Island and Gulf Islands occurs just above the intertidal zone and is affected by salt spray during storm events. Because of their proximity to the ocean, vernal pool species may be particularly vulnerable to marine pollution. More research is needed to determine the impacts of both diffuse marine pollution and/or a catastrophic point source spill on species at risk (Plants at Risk Recovery Implementation Group 2005b).

2.2 Recovery Feasibility

Recovery is defined alternatively as “restoring a species to a viable self-sustaining population level, able to withstand stochastic events and other environmental variables of a non-catastrophic nature” (National Recovery Working Group 2004); or as “any improvement in a species’ probability of long-term persistence in the wild” (Environment Canada *et al.* 2004). Full recovery in the first sense may not be strictly feasible if a species is by nature very rare; if it has a naturally highly fragmented distribution; or if its habitat has undergone such major alterations that it is precluded from achieving a distribution and population size consistent with the above definition. In such cases, the goal of recovery may simply be to maintain the current population size and distribution while reducing or eliminating threats (National Recovery Working Group 2004).

The following sections define recovery, and its feasibility, for individual species in this strategy. In most case, further studies and trials will be needed to determine whether there are insurmountable barriers to the restoration of 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. However, following the precautionary nature of *SARA*, and to prevent undue extinctions or extirpations, the premise of this strategy is that recovery is technically and biologically feasible for all six species (Table 4).

Table 4. Recovery feasibility of species in the Recovery Strategy. "Feasibility criteria" from Environment Canada *et al.* (2004).

Feasibility Criteria	Species					
	Bog bird's-foot trefoil	**Tall woolly-heads**	**Kellogg's rush**	**Water plantain-buttercup**	**Rosy owl-clover**	**Dwarf sandwort**
1. Are individuals capable of reproduction available to support recovery?	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
3. Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?	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
5. Current estimated population viability	Moderate	Moderate to high	Low	Low to moderate	Low	Low

2.2.1 Recovery feasibility of bog bird's-foot trefoil

As with many other rare Garry oak-associated plant species on Vancouver Island, we lack adequate detailed information about the historical distribution of bog bird's-foot trefoil. However, the existence of herbarium records from as early as 1939 indicate that the species has been established in and around Nanaimo for at least half a century (Table 2). Presumably, these populations predate European settlement, but this is difficult to confirm. At least three occurrences, all near Nanaimo, are believed to have been extirpated in recent decades due to human factors (Donovan 2004, A. Ceska, pers. comm. 2004). There is no evidence to indicate that bog bird's-foot trefoil was ever abundant or widespread on Vancouver Island, although it is possible these extant populations represent historical remnants of a more contiguous distribution along the southeastern portion of Vancouver Island and the Gulf Islands. The current population viability of bog bird's-foot trefoil is rated as "moderate" (Table 4).

Although bog bird's-foot trefoil biology and ecology are poorly understood, field observations suggest that regular recruitment is occurring (Donovan 2004). At least some populations appear to large enough to be self-sustaining. There also appears to be sufficient favourable habitat remaining at Harewood Plains and elsewhere to support one or more additional viable populations. Therefore, if the threats described above (and any other threats identified in the future) can be removed or minimized, and if techniques can be developed to augment and re-establish bog bird's-foot trefoil populations where required, it is expected that the species can be recovered to a fully viable population level (Table 4). Successful recovery will depend on a combination of habitat protection and management, demographic intervention, and long-term population monitoring. The level of effort required for recovery is expected to be moderate.

2.2.2 Recovery feasibility of tall woolly-heads (Pacific population)

Currently, within British Columbia, the known range of tall woolly-heads is restricted to sites around Victoria and Duncan on Vancouver Island. As with many other rare Garry oak-associated plant species, we lack adequate detailed information about the historical distribution of tall woolly-heads. Early records (Macoun 1909, 1913) exist from as far north as Sidney on the Saanich Peninsula and as far west as Ucluelet, although the Ucluelet record is now thought to be erroneous (M. Fairbarns, pers. comm. 2004). Of the nine populations documented on the Saanich Peninsula, five no longer exist, while a sixth has not been observed since 1962 and is also presumed extirpated (Douglas *et al.* 2001a, Table 2).

In the absence of evidence to the contrary, therefore, it can be assumed this species was once considerably more common on the Saanich Peninsula than it is now and that its current restricted distribution is due, at least in part, to anthropogenic factors. Although the three remaining extant populations are robust and appear to be self-sustaining, recent events at the Somenos site, which resulted in the partial destruction of the population there (see Section 2.1.2), serve to underscore their continuing vulnerability to disturbance. The current population viability of tall woolly-heads is rated as "moderate to high" (Table 4).

For tall woolly-heads, we define "recovery" as restoration to a level of abundance and distribution on Saanich Peninsula comparable to historical levels (as far as these are known), with the aim of ensuring a high probability of persistence for this species. Recovery to this extent is currently deemed to be ecologically and technically feasible (Table 4). This assessment is predicated on the assumption that there is sufficient suitable habitat available for translocations (Table 4), an assumption that has not been tested. Beyond this requirement, recovery success will be closely tied to activities such as habitat protection and management, demographic intervention, and long-term population monitoring. It is anticipated such activities will also benefit other rare vernal pool species in BC. The level of effort required for recovery is expected to be moderate.

2.2.3 Recovery feasibility of Kellogg's rush

Kellogg's rush is known from one site in Canada, Uplands Park, where it was first documented in 1985 (CDC HERB database 2004). There is no evidence to indicate either that Kellogg's rush was ever abundant or widespread in Canada, or that it has declined substantially from historical levels. It is possible the extant population is simply a disjunct, northern outlier of its wider North American range. On the other hand, much of the potential Kellogg's rush habitat on southeastern Vancouver Island has been lost during the past century as a result of land-use practices (Fuchs 2001). Kellogg's rush is a minute plant with a highly inconspicuous growth form, and is easily overlooked in the field. The fact that it has not been collected elsewhere is thus not necessarily reliable proof of its true historical (or current) range, and the possibility that the Uplands population represents the last vestige of a formerly more widespread distribution must also be considered (Douglas and Illingworth 1998). The current population viability of Kellogg's rush is rated as "low" (Table 4).

Kellogg's rush is an annual species and as such exhibits variable aboveground dynamics; recorded population sizes have ranged from as few as 3 to >200 individuals (Costanzo 2003). Given its apparent range marginality as well as high natural rarity, achieving a "high probability of persistence" may be an inappropriate goal to set for this species (National Recovery Working Group 2004). In this instance, population and distribution objectives that aim to maintain a minimum viable population with a moderate probability of persistence may be more appropriate (see Table 5, *recovery goals*). Recovery of Kellogg's rush to such a level is currently deemed to be ecologically and technically feasible (Table 4). The level of effort required for recovery is expected to be moderate to high.

2.2.4 Recovery feasibility of water plantain buttercup

The existence of several early herbarium records from Cadboro Bay and Oak Bay (e.g., Newcombe 1890, Anderson 1900) suggests that water plantain-buttercup was historically much more abundant in the Victoria area than at present. Urbanization and habitat loss are likely the main contributing factors in the decline in numbers over the past century. Although water plantain-buttercup was probably never widespread in the region, the existence of a Ballenas Island population, some 115 km to the north of Victoria, suggests the possibility that this species may have once occupied a more contiguous distribution along the southeastern portion of Vancouver Island and the Gulf Islands. However, there is no evidence to confirm this. The current population viability of water plantain-buttercup is rated as "low to moderate" (Table 4).

Since much of its original habitat has been permanently lost to development, full restoration of water plantain-buttercup to historical levels of occurrence is probably not feasible (even if these levels were known). For this species, an appropriate definition of "recovery" will thus likely fall somewhere on the spectrum between "survival" and "full recovery." Nevertheless, there are currently no obvious biological impediments that would prevent water plantain-buttercup from attaining, with some intervention, a viable population level. Although small, the Uplands Park and Ballenas Island populations appear to have remained generally stable over the past decade (CDC HERB Database 2004). A proportion of plants at both sites flower each year, and regular juvenile recruitment has also been observed. Across its range, water plantain-buttercup exhibits a relatively broad range of habitat tolerances ranging from muddy ditches, pond margins, and stream banks to swales and moist alpine meadows (see Section III, *Species Information*), suggesting that neither demographic constraints nor habitat specificity will be critical limiting factors for recovery. Restoring water plantain-buttercup to a level of long-term viability will necessitate increasing both the sizes of extant populations and also the number of total occurrences, goals deemed to be both ecologically and technically feasible (Table 4). Given the species' current extreme rarity, the level of effort required for recovery is expected to be moderate to high.

2.2.5 Recovery feasibility of rosy owl clover

Nine historical records, dating from 1887 to 1954 and representing at least five distinct populations, exist for rosy-owl clover in British Columbia. All originate from the Saanich Peninsula on southeastern Vancouver Island, and all are now thought to be extirpated (Fairbarns 2004). The species is currently known from a single vernal seep on Trial Island, near Victoria. This population has fluctuated from 40 to about 1000 individuals between 1998 and 2004 (Fairbarns 2004, M. Fairbarns, unpubl. data). The site is located within the Trial Island Ecological Reserve and as such is effectively protected under the *Ecological Reserves Act*. However, the seepage area contains a number of alien invasive plant species that could eventually out-compete rosy-owl clover. Furthermore, the site's small size (approx. 300 m^2) makes it highly vulnerable to stochastic environmental events (e.g., drought, recreational disturbances). If the rosy-owl clover population were eliminated, there would be no chance of a rescue effect from elsewhere. Consequently, the current population viability of dwarf sandwort is rated as "low" (Table 4).

Urban development in and around Victoria is believed to be the main factor responsible for the decline in the number of local occurrences. The widespread invasion of aggressive alien species may also have contributed to the decline, as rosy-owl clover does not easily tolerate competition (M. Fairbarns, unpubl. data). Although rosy-owl clover is not considered a vernal pool specialist—it also occurs in open, vernally wet habitats such as ditches, prairies and open fields—most other sites on Trial Island and nearby areas of Vancouver Island that might have been capable of supporting populations have been rendered unsuitable due to encroachment by highly competitive shrubs and grasses. At the same time, spring seepage conditions such as those at the Trial Island site may be extremely difficult to replicate artificially. Lack of available suitable habitat could thus be a serious impediment limiting the reintroduction potential of this species (Fairbarns 2004).

For rosy-owl clover, as for water plantain-buttercup, "recovery" will likely fall somewhere on the spectrum between "survival" and "full recovery." Aside from habitat availability, there are currently no obvious biological impediments that would prevent rosy-owl clover from attaining, with some intervention, a viable population level. At the Trial Island site, seed production, although variable, is generally high (greater than1000 seeds per year), and regular juvenile recruitment has been observed (M. Fairbarns, unpubl. data). Restoring rosy-owl clover to a level of long-term viability will necessitate (in addition to reducing or eliminating current threats) increasing both its abundance and total extent of occurrence. This is deemed to be both ecologically and technically feasible (Table 4). Given the species' current extreme rarity, the level of effort required for recovery is expected to be moderate to high.

2.2.6 Recovery feasibility of dwarf sandwort

Dwarf sandwort is known from a single vernal seep near Rocky Point. This small population was first documented in 1977 (CDC HERB database 2004). Intensive searches in adjacent areas have so far failed to yield any additional localities, and there is no evidence to indicate that dwarf sandwort was ever abundant or widespread in Canada, or that it has declined substantially from historical levels. It is possible the extant population is an isolated disjunct, the result of a chance long-distance dispersal event. On the other hand, dwarf sandwort is a minute plant with a highly inconspicuous growth form, and is easily overlooked in the field; the lack of collections elsewhere may thus not be reliable indication of its true historical (or current) range. Furthermore, much of the suitable dwarf sandwort habitat on southeastern Vancouver Island has been lost during the past century as a result of land-use practices (Fuchs 2001). The possibility that the Rocky Point population represents the last vestige of a formerly more widespread distribution must therefore also be considered.

The extant site is located on an uninhabited coastal bluff within the grounds of the Department of National Defence's Rocky Point Ammunition Depot, rendering it temporarily secure from development. Nevertheless, dwarf sandwort, like rosy-owl clover, exhibits highly variable aboveground dynamics: recorded population size has ranged from as few as nine to several hundred individuals (Penny and Costanzo 2004, M. Fairbarns, unpubl. data). Random fluctuations in demographic performance could be sufficient to drive this population to extinction. Furthermore, the site's small size (approx. 20 m^2) makes it highly vulnerable to stochastic environmental events (e.g., drought, disturbances from waterfowl, trampling by trespassing boaters). If the dwarf sandwort population were eliminated, there would be no chance of a rescue effect from elsewhere. Consequently, its current viability is rated as "low" (Table 4).

Given its apparent range marginality as well as high natural rarity, achieving a "high probability of persistence" may be an inappropriate goal to set for this species (National Recovery Working Group 2004). In this instance, population and distribution objectives that aim to maintain a minimum viable population with a moderate probability of persistence may be more appropriate (see Table 5, *Recovery goals*). Recovery of dwarf sandwort to such a level is currently deemed to be ecologically and technically feasible (Table 4). The level of effort required for recovery is expected to be moderate to high.

2.3 Recovery goals and objectives for species at risk

Recovery goals for the six species in this strategy are presented in Table 5. Preventing further losses or declines (or an increase in rarity) is, in all cases, an important first step in recovery. This is reflected in **Goal 1**: "maintain extant localities at current levels of abundance or greater" (Table 5).

The species under consideration differ with respect both to life history (e.g., annual vs. perennial) and specific habitat preferences (e.g., vernal pools vs. seeps). Although currently unknown, key demographic parameters (e.g., fecundity, intrinsic growth rate, population structure, dispersal, rescue effects) likely also differ (Miller 2004). The number, size, and distribution of populations needed for long-term persistence are ultimately determined by these intrinsic factors in combination with genetics (e.g., inbreeding effects) and various extrinsic factors including the rate of habitat change, stochastic events such as fire and drought, and interactions with competitors.

Population viability analysis (PVA) is one tool now commonly employed to set specific population and distribution targets for recovery (Shaffer 1981, Menges 1986, Nantel *et al.* 1996, Menges 2000, Caswell 2001). PVAs provide assessment of population persistence (or extinction risk) based on a combination of empirical data and modeling scenarios. Spatially explicit, metapopulation models are useful for predicting the importance of local extinction and colonization in overall dynamics and to predict how species might be affected by anthropogenic changes to landscapes (Schemske *et al*. 1994, Menges and Dolan 1998). Unfortunately, the data required to construct a PVA are difficult and expensive to collect (Beissinger and Westphal 1998), and therefore not often available to recovery planners. Moreover, many aspects of plant life history can present challenges when obtaining data for PVAs. These include seed and bulb dormancy (Kalisz and McPeek 1992, Miller *et al.* 2004), periodic recruitment (Menges and Dolan 1998), and clonal growth (Dammon and Cain 1998, Hawryzki 2002).

Population viability analyses have not yet been completed for any of the species in this strategy. Instead, **Goal 2** proposes specific population and distribution targets based on best available knowledge and the combined expertise of recovery team members. The targets reflect either the number of known historical populations, the estimated minimum number of populations required to redistribute the species across its former range, and/or the estimated number of populations required to achieve a level of viability consistent with **Goal 3** (Table 5).

Table 5. Recovery goals, and COSEWIC criteria addressed, for species in the Recovery Strategy

Species	Recovery Goals	COSEWIC Criteria Addressed
bog bird's-foot trefoil	1. To maintain extant localities at current levels of abundance or greater. 2. To restore bog bird's-foot trefoil to its approximate historical extent of occurrence and area of occupancy (minimum of three new, independent and self-sustaining populations in the Nanaimo area). 3. To attain a viable Canadian population with a high probability of persistence.[1]	B1ab(ii,iii,v)+2ab(ii,iii,v); C1
tall woolly-heads (Pacific pop.)	1. To maintain extant localities at current levels of abundance or greater. 2. To restore tall woolly-heads to its approximate historical extent of occurrence and area of occupancy on the Saanich Peninsula (minimum of five new, independent and self-sustaining populations). 3. To attain a viable Canadian (Pacific) population with a high probability of persistence.[1]	A4c; B1ac(iv)+2b(iv)

Species	Recovery Goals	COSEWIC Criteria Addressed
Kellogg's rush	1. To maintain the extant locality at current levels of abundance or greater. 2. To maintain the approximate current extent of occurrence while increasing the total area of occupancy (minimum of five additional local subpopulations at Uplands Park). 3. To attain a viable Canadian population with a moderate probability of persistence.[2]	D1
water plantain-buttercup	1. To maintain the two extant localities at current levels of abundance or greater. 2. To restore water plantain-buttercup to its approximate historical extent of occurrence and area of occupancy (minimum of five new, independent and self-sustaining populations in Victoria/Oak Bay). 3. To attain a viable Canadian population with a high probability of persistence.[1]	B1ab(iii)+2ab(iii); C2a(i, ii); D1
rosy owl-clover	1. To maintain the extant locality at current levels of abundance or greater. 2. To restore rosy-owl clover to its approximate historical extent of occurrence and area of occupancy (minimum of ten new, independent and self-sustaining populations on the Saanich Peninsula). 3. To attain a viable Canadian population with a high probability of persistence.[1]	B1ab(iii)+2ab(iii); C2a(i, ii); D1
Dwarf sandwort	1. To maintain the extant locality at current levels of abundance or greater. 2. To maintain the approximate current extent of occurrence while increasing the total area of occupancy (minimum of three additional subpopulations at Rocky Point). 3. To attain a viable Canadian population with a moderate probability of persistence.[3]	D1

[1] After 10 years, population size at four protected localities is stable or increasing, with the combined population exhibiting a projected stochastic population growth rate (λ_s) ≥1.0. (Population trends will be estimated using data collected from annual monitoring. Prior to the initiation of detailed monitoring surveys and/or demographic study, a pilot study should be undertaken to determine if 10 years represents an appropriate time scale to measure population changes for individual species at risk and to guide the development of sampling designs with the statistical rigor to detect such changes.)
[2] After 10 years, total population size at Uplands Park is at least 1000 flowering individuals, with the population exhibiting a projected stochastic population growth rate (λ_s) ≥1.0.
[3] After 10 years, total population size at Rocky Point is at least 1000 flowering individuals, with the population exhibiting a projected stochastic population growth rate (λ_s) ≥1.0.

Future population dynamics can be predicted only through demographic models because these represent the only framework that can integrate the birth and death rates that determine changes in population size (Caswell 2001). The most critical demographic parameter for endangered species management is λ, the discrete population growth rate. When λ is less than 1, the population is projected to decline; when $\lambda = 1$, the population is stable; and when λ is greater than 1, the population is projected to grow. However, because λ can vary greatly from year to year, a single estimate of λ is usually not a reliable predictor of long-term population dynamics.

In most instances, stochastic simulations that take into account year-to-year variability in λ (indicated by λ_s) provide a more accurate indication of long-term trends (Caswell 2001, Caswell and Kaye 2001). **Goal 3** (Table 5) sets out a quantitative, measurable target for λ_s that, if met, will ensure species persistence over the short term (10 years). It also provides a measurable standard against which to evaluate the efficacy of management actions, thus serving as a useful target to guide future adaptive management.

Table 6 lists the short-term (5-10 year) common objectives that will contribute to achieving the recovery goals by addressing known threats and COSEWIC assessment criteria.

Table 6. Recovery objectives, along with the primary focus (species or ecosystem) and recommended timeline for each.

Objective	Primary Focus	Suggested Time For Completion (Years)
1. To secure protection through stewardship and other mechanisms for species at risk occurrences.	species	5
2. To engage the cooperation of all implicated landholders in habitat protection.	species	5
3. To mitigate threats to habitat and survival from recreational activities, hydrologic alterations, and eutrophication.	species	5
4. To mitigate threats to habitat and survival from secondary succession and invasive species encroachment.	species	5
5. To restore to functioning condition a minimum of 10 historical (presently non-functional) vernal pools sites.	ecosystem	5
6. To identify and rank 5-10 potential recovery (translocation) sites for each species at risk.	species	5
7. To establish new populations (or subpopulations) of each species as per the recovery goal.	species	5
8. To increase plant population sizes and/or population growth rates at extant sites as per the recovery goal.	species	5-10
9. To establish Vernal Pool Conservation Areas at Uplands Park, Trial Island, Rocky Point, and Harewood Plains.	ecosystem	5
10. To increase public awareness of the existence and conservation value of vernal pools and associated species at risk.	ecosystem	ongoing

2.4 General description of research and management activities needed to meet the objectives

Recovery activities have been grouped under seven broad strategies designed to address the threats and meet the recovery objectives (Table 7). These are outlined below in general order of priority, although the exact order may vary with species.

1. **Habitat protection and stewardship:** A primary focus of this recovery strategy is to prevent further loss and fragmentation of vernal pool 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.

   Protecting and securing occurrences will involve the development of arrangements that ensure the land supporting the occurrence is perpetually managed for the benefit of species at risk. Practical methods for ensuring this protection include a) direct acquisition of land (from willing sellers) by public agencies or private organizations with formal commitments to plant conservation, b) development of stewardship agreements or conservation covenants and easements with implicated landowners, and c) legislative protection.

2. **Landholder contact:** Involving landowners/managers in effective management of vernal pool habitat will be key to the recovery of species at risk. This will include developing proactive communication with different landowners/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 lands. Implicated landowners/managers should be encouraged to collaborate with researchers, participate in restoration projects, and support species at risk monitoring. Other landowners may need to be identified and contacted for critical habitat studies at historical locations and for potential reintroduction sites.

3. **Ecological research:** Further habitat surveys, along with research on habitat attributes, are needed to completely delineate survival habitat (see *Knowledge gaps*).

   The community ecology and population biology of most species are poorly known. Effective long-term management will require species-specific information on habitat preferences, demographic rates, genetics, germination requirements, dispersal patterns, pollination, impacts of competition from native and nonnative invasive species, and responses to management practices such as mowing and invasive species removal. Annual censuses should be undertaken to determine whether populations are stable, increasing, or declining over time (evaluating success in meeting one of the recovery goals is contingent upon long-term monitoring of population trends at known occurrences). Where possible, annual census data should be analyzed using stage-based demographic models to determine population growth rate (λ) as well as the sensitivity of λ to different life-stage transitions (Caswell 2001).

Permanent study plots should be established in at least one population of each species, and graduate students and/or trained ecologists enlisted to design and undertake careful, quantitative field studies that investigate these and other questions relevant to conservation and management of species at risk.

Prior to initiating field studies, recovery planners should contact landholders to establish protocols for conducting on-site research.

4. **Habitat restoration and site management:** Appropriate management and restoration of habitats and ecosystem processes, both at protected sites and elsewhere, is crucial to long-term species recovery. Where possible, overgrown, degraded, or otherwise non-functioning wetland sites should be identified and restored to a point where they can serve as future recovery habitat for vernal pool species at risk. Threats to currently occupied sites should be assessed, and site-specific management plans developed and implemented to address threats and restore habitat. Priority habitats for restoration and management include Uplands Park, Somenos Marsh, and Harewood Plains.

   Information gained during monitoring and research should be used periodically to update and modify the site management plans, as needed.

5. **Population augmentation and establishment:** Meeting the long-term recovery goals will in most cases necessitate increasing the size of extant populations and/or establishing new ones, either at formerly occupied sites or at new sites. The Action Plan will thus include an augmentation/translocation plan for each of the six species in the Recovery Strategy. Translocation plans should (a) specify the conditions warranting, and (b) guide the introduction of, off-site plant material (seeds or plants) into areas currently supporting populations or for establishing new wild-land occurrences. In this, translocation plans will follow the recommendations outlined in the document "Guidelines for Translocation of Plant Species at Risk in British Columbia" (BC Ministry of Environment, in prep.). *Note: it is essential that threats be addressed prior to undertaking population enhancements or reintroductions.*

   Where the objective is to enhance population size at existing locations, information gained through demographic research (e.g., sensitivity analysis) should be used to target the life history stages most important to population growth (Schemske *et al*. 1994). Prior to establishment of new populations, it is recommended that one experimental population of each species be established at a suitable site for the purpose of testing and refining management techniques, and to serve as a baseline reference. In some circumstances, creation of an *ex situ* seed bank may be desirable to improve options for re-establishment of species in the event of catastrophic population loss or destruction of existing habitat.

   Specialists in native plant propagation should be consulted for advice on plant propagation techniques and protocols for long-term seed storage. Included with the Action Plan should be a determination of appropriate numbers of seeds to be collected from each known occurrence and the length of collection intervals needed to maintain seed viability with adequate genetic diversity in perpetuity.

6. **Inventory and monitoring:** A detailed inventory (and mapping) of extant vernal pools, seeps, and swales on southern Vancouver Island and adjacent Gulf Islands is crucial to overall conservation of these habitats and will also aid in the delineation of recovery habitat for individual species.

   Another important step in the recovery process will be to develop and implement a monitoring plan for all occurrences to identify new and ongoing threats over a period of at least 10 years. Biologists and land managers should participate in development of this plan, which should focus on determining habitat condition, anthropogenic threats, and gross population responses to these factors, as well as detailed assessments of population size and demography. The plan should also prescribe periodic reporting procedures to ensure monitoring results are regularly forwarded to relevant stakeholders and agencies. Information gained through inventory and monitoring should be adaptively incorporated into site management plans.

   Because some occurrences and sub-occurrences are located on private land, monitoring protocols will need to be developed in consultation with willing landowners. For this reason, any conservation agreements or easements developed as per item 1 should include provisions for regularly scheduled monitoring.

7. **Public outreach and education:** Both habitat protection and population monitoring will be facilitated by improved public awareness and appreciation of vernal pool ecosystems. Public awareness of the rarity and conservation of vernal pool plants may also foster interest in the unique character of the regional flora and its natural history. Public outreach and information programmes should therefore be set up and maintained.

Table 7. Broad approaches to effect recovery. See Tables 3 & 6 for numbered list of threats and objectives

Priority	Obj. No.	Broad Approach	Threat Addressed	Specific Steps	Outcomes or Deliverables
Urgent	1 & 2	Habitat protection and stewardship	1-9	• Prioritize sites for protection and/or securement • Determine ideal protection strategy (easement, acquisition, stewardship) for each priority site in conjunction with the Conservation Planning and Site Protection RIG of GOERT	• Prioritized list of candidate sites for site securement • Protection strategies identified and implemented for minimum of one high priority site for each species

Priority	Obj. No.	Broad Approach	Threat Addressed	Specific Steps	Outcomes or Deliverables
High	1-10	Landholder contact	1, 3, 4, 6 & 9	• Develop and implement a communications plan for engaging the cooperation of implicated landholders (e.g., DND, CRD, BC Parks, Oak Bay and Saanich municipalities, Swan Lake Christmas Hill Sanctuary, City of Nanaimo, Cascadia Forest Products, City of Duncan, residential property owners) • Identify and contact landholders for critical habitat studies at historical locations and for potential reintroduction sites	• Landholder involvement in the development of site-specific management plans and habitat protection
High	3-8	Ecological research	2-9	• Liaise with landholders to establish protocols for conducting ecological research at extant sites • Research to delineate critical habitat • Research to characterize: -Habitat requirements -Germination requirements -Pollinators -Dispersal -Competitive interactions • Establish permanent study plots at extant sites for long-term demographic studies • Collect annual census data and (if possible) analyze using stage-based demographic models	• Critical habitat delineation • Research protocols • Relevant ecological information for each species • Population projections (estimates of λ, log λ_s, stage-specific sensitivities and elasticities, etc.) for each species • Population viability analysis (PVA) for each species
High	3-5	Habitat restoration and site management	1, 3-8	• Assess threats to all survival habitat • Develop site-specific management plans to reduce threats • Develop and implement plan for recovery/restoration of degraded, non-functional vernal pool sites • Monitor sites to assess the effects of actions and adapt management in response to observed results • Report on management actions and outcomes	• All survival habitat assessed to quantify threats • Management plans developed and implemented for a minimum of 5 most significant vernal pool sites • Minimum of 10 degraded vernal pool sites restored to functional state • Survival habitat monitored to assess threat reduction and response of populations • Survival habitat restored • Populations maintained or increased at managed sites

Priority	Obj. No.	Broad Approach	Threat Addressed	Specific Steps	Outcomes or Deliverables
High	7 & 8	Population enhancement and establishment	2	• Investigate appropriateness of re-introduction • Prepare reintroduction plan • Use information gained through demographic studies to enhance critical life history stages (e.g., adult survival, seedling recruitment) where required • Create and maintain ex situ seed banks (where required) • Identify potential translocation sites (ideally, “vacant” vernal pools, swales, or seepage areas that could be easily monitored) • Establish one experimental population of each species for the purpose of testing and refining management techniques • Using experimental approach that is repeatable and quantifiable, determine most effective method for establishing self-sustaining populations of each species • Establish new populations as per recovery goals	• Experimental populations established • Extant populations maintained or increased at managed sites • New populations established
Neces-sary	3-8	Inventory and monitoring	1-9	• Identify and map extant and historical vernal pool sites on southern Vancouver Island and adjacent Gulf Islands • Identify and map potential habitat for species at risk • Develop and implement standardized monitoring protocol • Report monitoring results annually and assess trends in populations, area of occupancy and habitat condition every 5 years • Submit all data to BC CDC	• GIS reference map(s) of extant and historical vernal pool sites on southern Vancouver Island and adjacent Gulf Islands • Mapped locations of potential translocation sites • Monitoring protocol • Standardized monitoring of sites range-wide • Annual summary of monitoring results by site and assessment of trends in populations, area of occupancy and habitat conditions every 5 years • Status of populations and effects of recovery actions

Priority	Obj. No.	Broad Approach	Threat Addressed	Specific Steps	Outcomes or Deliverables
Bene-ficial	9 & 10	Public outreach and education	1, 3, 4, 6 & 9	• Develop and implement a public outreach plan for enhancing public and private awareness, interest, and participation in vernal pool species recovery (e.g., through volunteer habitat monitoring) • Continue to develop extension materials such as Insert Sheets for GOERT Species at Risk manual • Erect interpretive displays at appropriate locations (e.g., Uplands Park)	• Public Outreach Plan • Extension materials distributed • Public awareness • Volunteer participation in recovery

2.5 Critical habitat

No critical habitat, as defined under the federal *Species at Risk Act* [s2], is proposed for identification at this time in the 'Vernal Pools Recovery Strategy.'

While much is known about the habitat needs for survival and recovery of the species included within this recovery strategy, more definitive work must be completed before any specific sites can be proposed for protection 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 2.8).

Notwithstanding the above, information on the current state of knowledge on the habitat needs and sites of occupation of the species included in this recovery strategy are provided below.

2.5.1 Occupied habitat

For plants covered in this strategy, occupied habitat is known to exist on several federal municipal, and private lands. Adjacent upland areas are believed to contribute directly to sustaining hydrologic functions within certain areas of occupied habitat. As such, it will be important to evaluate the need for protection and management of these uplands as it relates to the maintenance of quality habitat.

For example, the security of occupied habitat for tall woolly-heads, Kellogg's rush, and water plantain-buttercup should probably include concern for the entire complex of vernal pools and swales at Uplands Park, together with their associated micro-catchments. Similarly, for bog bird's-foot trefoil, this might include the wetland complex, including riparian zones, at Woodley Range Ecological Reserve.

Sites occupied by bog bird's-foot trefoil sites at Harewood Plains, Extension Rd., and White Rapids Rd., support the greatest concentration of remaining bog bird's-foot trefoil plants in Canada.

In order to accurately define the known occupied habitat (and ultimately critical habitat) additional surveys and research will be necessary as outlined below (Section 2.8).

2.5.2 Potential habitat

Research, including field experiments, is required to determine the feasibility of translocation (e.g., seeding or planting out) as a method to expand populations into what is currently unoccupied habitat. Such potential habitat may be required to improve population viability and achieve recovery of certain species.

Potential habitat may need to undergo extensive restoration and/or threat mitigation before it becomes suitable for use. It is recommended that, for the species covered by this strategy areas that should be assessed as potential habitat include:

- Naturally-occurring vernal pool, seep, or other ephemeral wet area greater than1 m^2 on southeastern Vancouver Island and the Gulf Islands having the necessary ecological characteristics , along with assessing a 20 m buffer zone around said feature.
- The associated watershed and hydrologic features, including upland habitat, that contribute to the filling and drying of the above vernal pool or ephemeral wet area, and that maintain suitable periods of inundation, water quality, and soil moisture for species at risk germination, growth and reproduction, and dispersal.

There are several reasons for proposing this broad working definition for potential habitat:

1. Vernal pools are essentially small habitat islands within other communities (Jain 1976), hence island biogeographic theory predicts high rates of extinction in particular pools over time (MacArthur and Wilson 1967). The conservation implication of this is that preserves must contain many vernal pools to serve as sources of propagules for colonization. At present, we have very little concept of the number and sizes of populations required for metapopulation[4] persistence. Until we can gather more information about the spatial dynamics of these species, the most prudent approach is to assume that many discrete habitat patches are needed for long-term persistence.

2. Coastal bluffs, where many vernal pools are found, comprise one of the rarest components of the Garry oak ecosystem, representing only 0.3% (1,043 ha) of the land area of southeastern Vancouver Island and the Gulf Islands (Ward *et al.* 1998). The occurrence and distribution of coastal bluff ecosystems are influenced by the presence of exposed bedrock geology and by proximity to the shoreline, exposure to salt spray, and prevailing winds (Ward *et al.* 1998). Vernal pools, in turn, make up only a tiny fraction of the area within coastal bluffs, making them an extremely rare habitat commodity. Therefore, until evidence suggests otherwise (e.g., a pool already contains rare species

[4] The assemblage of discrete local populations in an area connected by dispersal or migration.

that would be negatively impacted by the introduction of another rare species), most intact vernal pools should be tentatively regarded as potential habitat.

3. A number of other vernal pool plants have either been approved, or proposed, for COSEWIC assessment (Table 8) and may be incorporated into this strategy at a later date. Defining occupied habitat broadly at the outset to include all intact vernal pools reduces the risk of prematurely excluding from the strategy any sites critical to the recovery of other species at risk.

2.6 Examples of activities likely to result in the destruction of any critical habitat identified in the future

Examples of types of activities that would be expected to result in the destruction of any critical habitat identified in the future include:

- residential development
- recreational off-road vehicle use
- garbage dumping
- logging road construction
- utility corridor maintenance
- wetland draw-down
- draining, ditching and dredging
- bicycle jump construction

Table 8. Partial list (and conservation status) of other vascular plants at risk in vernal pools and other ephemeral wet areas within Garry oak and associated ecosystems.

Species	Common Name	Provincial Rank	COSEWIC Status
Alopecurus carolinianus	Carolina meadow-foxtail	S2, Red	
Anagallis minima	chaffweed	S2S3, Blue	
Bidens amplissima	Vancouver Island beggarticks	S3, Blue	Special Concern
Callitriche heterophylla ssp. *heterophylla*	two-edged water-starwort	S2S3, Blue	
Callitriche marginata	winged water-starwort	S1, Red	status report in progress
Carex feta	greensheathed sedge	S2, Red	
Carex tumulicola	foothill sedge	S1, Red	status report in progress
Castilleja tenuis	hairy owl-clover	S1, Red	
Centaurium muehlenbergii	Muhlenberg's centaury	S1, Red	status report in progress
Crassula connata var. *connata*	erect pigmyweed	S2, Blue	
Epilobium densiflorum	dense spike-primrose	S1, Red	Endangered (2005)
Githopsis specularioides	common bluecup	S2S3, Blue	
Heterocodon rariflorum	heterocodon	S3, Blue	

Species	Common Name	Provincial Rank	COSEWIC Status
Idahoa scapigera	scalepod	S2, Red	
Isoetes nuttallii	Nuttall's quillwort	S3, Blue	
Lasthenia glaberimma	smooth goldfields	S1, Red	
Limnanthes macounii	Macoun's meadow-foam	S3, Blue	Threatened (2004)
Microseris bigelovii	coast microseris	S1, Red	status report submitted
Myosurus apetalus var. *borealis*	bristly mousetail	S2, Red	
Navarretia intertexta	needle-leaved navarretia	S2, Red	status report in progress
Ophioglossum pusillum	northern adder's-tongue	S2S3, Blue	
Plagiobothrys figuratus	fragrant popcornflower	S1, Red	status report in progress
Psilocarphus tenellus	slender woolly-heads	S2, Red	Not At Risk (1996)
Ranunculus lobbii	Lobb's water-buttercup	SX, Red	
Trifolium depauperatum var. *depauperatum*	poverty clover	S3, Blue	
Triphysaria versicolor ssp. *versicolor*	bearded owl-clover	S1, Red	Endangered (2000)

2.7 Existing and recommended approaches to habitat protection

Current levels of protection for sites in this strategy range from "none" to "effectively protected." Two sites (Ballenas Island and Rocky Point) are on uninhabited land managed by the Department of National Defence (DND). These properties are officially off-limits to the public and thus are not presently threatened by development.

Two sites (Woodley Range and part of Trial Island) are located within provincial ecological reserves. Ecological reserves offer protection in principle to all plant species found within their boundaries through the *Ecological Reserves Act*, which requires that a valid park use permit be obtained before a plant can be destroyed, damaged or disturbed. However, both species in question (bog bird's-foot trefoil and rosy owl-clover) occur near the boundaries of their respective reserves and thus remain vulnerable to influences from adjacent land use practices. Specifically, Woodley Range Ecological Reserve borders a residential area. Trial Island Ecological Reserve is bounded on one side by provincial land leased for a commercial radio broadcast station, and on the other side by a lighthouse station operated by The Canada Coast Guard.

Three populations of tall woolly-heads, a water plantain-buttercup population, and the single Kellogg's rush occurrence are afforded some measure of protection from urban development by virtue of their location in municipal parks or nature sanctuaries. There is a single historical (unconfirmed) record for tall woolly-heads at Francis/King Regional Park, which is managed by the Capital Regional District (CRD) Parks. Most other confirmed populations occur on privately-held land (Table 2).

A number of alternative approaches to protecting habitat exist. These potentially include: stewardship agreements such as conservation covenants (a legal agreement by which a landowner voluntarily restricts or limits the types and amounts of development that may take place on the land to protect its natural features), direct land acquisition. Sites covered by this strategy that would benefit immediately from some form of conservation covenant include Harewood Plains and other private properties around Nanaimo that support populations of bog bird's-foot trefoil. In consideration of its high conservation value, ecological sensitivity, and relatively undeveloped condition, Harewood Plains is also identified as a priority habitat area for land acquisition.

Somenos Marsh, Uplands Park, Christmas Hill, and Francis/King Park already have, or soon will have, habitat management plans in place. Specific protection for vernal pools and other ephemeral wet areas at these sites should be developed within the framework of existing plans.

2.8 Schedule of studies to identify critical habitat

Potentially important habitat attributes for each species, as far as these are known, have been summarized in Table 9. Further study in the following areas is required to define critical habitat for all species:

1. Identify critical habitat attributes for each species (e.g., moisture regime, length of inundation, soil and chemical properties, plant cover, etc.;). Suggested completion date: 2009.

2. Using established survey and mapping techniques (applied during phenologically appropriate periods), delimit the boundaries of all occupied habitats designated as survival habitat. Property boundaries at Somenos Marsh may require additional surveying in order to confirm legal tenure of the tall woolly-heads site. Additional surveys are also required to determine locations and tenure of all remaining bog bird's-foot trefoil sites south of Nanaimo. Suggested completion date: 2009.

3. For each occupied habitat, delimit the boundaries and condition of the associated water micro-catchment (that part of the catchment on which the hydrology of the site directly depends). Suggested completion date: 2009.

4. Identify, map, and describe all intact, functional vernal pools seeps, swales and other ephemeral wetlands on southeastern Vancouver Island and adjacent Gulf Islands that are currently unoccupied by species at risk. Rate these habitats for their potential to support the six identified species, as well as other species at risk. Suggested completion date: 2009.

5. Identify, map, and rate for restoration potential any significant, naturally-occurring vernal pools on southeastern Vancouver Island and adjacent Gulf Islands whose structure and/or function has been lost or compromised as a result of secondary succession related to fire suppression and/or alien plant invasion, eutrophication, or intentional draining. Suggested completion date: 2009.

6. Through experimental trials, test the suitability of high-ranking sites for plant translocations/reintroductions. Suggested completion date: 2009 and ongoing.

7. Using a scientifically valid and defensible method, identify the proportion, percentage, or some quantitative/qualitative measure and distribution characteristics of the habitat areas identified in steps (2-6) that must be protected to ensure the achievement of the recovery target of each species at risk. Suggested completion date: 2009.

8. Identify land ownership/jurisdiction for these proposed critical habitat areas, as well as landholder attitudes regarding species recovery and critical habitat designations. Suggested completion date: 2009.

9. Identify anticipated threats to these proposed critical habitat areas and recommend general or specific measures that can be employed to protect them from such threats. Suggested completion date: 2009.

10. Obtain appropriate peer review of findings resulting from steps (1-9). Suggested completion date: 2009.

11. Use the information gathered in steps (1-10) to provide advice to the Competent Minister responsible for finalizing Critical Habitat designations for species at risk. Suggested completion date: 2009.

Table 9. Summary of documented habitat attributes/preferences of species at risk covered in this strategy, as observed both within Canada and range-wide.

Species	Habitat Attributes/Preferences		
	Within Canada	Range-wide	Knowledge gaps
bog bird's-foot trefoil	• Mediterranean-like climate (warm dry summers and mild wet winters) • dry maritime (xm) subzone of the Coastal Douglas Fir (CDF) biogeoclimactic zone • open springy meadows, creek margins, seeps at low elevations (with prolonged moisture during spring) • shallow soils (Brunisol?) derived from sedimentary rock and inoculated with *Rhizobium* bacteria • may benefit from moderate levels of disturbance	• facultative wetland species that usually occurs in wetlands but is occasionally found in non-wetlands • bogs and swampy places; wetland prairies (ORE) • edges of slow-moving streams that dry up by midsummer, at elev. to 600 m (Columbia River Gorge) • wet meadows, bogs, ditches and stream beds from 600-1700 m elev. (CA)	• required length and timing of wet period/inundation • soil bacteria required for nitrogen fixation • optimal pH level • optimal soil texture and depth • optimal soil moisture regime • light and nutrient requirements • optimal disturbance regime

Species	Habitat Attributes/Preferences		
	Within Canada	**Range-wide**	**Knowledge gaps**
tall woolly-heads (Pacific population)	• Mediterranean-like climate (warm dry summers and mild wet winters) • limited to Coastal Douglas Fir (CDF) biogeoclimactic zone • dry beds of vernal pools, on organic to bare mineral soil • vernal swale and old tire ruts in seasonally flooded Garry oak meadow on (likely) Tolmie or Gleysol soil overlying marine clay parent material or bedrock • depressions on rocky marine bluff, on compacted loamy sand over till or bedrock (Langford soil) • silty soil on seasonally wetted wetland margin	• facultative wetland species that usually occurs in wetlands but is occasionally found in non-wetlands • dried beds of vernal pools and other open, vernally moist, often disturbed sites, at elev. below 1000 m (northern CA, ORE, WA, ID) • drying mud of roads and ditches (Columbia River Gorge)	• required length and timing of wet period/inundation • optimal pH level • optimal soil texture and depth • optimal soil moisture regime • light and nutrient requirements • optimal disturbance regime
Kellogg's rush	• Mediterranean climate (warm dry summers and mild wet winters) • limited to Coastal Douglas Fir (CDF) biogeoclimactic zone • vernal swale in seasonally flooded Garry oak meadow on (likely) Tolmie or Gleysol soil overlying marine clay parent material or bedrock	• facultative wetland species that usually occurs in wetlands but is occasionally found in non-wetlands • seasonally wet depressions and vernal pools (WA, ORE, CA) • low spots in fields and meadows	• required length and timing of wet period/inundation • optimal pH level • optimal soil texture and depth • optimal soil moisture regime • light and nutrient requirements • optimal disturbance regime
water plantain-buttercup	• Mediterranean climate (warm dry summers and mild wet winters) • limited to Coastal Douglas Fir (CDF) biogeoclimactic zone • vernal swale in seasonally flooded Garry oak meadow on (likely) Tolmie or Gleysol soil overlying marine clay parent material or bedrock • shallow muddy soils in rock outcrop depressions near the coast	• facultative wetland species that usually occurs in wetlands but is occasionally found in non-wetlands • open moist sites ranging from muddy ditches, bogs, shallow water in ponds, pond margins and streambanks to moist alpine meadows (WA, ID, w MT, ORE, n CA)	• required length and timing of wet period/inundation • optimal pH level • optimal soil texture and depth • optimal soil moisture regime • light and nutrient requirements • optimal disturbance regime

Species	Habitat Attributes/Preferences		
	Within Canada	**Range-wide**	**Knowledge gaps**
rosy-owl clover	• Mediterranean climate (warm dry summers and mild wet winters) • limited to Coastal Douglas Fir (CDF) biogeoclimactic zone • historically from moist meadows and fields in the lowland zone • shallow vernal pool-vernal seepage site on a sloping marine bluff • shallow mineral soil overtop of bedrock • soil saturated through the winter, drying by mid-summer • low competition environment	• open moist meadows at mainly low elevations (to 2000 m in California) • grass and herb dominated sites with little to no shrub or tree cover	• required length and timing of wet period/inundation • optimal pH level • optimal soil texture and depth • optimal soil moisture regime • light and nutrient requirements • optimal disturbance regime
dwarf sandwort	• Mediterranean climate (warm dry summers and mild wet winters) • limited to Coastal Douglas Fir (CDF) biogeoclimactic zone • vernal seepage site on rocky maritime headland • shallow mineral soil overtop of bedrock • low competition environment	• dry areas in sagebrush and ponderosa pine forest • dry rock cliffs • plains and chaparral slopes (California)	• required length and timing of wet period/inundation • optimal pH level • optimal soil texture and depth • optimal soil moisture regime • light and nutrient requirements • optimal disturbance regime

2.9 Anticipated impacts on non-target species

The six species covered in this strategy represent just a small fraction of the total number of rare and/or endangered plant taxa that occur in vernal pools and other ephemeral wetlands on southeastern Vancouver Island and Gulf Islands (Table 8.) Moreover, a number of COSEWIC-listed and provincial red- and blue-listed plant species co-occur in association with one or more of the species covered in this strategy and could be affected (positively or negatively) by management activities undertaken to recover the latter. Some of these taxa include: bearded owl-clover (*Triphysaria versicolor* ssp. *versicolor*) and Vancouver Island beggarticks (*Bidens amplissima*) (found with tall woolly-heads); Macoun’s meadowfoam (*Limnanthes macounii*), winged water-starwort (*Callitriche marginata*), and Muhlenberg’s centaury (*Centaurium muhlenbergii*) (found with tall woolly-heads, Kellogg’s rush, and water plantain-buttercup); and dense spike-primrose (*Epilobium densiflorum*) (found with bog bird’s-foot trefoil).

Because of the large number of plant taxa at risk and the high concentrations of rare species at some locations, it is not possible to describe all of the possible positive and negative impacts associated with recovery. Many of these plants are threatened by the same primary factors (e.g., development activities, introduced species, trampling) that threaten the six focal species, and therefore should benefit in general from actions taken to mitigate those threats. However, not all species should be expected to respond in the same way to *specific* activities such as weed removal, burning, or even protection from disturbances like trampling. Intentional introductions (translocations) of species at risk into sites already inhabited by other species at risk could also have unforeseen consequences for the latter.

Vernal pools and swales could serve as essential habitat for other rare organisms besides plants, including rare invertebrates (*cf.* fairy shrimps in the U.S.; U.S. Fish and Wildlife Service 1994). Currently there are no documented instances of rare animals (either vertebrate or invertebrate) associating closely with vernal pools in Garry oak and associated ecosystems on Vancouver Island (R. Cannings, pers. comm. 2005, T. Chatwin, pers. comm. 2005). However, this could simply reflect the fact that relatively little effort has been made to date to identify such associations. It is possible that rare aquatic organisms (e.g., insects or mollusks) do occur within pools, seeps, and swales, but have either been overlooked or else have not been recognized in the past as being rare (R. Cannings, pers. comm. 2005). Thus, although at present there are no anticipated negative impacts to “non-plant” species at risk associated with recovery of vernal pool plants, a similar precautionary approach is called for in this case (J. Heron, pers. comm. 2005).

This strategy recognizes the importance of the entire vernal pool community and also that of associated Garry oak ecosystems. By focusing on permanent habitat protection, maintenance of hydrologic regimes, habitat restoration, and public outreach, it is expected that the approaches recommended here will benefit not only individual species at risk but the wider ecological community as well. A program of research to identify specific impacts on associated species at risk will be provided in the Recovery Action Plan (RAP).

To ensure that recovery actions do not conflict with other actions planned or underway, open communication should be maintained with the following GOERT Recovery Implementation Groups (RIGs) and Steering Committees:

- Inventory, Mapping & Plant Communities RIG
- Conservation Planning & Site Protection RIG
- Restoration and Management RIG
    - Invasive Species Steering Committee
    - Native Plant Propagation Steering Committee
    - Fire & Stand Dynamics Steering Committee
- Invertebrates at Risk RIG
- Vertebrates at Risk RIG
- Research RIG
- Communication, Coordination & Public Involvement RIG

2.10 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.

Some activities occurring in and around vernal pools and other ephemeral wet areas 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 hydrologic 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 the vernal pool complex,
- directly damage or destroy an individual species at risk (such as through trampling or wheeled activities), or
- modify or destroy vernal pools or other ephemeral wet areas (such as through in-filling).

Vernal pools and other ephemeral wet areas are rare on the landscape and the overall land area required for physical protection of these sites is relatively small. 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.

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

2.11 Knowledge gaps

Successful decisions about conservation, restoration, and management of vernal pools and other ephemeral wet areas would be enhanced by several types of information currently unavailable.

- *Species inventories.* Not all historical locations have been recently inventoried to determine if populations still persist at these sites (Table 2). Information updates on extant populations are also essential to confirm current species distribution and population status, especially in the case of bog bird's-foot trefoil (M. Donovan, pers. comm. 2005).
- *Habitat inventories*. No comprehensive inventory exists of the number, size, location, type, land jurisdiction, and current land use of remaining vernal pool complexes on southeastern Vancouver Island and the Gulf Islands. Such information is crucial for identifying potential habitat, and also for identifying opportunities for conservation easements and land acquisition. Geographic information system (GIS) techniques could be used in conjunction with established survey techniques to map the distribution and size of vernal pool sites and to provide an accessible record of the ecological, landscape, and political contexts of each occurrence.
- *Community composition*. In many cases, the historical species composition of vernal pools is poorly known, making it difficult to know what the most appropriate restoration target should be for a given pool. We also need better information on the patterns and causes of variation in species composition from one vernal pool site to another. Such

information would allow managers to tailor restoration and management decisions for particular sites and to improve decisions about what pool complexes to protect.

- *Demography and population dynamics*. Detailed information on demography and population dynamics, including metapopulation dynamics, is critical for establishing realistic recovery goals, and also for designing plans to meet those goals (Massey and Whitson 1980, Schemske *et al.* 1994). In the absence of such information, the task of setting quantitative recovery criteria (e.g., the number of geographically distinct, self-sustaining populations required for viability) remains an exercise in guesswork at best. Unfortunately, the ecological dynamics of most vernal pool species in southern British Columbia remain virtually unknown. Effective management for conservation of these species will ultimately require additional data on plant vital rates (i.e., stage-specific birth, growth and death rates), population growth rate, seed bank dynamics, pollination requirements, population genetic structure, dispersal, and rescue effects.
- *Microsite attributes.* More information is needed on the individual requirements and tolerances of species with respect to microsite attributes such as soil texture and chemistry, soil depth, moisture levels, nutrient content, pH levels, and hydroperiod (length and timing of inundation) (Table9).
- *Threats*. To help guide management of vernal pools in areas frequented by the public (such as municipal parks), site-specific studies are needed to quantify the short- and long-term impacts of trampling (by people, bicycles, and dogs), contamination from dog feces, and maintenance activities such as mowing and fire suppression. It is possible that some types of disturbance, such as trampling and mowing, actually benefit vernal pool plants by reducing competition. However, this hypothesis has not been tested.
- *Restoration*. Another important gap in our knowledge is how vernal pool ecosystems (and species) will respond to restoration efforts. Ephemeral wetlands can differ greatly in composition, and some evidence shows that different wetland sites also respond individualistically to disturbance. If this variability in response is widespread, then management recommendations cannot be applied uniformly over sites. Management planners would also benefit from a more detailed understanding of the successional dynamics of these systems.
- *Seed storage and propagation techniques*. Preferred seed storage methods are unknown for most species, as are the techniques and conditions necessary for successful *ex situ* and *in situ* cultivation (in the event this is required).
- *"Other" rare vernal pool species*. More information is needed on the ecological utilization of ephemeral pools by rare organisms from other broad taxonomic groups such as dragonflies and damselflies, butterflies, amphibians, mollusks, crustaceans and birds.
- *Impacts of climate change*. Ephemeral pool species and ecosystems are tied directly to temperature and precipitation patterns, and thus at least have the potential to be greatly affected by climate change. Any large shift in wetting and drying patterns will likely result in a different system, probably with retention of some species, but with significant changes to community and ecosystem properties also likely (Graham 2004). Pollen analyses have revealed that Garry oak savannas and associated ecosystems were historically more widespread on Vancouver Island than at present, and are likely to expand in range again if climate warming proceeds as predicted (Hebda *et al.* 2000). Monitoring ephemeral pool ecosystems could thus provide early indications of biological impacts of shifting climate

(Graham 2004). Research might also indicate potential habitat that could develop as a result of small or large scale shifts in the ranges of different ecosystem types.

2.12 Evaluation and means of success

Evaluation of the overall approaches to recovery set out in this strategy will be largely accomplished through routine monitoring of the status of species at risk, hydrologic regimes, and within-pool habitat trends through time. Where possible, target levels have been established for plants in terms of abundance, viability, and occupied range. These targets will be used to assess progress. The Recovery Strategy will be reviewed in five years to evaluate the progress on stated objectives and to identify additional approaches and changes that may be required.

Additional performance measures that can be used to evaluate the progress of recovery include:

- Formalization of critical habitat designations through a Recovery Action Plan
- Level of protection achieved for proposed critical habitat
- Knowledge gaps addressed
- Successful prioritization of vernal pool sites for acquisition and protection under conservation covenants
- Creation of economic or other incentives for private landholders to protect vernal pools
- Number of high priority sites protected by acquisition or conservation covenants
- Designation of the six species under the provincial *Wildlife Act* as Species at Risk
- Number of education and outreach materials developed for vernal pools (e.g., Insert Sheets for inclusion in the GOERT field manual of species at risk in Garry oak and associated ecosystems)
- Number of sites with appropriate management plans implemented
- Creation of an *ex situ* seed storage programme (if deemed necessary)
- Creation of protocols, best management practices, and a decision support tool or equivalent to guide reintroductions and translocations
- Number of vernal pool sites improved through invasive species control and other restoration activities

2.13 Examples of actions completed or underway

This section provides a partial list of recovery strategies, plans, and actions already completed or underway that could affect species recovery and that link to the broad strategies for recovery identified in Section 2.5. Numerous additional examples exist that have not been listed. Further details can be obtained through the Garry Oak Ecosystems Recovery Team (GOERT).

2.13.1 Other recovery strategies

- Recovery Strategy for Garry oak and Associated Ecosystems and Their Associated Species at Risk in Canada: 2001-2006 (GOERT 2002)
- National Recovery Strategy for *Bartramia stricta* (rigid apple moss) (Plants at Risk Recovery Implementation Group 2005a)

- National Multi-species Recovery Strategy for Species at Risk in Maritime Meadows Associated with Garry Oak Ecosystems (Plants at Risk Recovery Implementation Group 2005b)
- National Recovery Strategy for Species at Risk in Garry Oak Woodlands (Plants at Risk Recovery Implementation Group 2005c)

2.13.2 Public outreach and habitat protection

- Preparation and delivery of education and extension materials to various audiences, including the hosting of workshops relating to rare plant conservation and preparation of "Field Manual: Species at Risk in Garry Oak and Associated Ecosystems in BC" (GOERT)
- Harewood Plains Environmentally Sensitive Areas Project (City of Nanaimo)
- Symposiums on Rare Plants Occurring on Federal Lands (Interdepartmental Recovery Fund and Canadian Forest Service)

2.13.3 Habitat mapping, surveys, and inventory

- Numerous surveys of vernal pool habitats and species completed on behalf of the BC CDC, Interdepartmental Recovery Fund, GOERT, and other agencies.
- Rare plant inventories and mapping for Uplands Park/Cattle Point (BC Conservation Data Centre 2003) and Somenos Garry Oak Protected Area (Roemer and Fairbarns 2003, Maslovat 2004, Roemer 2004)
- Ongoing studies of demographic and phenologic patterns in rosy-owl clover and dwarf sandwort are currently being conducted by M. Fairbarns.

2.13.4 Management/stewardship plans

- Uplands Park Stewardship Plan (Collier *et al.* 2004)
- Somenos Management Plan (Williams and Radcliffe 2001).
- Uplands Park Rare Species Management Plan (District of Oak Bay, in prep.).
- Range and Training Areas Plan (Dept. of National Defence)
- Management Plan for Christmas Hill Nature Sanctuary (District of Saanich, in prep.)

2.13.5 Habitat Restoration Projects

- Uplands Park invasive species removal, ongoing (District of Oak Bay).
- Invasive species control on DND properties (Interdepartmental Recovery Fund, Dept. of National Defence, and Canadian Forest Service)
- Garry oak meadow restoration at Somenos Garry Oak Protected Area (GOERT).

2.14 Suggested timeline for completion of recovery action plan (RAP)

It is recommended that a draft Recovery Action Plan be completed by October 2009.

3. SPECIES BACKGROUND

3.1 Bog bird's foot trefoil

Common Name: Bog bird's-foot trefoil

Scientific Name: *Lotus pinnatus* Hook.

Current status and most recent date of assessment: Endangered, May 2004

Reason for designation: Few small fragmented populations that are geographically restricted and found within wetland meadows of limited occurrence and considerably disjunct from the main range of the species in the northwestern United States. Populations are at risk from continued habitat loss and encroachment of invasive species and from recreational off-road vehicular activities with the likelihood of significant losses due to planned commercial development of habitat supporting the only sizeable remaining population.

Occurrence: BC

3.1.1 Description of the species

Bog bird's-foot trefoil is a short-lived perennial of the pea family (Fabaceae) with numerous erect or sprawling stems ranging from 15-60 cm long. The leaves are pinnately compound with 5-9 elliptic, oblong or egg-shaped leaflets, each 1-2 cm long. The leaves are 4-8 cm long. The flower heads are umbels consisting of 3-12 flowers. The flowers are cross-pollinated and are 10-15 mm long with a yellow banner and keel, and white wings. The calyx is tubular and lobed, with two upper lobes that are joined most of their length. The linear seed pods range are 3-6 cm long and 1.5-2 mm wide and contain 5-20 cylindrical, glossy, dark-coloured seeds (Douglas *et al.* 1999a). Seeds germinate in the late winter or early spring, with flowering generally occurring between May and the end of June (Donovan 2004).

Little information is available on the ecological dynamics of bog bird's-foot trefoil. Life history traits such as recruitment rates, age-specific survivorship, life span, generation time, and longevity of seeds in the soil are all unknown.

Bog bird's-foot trefoil is of minor economic significance in Canada: at least one native seed supplier on Vancouver Island is known to have stocked wild-collected bog bird's-foot trefoil seed in the past. Seeds can also be purchased through online seed catalogues in the U.S., presumably for horticultural purposes (Donovan 2004).

3.1.2 Distribution and status

The global range of bog bird's-foot trefoil extends from Vancouver Island south to northwest Washington, western Oregon and the Columbia River Gorge, central California, and sporadically eastward as far as Idaho. In Canada, bog bird's-foot trefoil is restricted to a small area of southeastern Vancouver Island around Nanaimo, and to Gabriola Island just off of Nanaimo (Table 2, Fig. 1).

Bog bird's-foot trefoil has a global conservation ranking of G4G5. It is ranked SNR (unranked) in California, Washington, Oregon, and Idaho (NatureServe 2005). The COSEWIC status report (Donovan 2004) estimates the Canadian extent of occurrence (EO) to be approximately 100 km^2, and the current area of occupancy (AO) to be 0.06 ha. This likely represents <<1 percent of the species' total global distribution.

3.1.3 Habitat

In southern Washington and Oregon, bog bird's-foot trefoil is found from sea level to higher elevations in the mountains, often along slow-moving streams that dry up by mid-summer (Table9) (Peck 1961, Hitchcock and Cronquist 1973, Jolley 1988). The species is also well established in the wet prairie communities of the Willamette and Umpqua Valleys and the southern Puget Trough. In California, bog bird's-foot trefoil occurs in a variety of habitats including wet meadows, bogs, ditches and stream beds (Isely 1993). It is federally classified as a "facultative wetland" species, the designation given to taxa that usually (with 67% to 99% probability) occur in wetlands but are occasionally found in non-wetlands (USDA-NRCS 2004).

In Canada, bog bird's-foot trefoil is confined to vernal seeps, vernally wet meadows, creek margins, and other microsites that receive abundant moisture through the spring but dry out during the summer (Table 9) (Douglas *et al.* 1999b, Donovan 2004). It is sometimes found at the margins of shrub thickets with Nootka rose (*Rosa nutkana*), ocean spray (*Holodiscus discolor*), and Pacific ninebark (*Physocarpus capitatus*). Plants have also been found growing in mineral soil within old tire ruts, in organic soils at the edge of a logged area, and in scattered openings within a Douglas-fir/arbutus forest. Other commonly associated species include yellow monkey-flower (*Mimulus guttatus*), sea-blush (*Plectritis congesta*), fool's onion (*Triteleia hyacinthina*), small-leaved montia (*Montia parvifolia*), Scouler's popcornflower (*Plagiobothrys scouleri*) and American brooklime (*Veronica beccabunga* ssp. *americana*).

The soil at Harewood Plains, site of the largest population, is a generally shallow (<15 cm deep) Lithic Dystric Brunisol overlying gently sloping sandstone or conglomerate bedrock of the Nanaimo formation (Jungen *et al.* 1985). However, detailed information is lacking on the requirements of bog bird's-foot trefoil with respect to microsite attributes such as soil texture, soil depth, moisture levels, nutrient content, soil bacteria (e.g., *Rhizobia*), pH levels, length and timing of inundation, and disturbance regimes (Table 9).

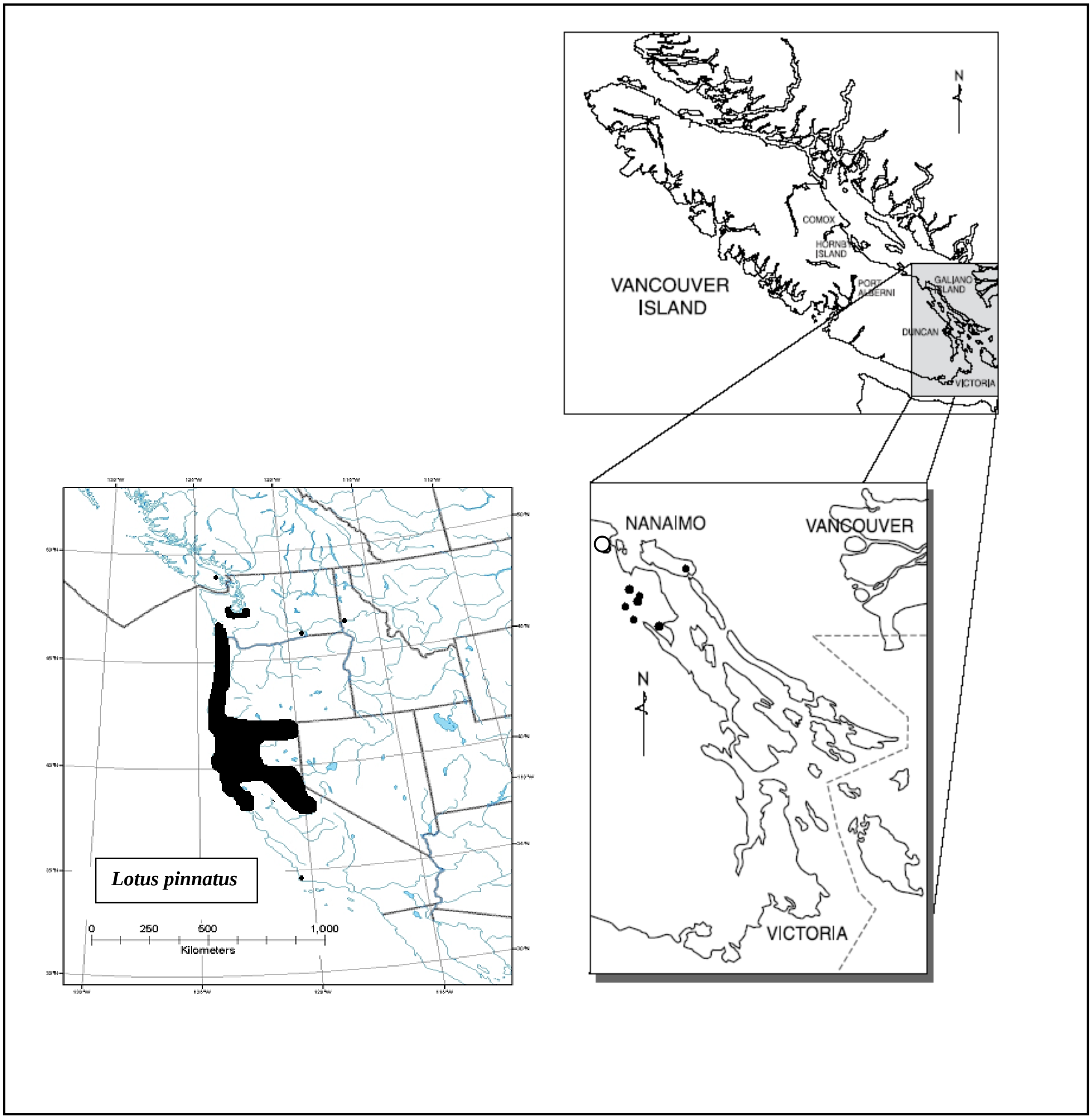

Figure 1. Distribution of bog bird's-foot trefoil in North America (left) and in British Columbia (right).
(Solid circles: extant range. Open circle: historical range.)

3.1.4 Population size and trends

The COSEWIC status report identifies seven extant populations and numerous sub-populations. As of 2003, population counts ranged from 10 to about 1500 flowering stems, combining for an estimated total population of 1500-2000 plants. However, this is a rough estimate only because the clumped, sprawling habit of bog bird's-foot trefoil makes it difficult to identify separate individuals. The actual number of genetic individuals (genets) is likely much lower than this (Donovan 2004).

Recent attempts to confirm two historical records for bog bird's-foot trefoil at sites near Nanaimo have been unsuccessful, and these populations are believed extirpated (Table 2). At the Extension Rd. site, near Nanaimo, at least some portions of the population are believed to have recently been extirpated due to a combination of recreational off-road vehicle use and residential development (A. Ceska, pers. comm. 2004). Beyond these recorded or suspected losses, however, there is little information on long-term-population trends for bog bird's-foot trefoil in Canada.

3.2 Tall woolly-heads (Pacific population)

Common Name: Tall woolly-heads

Scientific Name: *Psilocarphus elatior* Gray

Current status and most recent date of assessment: Endangered (Pacific population), May 2001

Reason for designation: Small annual species present in major urban area within Garry oak habitats with few small scattered populations subject to fluctuating numbers and at risk from habitat degradation and loss.

Occurrence: BC

3.2.1 Description of the species

Tall woolly-heads is a small annual herb in the aster, or sunflower, family (Asteraceae). The erect stems are densely covered with woolly hair, and range from 1 to 15 cm tall. The leaves are hairy, opposite, and linear to oblong in shape. The flowers occur in spherical heads up to 6 mm wide. The heads occur by themselves or in clusters at the forks and tips of branches. The fruits are cylindric, brown achenes 1.0-1.7 mm long, and lack a pappus. Seedlings emerge in early spring, with flowers developing by early to mid-summer. The plants are slow to whither and usually remain visible until late summer.

One other species *Psilocarphus*, slender wooly-heads (*P. tenellus* var. *tenellus*), occurs in moist vernal sites on Vancouver Island. Tall woolly-heads is distinguished from the latter by its upright habit, larger heads and larger receptacle bracts (Douglas *et al.* 2001a).

Little information exists regarding the biology of the species. Lack of structures attractive to insects and animals, and the type of floral structure, suggest that the species may self-pollinate. However, pollen may not be essential for seed production, and asexual reproduction may also occur (Douglas *et al.* 2001a). The longevity of seeds in the soil is unknown but, given the annual life cycle and variable habitat conditions, existence of a seed bank can be presumed. Cox and Austin (1990) found good recovery of the related interior species *P. brevissimus* following a burn treatment; however, the response of tall woolly-heads to fire has not been documented. Tall woolly-heads is of no economic or social significance in Canada.

3.2.2 Distribution and status

In Canada, tall woolly-heads has been reported from southwestern British Columbia, southeastern Alberta and southwestern Saskatchewan.[5] In the U.S., tall woolly-heads occurs from the Puget trough region of western Washington south to northern California and in the mountains of northeastern Oregon, southeastern Washington, and adjacent Idaho. Within Canada, the Pacific population is restricted to southeastern Vancouver Island[6] (Table 2, Fig. 2). Tall woolly-heads has a global conservation ranking of G4. It is ranked S3 in California and SNR (unranked) in Washington, Oregon, and Idaho, S2 in Alberta, and S1S2 in Saskatchewan (NatureServe 2005). The Canadian prairie population has been designated by COSEWIC as "special concern." The extent of occurrence (EO) of the Pacific population is approximately 300 km^2, and the area of occupancy (AO) is approximately 1,500 m^2. This represents <<1 percent of the species' total Pacific distribution.

3.2.3 Habitat

In the U.S., tall woolly-heads is federally classified as a "facultative wetland" species, the designation given to taxa that usually (with 67% to 99% probability) occur in wetlands but are occasionally found in non-wetlands (USDA-NRCS 2004).

On Vancouver Island and elsewhere in the Pacific Northwest, tall woolly-heads is known from low-elevation vernal pools and other open, sometimes disturbed, vernally moist places (Table 9) (Peck 1961, Hitchcock and Cronquist 1973, Jolley 1998, Morefield 1993, Douglas *et al.* 2001a, CDC HERB Database 2004). However, detailed information is lacking on the local requirements and tolerances of tall woolly-heads with respect to microsite attributes such as soil texture, soil depth, moisture levels, nutrient content, pH levels, length and timing of inundation, and disturbance regime (Table 9).

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[5] Although not confirmed, there is a strong possibility that the Alberta and Saskatchewan records for tall woolly-heads actually represent misidentified specimens of *P. brevissimus*, and that what is referred to in the COSEWIC status report as the "Pacific population" of *P. elatior* may therefore constitute the entire Canadian population (M. Fairbarns, pers. comm.). If so, the Endangered designation currently applied to the "Pacific population" would apply to the entire species in general.
[6] Tall woolly-heads has been reported historically from as far west as Ucluelet on Vancouver Island (Macoun 1909). However, this record is unconfirmed and may be erroneous (M. Fairbarns, pers. comm. 2004).

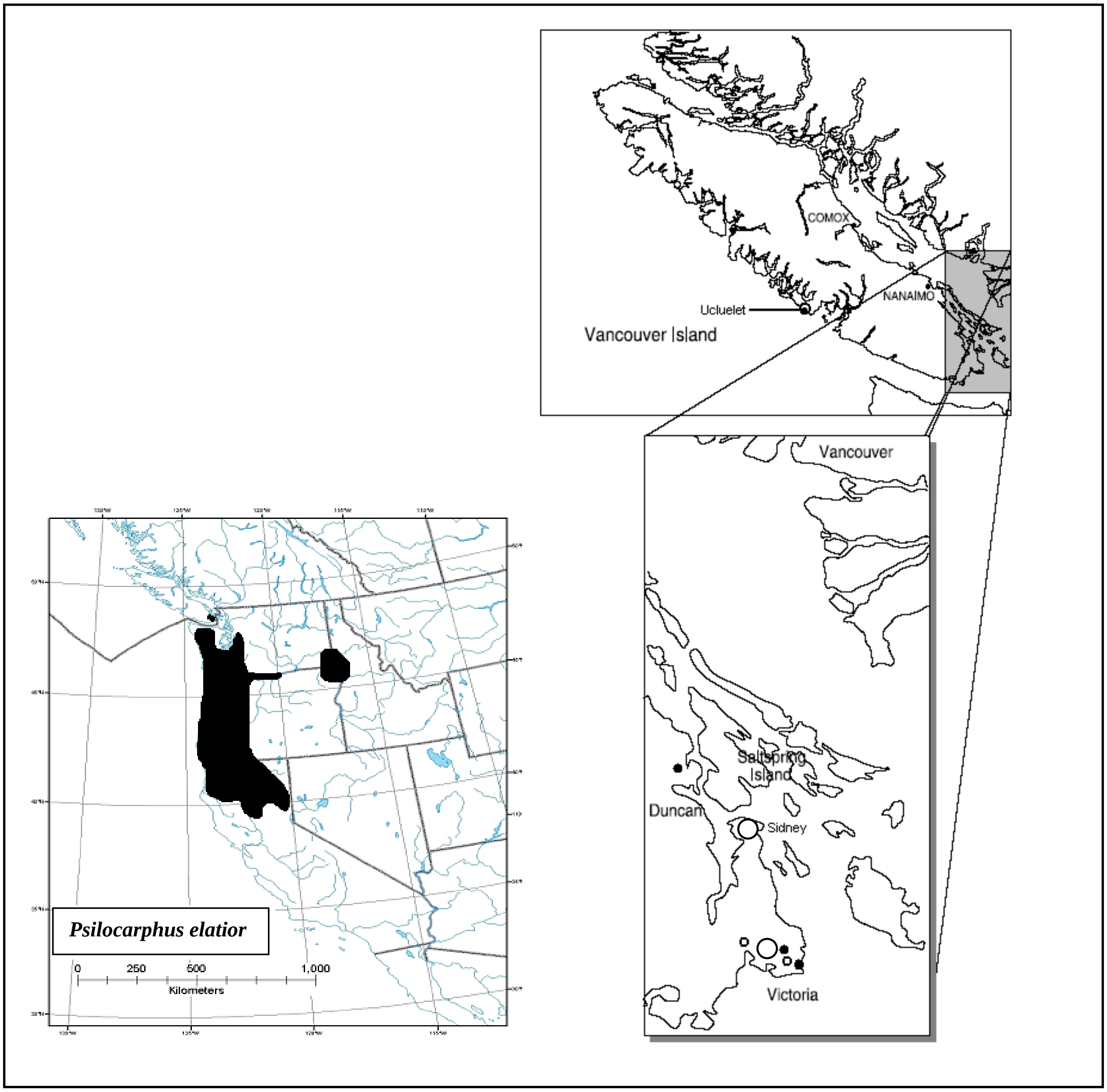

Figure 2. Distribution of tall woolly-heads (Pacific population) in North America (left) and in British Columbia (right).

(Solid circles: extant range. Open circles: historical range.)

(*Danthonia californica*), Scouler's popcornflower (*Plagiobothrys scouleri*), heterocodon (*Heterocodon rariflorum*), and greensheathed sedge (*Carex feta*) (BC HERB Database 2004). The highly invasive colonial bentgrass* (*Agrostis capillaris*) is well established in the bottom of the pool and poses a potential major threat to tall woolly-heads survival.

At Somenos Marsh, tall woolly-heads occurs in a narrow, 5 m wide band parallel to the creek in a patchy zone of open, silty soil that is apparently maintained by winter flooding (Roemer 2004). Sedges form the dominant vegetation within this zone, although the provincially red-listed needle-leaved navarretia (*Navarretia intertexta*) and the blue listed (and COSEWIC Special Concern) Vancouver Island beggar-ticks (*Bidens amplissima*) are also present (Roemer and Fairbarns 2003).

Tall woolly-heads is known from two geographically separate and more or less distinct habitat areas within Uplands Park. These are the remnant Garry oak woodlands that comprise the core of the park; and Cattle Point, a rocky marine bluff at the edge of the park. Within the former area, tall woolly-heads occurs in scattered subpopulations on the dry beds of small vernal pools on soils ranging from dark organic to bare mineral, often in association with lowland cudweed (*Gnaphalium palustre*). It is also found in old tire ruts and depressions within the large vernal swale in the central meadow. The soil in this part of the park is predominantly developed on poorly drained, medium to fine textured marine materials overlying marine clay, and is referred to as Tolmie soil (Day *et al.* 1959, Collier *et al.* 2004). At Cattle Point, tall woolly-heads occurs in shallow depressions 5 to 10 m in diameter, in hard, compacted loamy sand over an impermeable gravelly loam till (a soil type known as Langford; Day *et al.* 1959), with red sandspurry (*Spergularia rubra*) and paintbrush owl-clover (*Castilleja ambigua*). These depressions have been invaded to considerable degree by nonnative grasses such as hedgehog dogtail* (*Cynosurus echinatus*), perennial ryegrass* (*Lolium perenne*), and annual bluegrass* (*Poa annua*). Other species associated with tall woolly-heads at one or other site include Kellogg's rush; the two red-listed (and COSEWIC-candidate) species winged water-starwort (*Callitriche marginata*) and Muhlenberg's centaury (*Centaurium muehlenbergii*); and toad rush (*Juncus bufonius*), blue camas (*Camassia quamash*), foxtail (*Alopecurus* spp.), and creeping bentgrass* (*Agrostis stolonifera*) (Douglas *et al.* 2001a, BC Conservation Data Centre 2003).

3.2.4 Population sizes and trends

The COSEWIC status report describes four extant populations and numerous sub-populations (at Uplands Park). Two of the populations (Uplands Park and Cattle Point) are separated by <1 km, and for the purposes of this recovery strategy are treated as a single population (Table 2). Reported population counts for different localities range from 400 to >2,000,000 individuals (CDC HERB Database 2004, Roemer and Fairbarns 2003, Roemer 2004). As with most annual species, however, plant densities at any given site likely fluctuate substantially from year to year in response to changing microsite conditions, precipitation patterns, seed bank dynamics, and density-dependent feedbacks. Best recent available information suggests a total population size (not counting dormant seeds) in Canada of >>1,000,000 individuals, although this estimate may need to be revised downward in light of recent damage done to the population at Somenos Marsh (Section 2.6.1).

In addition to the three known populations, tall woolly-heads has been reported from seven other sites on Vancouver Island (Table 2). Of these, six sites are now presumed extirpated, while the status of another has not been recently confirmed and may also be extirpated. Beyond these recorded losses, however, there is no reliable long-term information on population trends for tall woolly-heads in Canada.

3.3 Kellogg's rush

Common Name: Kellogg's rush

Scientific Name: *Juncus kelloggii* Engelm.

Current status and most recent date of assessment: Endangered, May 2003

Reason for designation: This is a tiny, inconspicuous, annual species that likely numbers fewer than 600 plants. It occurs in a single, seasonally wet microhabitat that is subject to impacts from human recreational and developmental activities within an urban park located in a nationally rare Garry Oak habitat.

Occurrence: BC

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

3.3.1 Description of the species

Kellogg's rush is a small annual rush (grass-like plants in the family Juncaceae) with erect stems ranging from 0.4 to 4 cm tall. The leaves emerge from the base of the stem and are bristle-like. Flowers occur singly or in pairs at the top of the stem. The fruit is a blunt capsule, about as long as the perianth (flower) segments. The seeds are about 0.4 mm long. Kellogg's rush is usually visible between April and July, although due to its small size, the species is easily overlooked in the field.

In the field, Kellogg's rush could be confused with toad rush (*Juncus bufonis*), another small annual rush. The latter species has an involucral bract that appears as a continuation of the stem, whereas Kellogg's rush possesses only scalelike involucral bracts (Douglas *et al.* 2001b, Costanzo 2003).

Little information is available on the ecology or population dynamics of Kellogg's rush. The species is thought to be self-pollinating, and each capsule contains approximately 50 seeds (Ertter 1986). In greenhouse germination trials, not all seeds germinated in the same year, implying the existence of a persistent seed bank (Ertter 1986). Population size of the single known occurrence at Uplands Park has been known to fluctuate dramatically between years, presumably in response to fluctuations in seasonal precipitation (Costanzo 2003).
The species has no special economic or social significance in Canada.

3.3.2 Distribution and status

Kellogg's rush is known from extreme southern Washington, western Oregon, Nevada, and California west of the Sierra Nevada. The lone Canadian population on southern Vancouver Island (Table 2) is separated by 330 km from the nearest population in Washington State (Fig. 3). Kellogg's rush has a global conservation ranking of G3. It is listed as SNR (not ranked) in California and Nevada, SU (unrankable) in Oregon, and S1 in Washington (NatureServe 2005).

The COSEWIC status report (Costanzo 2003) estimates both the extent of occurrence (EO) and area of occupancy (AO) in Canada to be approximately 25 m^2. This presumably represents <<1 percent of the species' total global distribution.

3.3.3 Habitat

Across its range, Kellogg's rush is found on sandy and clayey damp soils around vernal pools, seasonally wet depressions, seepage areas, and damp fields and meadows up to 800 m (Peck 1961, Hitchcock and Cronquist 1973, Brooks and Clements 2000, Douglas *et al.* 2001b). In the U.S. it is federally classified as a "facultative wetland" species, the designation given to taxa that usually (with 67% to 99% probability) occur in wetlands but are occasionally found in non-wetlands (Table 9) (USDA-NRCS 2004).

In British Columbia, Kellogg's rush is known from a single depression within a seasonally flooded Garry oak meadow, at an elevation of 10 m. Trees are absent, presumably due to the wetness of the habitat. The soil beneath the population has not been profiled but is likely a poorly drained Tolmie or Gleysol developed from medium to fine textured marine materials overlying marine clay parent material (Day *et al.* 1959, H. Roemer, pers. comm. 2005). The associated herb layer contains a mix of native and nonnative forbs including tall woolly-heads, Muhlenberg's centaury (*Centaurium muhlenbergii*), winged water-starwort (*Callitriche marginata*), blue camas (*Camassia quamash*), toad rush (*Juncus bufonius*), chaffweed (*Anagallis minima*), and heterocodon (*Heterocodon rariflorum*). Introduced grasses such as soft brome* (*Bromus hordeaceus*), hedgehog dogtail* (*Cynosurus echinatus*), common velvet-grass* (*Holcus lanatus*), and orchard grass* (*Dactylis glomerata*) are also present (BC Conservation Data Centre 2003). However, more information is required on microsite attributes such as soil texture, soil depth, moisture levels, nutrient content, pH levels, length and timing of inundation, and disturbance regimes (Table 9). However, more information is required on microsite attributes such as soil texture, soil depth, moisture levels, nutrient content, pH levels, length and timing of inundation, and disturbance regimes (Table 9).

3.3.4 Population sizes and trends

The COSEWIC report states that since the early 1990's, when monitoring of Kellogg's rush first began at Uplands Park, annual population counts have ranged from as many as 200-600 individuals (in 1999) to as few as 3 (in 2001). A more recent survey undertaken in 2003 yielded an estimate of 1000-1500 individuals (A. Ceska, pers. comm. 2004). Beyond these minimal data, there is no information on long-term population trends for Kellogg's rush in Canada.

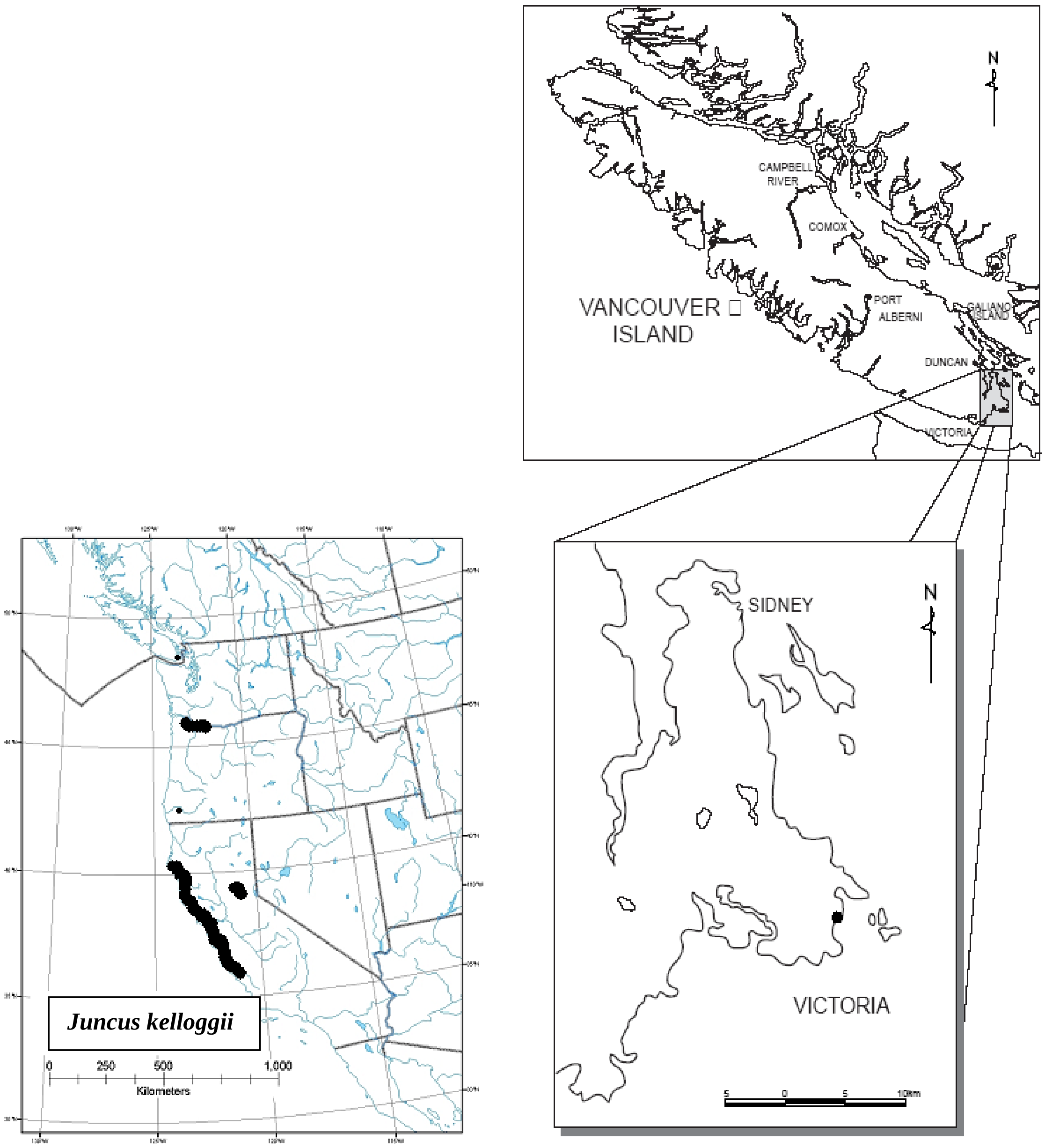

Figure 3. Distribution of Kellogg's rush in North America (left) and in British Columbia (right).

3.4 Water plantain buttercup

Common Name: water-plantain buttercup

Scientific Name: *Ranunculus alismaefolius* Geyer *ex* Benth. var. *alismaefolius*

Current status and most recent date of assessment: Endangered, May 2000

Reason for designation: Only two remaining populations of approximately 70 individuals threatened by recreational activities and competition from exotic plants.

Occurrence: BC

Status history: Designated Endangered in April 1996. Status re-examined and confirmed in May 2000. Last assessment based on an existing status report.

3.4.1 Description of the species

Water plantain-buttercup is a perennial herb of the buttercup family (Ranunculaceae). The flowers occur singly at the ends of the stalks. The bright yellow petals are up to 1 cm long, about 3 times as long as the sepals. Basal leaves are broadly lanceolate to egg-shaped and sometimes toothed, while the stem leaves are smooth and linear. The stems are upright, often branched, usually rather stout, up to 60 cm tall, smooth, and hollow, and arise from several thickened roots. In contrast to many buttercup species, the stems do not root at the nodes. The fruits are smooth achenes, 10-60 in a small spherical head and with short, curved to straight beaks (Hitchcock *et al.* 1964). Vegetative growth appears in early spring with flowers emerging in April and May and seeds maturing in June. During July, when drought conditions are prevalent, the foliage dies-back and the plants become dormant until the following year.

Aside from basic habitat relationships, little information is available on the ecology of the species (Illingworth and Douglas 1994), including pollination ecology, competitive ability, and life history traits such as recruitment rates, age-specific survivorship, life span, generation time, and longevity of seeds in the soil.

Water plantain-buttercup is of no known economic or social significance in Canada. However, seeds of water plantain-buttercup can be purchased through at least one online seed catalogue in the U.S., presumably for horticultural purposes. In Oregon, the seeds have been used as a component of seed mixes sown for wetland prairie restoration (City of Eugene 2002).

3.4.2 Distribution and status

The global range of water plantain-buttercup extends from the Gulf Islands southward through Washington, Idaho, and western Montana to Oregon and north-eastern California (Hitchcock *et al.* 1964, Illingworth and Douglas 1994, Douglas and Illingworth 1998) (Fig. 4). It is common in most northwest Pacific states. However, in Canada, the species is known from just two locations: Uplands Park in Oak Bay (Greater Victoria), and Ballenas Island off the southeast coast of Vancouver Island (Table 2, Fig. 4). Herbarium labels for Victoria from the late 19th century refer to two vague locations: “Oak Bay” and “Cadboro Bay Rd.” These sites are either extirpated or represent earlier records of the single extant site at Uplands Park (Illingworth and Douglas 1994).

Water plantain-buttercup has a global conservation ranking of G5T5. It is ranked SNR (unranked) in California, Washington, Idaho, Oregon, Montana, Nevada, and Wyoming (NatureServe 2005). The Canadian extent of occurrence (EO) of water plantain-buttercup is approximately 2.8 km^2, and the total area of occupancy (AO) is approximately 4 m^2. This represents <<1 percent of the species' total distribution.

3.4.3 Habitat

Across its range, water plantain-buttercup is found in swampy ground around lakes and mudflats, along streams and roadside ditches, and in wet prairies and meadows from sea level up to 2300 m in the subalpine (Peck 1961, Hitchcock and Cronquist 1973, Jolley 1988, Wilken 1993, Whittemore 1997, Douglas *et al.* 1999b). In the U.S., it is federally classified as a "facultative wetland" species, the designation given to taxa that usually (with 67% to 99% probability) occur in wetlands but are occasionally found in non-wetlands (USDA-NRCS 2004). However, detailed information is lacking on the requirements and tolerances of this species with respect to microsite attributes such as soil texture, soil depth, moisture levels, nutrient content, pH levels, length and timing of inundation, and disturbance regimes (Table 9).

In Canada, water plantain-buttercup is currently known only from low-elevation vernal pools and wet Garry oak meadows (Table9). At Uplands Park it grows in two separate locations: along a muddy trailside at the edge of a seasonably flooded grassy swale; and in a small wet depression about 200 meters southwest of the first site. The herb layer at the two locations is dominated by a mix of native and introduced forbs and grasses. Associated native species include tall woolly-heads, blue camas (*Camassia quamash*), rose (*Rosa* sp.), fool's onion (*Triteleia hyacinthina*), western buttercup (*Ranunculus occidentalis*) and graceful cinquefoil (*Potentilla gracilis*). Nonnative, invasive species include creeping buttercup* (*R. repens*), English plantain* (*Plantago lanceolata*), English hawthorn* (*Crataegus monogyna*), soft brome* (*Bromus hordeaceus*), hedgehog dogtail* (*Cynosurus echinatus*), common velvet-grass* (*Holcus lanatus*), and orchard grass* (*Dactylis glomerata*). Soils are a poorly drained Tolmie or Gleysol developed from medium to fine textured marine materials overlying marine clay parent material (Day *et al.* 1959, H. Roemer, pers. comm. 2005).

On Ballenas Island, water plantain-buttercup grows in shallow mud within two small, vernally wet depressions at the base of a seepage area, next to an aspen (*Populus tremuloides*) grove and surrounded by outcropping rock. Associated species include hairy honeysuckle (*Lonicera hispidula*), fool's onion, trailing blackberry (*Rubus ursinus*), Gairdner's yampah (*Perideridia gairdneri*) and Falkland Island sedge (*Carex macloviana*). Woody shrubs such as saskatoon (*Amelanchier alnifolia*) and evergreen blackberry* (*Rubus lacinatus*), and alien invasive grasses and herbs such as common velvet-grass* and common vetch* (*Vicia sativa*), are in the process of encroaching onto the sites and may pose a serious threat.

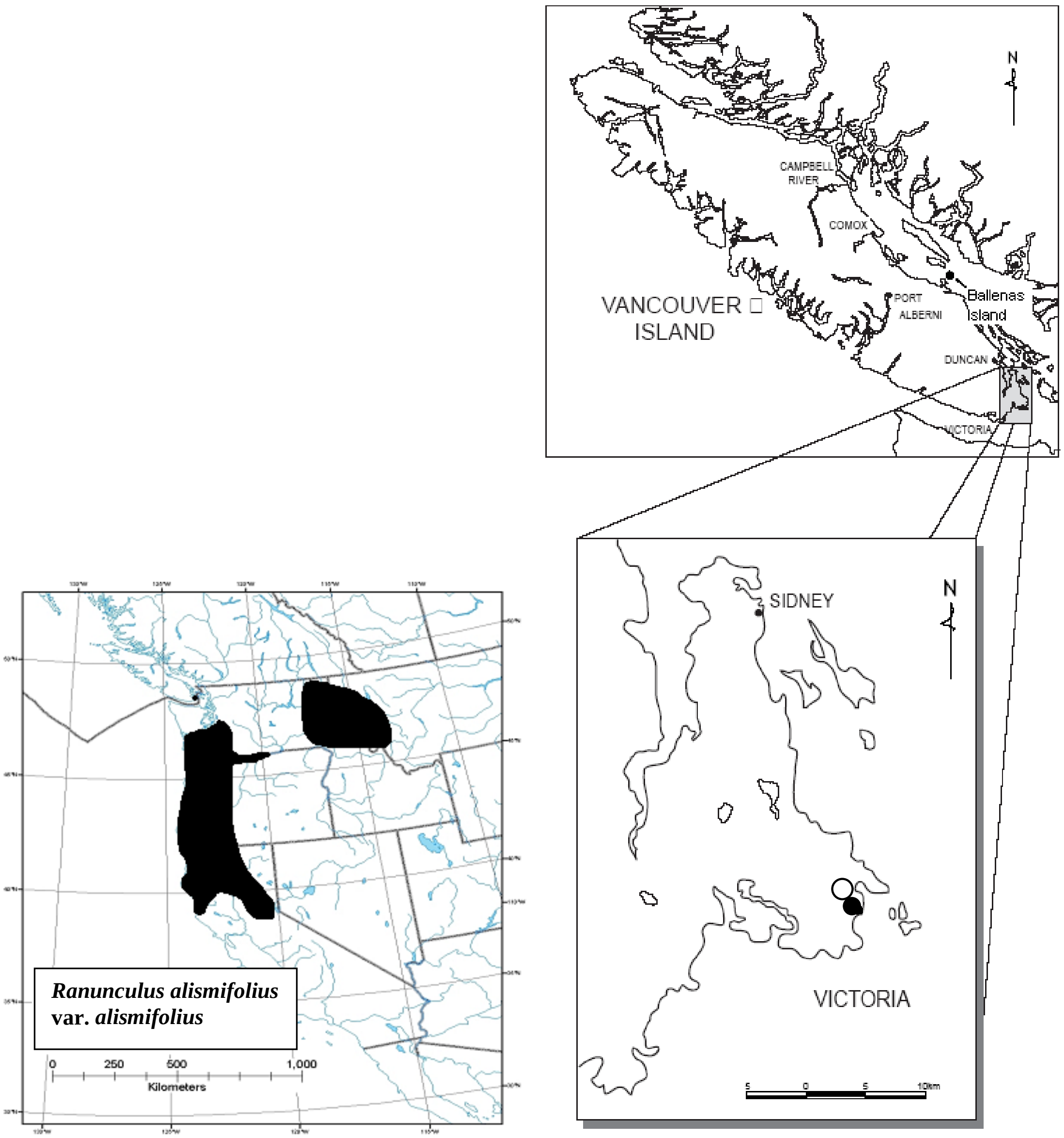

Figure 4. Distribution of water plantain-buttercup in North America (left) and in British Columbia (right). (Solid circle: extant range. Open circle: historical range.)

3.4.4 Population sizes and trends

The Uplands Park population consists of two subpopulations—one near the central meadow, and one in the southwest corner of the park. The two subpopulations are separated by ~250m. In 2005, the two patches contained an estimated 139 flowering individuals (M. Miller, pers. obs.). Although water plantain-buttercup has been known at Uplands Park since 1918, long-term population trends are unknown. Nevertheless, the population appears to be generally stable (Douglas and Illingworth 1998, CDC HERB Database 2004).

The population at Ballenas Island was first discovered only in 1996, when 15-20 plants were counted (CDC HERB Database 2004). In 2005, a total of 91 flowering individuals(and >100 non-flowering individuals in various size classes) were enumerated in two different patches. This population also appears to be generally stable.

The best recent available information for water plantain-buttercup suggests a total population size of <250 flowering individuals (Table 2). There is no indication of the size of the historical population in Canada.

3.5 Rosy owl clover

Common Name: rosy owl-clover

Scientific Name: *Orthocarpus bracteosus* Benth.

Current status and most recent date of assessment: Endangered, May 2004

Reason for designation: An annual herb of vernal pools and damp depressions present at a single remaining location where population size fluctuates widely with low numbers that may be fewer than 100 plants a year. Expansion is limited due to lack of suitable habitats and apparent low dispersal abilities. The population is at risk from spread of nearby invasive exotic plants, from trampling due to hiker traffic and local maintenance activities related to the nearby communications site and consequences of possible oil spills occurring in the busy shipping lanes surrounding the island site.

Occurrence: BC

3.5.1 Description of the species

Rosy owl-clover is a small, annual, hemiparasitic herb from an erect stem 10-40 cm tall. Its leaves are alternate and unstalked. The flowers are rose-purple (occasionally white) and are grouped in a dense terminal spike among prominent bracts. The upper lip of the corolla is slender and slightly hooked at the apex; the lower lip is sac-shaped. The plant is minutely hairy and somewhat sticky-glandular. The lower leaves are lance-shaped, while the upper leaves have 3 to 5 spreading lobes. The bracts are green or purplish and are also lobed (Peck 1961, Douglas *et al*. 2000). In the field, rosy owl-clover may be confused with other owl-clovers in the genera *Orthocarpus*, *Castilleja* and *Triphysaria*, especially in the early, pre-flowering stages.

The species has no special economic or social significance in Canada.

3.5.2 Distribution and status

Rosy owl-clover ranges from Vancouver Island (vicinity of Victoria) to Oregon west of the Cascades, southward to Plumas County, CA (Fig. 5). In Washington, it is currently known from one meadow complex in Klickitat County. There are also historical records from San Juan and Whatcom Counties, WA. In British Columbia there is a single known occurrence, plus about nine historical localities. These are all restricted to the Saanich peninsula, on Vancouver Island.

Rosy owl-clover has a global conservation ranking of G3. It is ranked S1 in British Columbia and Washington and SNR (unranked) in California, Oregon, Maryland, and New York (NatureServe 2005). The Canadian extent of occurrence (EO) and total area of occupancy (AO) of rosy owl-clover is approximately 0.01 hectares. This represents <<1 percent of the species' total distribution.

3.5.3 Habitat

Across its range, rosy owl-clover is known from moist meadows and fields at low elevations (Peck 1961, Hitchcock and Cronquist 1973, Douglas *et al.* 2000). The single documented Canadian population occurs on a sloping vernal seep on Trial Island, a small Gulf Island adjacent to Victoria. The substrate consists of shallow (8-18 cm deep) organic mineral soil lacking in pronounced structure, overtop of bedrock (Table 9). The soil is saturated during the winter and remains damp until June, becoming completely dry by late July. The dominant plant species include gumweed (*Grindelia integrifolia*), English plantain* (*Plantago lanceolata*), hairy cat's-ear* (*Hypochaeris radicata*), self-heal* (*Prunella vulgaris*) and rosy owl-clover. Less abundant species include the COSEWIC-endangered seaside trefoil (*Lotus formosissimus*), as well as yellow monkey-flower (*Mimulus gutattus*), sea thrift (*Armeria maritima*), red fescue (*Festuca rubra*), Nuttall's quillwort (*Isoetes nuttallii*), Macoun's meadow-foam (*Limnanthes macounii*) and paintbrush owl-clover (*Castilleja ambigua*).

The vegetation is probably at a climax successional stage, as encroachment by native trees, shrubs and robust mesophytic herbs is prevented by the shallow soils, their lack of aeration during the extended period of winter saturation, and the pronounced summer drought. There is a limited degree of invasion by a number of aggressive nonnative species including Scotch broom* (*Cytisus scoparius*), English gorse* (*Ulex europaeus*), leather-leaved daphne* (*Daphne laureola*), common velvet-grass* (*Holcus lanatus*), English ivy* (*Hedera helix*), barren fescue* (*Vulpia bromoides*), and dovefoot geranium* (*Geranium molle*) (Fairbarns 2004).
Sites now extirpated in the vicinity of Victoria may have occurred on a variety of soils. Herbarium labels indicate that collections from Oak Bay, the Patricia Bay Highway, Elk Lake and Sidney came from 'prairies', often on gravelly soil, while specimens from Blenkinsop Lake, Cedar Hill and one collection from Sidney were collected from peat meadows and ditches. This is consistent with habitat descriptions for populations in Washington State (Fairbarns 2004). However, more information is required on microsite attributes such as soil texture, soil depth, moisture levels, nutrient content, pH levels, length and timing of inundation, and disturbance regimes (Table 9).

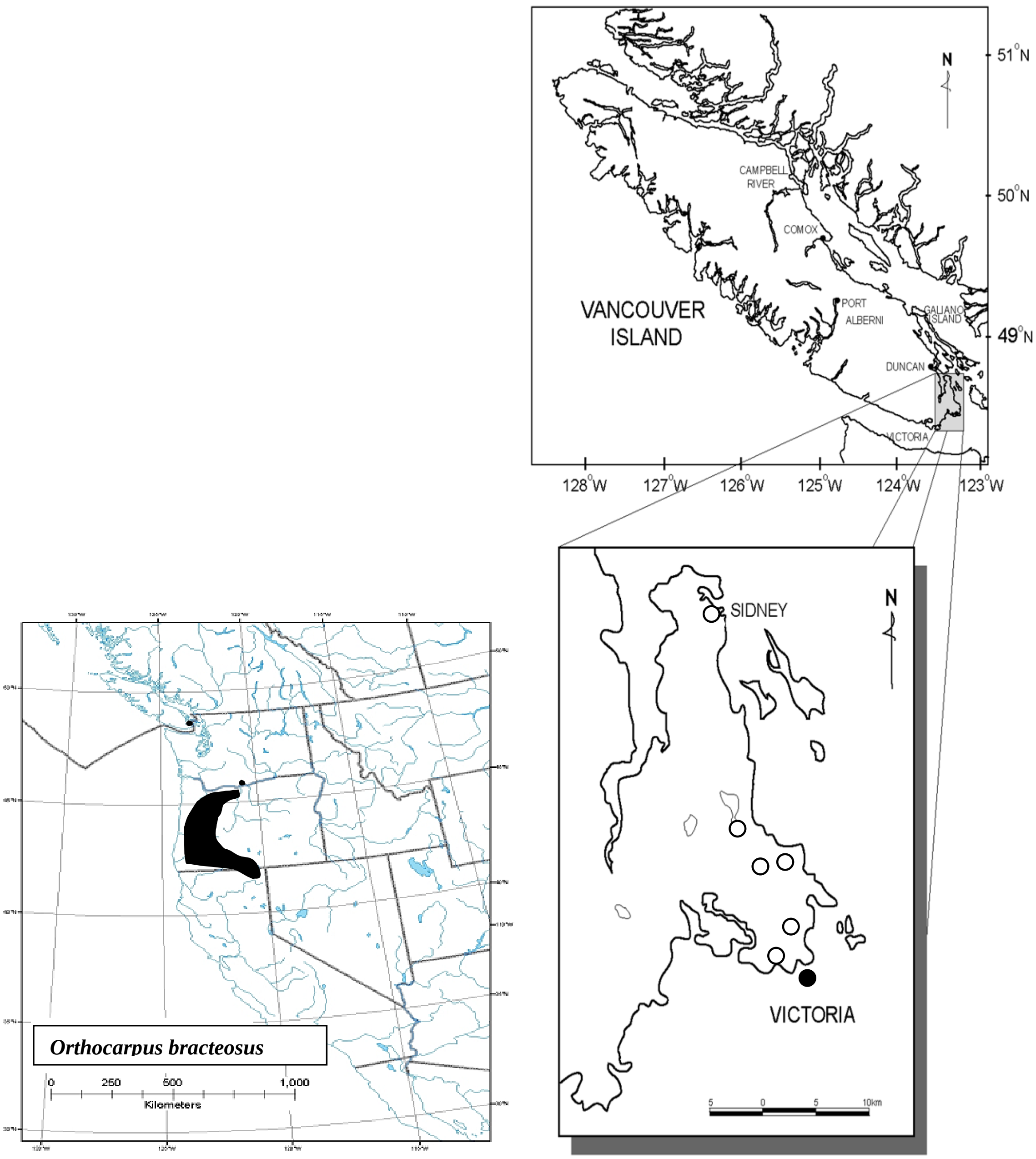

Figure 5. Distribution of rosy-owl clover in western North America (left) and in British Columbia (right).
(Solid circle: extant range. Open circles: historical range.)

3.5.4 Phenology and reproduction

At Trial Island, germination occurs from March to May, with flowering commencing in June (M. Fairbarns, unpubl. data). Each reproductive plant produces around 6 to 10 seed capsules, with each capsule producing approximately 7 seeds. Seed banking likely occurs, but this has not been confirmed. Plants begin to whither in July (earlier in drier microsites) as the soil dries, and are largely finished by August. Later-developing flowers and fruit tend to abort prematurely, presumably due to the onset of drought, suggesting that summer moisture stress in the vernal pool area may be depressing fecundity at this site (M. Fairbarns, unpubl. data).

3.5.5 Population sizes and trends

There are nine historical collections for rosy owl-clover in Canada, all in the Victoria area, but it is uncertain how many of these, in fact, represent distinct populations due to the vague location data (Fairbarns 2004). One population is currently extant on Trial Island. The earliest record from Trial Island (1976) did not include an estimate of population size. The total number of reproductive plants has varied in recent years from 40 to nearly 1000. In 2005, there were 210-230 flowering plants (M. Fairbarns, unpubl. data). Wide population fluctuations are typical in many other annual species (Harper 1977) and such fluctuations may obscure population trends—particularly if the increase in aboveground numbers occurs through seed bank depletion.

3.6 Dwarf sandwort

Common Name: dwarf sandwort

Scientific Name: *Minuartia pusilla* (S. Wats.) Mattf.

Current status and most recent date of assessment: Endangered, May 2004

Reason for designation: An annual ephemeral herb present at a single very small vernal seepage site along a rocky maritime headland in southern Vancouver Island highly disjunct from the nearest populations in southern Washington State. The maximum population size documented totals 20 plants with numbers likely fluctuating depending on precipitation patterns. Risks to the plants arise from the susceptibility of the single small population to stochastic events and on-going disturbance of the habitat by gulls, trampling by boaters and potentially from encroaching invasive plants.

Occurrence: BC

3.6.1 Description of the species

Dwarf sandwort is a small, annual herb from an erect stem 2 to 5 cm tall. The stems are solitary or branched, hairless, and have a glaucous tinge. The leaves are opposite and linear, 2 to 4 mm long and <0.5 mm wide. The inflorescence consists of 2 to 9 flowers in an open, leafy-bracted cyme that may comprise 4/5 the total height of the plant. The petals, when present, are elliptic and 1 to 2 mm long. The sepals are lance-shaped, 2 to 3 mm long, 3-nerved, and have long to abruptly sharp points. The capsules are egg-shaped, 1 to 2 mm long, and 3-valved. The seeds are purplish brown and about 0.5 mm long (Hitchcock and Cronquist 1973, Douglas *et al*. 1998b, Rabeler *et al.* 2005).

Dwarf sandwort has no special economic or social significance in Canada.

3.6.2 Distribution and status

The global range of dwarf sandwort extends from southwest British Columbia south to northern California and east to Idaho, Nevada and Utah (Douglas *et al.* 1998b, NatureServe 2005). In British Columbia, the species is known to occur at just a single location on the southern coast of Vancouver Island (Table 2, Fig. 6).

Dwarf sandwort has a global conservation ranking of G5T3T5. It is ranked S1 in British Columbia and SNR (unranked) in California, Idaho, Nevada, Oregon, Utah, and Washington (NatureServe 2005). The Canadian extent of occurrence (EO) and area of occupancy (AO) of dwarf sandwort are both approximately 10 m^2. This represents <<1 percent of the species' total distribution.

3.6.3 Habitat

In British Columbia, the known habitat of dwarf sandwort consists of a sloping vernal seepage site on a rocky maritime headland in the Coastal Douglas-fir zone (Table 9). However, this may not be representative of the typical habitat, as elsewhere in its range the species is known from dry areas in sagebrush steppe, pine barrens, chaparral slopes, and dry rock cliffs (Hitchcock and Cronquist 1973, Hartman 1993, Rabeler *et al.* 2005). Thus, more information is required on microsite attributes such as soil texture, soil depth, moisture levels, nutrient content, pH levels, length and timing of inundation, and disturbance regimes (Table 9).

The substrate at the Rocky Point seepage site consists of shallow (3-7 cm deep) organic mineral soil with no pronounced structure, overlying bedrock (Table 9). The soil is saturated during the winter and remains damp through the spring, but dries completely by early summer, traits that may help discourage in-growth of larger herbaceous or woody species that might otherwise overgrow or out-compete dwarf sandwort. Associated native plants include slimleaf onion (*Allium amplectens*), erect pygmyweed (*Crassula connata*), dwarf owl-clover (*Orthocarpus pusillus*), Scouler's popcornflower (*Plagiobothrys scouleri*), and beach bluegrass (*Poa confinis*). The COSEWIC-candidate species winged water-starwort, and the COSEWIC-endangered species snake-root sanicle (*Sanicula arctopoides*) and seaside trefoil (*Lotus formosissimus*), are also found nearby.

3.6.4 Population sizes and trends

The first Canadian collection of dwarf sandwort was made at Rocky Point in 1977. Since then, recorded population size has fluctuated from 9 to a few hundred individuals (Penny and Costanzo 2004, M. Fairbarns, unpubl. data). In 2005, approximately 80 flowering plants (with 1 to 2 seed capsules per plant) were observed. It is possible the species maintains a dormant seed bank, in which case aboveground stem counts may not provide an accurate indication of true population size. However, this has not been confirmed. Long-term trends at this site (and elsewhere in British Columbia) are unknown.

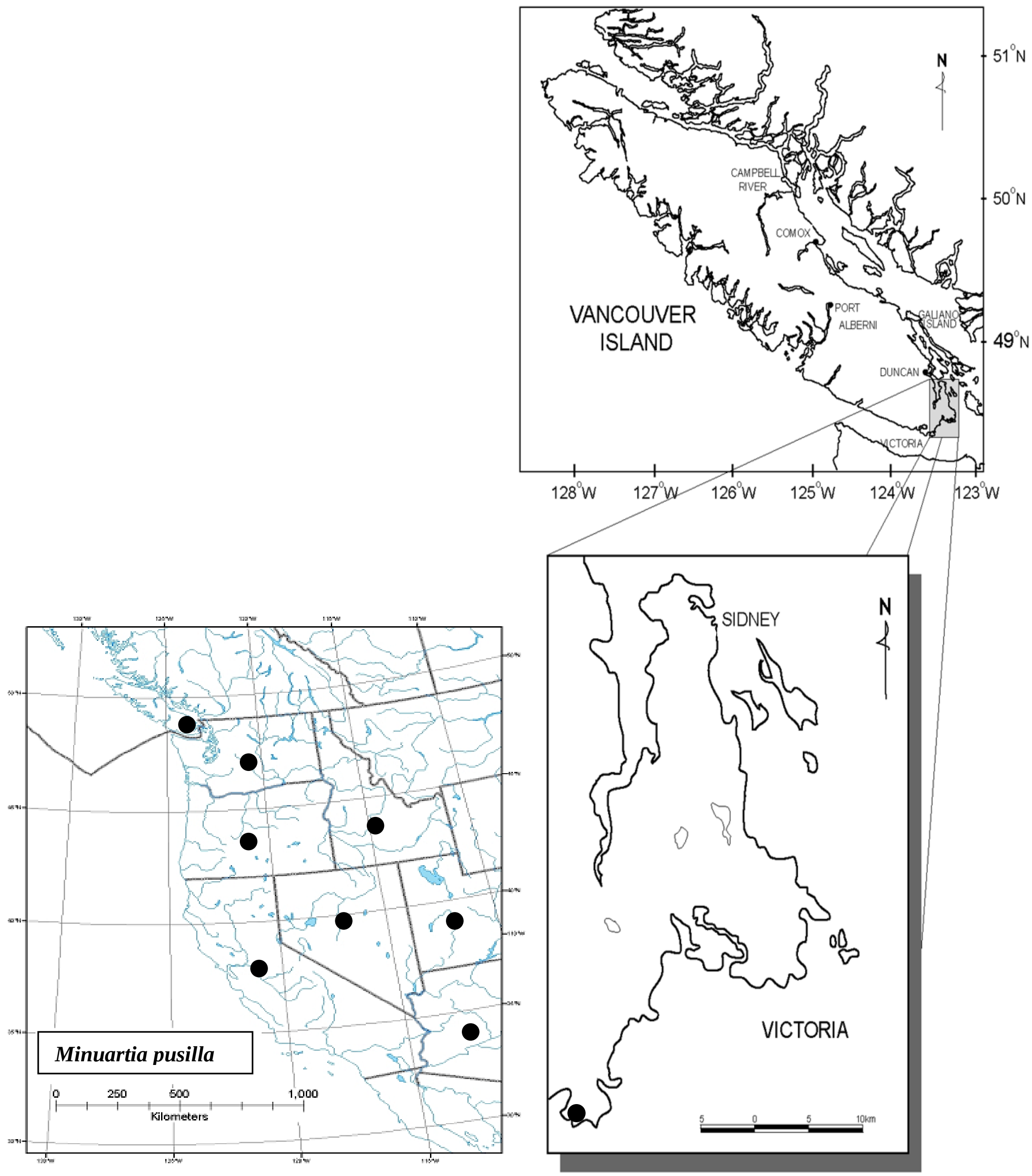

Figure 6. Distribution of dwarf sandwort in North America (left) and in British Columbia (right).
(For the U.S. distribution, dots merely indicate states where found.)

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APPENDIX A - RECORD OF CONSULTATIONS

Gail Adrienne. 2004. Harewood Plains Habitat Stewardship Meeting. Nanaimo Area Land Trust Society, Nanaimo, BC

Bill Beese. 2004. Harewood Plains Habitat Stewardship Meeting. Weyerhaeuser Company, Nanaimo, BC

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