VEGETATION OF FORT RODD HILL/ FISGARD LIGHTHOUSE NATIONAL HISTORIC SITES

Aruncus Consulting
September 2002

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Prepared by

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For

PARKS CANADA AGENCY

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Executive Summary

The objectives of this study of Fort Rodd Hill/Fisgard Lighthouse National Historic Sites were:

- To map vegetation,
- To determine the distribution, abundance and vigour of Daphne and other weedy species, and
- To identify and describe occurrences of rare plant species.

The study area is located on the west side of Esquimalt Harbour, in the Nanaimo Lowlands Ecosection and the Coastal Douglas-fir Biogeoclimatic zone. This ecosection and biogeoclimatic zone is heavily disturbed and contains the highest concentration of rare plant species in British Columbia. The regional climate is sub-Mediterranean, characterized by mild wet winters and cool dry summers. Most of the area is underlain by Wark gneiss, a coarse to medium-grained metamorphic rock that outcrops extensively. Glacial deposits overlay bedrock throughout much of the study area and deep soil pockets occur within many bedrock exposures.

Ecosystems were mapped at 1:5,000. Site classification was based on the Biogeoclimatic Ecosystem Classification, a 1972 thesis on forest vegetation of the Saanich Peninsula and a 1996 thesis on Garry oak communities of southwestern British Columbia. Fieldwork was conducted in August 2001 and May 2002.

Heavily disturbed sites were not described. The following ecosystems were described and mapped: western redcedar – grand fir – foamflower; Douglas-fir – grand fir – Oregon-grape; Douglas-fir – salal; Douglas-fir – arbutus; Garry oak – blue wildrye and Garry oak – *Racomitrium canescens*.

Daphne was found throughout much of the study area although its cover and vigour were low in dry, sunny ecosystems and beneath dense forests. Two major patches of Daphne were described and three daphne control exercises were discussed. Scotch broom was found on dry, open sites throughout the study area. Gorse, English ivy and English holly were less abundant and less vigorous in most of the study area. Gorse was abundant along some dry, open roadsides while English holly and English ivy, though widespread, were rarely abundant.

Seven rare species are now known for the study area: deltoid balsamroot, winged water-starwort, Carolina meadow-foxtail, red-stem springbeauty, Macoun's meadow-foam, Nuttall's quillwort and poverty clover. The population of deltoid balsamroot (a nationally endangered species) is small and declining. The populations of winged water-starwort and Carolina meadow-foxtail (both provincially red-listed species) are highly susceptible to stochastic catastrophes because they are restricted to a single small vernal pool. Red-stem springbeauty, Macoun's meadow-foam, Nuttall's quillwort and poverty clover are all potentially threatened by human activity and/or encroachment by non-native plants.

All occurrences of the seven rare species should be monitored annually to determine their status and trend and to determine their phenological and demographic characteristics.

Management plans are urgently needed to address the declining population of deltoid balsamroot and the declining Belmont Battery population of Macoun's meadow-foam. Management plans should be developed for the other occurrences of rare species but planning can develop over a 2-3 year period in order to incorporate knowledge gained from the first few years of annual monitoring.

Future studies are recommended to address the following issues:

- What effective techniques can be used to control daphne?
- Are populations of English ivy and English holly stable or increasing?

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Figure 1a. Base Map of Study Area

0 m 250 m 500 m 750 m 1,000 m

scale 1:5,000 (orthorectified)

Legend

- Study area boundary
- Roads
- Tracks

Figure 1b. Base Map of Study Area – Lot Boundaries

0 m | 250 m | 500 m | 750 m | 1,000 m

scale 1:5,000 (orthorectified)

Legend

Lot boundary

Introduction

Location

Fort Rodd Hill/Fisgard Lighthouse National Historic Sites lie between Esquimalt Lagoon and Esquimalt Harbour, 5 km west of Victoria. Fort Rodd Hill is an 18.7 ha National Historic Site and one of five contiguous blocks of land managed by Parks Canada Agency. The other blocks include Lot 5 (20.8 ha), Lot 6 known as the site entry (1.1 ha), Lot 12 known as Journey's End (3.8 ha) and the Cavendish Property (9.9 ha). This report refers to the full 54.3 ha of Park's Canada property as the study area (Figure 1a and 1b).

The study area can be accessed by boat but most visitors arrive by road, along Ocean Boulevard (which bisects the study area). A number of trails and paths run through the property but several have been blocked from vehicular traffic and most trails in Lot 5, Lot 12 and the Cavendish Property are closed to park visitors.

Background

A long history of aboriginal use in the study area is reflected in the large shellfish middens found within the study area. The presence of Garry oak ecosystems may reflect a history of First Nations burning to maintain camas meadows, although the Garry oak ecosystems that occur on drought-prone rocky outcrops may have developed without deliberate burning.

The British Navy began using Esquimalt Harbour as an anchorage in 1848 and it quickly became the main base of the Royal Navy's Pacific Fleet. Fort Rodd Hill was established as a coastal artillery fort in order to provide cover for the naval forces in 1895. It remained in service until modern aircraft and missiles rendered such coastal installations obsolete. It was finally abandoned as a military post in 1956 and has been managed since then as a National Historic Site.

Journey's End and the Cavendish Property are historically linked to Hatley Park, the lavish home built by James Dunsmuir. The "castle" at Hatley Park was completed in 1908 and was home of this coal baron and former premier of BC until he died in 1920. His widow and daughter continued to live at Hatley Park until 1937. Journey's End and the Cavendish Property served as residences for the Dunsmuirs and their relatives, and were linked by the 10 km of roads that wove through the Hatley Park estate. The Dominion Government bought the estate in 1940 and it served as a military training facility until 1995, when the Royal Roads properties were leased to the province in order to establish Royal Roads University. After a succession of uses, the house at Cavendish Estate was destroyed. Journey's End remains the headquarters for Fort Rodd Hill National Historic Site. Much of Journey's End and the Cavendish Property now support semi-natural forests but the two properties contain many vestiges of the 'built environment'. Lot 5 is in relatively natural condition aside from an old clearing and

abandoned cabin site along Ocean Boulevard, a gated road leading to the Department of National Defence facilities at Yew Point and associated structures.

The natural values of the study area have been recognized for some time. They have received greater attention since Parks Canada took over management responsibility for the site. The natural values are a major focus within the current Management Planning process for Fort Rodd Hill and Fisgard Lighthouse National Historic Sites.

Biophysical Setting

Ecoregion Classification

Ecoregional classification in British Columbia recognizes a hierarchical division with ecoprovinces composed of several ecoregions, each subdivided into ecosections.

Fort Rodd Hill lies in the Georgia Depression Ecoprovince, the Eastern Vancouver Ecoregion and the Nanaimo Lowlands Ecosection. The Georgia Depression Ecoprovince is a large basin, which contains the Straight of Georgia and Puget Sound as well as lowlands between the Vancouver Island Mountains and the southern Coastal Mountains. The Eastern Vancouver Island Ecoregion is the westernmost of three ecoregions in the Georgia Depression Ecoprovince. This ecoregion includes leeward slopes and lowlands along southeast Vancouver Island. The Nanaimo Lowlands Ecosection is the lowest portion of the Eastern Vancouver Island Ecoregion.

Biogeoclimatic Classification

The Coastal Douglas-fir moist maritime (CDFmm) is the only biogeoclimatic zone and subzone in the study area. This is one of the smallest forested subzones in the BGC system. The CDFmm is restricted to portions of the Georgia Depression Ecoregion from sea level to approximately 150 m. The CDF mm occurs along southeast Vancouver Island from Bowser to the Victoria area, in portions of the Gulf Islands south of Cortes Island, and in a narrow strip along the Sunshine Coast near Halfmoon Bay. The CDFmm is one of the most disturbed subzones in British Columbia with only a few fragments in relatively natural condition. It is characterized by climax forests on zonal sites which are dominated by Douglas-fir as well as grand fir and western red cedar. Their understoreys are usually dominated by salal (*Gaultheria shallon*), dull Oregon-grape (*Mahonia nervosa*), ocean-spray (*Holodiscus discolor*) and Oregon beaked moss (*Kindbergia oregana*).

Climate

The nearest comprehensive set of long-term climatic data (table 1) for a comparable location is from Victoria Gonzales Heights, about 10 km southeast of Fort Rodd Hill. Precipitation gradients are sharp within the general area. Annual precipitation at Fort Rodd Hill is likely 15-20% greater than at Gonzales Heights but temperatures are probably quite similar.

Table 1. Canadian Climate Normals for Victoria Gonzales Heights (1898-1988)[1]

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Daily maximum (^{0}C)	7	9	10	13	16	18	20	20	18	14	9	7	13
Daily minimum (^{0}C)	3	4	4	6	8	10	11	12	10	8	5	3	7
Degree days > 18^{0}C	0	0	0	0	2	2	5	6	3	0	0	0	17
Degree days > 5^{0}C	30	46	77	124	211	265	321	328	276	179	75	36	1966
Rainfall (mm)	93	67	42	32	24	19	14	20	32	59	92	99	593
Snowfall (cm)	11	3	2	0	0	0	0	0	0	0	3	9	28
Precipitation (mm)	102	70	45	32	24	19	14	20	32	59	95	108	619

The region has an exceptionally mild winter climate for such high latitude, is unusually dry compared to other areas of British Columbia's west coast, and receives the greatest annual sunshine in B.C. A pronounced summer drought develops despite relatively cool temperatures, because the strong North Pacific anticyclone prevents most cyclonal systems from entering the area. The rain-shadow effect of the Olympic and Vancouver Island Mountains moderate those cyclonal systems that reach the area. The summer water deficit, calculated using Thornthwaite's formula for potential evapotranspiration, is as low as that for southern portions of the Prairie Provinces. Overall, the climate can be categorized as sub-Mediterranean – it has the winter-wet summer-dry aspect of Mediterranean climates but summers are not as warm (Kerr 1951, Roemer 1972).

[1] Environment Canada: http://www.msc-smc.ec.gc.ca/climate, accessed February 2, 2002

Geology, Glacial History, Terrain and Soils

The oldest rocks originated as submarine volcanics that erupted on the sea floor during the Devonian Period. They are predominantly andesite – a fine-grained rock that resembles basalt but is neither as dark nor as rich in silicates. Coral reefs that dotted the sea floor during the Triassic Periods formed localized limestone deposits assigned to the Sutton Group. Magma from deep within the earth's crust intruded into the Sicker Group during the early Jurassic, forming the Wark Gneiss, a coarse- to medium-grained metamorphic rock banded with light and dark bands (Yorath and Nasmith 1995).

The rocks described above comprise part of Wrangellia, a fragment of the earth's crust that migrated towards North America and has continued to slide underneath the continent since the middle of the Cretaceous Period (ibid).

The Pacific Rim Terrane is a separate crustal fragment composed of similar materials. It collided with Wrangellia during the Tertiary and has been forced under Wrangellia along the San Juan – Survey Mountain Fault. This fault runs northwest-southeast through the Cavendish Property and reverses near the bridge to the Coburg Peninsula, running northeast past Yew Point (Yorath and Nasmith 1995, Muller 1983).

The Crescent Terrane is a third crustal fragment. It collided with and slid under the Pacific Rim Terrane along the Leech River Fault. This fault actually bisects Royal Roads and Esquimalt Lagoon outside of the study area, and deep surficial materials obscure its presence (Yorath and Nasmith 1995, Muller 1983).

The collision of terranes uplifted older strata, disposing them to the processes of peneplanation that wore away overlying rocks. The Wark Gneiss was thus exposed and now forms the majority of rock outcropping in the study area. Pockets of limestone belonging to the Sutton group were exposed in a similar manner. One such pocket is the Rosebank deposit. Located on the northern edge of the study area, this is the largest outcropping mass of limestone on southeast Vancouver Island. Between 1907 and 1932, limestone from the Rosebank deposit was quarried and transported on a narrow-gauge railway to Esquimalt Harbour, about a kilometre away (Mathews and McCammon 1957, Yorath and Nasmith 1995, Muller 1983). Outcrops of limestone are frequent in Lot 5.

Where rock does not outcrop, surficial materials associated with Quaternary glaciation and recent processes largely overlie it.

The Fraser Glaciation was the most recent glacial period. Erosional and depositional processes associated with the Fraser Glaciation have removed or obscured features of earlier glaciations. The oldest deposits associated with the Fraser Glaciation are sands and gravels of the Quadra Formation, which were deposited in the forefront of the advancing ice sheets. These sediments were derived from materials carried within the glacial ice. They were released as ice melted along the leading edge of the glacier and

were sorted by flowing melt water, which carried the lighter silt and clay particles away (Yorath and Nasmith 1995).

As the glaciers overrode Vancouver Island they deposited Vashon Till, an unsorted mixture of materials carried within the glacial ice. Locally, the Vashon Till takes the form of basal till – material deposited under the advancing glacial and compressed into dense, compact deposits by the great mass of overlying ice (ibid.).

The great weight of the glaciers depressed the land they overrode and the land rebounded slowly even after the glaciers melted back and ocean levels rose. Rivers draining the glacial melt met the ancient shoreline well inland from the current coastline. The coarser sands and gravels were deposited abruptly where the fast-flowing rivers met the sea, forming deltas. Finer silts and clays were carried farther out and accumulated on the sea floor. As the land continued to rise, the deltas and the marine sediments were exposed. The Colwood gravels, just southwest of the study area, comprise one of the largest glacial deltas on southeast Vancouver Island. Level deposits within the study area, including the central part of the Historic Site, may be glaciomarine sediments (Yorath and Nasmith 1995, pers. obs.).

The landforms of the study area are relatively stable today, with one major exception. Longshore currents sweep sands and silts northwest from eroding coastal cliffs. These materials are deposited as beaches, spits and offshore bars such as the Cobourg Peninsula and the beach below the Belmont Battery (pers. obs.).

Soils in the study area reflect the climate and vegetation they developed under and the materials they developed from. Orthic Dystric Brunisols probably dominate in the study area. These soils have formed from relatively acidic parent materials under moderate rainfall and coniferous or mixed vegetation. In some areas, these soils have developed a strongly cemented hardpan between 50 and 100 cm below the surface and are called Duric Dystric Brunisols (Soil Classification Working Group 1998, Jungen 1985, Synergy West 1976).

Sombric Brunisols develop on similar sites in the study area that have a long history as grasslands, shrublands and savannahs. The fine roots of grasses, forbs and shrubs decay slowly in the upper soil layer, enriching it with dark organic matter (Soil Classification Working Group 1998, Jungen 1985).

Areas of active bedrock erosion accumulate fresh materials along their periphery. These materials are too young to have well developed B (accumulation) horizons. They normally take the form of Orthic Regosols in the study area. Poorly drained sites often have standing water for prolonged periods. The anaerobic conditions convert iron to its reduced state, imparting a bluish tinge. If the soil dries out periodically, the iron concentrates in small spots as it re-oxidizes to form reddish pockets rather than a blue cast. These soils are referred to as Gleysols, and in the study area they commonly take the form of Orthic Humic Gleysols (Soil Classification Working Group 1998, Jungen 1985, Synergy West 1976).

Flora

Southeast Vancouver Island is one of the most floristically diverse areas in British Columbia. The mild winter climate of coastal lowlands favours an exceptionally diverse assemblage of plants with limited frost-tolerance. Other factors contributing to the diverse flora includes the high diversity of lowland habitats, a long disturbance history which has enabled many exotic species of mild regions to take hold, and a wide range of climates associated with broad gradients of elevation and rainfall.

The floristic assemblage of southeast Vancouver Island includes an exceptionally large number of plants on the provincial red and blue lists. Similar Garry oak woodlands, coastal bluffs and herbaceous vegetation in the Victoria area support over 60 red- and blue-listed plant species (Fuchs 2001) and several more occur in beach and shoreline vegetation and forests of Douglas-fir or grand fir (Douglas *et al.* 1998). COSEWIC lists 13 species from similar habitat types as Endangered, Threatened or of Special Concern and COSEWIC status reports are being prepared for many more.

Ecosystems

Forest Vegetation of the Saanich Peninsula

Roemer (1972) recognized three large vegetation complexes/alliances, seven associations and a number of sub-associations, variants, sub-variants and phases (table 2).

Roemer's classification was developed by comparing the representation of a number of species groups among the sample plots. Each species group consists of plants with similar patterns of distribution and abundance and is named for a diagnostic plant within the group. For example, the Geranium species group consists of dovefoot geranium (*Geranium molle)*, barren brome (*Bromus sterilis*), tiny vetch (*Vicia hirsuta*), blue-eyed Mary (*Collinsia parviflora*) and crested dogtail (*Cynosurus echinatus*). The Lomatium species group consists of spring gold (*Lomatium uticulatum*), small-flowered bird's-foot trefoil (*Lotus micranthus*), silver hairgrass (*Aira caryophyllea*), Wallace's selaginella (*Selaginella wallacei*), few-flowered clover (*Trifolium oliganthum)*, small-headed clover (*T. microcephalum*), tomcat clover (*T. willdenowii*), fescue (*Festuca* sp.) and long-spurred plectritis (*Plectritis macrocera*).

The various associations, sub-associations, variants and sub-variants are named according to the species group(s) that distinguishes them. For example, the Quercus-Geranium association is distinguished by the presence of the Geranium species group. It includes the typical sub-association and another defined by the Lomatium species group.

Roemer also recognized the existence of a number of rare and fragmental forest types that he did not classify because the descriptions would have to be based on a single, often disturbed stand or locality. These include shore pine (*Pinus contorta*) bog vegetation, and on the other end of the spectrum shore pine on dry rock outcrops. He also mentions a trembling aspen (P*opulus tremuloides*) community and shady ravine vegetation composed of dry habitat species from the *Pseudotsuga – Berberis* association (*Melica* sub

association, *Achlys* variant) along with species of fresh habitats: bigleaf maple (*Acer macrophyllum*) in the canopy; false Solomon's seal (*Maianthemum racemosum*), tiger lily (*Lilium columbianum*), fawn lily (*Erythronium oreganum*), Hooker's fairybells (*Prosartes hookeri*) and Lyall's anemone (*Anemone lyallii*) in the herb layer.

Table 2. Forest vegetation types of the Saanich Peninsula

Complex	Association	Sub association	Variant	Sub variant
Oak Vegetation	Quercus-Geranium	Typical		
		Lomatium		
	Quercus-Erythronium	Typical		
		Montia	Typical	
			Lomatium	
			Fragaria	
		Campanula		
Coniferous Vegetation	Arbutus-Pseudotsuga		Typical	
			Campanula – Satureja	
			Satureja	
	Pseudotsuga-Berberis	Typical	Typical	
			Achlys	
		Melica	Typical	
			Achlys	
		Tiarella	Typical	
			Melica	
			Alnus	Typical
				Achlys
Moist Site Vegetation	Abies-Alnus	Typical		
		Ribes		
	Populus-Pyrus		Typical[2]	
			Oenanthe	Typical
				Rumex
	Alnus-Athyrium	Typical	Typical[3]	
			Oenanthe	
			Mnium	
		Gaultheria	Typical	
			Plagiothecium	

[2] Roemer (1972) recognized very minor differences within this variant as phases, one the typical phase and the other with Cooley's hedge-nettle (*Stachys chamissonis*) and false lily-of-the-valley (*Maianthemum dilatatum*).

[3] Roemer (1972) recognized very minor differences in this variant as two phases, one the typical phase and the other with stink currant (*Ribes bracteosum*).

The Biogeoclimatic Ecosystem Classification (BEC)

Green and Klinka (1994), drawing in part from Roemer (1972), recognized fourteen site series (table 3) within the moist maritime variant of the Coastal Douglas-fir Biogeoclimatic Zone (CDFmm). These site series are named for the characteristic vegetation of their climax forests, although actual sites may be in earlier successional stages that bear little resemblance to the site series name.

Table 3. Site Series of the Coastal Douglas Fir Biogeoclimatic Zone

Site series name	#	Site notes
Douglas-fir / salal	01	General sites
Douglas-fir – lodgepole pine / arbutus	02	General sites
Douglas-fir / oniongrass	03	General sites
Douglas-fir – grand fir / Oregon-grape	04	General sites
Western red cedar – Douglas-fir / Kindbergia	05	General sites
Western red cedar – grand fir / foamflower	06	General sites
Western red cedar / snowberry	07	Floodplain – high bench
Black cottonwood / red osier dogwood	08	Floodplain – medium bench
Black cottonwood / willow	09	Floodplain – low bench
Lodgepole pine / Sphagnum	10	General sites
Western red cedar / skunk cabbage	11	General sites
Western red cedar / vanilla-leaf	12	Winter very moist / summer slightly dry
Western red cedar / Indian plum	13	Winter wet / summer fresh
Western red cedar / slough sedge	14	Winter very wet / summer moist

Garry Oak Plant Communities in Southwestern British Columbia

More recently, Erickson (1996) provided a classification of forty-three Garry oak plant communities types found in southwestern B.C. This classification is unusual in two respects: (1) it distinguishes communities in which ‘natural’ species are prominent (table 4) from those dominated by introduced species (table 5); and (2) it recognizes seasonal variations as distinct plant communities. The latter aspect is particularly idiosyncratic, since a single vegetation plot often has two of Erickson’s community types – one in the spring (early April to mid-May) and one in the summer (mid-May to early July). This reflects the profound shifts in community composition that often occur in Garry Oak communities prior to the depth of the summer drought.

Table 4. Native Garry oak plant communities and sub communities of southwestern British Columbia[4]

Early Season	Bedrock outcrops	Other	
Oak-Camassia quamash: typic	Dicranum scoparium-Montia parviflorum	Oak-Mahonia aquifolium	Oak-Bromus carinatus
Oak-Camassia quamash-Erythronium oreganum	Oak-Dicranum scoparium-Sedum spathulifolium	Oak-Lonicera hipidula	Oak-Carex inops
Camassia quamash-Dodecatheon hendersonii	Oak-Dicranum scoparium: typic	Oak-Festuca idahoensis: typic	Oak-Melica subulata
Camassia quamash-Ranunculus occidentalis	Racomitrium canescens-Selaginella wallacei	Oak-Festuca idahoensis-Cerastium arvense	Oak-Holodiscus discolor-Symphoricarpos albus-Polypodium glycyrrhiza
Camassia leichtlinii	Dicranum scoparium-Plectritus congesta	Oak-Festuca idahoensis-Trifolium microcephalum	Oak- (Douglas-fir)-Holodiscus discolor-Symphoricarpos albus-Rhytidiadelphus triquetrus
Montia perfoliata		Krummholz oak-Festuca idahoensis-Vicia Americana	Oak-Symphoricarpos albus-Rosa nutkana-Lonicera ciliosa
Dicranum scoparium-Plectritis congesta		Oak-Elymus glaucus	Oak-Symphoricarpos albus-Rosa nutkana-Oemleria cerasiformis
		Oak-Lathyrus nevadensis	

[4] green shading indicates an early season community

Table 5. Disturbance Garry oak plant communities and sub communities of southwestern British Columbia[5]

First-order (non-Broom) Disturbance Communities	Second-order (Broom series) Disturbance Communities	
	Rock Outcrops	Other Communities
Oak-Racomitrium canescens-Festuca bromoides	Oak-Broom-Racomitrium canescens-Festuca bromoides-Aira	Oak-Broom-Cynosurus echinatus
Oak-Cynosurus echinatus	Oak-Broom-Racomitrium canescens: typic	Oak-Broom-Anthoxanthum odoratum
Oak-Bromus sterilis	Oak-Broom-Racomitrium canescens-Bromus tectorum	Oak-Broom-Elymus glaucus
Oak-Anthoxanthum odoratum		Oak-Broom-Poa pratensis
Oak-Poa pratensis-Vicia sativa		Oak-Broom-Dactylis glomerata
Oak-Dactylis glomerata: typic		
Oak-Dactylis glomerata-Bromus carinatus		
Oak-Dactylis glomerata-Arrhenatherum elatius		
Oak-Dactylis glomerata-Agrotis stolonifera		

Plant Community Classification by the Garry Oak Ecosystems Recovery Team

The Garry Oak Ecosystems Recovery Team (GOERT) is currently developing a plant community classification for Garry oak and associated ecosystems, drawing heavily from Roemer (1972), Green and Klinka (1994) and Erickson (1996). Preliminary results have been shared for discussion (Del Meidinger, Vegetation Ecologist, Research Branch, B.C. Ministry of Forests pers. Comm. February 2002). The GOERT classification is not summarized in this report because of its draft nature, but was used as a guide in developing the map legend.

[5] orange shading indicates a late-season community

Project Details

Objectives

Vegetation Mapping

The purpose of vegetation mapping was to provide basic information for park management purposes including conservation and management of natural ecosystems and special management of rare ecosystems. Mapping was to be completed at a scale of 1:5,000 following the Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998) as closely as possible. RIC procedures had to be modified significantly because permits to allow soil sampling were not available. The location of all trails and structures were mapped except those occurring on the National Historic Site and features associated with residences and ruins in Journey's End and the Cavendish property.

Daphne Study

The purpose of studying *Daphne laureola* (commonly known as daphne or spurge-laurel) was to determine the distribution of this poorly understood exotic weed and identify suitable sites for experimental control. Mapping was to be completed at a scale of 1:5,000 and large, dense sub-populations were to be located using a global positioning system. Notes were to be gathered on the biology and potential management of daphne based on observations but no permits for destructive sampling were available.

Rare Species

The purpose of the rare species study was to search for and document occurrences of rare plants as defined by the Conservation Data Centre element tracking list and the provincial red and blue lists. Particular attention was to be paid to COSEWIC listed species. All occurrences were to be documented using procedures and forms provided by the Conservation Data Centre. Additional notes were to be made on issues relevant to management threats and opportunities on Parks Canada property.

Methodology

Vegetation Mapping

Methodology was based on recommendations from *Standard for Terrestrial Ecosystem Mapping in British Columbi*a (RIC 19998) modified as required because soil sampling was not permitted.

Compiling existing data

The base map was a digital orthophotograph of the study area and surrounding area supplied by Parks Canada and viewed using ER Viewer. The map was scaled to 1:5,000. Several years, scales and types of aerial photography were used in the mapping process but the final polygons were delineated on 1:5,000 black and white prints before being transferred to the orthophoto. The photography was flown in 1997 and the frames were 15BCB97005 #266-270. The images were clear, crisp and free of clouds and deciduous trees had shed their leaves.

Several vegetation and ecosystem studies were consulted including Roemer (1972), Green and Klinka (1994) and Erickson (1996). These studies were supplemented by Sensitive Ecosystems Inventory-style reports of the Cavendish Estate and Lot 5 (Mogensen 2000a,b) and a perfunctory inventory of natural resources of Fort Rodd Hill (Synergy West 1976). Maps prepared to accompany the Synergy West report could not be located.

There are no large-scale geology, geomorphology or soils maps or reports for the area although a number of small-scale studies were useful.

Field Reconnaissance
The author conducted site visits of the study area in April and June of 2001. A more formal field reconnaissance was conducted in early August 2001, after permissions were obtained. During the field reconnaissance visits the site series distribution and landscape features were observed, ground features were related to aerial photograph features, a list of vascular plants was developed and access points were identified. Parks Canada staff from the Victoria field office and Fort Rodd Hill National Historic Site were consulted during the reconnaissance visits.

Developing the Working Legend
A working legend was developed based on a review of the relevant literature, preliminary analysis of the aerial photographs and field reconnaissance visits. This working legend included a list of all ecosystem units present or expected in the study area along with their apparent relationship to topographic and terrain features. Soil drainage, surficial materials and soil depth had to be inferred based on surface expression, position and the mapper's familiarity with regional patterns of surficial geology.

Pre-typing of Aerial Photographs
No ecoregion or biogeoclimatic boundaries needed to be mapped because the entire study area lies within a single ecosection and biogeoclimatic subzone.

Clearly defined terrain or ecosystem boundaries were mapped first. These included shorelines, beaches, areas of outcropping rock, and areas of severe human disturbance. Areas of substantial human disturbance (particularly clearings and buildings) were not mapped in detail because of the low probability of finding rare elements, natural ecosystems or significant subpopulations of daphne within them. Gradational (soft) boundaries were located where vegetation change or subtle site changes suggested a change in ecosystem units recognized in the working legend. Polygons tended to be small because of the fine landscape pattern, Parks Canada's interest in small-scale features related to daphne and rare elements, and the ease of access throughout the study area.

Field Sampling
All but one of the plots were initially sampled in August and September of 2001. The previous winter had been quite dry so the 2001 growing season was characterized by a longer and more severe drought than is normal for this area.

Meadow and deciduous woodland vegetation in southeast Vancouver Island changes character extraordinarily between spring and summer. During spring, the vegetation of such sites is often characterized by an abundance of ephemeral herbs (particularly annuals and bulb-forming species) that are scarcely evident during the summer drought. In late summer a parched sward dominated by exotic grasses, revealing little of their inherent diversity, often characterizes the ground cover of these sites. When early fall rains begin to temper the summer drought, fugitive species such as dovefoot geranium (*Geranium molle*) and licorice fern (*Polypodium glycyrrhiza*) sprout from seeds or rhizomes. As autumn and winter progress, more species emerge. The vegetation continues to green up in late winter and spring, particularly as bulb-forming herbs emerge. A similar, though less pronounced pattern takes place in coniferous woodlands and forests.

Meadow and deciduous woodland plots were revisited in mid-May, 2002 in order to resample vegetation. In most cases, spring vegetation data describes the same plot area sampled in the previous summer. One complex plot (8234) was sampled differently between years: the summer 2001 data describe a mix of rock outcrop and shallow soil microsites while the spring 2002 data were adjusted to only reflect the vegetation of shallow soil microsites. This allowed for a more representative description of vegetation on shallow soils. A new plot (9999) was added in the spring of 2002 to describe a unique vernal pool with significant conservation values.

Polygons were sampled using one type of plot: ground inspection forms. The *Field Manual for Describing Terrestrial Ecosystems* (RIC 1998) provides a detailed methodology for data collection in ground inspection plots. A full species list was collected at each plot but soil and terrain characteristics that can only be determined from soil profiles were not noted.

The original, pre-typed black-and-white air photos were scanned and printouts were used in the field. The locations of all ground inspections were pinpricked on these printouts with the corresponding plot numbers written on the back. All of the main trails outside the 'built' environment were marked on a second set of printouts, along with notable landscape features.

The locations of all ground inspections and waypoints along all trails were also determined using the Global Positioning System (GPS). Locations and waypoints were not accepted unless the GPS unit indicated a locational error of 12 m or less, and locational errors of 7 m or less were achieved in almost all situations. Where the 12 m locational error rate could not otherwise be achieved, locations were obtained by projection from nearby sites with better satellite reception.

Map locations transcribed from air photo printouts were compared to GPS locations plotted on a digital orthophoto of the study area viewed using ER Viewer.

Data Synthesis, Analysis and Final Mapping
All data forms were reviewed upon completion of the fieldwork. Plot data were entered into an Excel spreadsheet. Each plot was assigned to the most appropriate type within the working legend and correlated with types described by Roemer (1972), Green and Klinka (1994) and Erickson (1996). Mapping units were redefined on the basis of field data and new mapping units were added to describe additional communities encountered in the field. Each ecosystem type was assigned an uppercase two-letter code. Many ecosystems were represented by seral communities and this was noted in the ecosystem descriptions. Up to three ecosystem units were noted for each polygon. The percentage of each ecosystem unit is indicated by deciles ranging from 1 to 10 (1=10%; 10=100%).

Daphne Mapping
All polygons were searched for daphne (*Daphne laureola*). Each polygon was rated according to its distributional pattern and vigour using codes provided in table 6. Similar ratings were also provided for Scotch broom (*Cytisus scoparius*) and English ivy (*Hedera helix*) where they occurred.

The locations of major concentrations of daphne were marked on printouts of scanned air photos backed up with GPS coordinates according to the procedures outline above.

Table 6. Distribution and Vigour Codes Used in Weed Mapping[6]

Class	Distribution in a typical 20 x 20 m area	Vigour
1	Rare occurrence, a single individual	Poor
2	A few (2-5) sporadically occurring individuals	Fair
3	A single patch or clump occupying less than ¼ of the area	Good
4	Several (≥ 6) sporadically occurring individuals	Excellent
	A few (2-5) small patches or clumps	
6	Several (≥ 6) well-spaced small patches or clumps	
7	Continuous occurrence of many well-spaced individuals	
8	Continuous occurrence with a few gaps in distribution	

Rare Elements Mapping
All polygons were searched for rare plant species on the BC Conservation Data Centre tracking list. Each occurrence became the centre of a ground inspection plot using methods outlined above. Information on the abundance, vigour and distribution of each rare plant species occurrence was collected, to supplement the vegetation and site data recorded on the ground inspection form.

The locations of rare plant species were marked on printouts of scanned air photos backed up with GPS coordinates according to the procedures outline above.

[6] adapted from Luttmerding *et al*. 1990

Results and Discussion

Site Series and Vegetation Units

Table 7 lists the various ecosystems mapped. These include four site series from Green and Klinka (1994), two ecosystem units derived by combining units from Erickson (1996) and two further units defined by the author. Wet types were rare in the study area because there is negligible water flow in stream courses during the summer drought and there were no substantial basins where water could be captured and retained through the summer.

Table 7. Ecosystems mapped in the Fort Rodd Hill study area.

Map Unit	Description	Correlation
CF	Western Red Cedar – Grand Fir - Foamflower	CDFmm /06 (BEC)
DG	Douglas-fir – Grand Fir – Oregon-grape	CDFmm /04 (BEC)
DS	Douglas-fir – Salal	CDFmm /01 (BEC)
DA	Douglas-fir – Arbutus	CDFmm /02 (BEC)
QW	Garry oak – Blue Wildrye	modified ex. Erickson
QR	(Garry oak) – Racomitrium canescens	modified ex. Erickson
BE	beach	new unit
DI	disturbed: orchards, lawns, gardens etc.	New unit

Western Redcedar – Grand Fir – Foamflower (CF)

The Biogeoclimatic Ecosystem Classification (BEC) recognizes western redcedar – grand fir – foamflower communities as the climax on rich, somewhat dry to fresh sites (site series 06) in the Coastal Douglas-fir zone. These climax forests are characterized by a closed canopy dominated by grand fir (*Abies grandis*) and western redcedar (*Thuja plicata*), with a secondary component of Douglas-fir (*Pseudotsuga menziesii*) and western flowering dogwood *(Cornus nuttallii*). The open shrub layer is dominated by dull Oregon-grape (*Mahonia nervosa*) and the well-developed herb layer is usually dominated by sword fern (*Polystichum munitum*) and three-leaved foamflower (*Tiarella trifoliata*) along with a vanilla-leaf (*Achlys triphylla*). The forest floor typically has a discontinuous moss carpet composed of Oregon beaked moss (*Kindbergia oregana*) and lesser amounts of palm tree moss (*Leucolepis acanthoneuron*), step moss (*Hylocomium splendens*) and electrified cat's tail moss (*Rhytidiadelphus triquetrus*) (Green and Klinka 1994).

The moist conditions previously prevented frequent fires, allowing shade tolerant trees such as western redcedar. Forestry, agricultural development and urbanization have altered disturbance regimes and eliminated natural vegetation, consequently old growth western redcedar – grand fir – foamflower communities are now scarce.

Figure 2. Young forest infested with daphne that would normally succeed to a western redcedar – grand fir – foamflower climax forest.

There are no old growth stands in the study area but localized areas of young forest (primarily structural stage 5) will gradually succeed to old growth (figure 2). These stands occur on level or depressional sites at slope toes (plots 8123, 8233, 8261, 8271 and 8275). The soils tend to be deep and are probably imperfectly to moderately drained. Fine organic matter dominates the surface substrates except where winter and spring flooding deposits fresh mineral soil. The canopies are composed of Douglas-fir, western redcedar, grand fir, bigleaf maple and red alder. The canopy is often sufficiently open to allow in moderate light, which allows a number of shrubs including Indian-plum and oceanspray to flourish. The herb cover rarely exceeds 20% and the most frequent species include trailing blackberry (*Rubus ursinus*), sword fern, cleavers (*Galium aparine*), Dewey's sedge (*Carex deweyana*), wall lettuce (*Lactuca muralis*) and Columbia brome (*Bromus vulgaris*).

Daphne (*Daphne laureola*) is usually present and can become strongly dominant in the shrub layers, as in plot 8233. English holly (*Ilex aquifolium*) is found sporadically and will probably gradually increase. English ivy (*Hedera helix*) germinates readily in the moist soil and has already become an abundant weed in a few areas. Scotch broom (*Cytisus scoparius*) is restricted to open young stands on the drier end of the spectrum, while gorse (*Ulex europaeus*) is rarely present.

Douglas-fir – Grand Fir – Oregon-grape (DG)

Douglas-fir – grand fir – Oregon-grape communities form the climax on moderately dry, rich to very rich sites (site series 04) in the Coastal Douglas-fir zone. At climax they have a closed canopy of Douglas-fir, grand fir, western redcedar and lesser amounts of bigleaf maple and western flowering dogwood. Salal (*Gaultheria shallon*), dull Oregon-grape and oceanspray are the most important shrubs. Sword fern and three-leaved foamflower dominate the herb layer, with lesser amounts of vanilla-leaf. The moss mat is often diverse: Oregon beaked moss may dominate but step moss, electrified cat's-tail moss and palm tree moss are often abundant (Green and Klinka 1994).

Figure 3. Seral community succeeding to Douglas-fir – grand fir – Oregon-grape forest

These forests are very scarce in the region because their high fertility and easy access attracted forestry, agricultural development and urbanization. The study area contains several stands of mature forest (mainly structural stage 6) that will succeed to this climax type (figure 3). These stands occur most often on level to moderate slopes at mid- or lower-slope positions and are scattered throughout the study area (plots 8121, 8125, 8195, 8224 and 8272). Their soils tend to be deep and are probably moderately drained. Fine organic matter and decaying wood cover the soil surface, with negligible rock outcropping or mineral soil exposure. The canopies tend to be dominated by Douglas-fir, red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), western redcedar and grand fir. The shrub layer may be open or closed and is usually dominated by oceanspray

(*Holodiscus discolor*), daphne and common snowberry (*Symphoricarpos albus*). Sword fern usually dominates the herb layer and frequent associates include herb-Robert

(*Geranium robertianum*), Columbia brome, wall-lettuce, cleavers and vanilla-leaf. Oregon beaked moss, palm tree moss and coastal leafy moss (*Plagiomnium insigne*) dominate the bryoid layer, which is rarely extensive.

Daphne is ubiquitous in these maturing forests and will likely become more abundant as canopy gaps develop. English holly and English ivy are also common. Scotch broom and gorse are usually absent, but the former may occur in drier openings.

Douglas-fir – Salal (DS)

Douglas-fir – salal communities form the climax on moderately dry, very poor to medium fertility sites (site series 01) of the Coastal Douglas-fir zone. At climax they, like the previous type, are characterized by a closed canopy dominated by Douglas-fir, grand fir and western redcedar, sometimes with a minor component of bigleaf maple, western flowering dogwood and arbutus (*Arbutus menziesii*). Their well-developed shrub layer is dominated by salal, dull Oregon-grape and oceanspray, again like the Douglas-fir – grand fir – Oregon-grape type. The herb layer is relatively sparse and is characterized by vanilla-leaf and bracken fern (*Pteridium aquilinum*). The forest floor usually has an extensive mat of mosses dominated by Oregon beaked moss with lesser amounts of step moss and electrified cat's-tail moss (Green and Klinka 1994).

Figure 4. Douglas-fir – salal forest in Lot 5.

Frequent, low-intensity fires formerly prevented thin-skinned trees such as western redcedar from becoming abundant. Douglas-fir has thicker bark that allows it to survive light fires so it dominates the canopy during the long periods between major fires. Early seral communities were rare across the landscape until forestry became a major force at the landscape level. It, along with agricultural development and urbanization, has eliminated most old growth Douglas-fir – salal communities in the region.

There are very small areas of old growth Douglas-fir – salal in the study area. Extensive areas of mature forest (primarily structural stage 6) will develop into old growth stands over time (figure 4). These stands occur most frequently on relatively level mid- or lower slope positions in Lot 5 (plots 8122, 8243 and 8274) and the Cavendish Property (plots 8193 and 8262). Smaller occurrences may be found in Journey's End (plot 8277) and the National Historic Site (plot 8273). The soils tend to be deep and are probably moderately drained. Their surfaces are dominated by fine organic matter and decaying wood, with little rock outcropping and negligible exposures of mineral soil. Douglas-fir has matured on these sites and western redcedar has become established in some areas. A shrub layer dominated by salal and dull Oregon-grape has developed where gaps in the dense canopy allow light to reach below. The herb cover rarely exceeds 15% and the most frequent species include trailing blackberry, western fescue (*Festuca occidentalis*), wall-lettuce, hairy honeysuckle (*Lonicera hispidula*), rattlesnake-plantain (*Goodyera oblongifolia*) and broad-leaved starflower (*Trientalis borealis* ssp. *latifolia*).

Daphne has become a significant, often dominant shrub in many areas. Plot 8273, between the Upper and Belmont Batteries, has a 50% cover of this weed. As the canopy of maturing stands opens up, daphne is likely to become an increasing problem at the expense of native shrubs such as salal and dull Oregon-grape. English holly and English ivy are scattered at present but both show the potential to become serious weeds in these forests. Broom may occur on recently disturbed sites but does not thrive in the shaded forests, while gorse was not observed in this type.

Douglas-fir – Arbutus (DA)

The Douglas-fir – Arbutus site series (02) is the climax vegetation of very dry sites with very poor to medium fertility. Douglas-fir and arbutus form a fairly closed canopy over a diverse shrub layer most often dominated by oceanspray and dull Oregon-grape. The herb layer is also diverse but is usually fairly open. Frequent species include hairy honeysuckle, Alaska oniongrass (*Melica subulata*), purple peavine (*Lathyrus nevadensis*), Pacific sanicle (*Sanicula crassicaulis*) and big-leaved sandwort (*Moehringia macrophylla*). The moss layer tends to be well developed and dominated by electrified cat's tail moss, Oregon beaked moss and step moss (Green and Klinka 1994).

This community type is less susceptible to forestry and agricultural development because of its low fertility and rocky soils. Urbanization has eliminated or vastly modified much of this community complex throughout the region.

Figure 5. Douglas-fir - Arbutus forest in the Cavendish Property

There are many small occurrences (plots 8126 and 8263) of this vegetation along the margins of rock outcrops in the study area. The Douglas-fir and arbutus are often less than 10 m tall and such stands are placed in the tall shrub structural stage. Taller stands belong to the mature forest and old forest structural stages. The tall shrub, mature forest and old forest structural stages share similar site and vegetation characteristics. They occupy upper slope and crest positions with rocky soils. Stands usually contain a diversity of microsites including outcropping rock, shallow soils and deep soil pockets in rock clefts. Mineral soil exposures are uncommon but the proportions of fine organic matter, bedrock and decaying wood varies considerably among locations.

The trees usually form an open canopy, rooting in deep soils between rock outcrops (figure 5). The sites are too droughty for shade-tolerant trees to become established so shade-intolerant trees persist throughout the successional sequence. The most common shrubs are Scotch broom, oceanspray, salal, baldhip rose (*Rosa gymnocarpa*), common snowberry, dull Oregon-grape and saskatoon (*Amelanchier alnifolia*).

The most frequent summer herbs include a number of introduced grasses, blue wildrye (*Elymus glaucus*), California brome (*Bromus carinatus*), western fescue, hairy honeysuckle, trailing blackberry, cleavers, yerba buena (*Clinopodium douglasii*), big-leaved sandwort and licorice fern (*Polypodium glycyrrhiza*). The spring flora of these sites is somewhat different, and much richer in species. Spring vegetation includes many bulb plants led by harvest brodiaea (*Brodiaea coronaria*), great camas (*Camassia leichtlinii*) and common camas (*C. quamash*) as well as spring ephemerals such as tomcat clover (*Trifolium willdenowii*), spring vetch (*Vicia lathyroides*) and common vetch (*V. hirsuta*). The cover of introduced grasses such as early vernalgrass may also rise sharply in late spring and early summer on moist level areas and deep soil pockets.

The moss layer is usually well developed. Electrified cat's tail moss is usually the most abundant species although Oregon beaked moss may be common. Step moss favours moister, more shaded microsites while broom moss (*Dicranum scoparium*) may be abundant over shallow soils and bedrock on cooler exposures. Lichens of the genus *Cladonia* are prominent, although their cover is usually low. *Cladonia cornuta, C. chlorophaea, C. squamosa* and *C. furcata* are the most common species, typically growing in mats of electrified cat's tail moss.

Daphne is usually a minor threat in these ecosystems although it may grow densely in rock clefts. English holly and English ivy are rarely present. Scotch broom becomes quite abundant in these communities, growing most vigorously in deep soil pockets but capable of exploiting even narrow crevices within bedrock exposures. Gorse is generally absent. Introduced grasses, including annual vernalgrass (*Anthoxanthum odoratum*), Kentucky bluegrass (*Poa pratensis*) and orchardgrass (*Dactylis glomerata*) tend to dominate soil pockets in the summer. Smaller introduced herbs including common chickweed (*Stellaria media*), early hairgrass (*Aira praecox*) and barren fescue (*Vulpia bromoides*) usually grow on thin soils during the winter and spring, displacing native herbs.

Garry Oak – Blue Wildrye (QW)

Erickson (1996) recognizes a number of Garry oak (*Quercus garryana*) communities in which robust alien grasses dominate, with or without broom. These include the Oak-Bromus sterilis, Oak – Anthoxanthum odoratum, and Oak-Dactylis glomerata communities and their broom-infested equivalents. It appears they are derived from communities in which native grasses (particularly blue wildrye) occurred beneath oak canopies. Erickson describes an Oak – Elymus glaucus type which is widespread and occurs in similar habitats to plots 8192, 8232, 8234, 8235 and 8241). A number of other Garry oak – native grass types described by Erickson also resemble the Garry oak – blue wildrye type.

This complex is widely distributed in the study area as small occurrences in deep soil pockets within fractured bedrock outcrops (figure 6). It is generally found on moderate slopes in crest, upper slope and mid-slope positions. Slope aspect varies from southeast to southwest. The canopy is less than 10 m tall (Garry oak may even be absent in some circumstances) so these communities fall into the tall shrub structural stage.

Figure 6. Garry-oak – blue wildrye community near the Lower Battery

The open canopy tends to be dominated by Garry oak with a secondary component of arbutus and Douglas-fir. Scotch broom tends to dominate the shrub layer along with oceanspray, baldhip rose, common snowberry and dull Oregon-grape, but shrubs are sometimes very sparse.

In summer, the herb layer is dominated by robust introduced grasses including orchardgrass, early vernalgrass, barren brome (*Bromus sterilis*), soft brome (*Bromus hordeaceus*), Kentucky bluegrass and crested dogtail (*Cynosurus echinatus*) along with blue wildrye. A number of forbs including cleavers, Pacific sanicle, dovefoot geranium, trailing blackberry, yerba buena, hairy honeyuckle, field chickweed (*Cerastium arvense*), common chickweed, ribwort plantain (*Plantago lanceolata*) and yarrow (*Achillaea millefolium*) occur in sparse spots within the grass sward. In spring, the herb layer is much more species rich. The spring flora is characterized by a complement of bulb species such as harvest brodiaea, great camas, common camas, white fawn lily (*Erythronium oreganum*) and drought-sensitive herbs including streambank springbeauty (*Claytonia parviflora*), miner's lettuce (*C. perfoliata*), spring gold (*Lomatium utriculatum*), small-flowered nemophila (*Nemophila parviflora*), sea blush (*Plectritis congesta*), small buttercup (*Ranunculus uncinatus*), tiny vetch (*Vicia hirsuta*), spring vetch and common vetch. The cover of coarse non-native grasses increases rapidly during late spring so cover values are very sensitive to interactions between sampling date and microsite characteristics.

Scotch broom is by far the most serious shrubby weed of these sites. It benefits from the juxtaposition of deep soil pockets where it can root, and high light levels due to the open vegetation of extensive adjacent rock outcropping. Daphne may become moderately abundant in shaded pockets of deep soil such as plot 8232. English holly and English ivy are poorly adapted to the sites and never become a serious problem.

(Garry Oak) – Racomitrium canescens (QR)

Erickson (1996) recognized two Garry oak communities with a ground cover dominated by the rock moss *Racomitrium canescens*. One is characterized by native species and the other has a high cover of introduced plants. While Erickson restricted himself to analysis of Garry oak communities, the same suite of species occurs on rocky outcrops in the absence of Garry oak (figure 7) and has been referred to as the *Racomitrium* spp. – *Selaginella wallacei* bryophyte vegetation association (Puget-Georgia-Willamette Ecoregional Vegetation Targets working document, no date). I have combined these units into the (Garry oak) – *Racomitrium* type because of similarities in their floristics and site characteristics.

Within the study area, the cover of Garry oak rarely exceeds 10% in any community type. Douglas-fir and arbutus may be present but are never abundant. The canopy rarely exceeds 10 m so wooded versions belong to the tall shrub structural stage (plots 8041, 8042, 8252, 8264, 8276). Otherwise the communities (plots 8191, 8223, 8231, 8242) belong to the low shrub, herb or sparse vegetation structural stages.

Figure 7. (Garry oak) – Racomitrium understory

These communities tend to occur at crest, upper slope and mid-slope positions on warm aspects. They grow on non-soil or thin soil where rock outcrops extensively. Higher structural stages cannot develop due to the lack of soil.

The development of the shrub, herb and moss layers is dictated by the extent and depth of soil rather than canopy characteristics. Scotch broom may cover up to 15% of sites if there are pockets of deep soil. Such situations are transitional to the Garry oak – blue wildrye type described above, with coarse grasses including early vernalgrass, common velvet-grass (*Holcus lanatus*), barren brome, orchardgrass and soft brome growing vigorously in soil pockets. The (Garry oak) - Racomitrium type is characterized by shallow soil and rock outcrops, and these microsites are dominated by grey rock moss (*Racomitrium canescens*) with minor amounts of juniper haircap moss (*Polytrichum juniperinum*), broom moss and hairy screw moss (*Tortula ruralis*). Wallace's selaginella and reindeer lichens (primarily *Cladina portentosa*) may be moderately abundant.

Most herbs evident by late summer were species capable of growing in rock crevices or within the moss carpet: sheep sorrel (*Rumex acetosella*), hairy cat's ear (*Hypochaeris radicata*), licorice fern, common chickweed, field chickweed, dovefoot geranium, early hairgrass and barren fescue. In late spring, the herb layer is strikingly different and much richer. The spring flora has a significant component of bulb species including common camas (and to a lesser extent great camas), harvest brodiaea and white triteleia. A number of drought-sensitive forbs are also present in the spring, including common vetch, spring vetch, tiny vetch, bur chervil, small-flowered fringecup (*Lithophragma parviflora*), hairy bitter-cress (*Cardamine hirsuta*), miner's lettuce, blue-eyed Mary (*Collinsia parviflora*), small-flowered nemophila, Pacific sanicle (*Sanicula crassicaulis*), tomcat clover, thimble clover (*Trifolium microdon*), few-flowered clover (*Trifolium oliganthum*), spring gold, dwarf owl-clover (*Triphysaria pusilla*) and common whitlow-grass (*Draba verna*). Many of these drought-sensitive forbs are winter annuals, germinating in thin soil as it is moistened by the onset of fall rain and completing their life cycle before the onset of summer drought.

Scotch broom is regularly present and often abundant on these sites, growing most vigorously where it can root in pockets of deep soil. Daphne occasionally grows in pockets of deep soil on cool exposures, but is usually absent. English ivy and English holly are never present.

Other Vegetation

Plot 8225 is from an intertidal herbaceous strand or salt marsh below the Upper Battery. It is strongly dominated by American glasswort (*Salicornia virginica*) with a minor admixture of other salt-tolerant species including Pacific alkaligrass (*Puccinellia nutkaensis*), seashore saltgrass (*Distichlis spicata*), seaside arrow-grass (*Triglochin maritima*), Gerard's rush (*Juncus gerardii*), sea plantain (*Plantago maritima*), American searocket (*Cakile edentula*) and sea-milkwort (*Glaux maritima*). Lamb's-quarters (*Chenopodium album*) is the only non-native species present and its cover was quite low.

Plot 8194 is from an abandoned orchard associated with the Cavendish buildings. It was sampled despite the fact that the site was heavily disturbed, in order to assess how effectively native species can enter abandoned fields. The vegetation remains heavily dominated by non-native grasses including redtop (*Agrostis gigantea*), orchardgrass, tall fescue (*Lolium arundinaceum*) and common velvet-grass. No native species were found during the August survey.

Plot 8221 is from the rocky area around the Fisgard Lighthouse. The total vegetation cover was very low and dominated by non-native species.

Plot 9999 is a vernal pool that contains two rare plants discovered in 2002: Carolina meadow-foxtail (*Alopecurus carolinianus*) and winged water-starwort (*Callitriche marginata*). This site is described in detail in the section on winged water-starwort.

Daphne and Other Exotic Plants

The distribution and vigour of *Daphne laureola* (daphne or spurge-laurel), *Cytisus scoparius* (Scotch broom), *Ulex europaeus* (gorse) and *Hedera helix* (English ivy) within each polygon is summarized in appendix 3.

Daphne was widely spread throughout subxeric to subhygric, shaded to semi-open habitats. It occurred in most polygons in Lot 5, Journey's End, Fort Rodd Hill National Historic Site and the Cavendish Property. Plants growing under dense canopies were generally small and rarely flowered. They had been transported some distance from the parent plants and may not survive to flower and fruit unless a canopy gap develops.

Daphne was most abundant in lightly shaded mesic forests and woodlands, especially in ravines and at the base of bedrock knolls where runoff collected. Two very dense populations were encountered, both in Fort Rodd Hill National Historic Site. One was along the nature trail between the Belmont and Upper Batteries. The other was near the northeast corner of the Lower Battery. In both cases, it dominated the understory.

Figure 8. Daphne recovery after June 1999 hand-pulling (photo taken in August 2001)

Three daphne control sites were examined. Rick Ackerman (technical services manager, Fort Rodd Hill National Historic Site, February 20, 2002) provided information on past treatments. One was a frequently mowed area near the Lower Battery. Daphne was first found here about 25 years ago. Grounds staff mistook it for an ornamental Rhododendron and mowed around the initial clump of three plants for several years. The population has spread rapidly over the past few years. A small pocket is now mowed regularly and the plants have disappeared. A single episode of hand-pulling in an

adjacent plot during December 1999 has reduced the density of Daphne but the subpopulation is now recovering.

A larger area across the path from the canteen was hand-pulled in June 1999 (figure 8). Recovery has been slow but there were a few, scattered plants in flower during the winter of 2001/2. This population will probably re-establish quickly without further action.

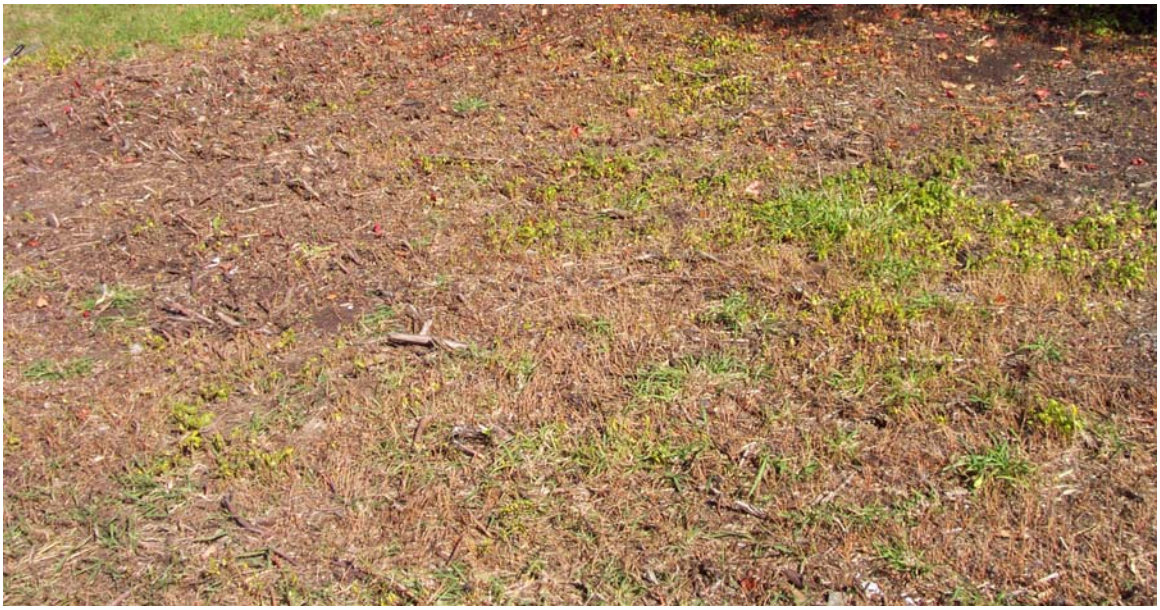

Figure 9. Abundant seedling recruitment after chopping daphne

Figure 10. Daphne resprouting from stem and germinating from seed.

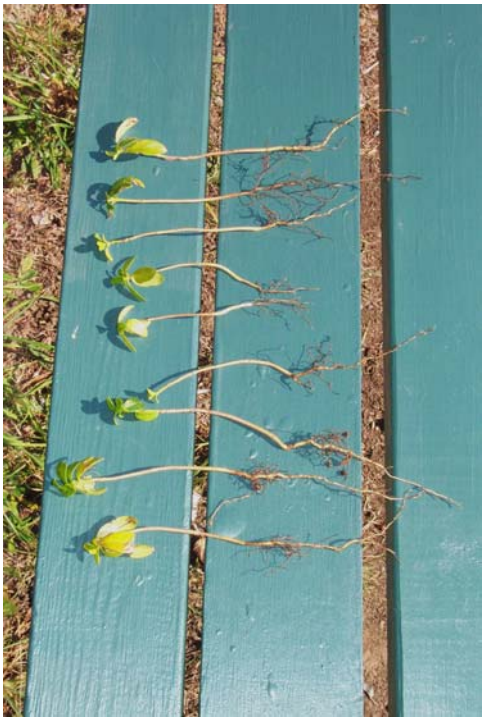

Figure 11. Daphne germinants showing well developed root systems

Plants at the third control site were clipped 5-10 cm from the ground in 2001 (figure 9). A small number of shoots resprouted from the base (figure 10) but there was a dense carpet of young seedlings in 2001. The young seedlings were well established and had developed strong taproots by September 2001 (figure 11).

English ivy also favours mesic forests but unlike daphne it grows well in moist depressions. It is distributed throughout the study area but is rarely abundant except in the Historic Site and in Lot 5 forests along Ocean Boulevard. Many forests have abundant seedlings and young plants, even where mature plants are quite distant. This may indicate an impending explosion of the population but it is possible these plants will not be able to mature and reproduce in many places. English holly has a similar distribution to English ivy and Daphne but no dense populations were encountered in the study. Instead, it was found scattered in mesic forests, particularly where there had been some disturbance to the canopy.

Figure 12. Broom-choked opening near Yew Point

Scotch broom and gorse prefer a different suite of habitats although Scotch broom sometimes occurs with daphne, English ivy or English holly. More often, it occurs on deep soil pockets in dry open habitats or on mesic sites along roadsides, trails and other openings (figure 12). Gorse is primarily restricted to the dry verges of roads and is far more locally distributed than Scotch broom.

Several other introduced shrubs do not present strong threats to natural values. Dense tangles of Himalayan blackberry (*Rubus discolor*) occur around settled areas, particularly in the Cavendish Property. They show little sign of invading adjacent forests.

Many introduced grasses have invaded natural habitats in the study area. Deep soil pockets within outcropping rock provide high levels of light and retain moisture into early summer. These sites may once have been dominated by native grasses including blue wildrye (*Elymus glaucus*) and California brome (*Bromus carinatus*), which are now outcompeted by exotic species including early vernalgrass (*Anthoxanthum odoratum*), orchardgrass (*Dactylis glomerata*) and barren brome (*Bromus sterilis*).

Barren fescue (*Vulpia bromoides*), early and silver hairgrass (*Aira praecox* and *A. caryophyllea*) and soft brome (*Bromus hordeaceus*) are now common and abundant on shallow soils and in bedrock crevices in open areas but it is not clear if these introduced grasses have displaced native species. These four small, introduced grasses have spread to suitable habitats throughout the study area and now comprise an essentially ineradicable element of dry open systems.

Rare Species

Seven rare plant species are now known to occur in the study area. COSEWIC has listed deltoid balsamroot (*Balsamorhiza deltoidea*) as nationally endangered and Macoun's meadowfoam (*Limnanthes macounii*) as species of special concern.

A population of winged water-starwort (*Callitriche marginata*) was found during this study (May 2002). Two occurrences of Macoun's meadow-foam were also documented. The Macoun's meadow-foam occurrences were initially found by Adolf and Oluna Ceska (pers. com., April 29, 2001). Roemer (2002) summarizes characteristics of these three rare plant occurrences and reports on occurrences of a further five species on the BC Conservation Data Centre's red or blue lists: deltoid balsamroot (1 observation), Carolina meadow-foxtail (*Alopecurus carolinianus* – 1 observation), red-stem springbeauty (*Claytonia rubra* ssp. *depressa* – 2 observations), poverty clover (*Trifolium depauperatum* – 3 observations) and Nuttall's quillwort (*Isoetes nuttallii* – 2 observations). Wood and Ebanau (unpublished species list from April 17, 2000) reported the presence of tooth-leaved monkeyflower (*Mimulus dentatus*) and needle-leaved navarretia (*Navarretia intertexta*) in Lot 5 but these reports are likely to have been based on misidentifications.

Table 8. Location of Rare Plant Species

species	First occurrence	Second occurrence
winged water starwort	10U 466570 5364433	
Macoun's meadow-foam	10U 466555 5364305	10U 466742 5364892
deltoid balsamroot	10U 466356 5364414	
Carolina meadow-foxtail	10U 466570 5364433	
red-stem springbeauty	10U 466856 5364216	10U 466581 5364270
poverty clover	10U 466826 5364907*	10U 465910 5364454
Nuttall's quillwort	10U 466831 5364924	10U 466468 5365361

* one end of Yew Point population (sites 2 and 4 of Roemer 2002)

Winged Water-Starwort near Belmont Battery

The winged water-starwort population near the Belmont Battery occurs in a slight bedrock depression at the crest of a bedrock knoll (figure 13). The population was first observed on May 15, 2002. At that date, there was no standing water left in the pool and the plants had settled onto the substrate. The evanescent pedicels of the water-starwort were forcing its mature fruits into the saturated soil at the bottom of the depression. Within a few weeks, the pool had dried up and the plants were desiccated and indistinguishable.

Figure 13. Dried-up vernal pool with close-up of mineral soil exposure

The vegetation of the vernal pool changes rapidly during the spring, as it dries out. There are no observations of early spring vegetation. By mid-spring the moist lower portions of the pool are thinly vegetated by purslane speedwell (*Veronica peregrina*), tiny mousetail (*Myosurus minimus*), Scouler's popcornflower (*Plagiobothrys scouleri*) and winged water-starwort. By late spring, winged water-starwort has disappeared and the vegetation is augmented by common camas, one-sided sedge (*Carex unilateralis*), creeping bentgrass (*Agrostis stolonifera*) and lowland cudweed (*Gnaphalium palustre*). Soil moisture levels drop below the permanent wilting point by early summer and the centre of the vernal pool turns into a parched patch of scarcely vegetated soil while its margins are dominated by creeping bentgrass and one-sided sedge.

The vernal pool is surrounded by low, open Garry oak woodland. The surrounding vegetation casts limited shade on the pool and deposits relatively little deciduous tree leaf litter.

Winged water-starwort is red-listed in British Columbia, does not occur in any other provinces or territories, and is a strong candidate for eventual COSEWIC listing as nationally threatened or perhaps even endangered. The Belmont Battery population appears to face a relatively low degree of threat apart from the fact that its annual habit makes it susceptible to chance events. Annual monitoring would enable scientists to determine longer-term risks.

Carolina Meadow-foxtail near Belmont Battery

The Carolina meadow-foxtail population near the Belmont Battery occurs in the same bedrock depression as the winged water-starwort. The population was first observed by Hans Roemer on June 12, 2002. At that time the 48 plants were still in flower.

The vegetation and site characteristics of the vernal pool are described in the preceding section.

Carolina meadow-foxtail is red-listed in British Columbia, critically imperilled in Saskatchewan, vulnerable in Alberta and absent from all other provinces and territories. It is a weak candidate for COSEWIC listing as nationally of special concern. The Belmont Battery population appears to face a relatively low degree of threat apart from the fact that its annual habit makes it susceptible to chance events. Annual monitoring would enable resource managers to determine trend and long-term risks.

Deltoid Balsamroot near the Upper Battery

The deltoid balsamroot population below the Upper Battery occurs on a rocky, hummocky south-facing slope. The four plants occur on a strong (15-30%), south-facing slope, approximately 20 m above sea level. The population was reported in April 1966 but the original collection had imprecise location information. Drs. Hans Roemer and Nancy Turner rediscovered the population in a targeted search on May 4, 2002. At that time the basal leaves were well developed. Subsequent observations by Roemer and Fairbarns in June and July 2002 revealed that the plants did not flower in 2002 and that most leaves were damaged by herbivory. As is typical of the species, all leaves were blackened and desiccated by July.

The plants occurred in an open Garry oak woodland. Dominant species in the understory included a number of non-native species including shrubs (broom seedlings, spurge laurel); grasses (sweet vernal-grass, Kentucky bluegrass, orchard grass); and forbs (common vetch, tiny vetch, dovefoot geranium, ribwort plantain, common chickweed and bur chervil). Native species included tall Oregon-grape, common snowberry, blue wild rye, California brome, spring gold, Pacific sanicle, miner's lettuce, field chickweed, cleavers, great camas, royal rein orchid (*Piperia transversa*), mountain sweet cicely and small-flowered nemophila (Roemer 2002).

Deltoid balsamroot is red-listed in British Columbia, occurs in no other provinces or territories, and has been listed as nationally endangered by COSEWIC. The low vigour of the small population of deltoid balsamroot reflects an alarming need for urgent management actions as proposed by Roemer (2002).

Poverty Clover near Yew Point

The Yew Point population of poverty clover (*Trifolium depauperatum*) occurs on a low bench and nearby animal track near the base of a 30% slope, 4-7 metres above sea level. The soil is quite shallow and the site is highly exposed to ocean winds. The plants were first discovered by Hans Roemer on April 26, 2002, and were in flower on that date. About 170 plants were observed at Yew Point in 2002 but numbers likely vary from year to year because of the species' annual habit.

The plants occur within a short turf dominated by white triteleia and white-tipped clover (*Trifolium variegatum*). The short turf vegetation includes a number of other forbs and grasses, over half of which are introduced (Roemer 2002).

The BC status of poverty clover is under review. It is not currently on the red or blue lists but will be added to the blue list in the January 2003 revision. It does not occur in any other provinces or territories. Poverty clover is a moderately strong candidate for eventual COSEWIC listing as special concern. The Yew Point population faces moderate threat from competition, especially by non-native species. Annual monitoring would enable resource managers to determine trend and long-term risks.

Poverty Clover near Esquimalt Lagoon

The Esquimalt Lagoon population of poverty clover consists of a single plant first observed by Hans Roemer on May 1, 2002. The site, which receives some spring seepage but is very dry in summer, is a rocky shoreline outcrop about 5 m above sea level. It is on a 35% slope with a SSE aspect and is exposed to ocean winds.

The vegetation is a short turf dominated by white triteleia, field parsley-piert (*Aphanes arvensis*) and early hairgrass. A number of other low introduced and native annuals occur on the site (Roemer 2002).

Small populations of annual plants are at considerable risk of disappearing, even as a result of chance events. Annual monitoring of the Esquimalt Lagoon population would enable resource managers to determine trend and long-term risks.

Red-stem Springbeauty near Fisgard Lighthouse

The Fisgard Lighthouse observation of red-stem springbeauty (*Claytonia rubra* ssp. *depressa*) occurs in cracks of shore rocks, shaded in the day, near Fisgard Lighthouse. The site is 6 m above sea level, faces WNW, and is shaded during part of the day.

The plants were first observed by Hans Roemer on May 6, 2002. The 14 plants were in bud and/or flower, and though small they seemed to be in good vigour.

The sparse vegetation was characterized by Puget Sound gumweed, blinks (*Montia fontana*), sticky chickweed (*Cerastium glomeratum*), annual bluegrass, common chickweed, early hairgrass, common whitlow-grass (*Draba verna*) and common sow-thistle (*Sonchus oleraceus*) (Roemer 2002).

The *depressa* subspecies of red-stem springbeauty is red-listed in British Columbia and does not occur in any other provinces or territories. It is distinguished from the more common subspecies (ssp. *rubra*) by several characters. Both subspecies occur at Fort Rodd Hill. The subspecies *depressa* has not been widely recognized until quite recently. Current evidence suggests it is a good candidate for COSEWIC threatened status but further collecting may demonstrate that it is less rare than is currently believed. The plants at Fisgard Lighthouse are subject to salt spray and some eutrophication by bird droppings but appear to be in good condition and face no apparent threats. Annual monitoring would enable resource managers to determine trend and long-term risks.

Red-stem Springbeauty near Belmont Battery

The Belmont Battery observation of red-stem springbeauty (ssp. *depressa*) occurs in near-vertical cracks on shoreline rock outcrops. The plants are 4 m above sea level on a NNE aspect and are shaded for much of the day.

The population was first observed by Hans Roemer on May 6, 2002. Approximately 120 plants were found, some in bud, some in flower and some with immature fruit. They appeared to be in good condition and faced no apparent threats.

The very sparse vegetation was characterized by adventives including annual bluegrass, sticky chickweed and mouse barley (*Hordeum murinum*). These associates were opportunistic colonizers in rock crevices and place negligible competitive pressure on the red-stem springbeauty (Roemer 2002).

Annual monitoring would enable resource managers to determine trend and long-term risks.

Nuttall's Quillwort near Yew Point

The Nuttall's quillwort observation near Yew Point occurs in a small, muddy depression in an open area of grassy rock outcrops. The site is 5 m above sea level, is inundated in winter and spring, and dries to xeric conditions in summer. The 15 plants were found by Hans Roemer on April 30, 2002 when they were in leaf. Nuttall's quillwort is a non-flowering plant most closely related to ferns and clubmosses. Its reproductive structures are hidden in leaf bases at the bottom of the plant. As such, its reproductive status is hard to determine without damaging the plant.

White triteleia was growing with the quillwort, while the surrounding area had mouse barley, annual bluegrass, perennial ryegrass, great camas and sticky chickweed (Roemer 2002).

Nuttall's quillwort is blue-listed in British Columbia and does not occur in any other provinces or territories. The plants at Yew Point appear to be healthy and face no obvious threats. Annual monitoring would enable resource managers to determine trend and long-term risks.

Nuttall's Quillwort in Lot 5 Old Clearing

The Nuttall's quillwort observation in the old clearing in Lot 5 occurs in a flat, open area of shallow clay over bedrock. The soil is wet in winter and spring and very dry by mid-summer. The plants were first observed by Hans Roemer on May 7, 2002 at which time they were in leaf. The observation consists of 800-1,000 plants.

The old clearing is gradually filling in with forest trees and the quillwort site is surrounded by young Douglas-fir. The quillwort grows with sweet vernalgrass and creeping bentgrass, along with California oatgrass, hairy cat's-ear, sheep sorrel, common velvet-grass and scattered broom plants (Roemer 2002).

The plants in the old clearing at Lot 5 appear to be a remnant of a former natural population. Although they are abundant, the trend and condition of these plants is unclear. The quillwort plants occupy the wettest microhabitats and face no direct competition, even from neighbouring grasses. Forest ingrowth might eventually threaten the plants by shading them and smothering them with leaf litter. Annual monitoring would enable resource managers to determine trend and long-term risks.

Macoun's Meadow-foam at Belmont Battery

The Macoun's meadow-foam population below Belmont Battery occurs in a seep in a cleft between two rock outcrops (figures 14 and 15). The population was observed on April 29, 2001. The site was sampled on August 22, 2001 after the plants had withered and decayed and again on May 14, 2002 when the vegetation was lush and fully-developed.

Figure 14. Macoun's meadowfoam site looking down into cleft from Belmont Battery

Figure 15. Seep within rock cleft where Macoun's meadowfoam occurs (plants grew in the lightly-vegetated pale brown area

The gently sloping (9%) site is about 3 m above sea level and faces southwest (202^{o}). The soil moisture regime fluctuates greatly during the growing season: it is wet in the winter and early spring but very dry by midsummer.

The head of the seep contains a thicket of Nootka rose (*Rosa nutkana*), common snowberry (*Symphoricarpos albus*), daphne (*Daphne laureola*), saskatoon (*Amelanchier alnifolia*), Scotch broom (*Cytisus scoparius*) and very stunted Garry oak. This thicket is a few metres upslope of the meadowfoam and shrubs are virtually absent from where it actually occurs. The periphery of the meadowfoam population is dominated by introduced grasses including crested dogtail (*Cynosurus echinatus*), soft brome (*Bromus hordeaceus*), barren brome (*Bromus sterilis*), orchardgrass (*Dactylis glomerata*) and perennial ryegrass (*Lolium perenne*). The actual patch of meadow-foam is dominated in mid-summer by small grasses including barren fescue (*Festuca bromoides*) and early hairgrass (*Aira praecox*) along with a scattering of low forbs including spotted medic (*Medicago arabica*), hairy cat's ear (*Hypochaeris radicata*), dovefoot geranium (*Geranium molle*), small-flowered catchfly (*Silene gallica*) and slender plantain (*Plantago elongata*) There is very little moss among the meadow-foam plants.

The population is restricted to a small area and similar microsites in the vicinity lack Macoun's meadow-foam. Introduced grasses pose a threat because their foliage tends to lodge and smother sites where meadow-foam might grow. This seep may be too moist in winter for daphne to grow, but it does dominate a similar nearby seep. The population appears to be in decline.

Macoun's Meadow-foam near Yew Point

The Macoun's meadow-foam population south of Yew Point occurs on a bedrock bench midway up a moderately steep slope (figures 16 and 17). The population was observed on April 29, 2001. The site was sampled on August 22, 2001 (after the plants had withered and decayed) and again on May 22, 2002 (when the vegetation was lush and fully-developed).

The gently sloping (10%) site is about 5 m above sea level and faces southeast (118^{o}). Soil moisture fluctuates greatly over the year – it is wet in winter and spring but very dry by midsummer. The area is heavily used by gulls and river otters, which enrich the soil with their droppings.

There are no trees or shrubs and grasses dominate. The cover of grass in the growing season was not determined because birds had crushed the sward. The major grasses included soft brome, barren brome, early vernalgrass and perennial ryegrass. Microsites with little soil were dominated by small, introduced grasses including early hairgrass and barren fescue. Introduced forbs including dovefoot geranium, curled dock (Rumex crispus), sheep sorrel, field chickweed, common chickweed, dandelion (*Taraxacum officinale*) and tiny vetch (*Vicia hirsuta*) were of secondary importance. Native herbs were very sparse when the site was sampled.

Macoun's meadow-foam was restricted to the base of rocks that outcropped over about 20% of the bench. Water seeping across the bench ponds against these rocks where the meadow-foam grows. The plants only occur in a small area despite the presence of similar microsites elsewhere on the bench. Introduced grasses pose a threat to the meadow-foam because their foliage lodges and smothers the soil during the winter and early spring when meadow-foam germinates, grows and reproduces. The Yew Point population appears to be relatively healthy.

Figure 16. Bench south of Yew Point where Macoun's meadow-foam grows.

Figure 17. Rock outcrops on bench. Macoun's meadow-foam grows at the base of the outcrops.

Recommendations for Further Study

1. Determine effective techniques for controlling daphne

Fort Rodd Hill is one of the most heavily daphne-infested areas in the Victoria region. Daphne represents a serious threat to the ecology of many sites. Little is known about this highly invasive species, which does not appear to be a major threat outside of the Georgia Basin/Puget Sound/Willamette Valley area. Daphne is a prolific seed producer, sprouts readily from cut stumps, but does not appear to sucker from underground roots or rhizomes. Experiments on the control of Daphne should consider the species reproductive biology and phenology and should also consider the ecosystem values under threat. The application of a systemic herbicide to cut stumps may turn out to be the only effective technique which does not have a strong negative effect on the natural biodiversity of stands where daphne occurs, but fire, cutting, and uprooting should be tested to see any of them presents a reasonable alternative to the use of herbicide.

2. Monitor trends in English ivy and English holly

English ivy and English holly have not yet had a major impact on ecosystem values, unlike daphne and Scotch broom. English ivy germinants occur frequently in the study area, particularly in moist forests. English holly is scattered in forest openings. Both species should be monitored to determine if their populations are stable or increasing.

3. Develop and implement recover actions for rare plants

A management plan is urgently needed in order to maintain the declining population of deltoid balsamroot, a nationally endangered species. The Belmont Battery occurrence of Macoun's meadow-foam also requires urgent management attention because it appears to be a declining population facing the threat of elimination.

Management plans are also required for the Yew Point occurrence of Macoun's meadow-foam as well as all occurrences of Nuttall's quillwort, red-stem springbeauty, poverty clover, Carolina meadow-foxtail and winged water-starwort. These occurrences should be monitored annually until their status and trend can be confirmed. Management plans for these species should be developed over a 2-3 year period, as they do not appear to face immediate pressures as severe as those facing the deltoid balsamroot population or the Belmont battery occurrence of Macoun's meadow-foam.

References

Erickson, W.R. 1996. Classification and interpretation of Garry oak (*Quercus garryana*) plant communities and ecosystems in southwestern British Columbia. M.Sc. Thesis, University of Victoria, Victoria, B.C.

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Ministry of Forests, Research Branch, Victoria, B.C.

Jungen, J.R. 1985. Soils of Southern Vancouver Island. British Columbia Soil Survey Report No. 44. Ministry of the Environment Technical Report 17. 198 pp.

Kerr, D.P. 1971. The summer-dry climate of the Georgia Basin, British Columbia. Transactions of the Royal Canadian Institute 29:23-31.

Luttmerding, H.A., D.A. Demarchi, E.C. Lea, D.V. Meidinger and T. Vold (eds.). 1990. Describing Ecosystems in the Field (second edition). British Columbia Ministry of the Environment Manual 11. 213 pp.

Mathews, W.H. and J.W. McCammon. 1957. Calcareous deposits of southwestern British Columbia. British Columbia Ministry of Mines. Bulletin 40.

Mogenson, N. 2000a. Victoria Natural History Society's Partial Inventory of Natural Features of Lot 5 (VNHS site: PC #1). Unpublished report. 29 pp.

Mogenson, N. 2000b. Victoria Natural History Society's Partial Inventory of Natural Features of Cavendish Estate (VNHS site: PC #2). Unpublished report. 10 pp. + inserts.

Muller, J.A. 1983. Geology of Victoria. Geological Survey of Canada, Map 1553A.

Roemer, H.L. 1972. Forest vegetation and environments on the Saanich Peninsula, Vancouver Island. Ph.D. thesis. University of Victoria, Victoria, B.C.

Roemer, H. 2002. A Plant Species Inventory with Emphasis on Rare Species: Fort Rodd Hill / Fisgard Lighthouse National Historic Sites. Prepared for Parks Canada.

Soil Classification Working Group. 1998. The Canadian System of Soil Classification. Agric. And Agri-Food Canada Publ. 1646 (revised) 187 pp.

Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth and C. Cadrin. 1998. Sensitive ecosystems inventory: East Vancouver Island and Gulf Islands 1993-1197. Volume 1: Methodology, ecological descriptions and results. Canadian Wildlife Service Technical Report Series No. 320. Pacific and Yukon Region. 146 pp.

Yorath, C.J. and H.W. Nasmith. 1995. The geology of Southern Vancouver Island. Orca Book Publishers. Victoria, B.C. 172 pp.

Appendix 1: Vascular Flora[7]

				Recorded by Fairbarns (F)	|	
				Recorded by Roemer (R)	|	|
				Introduced species (A=adventive)	|	|	|
		Abundance (very common/common/occasional/rare)	V	V	V	V	
Abies grandis	Pinaceae		C		R	F	grand fir
Acer glabrum	Aceraceae		O		R	F	Rocky Mountain maple
Acer macrophyllum	Aceraceae		C		R	F	bigleaf maple
Achillaea millefolium	Asteraceae		C		R	F	yarrow
Achlys triphylla	Berberidaceae		O		R	F	vanilla-leaf
Adenocaulon bicolor	Asteraceae		O		R	F	pathfinder
Aesculus hippocastanum	Hippocastanaceae		R	A	R	F	horse chestnut
Agrostis capillaris	Poaceae		C	A	R	F	colonial bentgrass
Agrostis gigantea	Poaceae		C	A	R	F	redtop
Agrostis stolonifera	Poaceae		C	A	R	F	creeping bentgrass
Aira caryophyllea	Poaceae		O	A	R	F	silver hairgrass
Aira praecox	Poaceae		V	A	R	F	early hairgrass
Alnus rubra	Betulaceae		C		R	F	red alder
Alopecurus carolinianus	Poaceae		R		R	F	Carolina meadow-foxtail
Alopecurus pratensis	Poaceae		O	A	R		meadow-foxtail
Ambrosia chamissonis	Asteraceae		O		R	F	silver burweed
Amelanchier alnifolia	Rosaceae		O		R	F	saskatoon
Anemone lyallii	Ranunculaceae		O		R		Lyall's anemone
Angelica genuflexa	Apiaceae		O		R		kneeling angelica
Anthoxanthum odoratum	Poaceae		V	A	R	F	sweet vernalgrass
Anthriscus caucalis	Apiaceae		V	A	R	F	bur chervil
Aphanes arvensis	Rosaceae		C		R	F	field parsley-piert
Aphanes microcarpa	Rosaceae		O	A	R		small-fruited parsley-piert
Arabidopsis thaliana	Brassicaceae		R	A	R		mouse ear
Arbutus menziesii	Ericaceae		C		R	F	arbutus
Arenaria serpyllifolia	Caryophyllaceae		O	A	R	F	thyme-leaved sandwort
Armeria maritima	Plumbaginaceae		O		R	F	thrift
Arrhenatherum elatius	Poaceae		C	A	R	F	tall oatgrass
Athyrium filix-femina	Dryopteridaceae		O		R	F	lady fern
Aubrieta deltoides	Brassicaceae		R	A	R	F	aubrieta
Balsamorhiza deltoidea	Asteraceae		R		R	F	deltoid balsamroot
Barbarea orthoceras	Brassicaceae		O		R		American winter-cress
Bellis perennis	Asteraceae		O	A	R	F	English daisy

[7] From Roemer 2002 based on observations by Ceska and Ceska (pers. com., April 29, 2002), observations from this study and 2002 observations by Roemer

Betula pendula	Betulaceae	R	A	R		European birch
Blechnum spicant	Blechnaceae	R		R	F	deer fern
Brassica campestris	Brassicaceae	O	A	R		field mustard
Brodiaea coronaria	Liliaceae	C		R	F	harvest brodiaea
Bromus carinatus	Poaceae	C		R	F	California brome
Bromus commutatus	Poaceae	O	A	R		meadow brome
Bromus hordeaceus	Poaceae	V	A	R	F	soft brome
Bromus racemosus	Poaceae	O	A	R		smooth brome
Bromus rigidus	Poaceae	C	A	R	F	rip-gut brome
Bromus sitchensis	Poaceae	O		R	F	Sitka brome
Bromus sterilis	Poaceae	C	A	R	F	barren brome
Bromus tectorum	Poaceae	C	A	R	F	cheatgrass
Bromus vulgaris	Poaceae	C		R	F	Columbia brome
Cakile edentula	Brassicaceae	C		R	F	American searocket
Calandrinia ciliata	Portulacaceae	O		R	F	red maids
Callitriche marginata	Callitrichaceae	R		R	F	winged water-starwort
Calluna vulgaris	Ericaceae	R	A	R	F	common heather
Calypso bulbosa	Orchidaceae	O		R		Calypso orchid
Camassia leichtlinii	Liliaceae	O		R	F	great camas
Camassia quamash	Liliaceae	C		R	F	common camas
Cardamine hirsuta	Brassicaceae	C	A	R	F	hairy bitter-cress
Cardamine nuttallii var. nuttallii	Brassicaceae	O		R		Nuttall’s bitter-cress
Cardamine oligosperma	Brassicaceae	?			F	little western bitter-cress
Carex deweyana	Cyperaceae	O		R	F	Dewey’s sedge
Carex hendersonii	Cyperaceae	O		R	F	Henderson’s sedge
Carex inops	Cyperaceae	C		R	F	long-stoloned sedge
Carex lyngbyei	Cyperaceae	O		R		Lyngby’s sedge
Carex obnupta	Cyperaceae	C		R		slough sedge
Carex tracyi	Cyperaceae	O		R	F	Tracy’s sedge
Carex unilateralis	Cyperaceae	O		R	F	one-sided sedge
Cerastium arvense	Caryophyllaceae	O		R	F	field chickweed
Cerastium fontanum ssp. triviale	Caryophyllaceae	R	A		F	mouse-ear chickweed
Cerastium glomeratum	Caryophyllaceae	C	A	R	F	sticky chickweed
Cerastium semidecandrum	Caryophyllaceae	O	A	R		little chickweed
Cheiranthus cheirii	Brassicaceae	O	A	R	F	common wallflower
Chenopodium album	Chenopodiaceae	O	A	R	F	lamb's-quarters
Cirsium arvense	Asteraceae	O	A	R	F	Canada thistle
Cirsium vulgare	Asteraceae	O	A	R	F	bull thistle
Clarkia amoena	Onagraceae	O		R		farewell-to-spring
Claytonia parviflora	Portulacaceae	O		R	F	streambank springbeauty
Claytonia perfoliata	Portulacaceae	O		R	F	miner's lettuce
Claytonia rubra ssp. depressa	Portulacaceae	R		R		red-stem springbeauty
Claytonia rubra ssp. rubra	Portulacaceae	R		R		red-stem springbeauty

Claytonia sibirica	Portulacaceae	O		R	F	Siberian miner's lettuce
Clinopodium douglasii	Lamiaceae	O		R	F	yerba buena
Collinsia grandiflora var. pusilla	Scrophulariaceae	C		R	F	blue-eyed Mary
Conioselinum gmelinii	Apiaceae	O		R		Pacific hemlock-parsley
Convolvulus arvensis	Convolvulaceae	O	A		F	field bindweed
Corallorhiza maculata	Orchidaceae	O		R	F	spotted coralroot
Cornus nuttallii	Cornaceae	O		R	F	western flowering dogwood
Cornus stolonifera	Cornaceae	O		R	F	red-osier dogwood
Cotoneaster sp.	Rosaceae	O	A	R	F	cotoneaster
Crataegus douglasii	Rosaceae	C		R	F	black hawthorn
Crataegus monogyna	Rosaceae	O	A		F	common hawthorn
Crepis capillaris	Asteraceae	O	A	R		smooth hawksbeard
Cynosurus cristatus	Poaceae	O	A	R		crested dogtail
Cynosurus echinatus	Poaceae	C	A	R	F	hedgehog dogtail
Cytisus scoparius	Fabaceae	V	A	R	F	Scotch broom
Dactylis glomerata	Poaceae	V	A	R	F	orchard-grass
Danthonia californica	Poaceae	O		R	F	California oatgrass
Daphne laureola	Thymeleaceae	V	A	R	F	spurge-laurel
Daucus carota	Apiaceae	O	A	R	F	wild carrot
Delphinium menziesii	Ranunculaceae	O		R	F	Menzies' larkspur
Deschampsia elongata	Poaceae	R			F	slender hairgrass
Digitalis purpurea	Scrophulariaceae	O	A	R	F	common foxglove
Distichlis spicata var. *spicata*	Poaceae	O		R	F	seashore saltgrass
Dodecatheon hendersonii	Primulaceae	C		R	F	broad-leaved shootingstar
Draba verna	Brassicaceae	O	A	R	F	common whitlow-grass
Elymus glaucus	Poaceae	C		R	F	blue wildrye
Elymus repens	Poaceae	O	A	R	F	quackgrass
Epilobium brachycarpum	Onagraceae	O		R		tall annual willowherb
Epilobium ciliatum ssp. ciliatum	Onagraceae	R			F	purple-leaved willowherb
Epipactis helleborine	Orchidaceae	O	A		F	helleborine
Equisetum arvense	Equisetaceae	O		R	F	common horsetail
Equisetum telmateia	Equisetaceae	O		R	F	giant horsetail
Erica cf. australis	Ericaceae	R	A	R		Spanish tree heather
Eriophyllum lanatum	Asteraceae	O			F	woolly eriophyllum
Erodium cicutarium	Geraniaceae	C	A	R	F	common stork's-bill
Erythronium oregonum	Liliaceae	O		R	F	white fawn lily
Fagus sylvatica	Fagaceae	R	A	R		European beech
Festuca occidentalis	Poaceae	O		R	F	western fescue
Festuca rubra	Poaceae	O	A	R	F	red fescue
Festuca rubra ssp. arenicola	Poaceae	O		R	F	native red fescue
Festuca subuliflora	Poaceae	O		R	F	crinkle-awn fescue
Fragaria vesca	Rosaceae	O		R	F	wood strawberry
Fritillaria affinis	Liliaceae	O		R	F	chocolate lily

Galium aparine	Rubiaceae	C	A	R	F	cleavers
Galium triflorum	Rubiaceae	C		R	F	sweet-scented bedstraw
Gaultheria shallon	Ericaceae	C		R	F	salal
Geranium dissectum	Geraniaceae	O	A	R	F	cut-leaved geranium
Geranium molle	Geraniaceae	C	A	R	F	dovefoot geranium
Geranium pusillum	Geraniaceae	R	A		F	small-flowered geranium
Geranium robertianum	Geraniaceae	C	A	R	F	herb-Robert
Geum macrophyllum	Rosaceae	O		R	F	large-leaved avens
Glaux maritima	Primulaceae	O		R	F	sea-milkwort
Gnaphalium palustre	Asteraceae	R		R	F	lowland cudweed
Goodyera oblongifolia	Orchidaceae	O		R	F	rattlesnake-plantain
Gratiola ebracteata	Scrophulariaceae	R		R	F	bractless hedge-hyssop
Grindelia integrifolia	Asteraceae	C		R	F	Puget Sound gumweed
Hedera helix	Araliaceae	O	A	R	F	English ivy
Heuchera micrantha	Saxifragaceae	O		R	F	small-flowered alumroot
Hieracium albiflorum	Asteraceae	O		R	F	white hawkweed
Holcus lanatus	Poaceae	C	A	R	F	common velvet-grass
Holodiscus discolor	Rosaceae	C		R	F	oceanspray
Hordeum brachyantherum	Poaceae	O		R	F	meadow barley
Hordeum murinum ssp. murinum	Poaceae	C	A	R	F	mouse barley
Hyacinthoides non-scripta	Liliaceae	O	A	R	F	English bluebell
Hypericum calycinum	Clusiaceae	O	A	R	F	St.John’s wort
Hypericum olympicum	Clusiaceae	R	A	R		St.John’s wort
Hypochaeris radicata	Asteraceae	C	A	R	F	hairy cat's-ear
Ilex aquifolium	Aquifoliaceae	C	A	R	F	English holly
Isoetes nutallii	Isoetaceae	O		R		Nuttall’s quillwort
Juncus balticus	Juncaceae	O		R	F	Baltic rush
Juncus bufonius	Juncaceae	O		R	F	toad rush
Juncus effusus	Juncaceae	O	A	R	F	common rush
Juncus ensifolius	Juncaceae	O		R		dagger-leaf rush
Juncus gerardii	Juncaceae	O		R	F	Gerard’s rush
Kolkwitzia amabilis	Caprifoliaceae	R	A	R		beauty bush
Laburnum anagyroides	Fagaceae	O	A	R		laburnum
Lactuca muralis	Asteraceae	C	A	R	F	wall-lettuce
Lamium purpureum	Lamiaceae	C	A	R	F	purple dead-nettle
Lapsana communis	Asteraceae	C	A	R		nipplewort
Lathyrus japonicus	Fabaceae	O		R	F	beach pea
Lathyrus nevadensis	Fabaceae	O		R	F	purple peavine
Leontodon taraxacoides	Asteraceae	C	A	R	F	hairy hawkbit
Lepidium heterophyllum	Brassicaceae	O	A	R	F	Smith’s pepper-grass
Leucanthemum vulgare	Asteraceae	O	A	R	F	oxeye daisy
Leymus mollis	Poaceae	C		R	F	dune wildrye
Lilium columbianum	Liliaceae	O		R	F	Columbia lily
Limnanthes macounii	Limnanthaceae	R		R	F	Macoun's meadow-foam

Linaria canadensis	Scrophulariaceae	O		R	F	Canadian toadflax
Linnaea borealis	Caprifoliaceae	C		R	F	twinflower
Lithophragma parviflora	Saxifragaceae	O		R	F	small-flowered fringecup
Lolium arundinaceum	Poaceae	R	A	R	F	tall fescue
Lolium perenne	Poaceae	C	A	R	F	perennial ryegrass
Lolium pratense	Poaceae	C	A	R		perennial ryegrass
Lomatium nudicaule	Apiaceae	O		R	F	barestem desert-parsley
Lomatium utriculatum	Apiaceae	O		R	F	spring gold
Lonicera ciliosa	Caprifoliaceae	O		R	F	western trumpet
Lonicera hispidula	Caprifoliaceae	O		R	F	hairy honeysuckle
Lotus micranthus	Fabaceae	O		R	F	small-flowered birdsfoot trefoil
Lupinus bicolor	Fabaceae	O		R	F	two-coloured lupine
Luzula multiflora	Juncaceae	O		R	F	field woodrush
Lysichiton americanum	Araceae	R		R	F	skunk cabbage
Madia madioides	Asteraceae	O		R	F	woodland tarweed
Mahonia aquifolium	Berberidaceae	O		R	F	tall Oregon-grape
Mahonia nervosa	Berberidaceae	V		R	F	dull Oregon-grape
Maianthemum dilatatum	Liliaceae	O		R	F	false lily-of-the-valley
Malus fusca	Rosaceae	O		R	F	Pacific crab apple
Malus pumila	Rosaceae	O	A	R	F	cultivated apple
Medicago arabica	Fabaceae	C	A	R	F	spotted medic
Medicago lupulina	Fabaceae	C	A	R	F	black medic
Medicago polymorpha	Fabaceae	O	A	R	F	bur clover
Melica subulata	Poaceae	C		R	F	Alaska oniongrass
Mentha piperita	Lamiaceae	O	A	R		peppermint
Mimulus "sookensis"	Scrophulariaceae	O		R		local, undescribed monkeyflower
Mimulus alsinoides	Scrophulariaceae	O		R	F	chickweed monkeyflower
Mimulus moschatus	Scrophulariaceae	R		R		musk flower
Moehringia macrophylla	Caryophyllaceae	C		R	F	big-leaved sandwort
Montia fontana	Portulacaceae	C		R	F	blinks
Montia howellii	Portulacaceae	R		R	F	Howell's montia
Montia linearis	Portulacaceae	R		R		narrow-leaved montia
Montia parvifolia	Portulacaceae	O		R	F	small-leaved montia
Myosotis arvensis	Boraginaceae	?	A		F	field forget-me-not
Myosotis discolor	Boraginaceae	O	A	R	F	common forget-me-not
Myosurus minimus	Ranunculaceae	R		R	F	tiny mousetail
Narcissus poeticus	Liliaceae	R	A	R		poet's narcissus
Narcissus pseudonarcissus	Liliaceae	O	A	R	F	daffodil
Nemophila parviflora	Hydrophyllaceae	O		R	F	small-flowered nemophila
Nemophila pedunculata	Hydrophyllaceae	O		R		meadow nemophila
Oemleria cerasiformis	Rosaceae	C		R	F	Indian-plum
Oenanthe sarmentosa	Apiaceae	O		R	F	Pacific water-parsley
Osmorhiza berteroi	Apiaceae	C		R	F	mountain sweet cicely
Pachistima myrsinites	Celastraceae	O		R	F	false-box

Pentagramma triangularis	Pteridaceae	O		R	F	goldenback fern
Perideridia gairdneri	Apiaceae	O		R		yampah
Petroselinum crispum	Apiaceae	O	A	R	F	parsley
Philadelphus lewisii	Hydrangeaceae	O		R	F	mock orange
Physocarpus capitatus	Rosaceae	O		R	F	ninebark
Pinus contorta var. contorta	Pinaceae	O		R	F	shore pine
Piperia transversa	Orchidaceae	R		R	F	royal rein orchid
Plagiobothrys scouleri	Boraginaceae	O		R	F	Scouler's popcornflower
Plantago elongata	Plantaginaceae	O		R	F	slender plantain
Plantago lanceolata	Plantaginaceae	C	A	R	F	ribwort plantain
Plantago major	Plantaginaceae	O	A		F	common plantain
Plantago maritima	Plantaginaceae	O		R	F	sea plantain
Plectritis congesta	Valerianaceae	O		R	F	sea blush
Plectritis macrocera	Valerianaceae	O		R		long-spurred plectritis
Poa annua	Poaceae	C	A	R	F	annual bluegrass
Poa bulbosa	Poaceae	O	A	R	F	bulbous bluegrass
Poa palustris	Poaceae	O	A	R		swamp bluegrass
Poa pratensis	Poaceae	C	A	R	F	Kentucky bluegrass
Poa trivialis	Poaceae	O	A	R		rough bluegrass
Polygonum paronychia	Polygonaceae	O		R	F	beach knotweed
Polypodium glycyrrhiza	Polypodiaceae	C		R	F	licorice fern
Polystichum munitum	Dryopteridaceae	C		R	F	sword fern
Populus tremuloides	Salicaceae	C		R	F	trembling aspen
Populus trichocarpa	Salicaceae	O		R		black cottonwood
Potentilla egedii	Rosaceae	O		R	F	coast silverweed
Prunella vulgaris	Lamiaceae	O	A		F	self-heal
Prunus cerasifera nigra	Rosaceae	O	A	R		Japanese plum
Prunus emarginata	Rosaceae	O		R	F	bitter cherry
Prunus laurocerasus	Rosaceae	O	A	R	F	cherry-laurel
Prunus lusitanica	Rosaceae	R	A	R		Portuguese laurel
Pseudotsuga douglasii	Pinaceae	V		R	F	Douglas-fir
Pteridium aquilinum	Dennstaedticeae	C		R	F	bracken fern
Puccinellia nutkaensis	Poaceae	O		R	F	Pacific alkaligrass
Quercus garryana	Fagaceae	C		R	F	Garry oak
Ranunculus acris	Ranunculaceae	O	A	R		meadow buttercup
Ranunculus occidentalis	Ranunculaceae	R			F	western buttercup
Ranunculus repens	Ranunculaceae	O	A	R	F	creeping buttercup
Ranunculus uncinatus	Ranunculaceae	O		R	F	small buttercup
Rhamnus purshiana	Rhamnaceae	O		R	F	cascara
Rhododendron ponticum s.l.	Ericaceae	R	A	R		rhododendron
Ribes divaricatum	Grossulariaceae	O		R		coastal black gooseberry
Ribes laxiflorum	Grossulariaceae	R			F	trailing black currant
Ribes sanguineum	Grossulariaceae	R			F	red-flowering currant

Rosa eglanteria	Rosaceae	C	A	R	F	dog rose
Rosa gymnocarpa	Rosaceae	C		R	F	baldhip rose
Rosa nutkana	Rosaceae	C		R	F	Nootka rose
Rosa pisocarpa	Rosaceae	R			F	clustered wild rose
Rubus discolor	Rosaceae	C	A	R	F	Himalayan blackberry
Rubus laciniatus	Rosaceae	O	A	R	F	cut-leaf blackberry
Rubus parviflorus	Rosaceae	O		R	F	thimbleberry
Rubus spectabilis	Rosaceae	O		R	F	salmonberry
Rubus ursinus	Rosaceae	C		R	F	trailing blackberry
Rumex acetosella	Polygonaceae	C	A	R	F	sheep sorrel
Rumex conglomeratus	Polygonaceae	O	A	R	F	clustered dock
Rumex crispus	Polygonaceae	O	A		F	curled dock
Rumex obtusifolius	Polygonaceae	O	A	R		bitter dock
Sagina apetala	Caryophyllaceae	O	A		F	pearlwort
Sagina maxima ssp. procumbens	Caryophyllaceae	O		R	F	pearlwort
Salicornia virginica	Chenopodiaceae	O		R	F	American glasswort
Salix hookeriana	Salicaceae	O		R		Hooker’s willow
Salix lucida	Salicaceae	O		R		Pacific willow
Salix scouleriana	Salicaceae	C		R	F	Scouler's willow
Salix sitchensis	Salicaceae	O		R		Sitka willow
Sambucus racemosa	Caprifoliaceae	O		R	F	red elderberry
Sanicula crassicaulis	Apiaceae	C		R	F	Pacific sanicle
Saxifraga integrifolia	Saxifragaceae	O		R	F	grassland saxifrage
Saxifraga tridactylites	Saxifragaceae	O	A	R	F	rue-leaved saxifrage
Sedum album	Crassulaceae	O	A	R	F	white-flowered stonecrop
Sedum lanceolatum var. nesioticum	Crassulaceae	R		R	F	lance-leaved stonecrop
Sedum spathulifolium	Crassulaceae	O		R	F	broad-leaved stonecrop
Selaginella wallacei	Selaginellaceae	C		R	F	Wallace's selaginella
Senecio vulgaris	Asteraceae	O	A	R	F	common groundsel
Shepherdia canadensis	Eleagnaceae	R		R	F	soopolallie
Sherardia arvensis	Rubiaceae	O	A	R		field madder
Silene gallica	Caryophyllaceae	C	A	R	F	small-flowered catchfly
Solidago canadensis	Asteraceae	O		R	F	Canadian goldenrod
Sonchus arvensis	Asteraceae	O	A	R		field sow-thistle
Sonchus oleraceus	Asteraceae	O	A	R	F	common sow-thistle
Sorbus aucuparia	Rosaceae	O	A	R	F	European mountain-ash
Spergularia rubra	Caryophyllaceae	O	A	R	F	Red sand-spurry
Stachys chamissonis var. *cooleyae*	Lamiaceae	O		R	F	Cooley's hedge-nettle
Stellaria crispa	Caryophyllaceae	O		R		crisp starwort
Stellaria media	Caryophyllaceae	C	A	R	F	common chickweed
Symphoricarpos albus	Caprifoliaceae	C		R	F	common snowberry
Symphoricarpos mollis v. hesperius	Caprifoliaceae	C		R	F	trailing snowberry
Syringa vulgaris	Oleaceae	R	A		F	lilac

Taraxacum officinale	Asteraceae	O	A	R	F	common dandelion
Taraxacum sp.	Asteraceae	O		R		dandelion species
Taxus brevifolia	Taxaceae	O		R	F	western yew
Teesdalia nudicaulis	Brassicaceae	C	A	R	F	shepherd's cress
Tellima grandiflora	Saxifragaceae	O		R	F	fringecup
Thuja plicata	Cupressaceae	O		R	F	western redcedar
Tiarella trifoliata var. trifoliata	Saxifragaceae	O		R	F	three-leaved foamflower
Trientalis borealis ssp. latifolia	Primulaceae	O		R	F	broad-leaved starflower
Trifolium depauperatum	Fabaceae	R		R	F	poverty clover
Trifolium dubium	Fabaceae	C	A	R	F	small hop-clover
Trifolium microcephalum	Fabaceae	R		R	F	small-headed clover
Trifolium microdon	Fabaceae	R		R	F	thimble clover
Trifolium oliganthum	Fabaceae	R		R	F	few-flowered clover
Trifolium pratense	Fabaceae	O	A	R	F	red clover
Trifolium repens	Fabaceae	O	A	R	F	white clover
Trifolium subterraneum	Fabaceae	O	A	R	F	subterranean clover
Trifolium variegatum	Fabaceae	O		R	F	white-tipped clover
Trifolium willdenowii	Fabaceae	O		R	F	tomcat clover
Trifolium wormskjoldii	Fabaceae	R			F	springbank clover
Triglochin maritima	Juncaginaceae	O		R	F	seaside arrowgrass
Trillium ovatum	Liliaceae	O		R	F	western trillium
Triphysaria pusilla	Scrophulariaceae	O		R	F	dwarf owl-clover
Triteleia hyacinthina	Liliaceae	C		R	F	white triteleia, fool’s onion
Tsuga heterophylla	Pinaceae	R			F	western hemlock
Ulex europaeus	Fabaceae	C	A	R	F	gorse
Urtica dioica ssp. *gracilis*	Urticaceae	O		R	F	stinging nettle
Veronica beccabunga ssp. *americana*	Scrophulariaceae	O		R		American speedwell
Veronica arvensis	Scrophulariaceae	C	A	R	F	wall speedwell
Veronica peregrina	Scrophulariaceae	O	A	R	F	purslane speedwell
Veronica serpyllifolia	Scrophulariaceae	R	A		F	thyme-leaved speedwell
Vicia hirsuta	Fabaceae	O	A	R	F	tiny vetch
Vicia lathyroides	Fabaceae	O	A	R	F	spring vetch
Vicia sativa var. angustifolia	Fabaceae	C	A	R		narrow-leaved common vetch
Vicia sativa var. cordata	Fabaceae	O	A	R		heart-leaved common vetch
Vicia sativa var. sativa	Fabaceae	C	A	R	F	common vetch
Vinca major	Apocynaceae	O	A	R		large periwinkle
Viola odorata	Violaceae	O	A	R		scented violet
Vulpia bromoides	Poaceae	C	A	R	F	barren fescue
Vulpia myuros	Poaceae	C	A	R	F	rat-tail fescue

Appendix 2: Plot Data

(see pocket on back cover)

Appendix 3: Polygon Map Legend

Polygon Number	Ecosystem[8]			Target Weeds[9]		
	1	2	3	Daphne	English Ivy	Broom
1	DS7	DG2	CF1	1-1	2-2	0
2	DI8	CF2		1-2	1-2	3-3
3	DS8	DA2		1-1	0	1-1
4	QR			0	0	5-3
5	DS7	DA3		1-1	0	0
6	QR8	QW2		0	0	5-3
7	CF8	DI2		5-3	2-1	0
8	DS			0	0	0
9	QR7	QW3		0	0	5-3
10	DI			0	0	4-4
11	QR7	QW3		0	0	5-3
12	DG8	DS2		1-2	11	0
13	DS8	DA2		1-1	0	1-2
14	D17	QR2	QW1	1-1	1-1	5-3
15	DS6	DG4		2-3	0	1-1
16	QW6	DA4		1-1	1-1	2-2
17	DA5	DS5		1-1	1-1	1-1
18	DI			Not assessed		
19	DA5	QR3	QW2	5-4	1-1	5-2
20	QR8	QW2		0	0	5-2
21	QR			2-2	0	4-2
22	DS7	DG3		8-4	1-1	1-2
23a	BE			0	0	0
23b	BE			0	0	2-1
23c	DI			0	0	2-1
24	QR5	QW3	DA2	0	0	5-3
25	DS6	DG4		5-2	1-2	2-1
26	BE			0	0	0
27	CF			5-2	0	1-2
28	DG5	CF3	DS2	1-1	1-1	0
29	DS7	DG3		3-2	0	2-2
30	DA5	QR5		0	0	4-3
31	CF5	DG5		2-2	1-2	0
32	QR6	DA3	QW1	0	0	2-3
33	DI			Not assessed		
34	DS7	DG3		3-3	1-3	1-1
35	DA6	QR3	QW1	0	0	4-3
36	QR8	QW2		0	0	5-3

[8] ecosystem identifiers followed by decile (e.g. DS3 = 30% means 30% of polygon is covered by Douglas-fir – Salal type)

[9] first value is the distribution code and the second value is vigour code

Appendix 4: Plot Location Information

quadrat	UTM zone	UTM easting	UTM northing	UTM datum	Lot	location name
8041	10U	466380	5364364	NAD 83	Fort Rodd Hill	up. batt.
8042	10U	466380	5364358	NAD 83	Fort Rodd Hill	up. batt.
8121	10U	466280	5365404	NAD 83	Lot 5	near clrng
8122	10U	466306	5365413	NAD 83	Lot 5	near clrng
8123	10U	466131	5365375	NAD 83	Lot 5	near rec area
8125	10U	466349	5365557	NAD 83	Lot 5	slumps
8126	10U	466672	5365193	NAD 83	Lot 5	rocky knoll
8191	10U	466228	5364678	NAD 83	Cavendish	rocky knoll
8192	10U	466211	5364671	NAD 83	Cavendish	rocky knoll
8193	10U	466132	5364752	NAD 83	Cavendish	rocky knoll
8194	10U	466118	5364673	NAD 83	Cavendish	orchard
8195	10U	466160	5364602	NAD 83	Cavendish	swamp
8221	10U	466869	5364212	NAD 83	Fort Rodd Hill	lighth.
8222	10U	466555	5364305	NAD 83	Fort Rodd Hill	belmont bat
8223	10U	466551	5364309	NAD 83	Fort Rodd Hill	belmont bat
8224	10U	466236	5364366	NAD 83	Fort Rodd Hill	bridge decid
8225	10U	466247	5364346	NAD 83	Fort Rodd Hill	salt marsh
8231	10U	466728	5364565	NAD 83	Fort Rodd Hill	belmont bat
8232	10U	466708	5364532	NAD 83	Fort Rodd Hill	belmont bat
8233	10U	466778	5364510	NAD 83	Fort Rodd Hill	belmont bat
8234	10U	466570	5364433	NAD 83	Fort Rodd Hill	blacksmith
8235	10U	466496	5364699	NAD 83	Fort Rodd Hill	access rd
8241	10U	466742	5364744	NAD 83	Journey's end	shore slope
8242	10U	466618	5364923	NAD 83	Journey's end	balds
8243	10U	466722	5364879	NAD 83	Lot 5	yew pt
8251	10U	466838	5364892	NAD 83	Lot 5	yew pt
8252	10U	466834	5364903	NAD 83	Lot 5	yew pt
8261	10U	466088	5364801	NAD 83	Cavendish	belmont est
8262	10U	466017	5364567	NAD 83	Cavendish	sw
8263	10U	465968	5364610	NAD 83	Cavendish	sw
8264	10U	465961	5364500	NAD 83	Cavendish	sw
8271	10U	466143	5364514	NAD 83	Cavendish	bridge
8272	10U	466296	5364574	NAD 83	Fort Rodd Hill	access
8273	10U	466481	5364354	NAD 83	Fort Rodd Hill	nature trail
8274	10U	466819	5364008	NAD 83	Lot 5	DND gate
8275	10U	466788	5365032	NAD 83	Lot 5	DND gate
8276	10U	466747	5365050	NAD 83	Lot 5	dogleg
8277	10U	466591	5364708	NAD 83	Journey's end	staff pking
9999	10U	466570	5364433	NAD 83	Fort Rodd Hill	vernal pool

Revised Plot Locations APPENDIX 4

plot	Photo roll	Photo frame	x	y	date	surveyor	map sheet	plot identifier	UTM zone	northing	easting	aspect (degrees)	elevation (m)	slope (percent)	SMR	SNR	meso-slope	BGC unit	site series	structural stage	ecosection
8123	BCB97005	267	9.3	15.8	8/12	MDF	092b043	seepy deciduous and mixed plot near fence by recreation area	10U	466131	5365375	999	15	0	7	D	de	CDFmm	6	5	NAL
8233	BCB97005	269	13.0	4.6	8/23	MDF	092b043	rocky knob between lower battery and depot	10U	466778	5364510	2	4	2	4	D	to	CDFmm	4	5	NAL
8261	BCB97005	268	8.9	16.5	8/26	MDF	092b043	Cavendish - mixed decid at old road entrance	10U	466088	5364801	140		10	5	D	ls	CDFmm	6	5	NAL
8271	BCB97005	269	12.8	15.1	8/27	MDF	092b043	Cavendish mixed woods near bridge	10U	466143	5364514	162	10	12	5	D	ls	CDFmm	6	6	NAL
8275	BCB97005	268	13.1	3.8	8/27	MDF	092b043	Lot 5 mixed near DND gate	10U	466788	5365032	80	15	10	4	D	ls	CDFmm	4	6	NAL
8121	BCB97005	267	9.8	12.3	8/12	MDF	092b043	forest near block 5 clearing	10U	466280	5365404	348	20	2	5	D	ms	CDFmm	5	6	NAL
8125	BCB97005	267	12.6	11.7	8/12	MDF	092b043	shoulder between slumps above DND fence	10U	466349	5365557	20		15	6	3	ls	CDFmm	6	6	NAL
8195	BCB97005	269	14.2	15.0	8/19	MDF	092b043	Cavendish deciduous between clearing and road	10U	466160	5364602	6		6	5	D	ls	CDFmm	6	5	NAL
8224	BCB97005	269	10.5	13.2	8/22	MDF	092b043	lot 4 deciduous	10U	466236	5364366	210	10	3	6	D	to	CDFmm	6	5	NAL
8272	BCB97005	269	14.3	12.6	8/27	MDF	092b043	forest between Ocean Blvd and upper battery	10U	466296	5364574	212	27	10	3	D	de	CDFmm	4	6	NAL
8122	BCB97005	267	10.2	12.2	8/12	MDF	092b043	forest near lot 5 clearing	10U	466306	5365413	352	20	4	4	D	ls	CDFmm	1	6	NAL
8193	BCB97005	269	17.1	15.4	8/19	MDF	092b043	Cavendish level between rocky knoll and trail	10U	466132	5364752	166	10	20	3	C	ms	CDFmm	1	6	NAL
8243	BCB97005	268	10.8	4.7	8/24	MDF	092b043	forest behind Yew Point	10U	466722	5364879	100	23	16	3	B	ls	CDFmm	1	6	NAL
8262	BCB97005	269	13.7	17.7	8/26	MDF	092b043	Cavendish southwest of campsite	10U	466017	5364567	88	50	12	4	C	to	CDFmm	1	6	NAL
8273	BCB97005	269	10.4	9.3	8/27	MDF	092b043	conif forest along nature trail	10U	466481	5364354	176	10	16	2	C	ms	CDFmm	1	6	NAL
8274	BCB97005	268	12.8	3.3	8/27	MDF	092b043	block 5 conifers near DND gate	10U	466819	5364008	86	10	10	3	C	ms	CDFmm	1	6	NAL
8277	BCB97005	269	17.0	7.5	8/27	MDF	092b043	Journey's End conifer by park staffing	10U	466591	5364708	108	30	12	3	C	ls	CDFmm	1	6	NAL
8126	BCB97005	268	15.2	6.1	8/12	MDF	092b043	rocky knoll between lot 5 level forest and Journey's End	10U	466672	5365193	30		10	1	D	cr	CDFmm	2	6	NAL
8263	BCB97005	269	14.5	18.3	8/26	MDF	092b043	Cavendish - rocky woods on west side	10U	465968	5364610	124	37	30	0/3	B	us	CDFmm	2	6	NAL
8192	BCB97005	269	15.8	14.2	8/19	MDF	092b043	rocky knoll in north end of Cavendish property	10U	466211	5364671	248	35	22	3	C	ms	CDFmm	n/a	6	NAL
8232	BCB97005	269	13.6	5.2	8/23	MDF	092b043	rocky knob between lower battery and depot	10U	466708	5364532	210	20	25	3	B	ms	CDFmm	3	6	NAL
8235	BCB97005	269	16.3	9.3	8/23	MDF	092b043	mixed plot on access road above Journey's End	10U	466496	5364699	188	43	35	2	D	us	CDFmm	3	3b	NAL
8241	BCB97005	269	17.2	4.8	8/24	MDF	092b043	steep slope above shore at Journey's End	10U	466742	5364744	54	18	60	1	C	ms	CDFmm	2	3b	NAL
8234	BCB97005	269	11.6	7.7	8/23	MDF	092b043	rocky knoll near blacksmithy	10U	466570	5364433	130	40	25	0/2	A/D	us	CDFmm	3	3b	NAL
8041	BCB97005	269	10.3	11.1	8/4	MDF	092b043	rocky opening below lower battery	10U	466380	5364364	165	13	21	1	C	ms	CDFmm	2	3b	NAL
8042	BCB97005	269	10.2	11.2	8/4	MDF	092b043	rocky knoll below upper battery	10U	466380	5364358	163	13	21	0	C	us	CDFmm	n/a	3b	NAL
8223	BCB97005	269	9.5	8.1	8/22	MDF	092b043	rocky shore below Belmont batteries	10U	466551	5364309	216	4	4	0	C	cr	CDFmm	n/a	1b	NAL
8231	BCB97005	269	14.0	4.7	8/23	MDF	092b043	rocky knob between lower battery and depot	10U	466728	5364565	174	20	10	0/3	A/E	cr	CDFmm	3	2b	NAL
8242	BCB97005	268	11.4	6.7	8/24	MDF	092b043	Garry oak balds behind Journey's End	10U	466618	5364923	50	43	20	0	poor	us	CDFmm	n/a	2b	NAL
8252	BCB97005	268	11.2	3.4	8/25	MDF	092b043	rock slope above Yew Point Limnanthes	10U	466834	5364903	84		65	0	D	ls	CDFmm	n/a	2b	NAL
8264	BCB97005	269	12.3	18.5	8/26	MDF	092b043	Cavendish barrens on west shore	10U	465961	5364500	136	20	20	0	B	cr	CDFmm	n/a	1b	NAL
8276	BCB97005	268	13.7	4.6	8/27	MDF	092b043	lot 5 barrens at dogleg in fence	10U	466747	5365050	43	25	18	0	A	ms	CDFmm	n/a	3b	NAL
8191	BCB97005	269	16.2	13.8	8/19	MDF	092b043	rocky knoll in north end of Cavendish property	10U	466228	5364678	98	38	16	0	A	cr	CDFmm	n/a	1b	NAL
8194	BCB97005	269	15.8	15.8	8/19	MDF	092b043	fruit orchard at Cavendish	10U	466118	5364673	98	8	10	5	D	ms	CDFmm	6	2b	NAL
8225	BCB97005	269	10.0	13.4	8/22	MDF	092b043	Cavendish salt marsh	10U	466247	5364346	106	0	3	8	9	to	CDFmm	n/a	2a	NAL
8221	BCB97005	269	7.8	2.4	8/22	MDF	092b043	lighthouse rocks	10U	466869	5364212	48	8	35	0	A	cr	CDFmm	n/a	2b	NAL
9999	BCB97005	269	11.6	7.7	5/15	MDF	092b043	vernal pool near blacksmithy	10U	466570	5364433	999	40	0	5/2	A/D	us	CDFmm	n/a	1b	NAL
8222	BCB97005	269	9.3	7.8	8/22	MDF	092b043	Limnanthes at Belmont batteries	10U	466555	5364305	222	4	16	2	C	ls	CDFmm	n/a	2a	NAL
8251	BCB97005	268	11.0	3.4	8/25	MDF	092b043	Limnanthes - Yew Point	10U	466838	5364892	118	5	10	2/5	D	to	CDFmm	n/a	2b	NAL