Savary Island Dune And Shoreline Study
Ecological Component

Report to

Powell River Regional District

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1.0 Introduction

The ecological component of this study by Thurber Engineering Ltd. endeavours to determine potential effects of the estimated shoreline retreat by describing existing conditions in key areas. The two major assumptions that can be used when estimating these potential ecological effects are

1. that the entire estimated shoreline retreat area will be eliminated. This is the worst case, and most unlikely scenario;

2. that within the estimated shoreline retreat area there will be differential processes and effects that will result in the persistence and prolongation of certain features, the modification, movement, or decimation of others, and the creation of new ones.

The most likely scenario will involve elements of number 2, but it is useful to consider number 1 as it forces one to focus on the relative values (such as diversity, rarity, fragility, insularity, and non-recreatability[1]) inherent in the areas considered.

One should also consider potential overall effects, or the effects within a larger scale. For example, how will the projected loss of land affect the distribution and abundance of plants and animals over the entire Island? What levels of human activity and development can certain organisms or communities withstand and how will these be influenced by potential shoreline retreat? Some elements of ecology to consider include the introduction and spread of non-native plants and animals (introduced rabbits, for example, can have devastating effects on dune plant communities), habitat fragmentation, insularity, uniqueness, and non-recreatability.

The Development Guideline Areas Map provided for this project was used to describe the study area. This map delineates the major Development Guideline Areas: DG-1, Shoreline Areas; DG-2 Ecologically Sensitive Areas; DG-3 Inland Dune Area; and DG-4 Indian Springs. It also shows contour lines and property boundaries. In this report, the DG-2 areas are distinguished from one another by the addition of a letter: “a” through “g”.

A number of general areas were selected for description based on those outlined in Powell River Regional District’s (PRRD’s) Terms of Reference for this study and Thurber Engineering’s (TEL’s) proposal. They include the *South Slope* (various types of slopes or bluffs), the *Dunes*, the *Bluff Crest*, and *Indian Springs*. *Indian Point* and the *Mace Point Rock Outcrop* were added because of issues of ecological significance. The focus was on the south shore because of the greater rates of erosion and its concentration of ecologically significant features. Most of the descriptions for these areas are based on vegetation. The animals of Savary Island are discussed briefly at the end of the report

This is the final version of the report. The draft version was circulated and available on the Powell River Regional District’s web site (http://www.powellriverrd.bc.ca/) and that of the Savary Island Land Trust (http://www.silt.ca). Few comments were forthcoming.

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[1] non-recreatability – inability to re-create the richness and complexity of the original ecosystem (Morris and Therivel 1995)

Comments from Liz Webster of the Savary Island Land Trust were gratefully appreciated and incorporated into this final report. Golder Associates Ltd. (and Shearwater Mapping Ltd.) conducted its own ecological survey of the area for Roger Sahlin, co-owner of D.L. 1375, as well as a formal critical review of the Thurber and Strix draft reports. Its comments were considered for this final report.

1.1 Physical and Ecological Setting

Savary Island is located 30 km northwest of Powell River in the Straight of Georgia. It is a long, narrow island 7.5 km long by 0.37 to 1 km wide, comprising 450 hectares (1,100 acres). Generally, the island's elevation profile is saddle-shaped, with the central dunefield comprising the lowest area, and higher land rising to the east and west. The highest point is approximately 55 m. The island has no permanent watercourses, and no natural inland waterbodies.

The BC Government uses the Biogeoclimatic Ecosystem Classification (BEC) system to classify ecosystems across the province. This system of classification uses vegetation, soil, climate and other features to group areas with similar characteristics. Savary Island lies within, and at the northern limit of, the Coastal Douglas-fir Biogeoclimatic Zone (CDFmm) (Roemer 2000; CDC 2002). This zone is characterized by warm, dry summers and mild, wet winters (Green and Klinka 1994). The CDF formerly consisted of two subzones, one of which has now been grouped into the Coastal Western Hemlock biogeoclimatic zone (CWHxm) which occupies adjacent sites and is distinguished from the CDFmm by its occurrence at higher elevations (>150 m when next to CDFmm), a greater abundance of western hemlock (considered rare in CDFmm)[2], very few bigleaf maple (common in CDF), and fewer arbutus on drier sites (Meidinger and Pojar 1991; Green and Klinka 1994). Two site associations typical of the CDFmm that are well represented on Savary Island, particularly within the central dune area, are *Douglas-fir – Salal* and *Douglas-fir – Shore pine – Arbutus.*

[2] The information presented in Section 3.4 suggests that western hemlock is not rare on Savary Island. Some plant communities within the CDFmm have a high occurrence of western hemlock. Western hemlock occurs in at least 60% of the sites for the *Thuja plicata - Pseudotsuga menziesii - Kindbergia oregana (Eurhynchium oregana)* plant community of the CDFmm (Carmen Cadrin, pers. comm.).

2.0 South Shoreline

The portion of the south shoreline examined for the ecological component of this study includes the area between the rock outcrop at Mace Point at the east end of the island, and the small foredune[3] immediately west of Sunset Trail near the west end of the island. The total shoreline distance between these points is approximately 8.6 km. The area considered is not restricted to the shoreline, but includes the backshore[4], the foredunes, and the slopes or banks rising to the inland forests. It is these banks and foredunes that are emphasized because of their fragility and the unique assemblages of plants that they support.

Much of this area was traversed on foot, but the examination of some areas involved visual inspection from the beach and the bluffs, often with the aid of binoculars. Recent and historical aerial photographs were also examined.

Steep slopes comprise approximately 5.5 km, or 64 per cent, of the South Shoreline. They are present to the east and west of the low elevation dunefield located between Whalebone and Beacon Points. The eastern portion of continuous high, steep banks extends 280 m west from the rock outcrop at Mace Point (the east end of the island) to Whalebone Point. The western section of high, steep banks, or bluffs, extends approximately 270 m westward from Beacon Point. These bluffs generally range in slope from 30 to 50 degrees, but in some areas are nearly vertical. Maximum bluff height is approximately 50 m. The majority of these bluffs are covered with a mix of shrubs and herbaceous plants, but in a few areas are forested or barren. The barren areas tend to occur on the steepest slopes.

2.1 Forested Bluffs

Forested bluffs are relatively uncommon along the south shore; the majority of bluffs support shrubs and herbaceous plants while the steepest slopes remain barren. On the forested bluffs, Douglas-fir (*Pseudotsuga menziesii*) is the most common tree, but others such as shore pine (*Pinus contorta* var. *contorta*), arbutus and even bigleaf maple (*Acer macrophyllum*) are present on some slopes. A forested portion of the bluff at the west end of South Beach (between Mace Point and Garnet Point) is dominated by Douglas-fir, but also includes a few arbutus (*Arbutus menziesii*), small western redcedar (*Thuja plicata*) near the bottom, and salal (*Gaultheria shallon*), dull Oregon-grape (*Mahonia nervosa*), Scots broom (*Cytisus scoparius*), and Pacific crab apple (*Malus fusca*). Near the east side of Garnet Point, a column of arbutus extends up the bluff, and bigleaf maple grows nearby.

2.1.1 Gentle to Moderate Forested Slopes

A few small sections of gentle to moderate forested slopes are present on the south side of Lot 1375 between the open areas of sand dune. A 40 m stretch of forest comprised of dense

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[3] foredune – the frontal dune developing immediately behind (landward to) the backshore. This area is DG-2-F.

[4] backshore – area adjacent to the foreshore (area between high and low tide marks, i.e., the area normally influenced by tides and waves) beyond the reach of normal tide and wave action (may be affected by storms and exceptionally high water). Primary source of dry sand for dune formation.

3-5 m shore pines and Douglas-firs is present within a low portion of DG-2-B. Growing amongst these small trees are various grasses, Scots broom, trailing blackberry (*Rubus ursinus*), evergreen huckleberry (*Vaccinium ovatum*), and yarrow (*Achillea millefolium*). A forest of shore pines and Douglas-firs stretches approximately 100 m between the small dune meadow at the west end of DG-2-B and the dune meadow of DG-2-C. Salal is abundant in the understory, especially near the shoreline.

Farther west, a forested slope of shore pine is present between the dune meadows of DG-2-C and DG-2-D. A dense thicket of salal forms a 5 m wide strip that separates this forest from the rocks and logs of the beach ridge[5] below. A freshwater seep drains from this forest, giving rise to a dense patch (7 m^2) of Lyngby's sedge (*Carex lyngbyei*) amongst the rocks where the sea meets the land.

Moderate forested slopes are present along Sunset Trail at the west end of the *South Shoreline*, an area in which many residential lots are developed.

2.2 Non-forested Slopes

Non-forested slopes are the most common slopes along the south shoreline. They are covered with various mixtures of shrubs and herbs, or are barren as a consequence of steepness.

2.2.1 Steep Non-forested Slopes (Bluffs)

Steep non-forested slopes are characteristic of the *South Shoreline*. They are predominantly a mixture of shrubs and herbaceous plants whose abundance and species composition varies with the amount of disturbance, water, and nutrients. In many areas Scots broom forms the dominant cover on the slopes, fulfilling its intended role as soil binder and bank stabilizer. It was first introduced to Savary Island in 1912 (Sherman 1931) or approximately 1914 (Kennedy 1992). Scots broom destroys native plant communities by displacing native species, a fact noted by Sherman (1931) in his account of the ecology of Savary Island published in 1931: "If it could be confined to the steep sand-slopes of the south shore, this shrub might in time vindicate its existence and the wisdom of those who introduced it; but, unfortunately, it has invaded the interior of the island where it is becoming a menace to our native flora."

Broom persists on the dry, open slopes where it has aided bank stabilization, but has resulted in low structural and floristic diversity, especially of native species (Figure 1). On the slopes above South Beach, numerous plants — mostly weed species — grow amongst and beneath the dense cover of Scots broom: field chickweed (*Cerastium arvense*), entire-leaved gumweed (*Grindelia integrifolia*), hairy cat's-ear (*Hypochoeris radicata*), yarrow (*Achillea millefolium*), cleavers (*Galium aperine*), miner's-lettuce (*Claytonia perfoliata*), sheep sorrel (*Rumex acetosella*), chickweed (*Stellaria media*), dovefoot geranium (*Geranium molle*), bull thistle (*Cirsium vulgare*), purple dead-nettle (*Lamium purpureum*), sweet vernalgrass (*Anthoxanthum odoratum*), orchardgrass (*Dactylis glomerata*), other grasses, and trailing blackberry (*Rubus ursinus*).

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[5] beach ridge – a mound of material deposited by wave and wind action behind the beach or in the backshore.

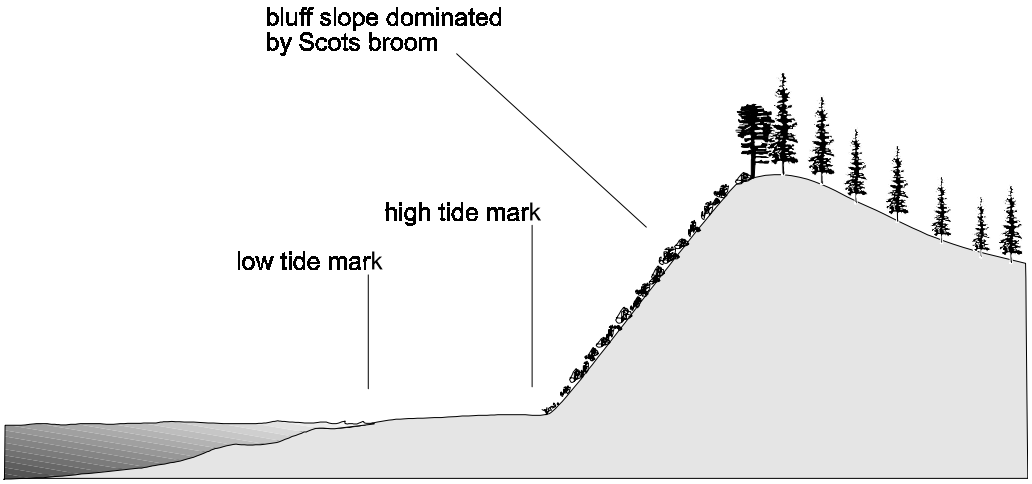

Figure 1. Cross sectional view east to west of South Beach, showing the easternmost portion dominated (and stabilized) by Scots broom.

Salal and other native shrubs thrive on wetter slopes, which broom — despite its prevalence on dry slopes — also invades. Other shrubs present on these slopes, but which are generally less abundant than salal, include Pacific crab apple (*Malus fusca*), trailing blackberry, tall and dull Oregon-grape (*Mahonia aquifolium* and *Mahonia nervosa*). Small specimens of Douglas-fir, arbutus, and shore pine are in some areas present amongst the shrubs. At the top of the bluff, approximately 170 m west of Beacon Point, scouring rush (*Equisetum hyamale*) grows in dense patches beneath the thick cover of salal. Scouring rush indicates an abundance of subsurface water.

Loose soils and steep slopes appear to conspire against the establishment of all but a few shrubs and trees along banks on which herbaceous species predominate. In these "sloping fields" the thin layer of plants are often sloughed off, exposing barren patches of the underlying sandy soil. As a result of sloughing and erosion, the topography of these slopes can be quite varied: a series of ridges, depressions, cliffs, gullies and mounds. These landforms and the underlying moisture and nutrients influence the type of plants that occur, and their configuration.

Generally, these "open" slopes support a variety of grasses, a few weedy species such as sheep sorrel, and an abundance of native plants such as northern wormwood (*Artemisia campestris* ssp. *pacifica*), entire-leaved gumweed (*Grindelia integrifolia*), meadow death-camas (*Zygadenus venenosus*), barestem desert-parsley (*Lomatium nudicaule*), common vetch (*Vicia sativa*), two-coloured lupine (*Lupinus bicolor*), field chickweed (*Cerastium arvense*), western buttercup (*Ranunculus occidentalis*), bracken fern (*Pteridium aquilinum*), scouring rush, and common horsetail (*Equisetum arvense*). Many of these same species are present in the gently sloping dune meadows.

The steep slopes along the shoreline, extending approximately 1000 m west of Beacon Point, have very sparse vegetation cover.

2.5 Gentle to Moderate Non-forested Slopes

The gentle to moderate non-forested slopes tend to occur in transitional shoreline areas where high steep banks yield to low banks of gentle slope. They occur within the Environmentally Sensitive Areas (DG-2) where the outer sand dunes (foredunes) interface with older dunes, or mounds of differentially derived materials whose soils are more consolidated. A good example is DG-2-G (See map, Appendix 1) which consists of unconsolidated sand material and sparse vegetation cover in the western foredune portion, and extensive vegetation cover in the eastern portion comprised of a 30° slope (Figure 2). In May, this eastern slope was completely covered with grasses and various native herbaceous species such as meadow death-camas, chocolate lily (*Fritillaria affinis*), field chickweed, western buttercup, two-colored lupine, bracken fern, common vetch, giant vetch (*Vicia gigantea*), seashore bluegrass (*Poa micrantha*), and two shrubs: trailing blackberry and tall Oregon-grape. The west portion of DG-2-G has an excellent example of a foredune running parallel to the bank and located just above the shoreline (See Section 3.0 Dunes).

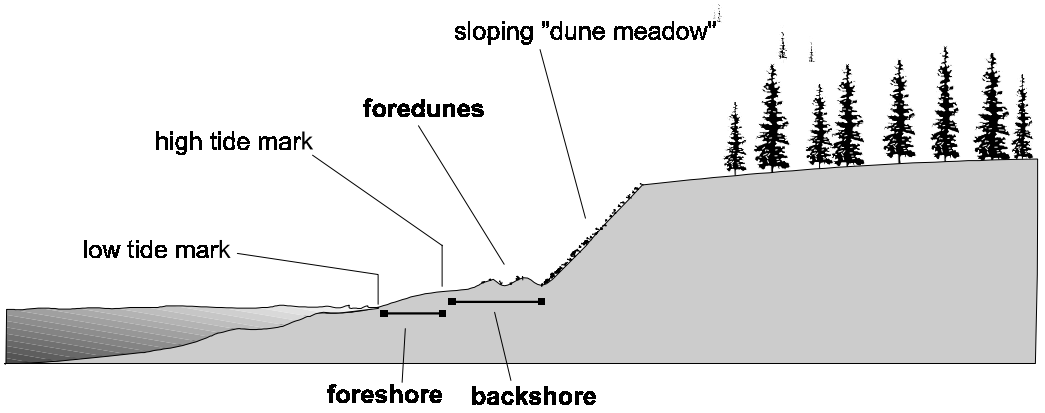

Figure 2. Cross sectional view east to west of the "dune meadows" on the steep slope overlooking the foredune just east of the east terminus of Sunset Trail (DG-2-G). This slope supports a great diversity of herbaceous plants (plus tall Oregon-grape) typical of foredune and coastline dune meadows.

3.0 Dunes

A number of previous reports have focussed on the ecology and geomorphology of the dunes in Lot 1375 (Sherman 1931; Dunster 2000; Roemer 2000; Bawtinheimer and Roemer 2000; Sadler 2000; CDC 2002). The Savary Island dune complex is considered the greatest remaining example of dunes within the Coastal Douglas-Fir biogeoclimatic zone (CDF) (Roemer 2000) and one of the best examples of coastal sand dunes in Canada (Dunster 2000). Other dunes occur within the Coastal Western Hemlock biogeoclimatic zone but these support different vegetation assemblages and associations owing to differences in climate (Roemer 2000).

Dunster (2000) outlines the geologic history of the dunes. Basically, two glaciation events — the retreat of Semiahmoo Glaciation 60,000 to 25,000 years ago and the advance and retreat of Fraser Glaciation 25,000 to 11,000 years ago — resulted in the deposition of silt, sand and gravel. Sand was also deposited from streams and rivers draining onto floodplains that were present in the area (Bornhold et al. 1996). Sand available for dune formation is transported landward by water current and wave action in the nearshore bottom zone (low water mark to 9 m below water surface) which is always submerged, and the foreshore or littoral zone (low water mark to high water mark) which is alternately submerged and exposed; and by wind action in the foreshore zone and the backshore zone (zone above the high water mark) (Krumbein and Slack 1956, *cited* in Ranwell 1972 and Packham and Willis 1997; Brown and McLachlan 1990). The dune zone or dunefield is entirely terrestrial and influenced by wind.

The movement of sand particles is influenced by moisture, wind velocity and the size of the particles. Sand moves across the surface in three main ways which are dependent on the size of the particle: suspension, saltation, and surface creep. The smallest particles, forming dust, are suspended in the air; larger particles leap and bounce across the surface (saltation); and the largest particles roll across the surface when they are struck by the saltating particles (surface creep). The saltating particles are thrust upward and move in a small arc before striking the surface and pushing larger particles forward (Dunster 2000, Brown and McLachlan 1990).

The sand particles continue moving until impeded by physical obstructions such as vegetation. The vegetation traps the sand and small mounds or ridges form. Wind passing over these mounds of sand loses velocity, causing deposition of the sand on the leeward side of the ridge (Wiedemann 1999). The sand accumulates until the ridge slope reaches an angle of approximately 33 degrees at which point the sand slips away. It is by this means that the dune advances. This process occurs on a small scale, such as in the formation of 1 to 2 m high foredunes (DG-2-G), and on a large scale where huge ridges advance on more substantial vegetation such as trees (inland dunes). Dunster (2000) noted the presence of buried trees near Beacon Point!

Wind descending the leeward side of the ridge increases in velocity and removes sand until wet, heavy material is exposed that cannot be moved. The resultant depressions between dune ridges are called dune slacks. Because of greater levels of moisture, dune slacks usually support different types and assemblages of plants than dune ridges.

A characteristic of coastal dunefields is a general gradient of influence from predominantly physical forces near the beach to predominantly biological forces inland. A floral (plant) and faunal (animal) gradient of increasing diversity is evident from the shoreline foredunes (pioneer or early successional dunes) to the interior longitudinal dunes (forested dunes). Vegetation cover and canopy height also increase along the gradient from shoreline to interior dunes. Biological interactions increase from shoreline to the interior dunes (Brown and McLachlan 1990).

The degree of endemism (when organisms are restricted to a certain region) in plants and the incidence of unique plant species are high in dunes, while plant diversity (number of species) is generally low. The degree of endemism in animals and the incidence of unique animal species is generally low in dunes (Brown and McLachlan 1990).

3.1 Foredunes and Coastline Dunes

The foredunes are the frontal or most seaward dunes (Figure 2). They develop in the backshore or upper shore area beyond the reach of ordinary wave and tide action. The foredunes consist mainly of open sand with intermittent patches of vegetation. For the most part, the material is unconsolidated and readily moved by wind, so plants found there are usually well adopted to periodic burial. Foredunes represent an early successional stage in the development of a transverse dunefield.

In some areas foredunes seem to be lacking or are indistinct from the first ridge of the inland dunefield in the centre portion of the island (Lot 1375). This seems to be the case in the mid-portion of DG 2-B at Duck Bay. The main dune face with its areas of loose sand and dune meadows, is the south side of large dune ridge extending inland to the northwest. These large frontal dunes which are distinct from the small foredunes will henceforth be referred to as coastline dunes.

Plants that are able to endure partial burial are considered dune building species. They provide the barrier against which wind-blown sand can accumulate. To survive in this dry, nutrient poor environment, pioneer sand dune plants have specialized root systems. Some have roots that spread considerable distances horizontally; others have taproots that reach great depths (Salisbury 1952; Wiedemann et al. 1999). Some plants such as large-headed sedge (*Carex macrocephala*) and seashore bluegrass have extensive underground stems (rhizomes) which allow them to spread across the open sand. Seashore bindweed (*Convolvulus soldanella*) spreads by means of prostrate stems (stolons) that extend across the surface of the sand.

The *Gentle to Moderate Non-forested Slopes* and the *Open Foredunes and Coastline Dunes* together comprise the Ecologically Sensitive Areas (DG-2). The five distinct DG-2 areas discussed in this report occur along approximately 1800 m, or 20 per cent, of the *South Shoreline*. The unconsolidated sand dunes vary on Savary Island from gentle sloping mounds (DG-2-F, west Sunset) to steep banks (portions of DG-2-G and DG-2-B).

The Red-listed contorted-pod evening-primrose (*Camissonia contorta*) was found in DG-2-B (see section 3.5). Other plants found in the DG-2 areas include dwarf owl-clover[6] (*Triphysaria pusilla*) and springbeauty (*Claytonia* sp.).

The backshore and foredune areas are the most sensitive to human disturbance (Brown and McLachlan 1990). Sensitivity decreases as one moves inland from these areas to older, forested dunes. The uniqueness of the plants and plant associations found on the foredunes and coastline dunes (Table 1, 2), and the sensitivity of these areas to disturbance[7], are the prime reasons for their ecological significance.

Table 1. Rare Plant Associations of Ecologically Sensitive Areas, DG-2's. (CDC 2002)

Artemisia campestris - Grindelia integrifolia (*Festuca rubra*) pacific sagebrush - entire-leaved gumweed - (red fescue) S1 - Red list;
Carex macrocephala herbaceous vegetation large-headed sedge S2 - Red list;
Festuca rubra - Ambrosia chamissonis herbaceous vegetation red fescue - silver burweed S2 - Red list;
Leymus mollis ssp *mollis - Lathyrus japonicus* herbaceous vegetation leymus - beach pea S3 - Blue list[8]

[6] dwarf owl-clover (*Triphysaria pusilla*) specimen identified by Ken Marr, Curator of Botany, RBCM. Specimens deposited with the RBCM herbarium.

[7] Within the context of the natural processes affecting these areas, the plants and the ecosystems in which they occur are tolerant of, and adapted to, disturbance. They are sensitive to environmental processes (such as wind, and sand deposition) in that they respond to them and persist. They are more susceptible (sensitive) to disturbance caused by humans (such as trampling, compaction and scarification). This was evident by a bicycle trail that detoured across firm ground consolidated by plants in the foredune where the forest opens into the northwestern backshore dune (DG-2-F). The main trail was no longer suitable for riding as the plants that bind the sand had been destroyed.

[8] Blue list – Includes indigenous species or subspecies considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered or Threatened. (CDC 2002)

Table 2. Some uncommon plants of the Ecologically Sensitive Areas, DG-2's (CDC 2002)

scientific name	common name	status	
Allium acuminatum	taper-tip onion	G5 - S3	
Brodiaea coronaria	harvest brodiaea	G4 - S3	
Camissonia contorta	contorted-pod evening-primrose	G5 - S1	Red List
Carex inops	long-stoloned sedge	G5 - S3	
Carex macrocephala	large-headed sedge	G5 - S3	
Claytonia exigua ssp *exigua*[9]	pale springbeauty	G?t? - S3	
Convolvulus soldanella	seashore bindweed	G5 - S3	
Grindelia hirsutula var *hirsutula* (historic record for which the location is not specified and the population has not been relocated)	hairy gumweed	G5t? - S1	Red List
Lupinus bicolor ssp *bicolor*	two-coloured lupine	G5t5 - S3	
Lupinus littoralis	seashore lupine	G5 - S3	
Montia fontana	water chickweed	G5 - S3	
Homalothecium arenarium (moss present on foredunes and in dune-meadow transitional areas)		*G4 - S2S3*	*Blue List*

3.2 Dune Meadows

As discussed in Section 2.4, *Steep Non-forested Slopes*, dune meadows (areas with an assemblage of plants very close to low-slope dune meadows) occur on steep slopes (Figure 2), but usually they occur on gentle slopes. They often occur on the periphery of areas of open, loose sand, such as in the west portion of DG-2-B. There, the meadows form around a "bowl" of open sand and support such species as meadow death -camas, sea blush, field chickweed, seashore bluegrass, long-stoloned sedge, cheatgrass (*Bromus tectorum*), bracken fern, and tall Oregon-grape. See Section 2.4, *Steep Non-forested Slopes* and Figure 3, for further details on plants typical of dune meadows.

Dune meadows represent a stage in the succession of the plant community. The general sequence in the development of plant communities from open sand to dune meadows is presented in Figure 3. Dune meadows should eventually succeed to a shrub-dominated community, and finally to a forest. However, dune meadows — as with other successional stages represented on Savary Island — may persist for longer than expected, or indefinitely, because of the environmental pressures to which they are subjected: exposure to sun, wind, sand deposition, wave action, erosion, and salt water spray.

[9] *Claytonia exigua* ssp. *exigua*. Also known as *Claytonia spathulata* (Douglas et al. 1990; Hitchcock et al. 1964).

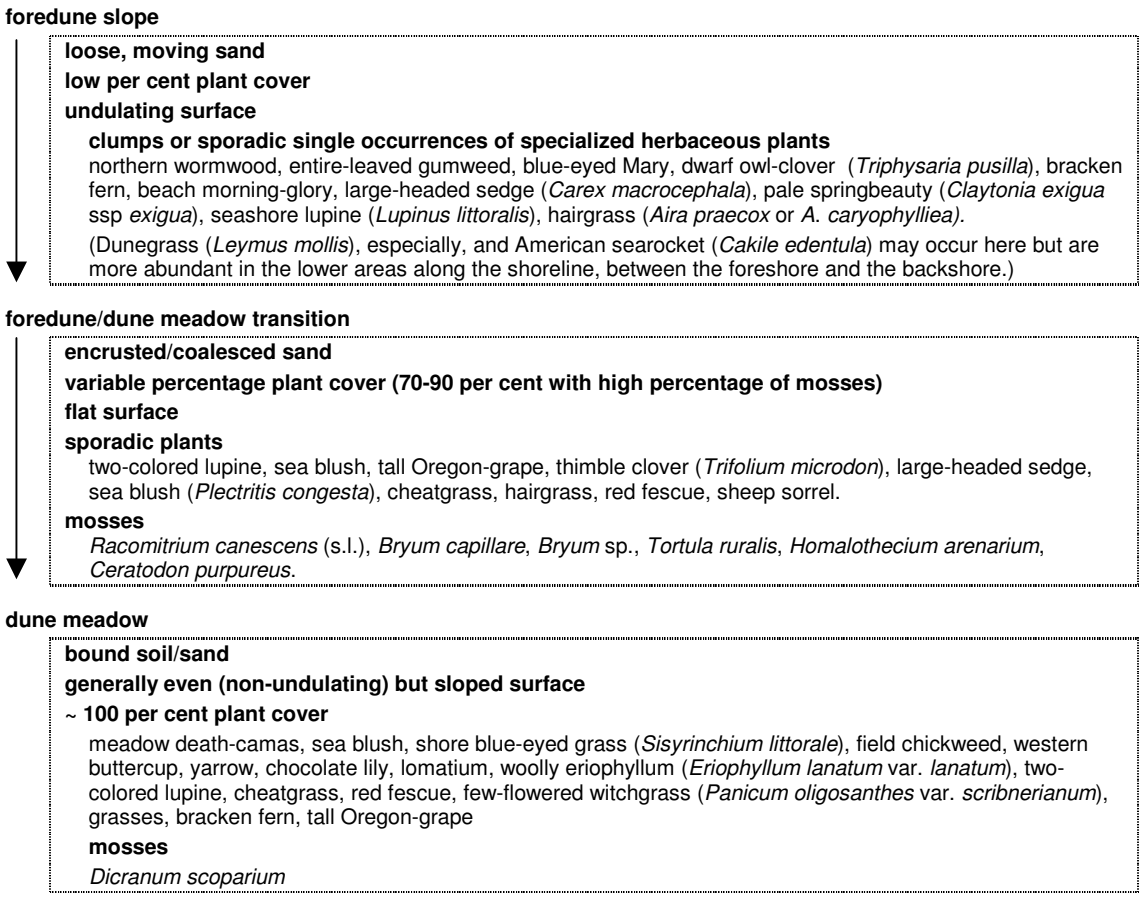

Figure 3. Succession from foredune and unconsolidated sand dune area, to dune meadows.

3.3 Inland Dune Area (DG-3)

The ancient sand dunes are most fully developed in the centre portion of the island (Figure 4). They comprise one third of the area of Savary Island, or 150 ha (CDC 2002). The series of parallel ridges and slacks (depressions between ridges) are aligned along a southeast-northwest axis, following the alignment of the prevailing southeast winds. These dunes lie mainly within Lot 1375 but extend to and terminate in Lot 1376 to the northwest. The dune ridges reach a maximum elevation of 31 m above sea level. The greatest difference in elevation between dune ridges and adjacent slacks is approximately 20 m.

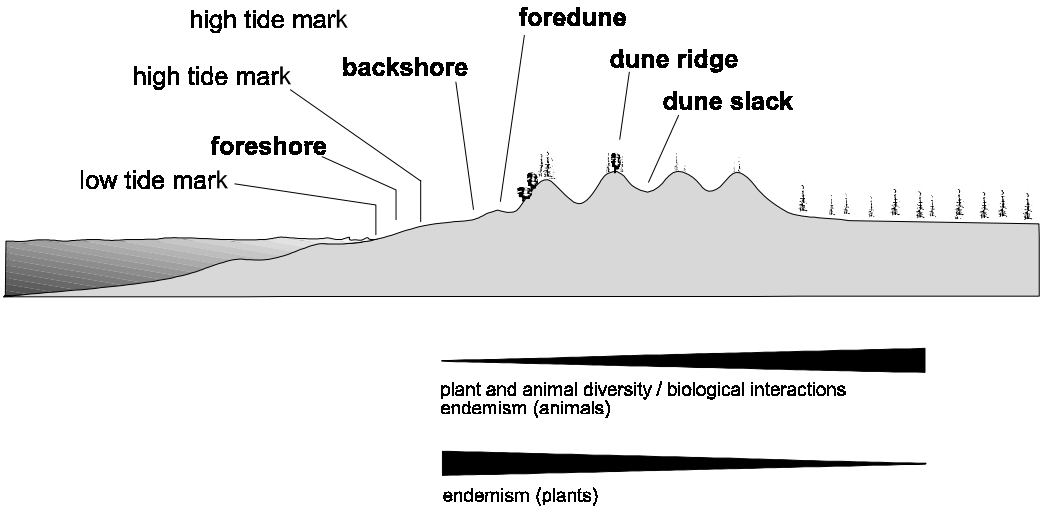

Figure 4. Cross sectional view from east to west of the inland dunes extending northeast from foredunes and dune meadows east of Beacon Point (DG-2-C,D). To illustrate the general configuration, the dunes in this diagram are represented as being parallel to the shoreline when they are actually aligned obliquely to the shoreline: the shoreline is oriented east-west, while the dunes are oriented southeast-northwest. The elongated triangles show trends (increasing or decreasing) in diversity, endemism and biological interactions along a gradient from foredunes/dunes to inland forests (after Brown and McLachlan 1990).

The large central dune ridges and slacks are forested. The forests of the dune ridges differ from those in the slacks, and generally differ from forests present elsewhere on the island outside of the dune ridge complex. The dune ridge forests are less diverse than forests outside the dunes and support species that favour or tolerate drier, nutrient poor soil. Douglas-fir (some very large), western hemlock (smaller), shore pine, and arbutus are the typical species of the dune forest. Large and small arbutus are scattered throughout the dune ridges, with some particularly old, large specimens struggling beneath the canopy of the dominant Douglas-fir. Shore pine grows sporadically throughout the dune ridges, and occurs in association with Douglas-fir and salal, forming a plant association — shore pine, Douglas-fir and salal — considered very rare and designated as Red-listed[10] (Bawtinheimer and Roemer 2000; Dunster 2000; CDC 2002).

The common shrubs of the dune ridges are salal, red huckleberry (*Vaccinium parvifolium*), evergreen huckleberry, dull Oregon-grape and trailing blackberry. Ridges with smaller trees and more canopy gaps support a greater density of shrubs. Forests along the large ridges in the southwest portion of the dune complex are comprised of huge Douglas-firs and a relatively sparse shrub layer (~25% cover) of salal and red huckleberry. A very dense undergrowth of salal, with a minor component of evergreen huckleberry and red huckleberry, dominates the shrub layer of the Douglas-fir forests present on the dune ridge slopes and slacks in the south portion of Lot 1375.

[10] Red-listed – Includes indigenous species or subspecies that have, or are candidates for Extirpated, Endangered, or Threatened status in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. (CDC 2002)

Herb layer plants are similarly varied and generally sparse on the dune ridges. Bracken fern appears to be the most abundant plant, a characteristic also noted by Roemer (Bawtinheimer and Roemer 2000). Northern twayblade (*Listera caurina*) and groundcone (*Boschniakia hookeri*), a plant parasitic on the roots of salal, were noted on one ridge. Roemer also recorded rattlesnake-plantain (*Goodyera oblongifolia*), Alaska oniongrass (*Melica subulata*), broad-leaved starflower (*Trientalis latifolia*), western fescue (*Festuca occidentalis*) and white-veined wintergreen (*Pyrola* c.f. *picta*).

On the main dunes within Lot 1375, the moss layer is poorly developed and tends to be associated with woody debris that has fallen from the trees. In open areas, mosses such as *Racomitrium canescens* (s.l.) can form extensive cover.

Smaller Douglas-fir and western hemlock are typical of the dune slacks. The shrub layer of the slacks is more dense and diverse than on the ridges, and is comprised mainly of salal with a small percentage of dull Oregon-grape, red huckleberry and trailing blackberry. Very small western hemlock were also present within the herb-layer in which herbaceous perennials were scarce. The slacks appear to have more coarse woody debris[11] than the ridges which have a greater cover of small debris[12] such as needles, cones and twigs. Moss is generally more abundant and diverse in the slacks, owing in part to the greater accumulation of organic material, increased shade, and moisture. Six species (*Dicranum fuscescens*, *Eurynchium praelonga*, *Hylocomnium splendens*, *Hypnum circinale*, *Rhizomnium glabrescens*, and *Rhytidiadelphus loreus*) representing 7 per cent cover were observed within one vegetation plot in a dune slack. By comparison, only two species (*Brachythecium asperrimum* (Wilf Schofield, pers. comm.), and *Eurynchium* sp.) with less than 5 per cent cover were found in two vegetation plots on dune ridges.

Soil nutrients and characteristics of dunes change in a typical manner along a gradient from the shoreline to the forested dunes (Brown and McLachlan 1990; Packham and Willis 1997). This is mainly a function of age, the oldest dunes being located inland. The following features decrease along a transect running inland from the shore: calcium carbonate, magnesium, potassium, pH, sand grain size, and sand transport potential. Nitrogen and organic matter tend to increase along transects running inland from the shore (Brown and McLachlan 1990; Packham and Willis 1997).

3.4 Ecological Differences in Dune Ridge, Peripheral Dune Ridge, and non-Dune Areas: Vegetation Plot Data

In addition to differences in vegetation between dune ridge and dune slacks, and between dunes and non-dune areas, vegetation also differs among dune ridges located within different areas of the forested dunefield. Vegetation plots were established to supplement information from walk-through surveys and these suggest differences in vegetation species composition between the main dune ridges (Lot 1375) and peripheral dune ridges (properties west of Lot 1375).

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[11] coarse woody debris (CWD) - sound and rotting logs and stumps that provide habitat for fungi, plants, animals, their predators, and nutrients for soil development. It includes snags, stumps and downed wood with a diameter greater than 1 cm (Note that there is no internationally accepted standard definition for CWD; some definitions do not allow for the inclusion of snags, and may have a smaller minimum diameter.)

[12] small organic material less than 1 cm in diameter can be referred to as *litter*.

3.4.1 Soil

Five soil pits were dug within each of a small number of 5 m radius vegetation plots established to supplement information from walk-through surveys. Three plots were established in non-dune areas, three were established within the main dune area (Lot 1375) (two dune ridge and one dune slack), and five were established west of Lot 1375. The objective was to reveal general trends that would help define the dunes and distinguish them — in addition to information on topography and vegetation — from adjacent areas that may not represent dunes. The soil pits were up to 20 cm deep and approximately 7 cm in diameter. The main feature recorded for each pit was the depth at which the sand layer occurred. General notes on soil characteristics (colour, texture, organics, etc.) were also recorded.

Sand was evident in all of the plots but the amount of sand within the pits, and its characteristics, differed between sites. Two plots were established in the non-dune area northeast of the airstrip as a baseline for comparison to those within the dune complex and on its periphery. In these non-dune plots a distinct sand layer was usually absent within the 20 cm, so the depth at which sand particles were discernible was recorded. This depth was approximately double (13 cm) that recorded for pits (5.8 cm) on the dune ridges, the dune slacks, and along the western portion of the dunes near the borders differentiated in the Development Guideline Areas map. With the exception of one plot located at the bluff crest (avg. sand depth: 2.2 cm) there was no obvious difference between the average depth of the distinct sand layer for the eight plots located within the Inland Dune Area (DG-3) demarcated on the map. (See Appendix 2 for statistical details.)

Soil colour and texture differed between plots on the dune ridges within the central dune complex and those located on the periphery, to the west. Sand comprising the sand layer of the central dune plots was white-grey and coarse. Sand within the peripheral plots was medium to fine grained with some degree of red coloration: reddish-brown, grey-reddish, or orange-grey. Sand from a central dune ridge extending into Lot 1376 (DR7) was light brown-grey and of medium to fine texture. Sand from the southernmost dune ridge extending west of Lot 1375 was of medium texture and brown-grey-red. Sand within the plots located in the non-dune area northeast of the air strip was reddish and of medium coarseness (texture) and occurred within a mixture of finer organic-based soil; not as a distinct layer. Sand from another non-dune plot located west of the dune complex, at the east border of the area designated Indian Springs (DG-4), was grey-black and of very fine texture; it stuck together when pressed between the fingers.

3.4.2 Vegetation

Douglas-fir is the most abundant tree in the dunefield. The largest specimens are present along the south portion of the dune fields in a Douglas-fir forest with an dense understory of salal. In this area, Douglas-fir — with the occasional arbutus — is the only tree species present on the dune ridges, the slacks, and the south slope of the last dune ridge, facing the ocean. On the dune ridges to the north, the trees are generally smaller and western hemlock and shore pine become more common. Shore pine is the least abundant of these three main conifers. It occurs sporadically along the dune ridges, and on some ridges forms small "forests." Arbutus is nowhere abundant, and shows a scattered distribution across the dune

ridges of the central portion of the dunefield (the largest dunes within Lot 1375). Information from the small number of plots show that Douglas-fir is slightly more abundant than western hemlock in the central portion of the dunefield. However, data from plots in this central area and the peripheral area to the west (Lot 1376), reveal a similar abundance (based on per cent cover) of Douglas-fir (23 %) and western hemlock (28 %). Western hemlock becomes more abundant on the peripheral, western dunes, and seemingly on dunes that have been disturbed more recently. It is common in some areas of the dunefield and areas outside the dunefield. Western redcedar is restricted to the peripheral dune ridges and becomes more abundant in areas outside the dunefield. Bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), and grand fir (*Abies grandis*) are common in interior portions of the island outside the dunefield.

Salal is the most common shrub within and outside the dunes, followed by evergreen huckleberry, red huckleberry and dull Oregon-grape. Common herb-layer plants within the dunes include bracken fern, sword fern and broad-leaved starflower (*Trientalis latifolia*). Sword fern and bracken fern are also common in forests outside the dunefield.

Although information from these plots is limited because of the small number of plots examined and the depth of the soil pits, it does suggest that the Development Guideline Areas Map accurately defines the extent of the dune complex, DG-3. The presence of different soil and plant characteristics on the periphery of the dune complex does not mean that these areas are not dunes; one expects a certain degree of common features within an area transitional between two distinct ecological areas. One assumes that the duration and magnitude of processes acting on (influencing) the central dune area are different than those acting on the peripheral portions. This may explain the absence of arbutus and presence of western redcedar on the peripheral dune ridges near the west boundary of DG-3, west of Lot 1375.

3.5 Red- and Blue-listed Elements

A rare plant was discovered on the coastline dune of DG-2-B. During field work May 7, 2002, specimens of contorted-pod evening primrose (*Camissonia contorta*) were photographed and collected (two specimens deposited with the RBCM herbarium) on the dune along the south edge of District Lot 1375 (DG-2-B). Jennifer Penny, Botanist with the CDC, identified the specimens (Jennifer Penny, pers. comm.). Contorted-pod evening primrose is a Red-listed species found in only four sites in BC: one recently, two in the 1970's, and one historically (Jennifer Penny, pers. comm). This Savary Island record appears to be the most northern documented occurrence in B.C.

The Blue-listed moss *Homalothecium arenarium* was recorded in the sand of open dune habitats, and was abundant in D.L. 1375 (Sadler 2000). It was also noted during field work for this report in DG-2-B (D.L. 1375) and in DG-2-F.

The following rare plant association occurs within the forested dunes of District Lot 1375 (CDC 2002):

Pinus contorta var. contorta - Pseudotsuga menziesii/Gaultheria shallon
shore pine - Douglas-fir/salal
S2 - Red list.

The complete BC Conservation Data Centre information is provided in Appendix 4.

4.0 Bluff Crests

Vegetation along the bluff crests is variable but typically composed of the common species found on the island. Thus, Douglas-fir dominates these areas. Arbutus is perhaps more abundant along the bluff crest than in any other area of the island outside of the dunefield. Arbutus and western yew (*Taxus brevifolia*) grow along the edge of the bluffs, and a few very large specimens of each are found there. The famous "giant arbutus" of Savary Island, a record specimen for BC (CDC 2002), is present on Garnet Point at the west end of South Beach. This specimen has a circumference at breast height of 5.58 m (diameter of approximately 1.7 m) and is ranked the sixth largest arbutus in BC with 312 AFAR points, based on circumference, height, and average crown spread. A large western yew near the top of the bank was estimated to have a diameter at breast height of 0.5 m. Large Douglas-firs along the bluffs provide excellent perches for bald eagles, and a number of nests are present in these trees near the cliff edge.

A small section of forest on the bluff above South Beach, just east of the giant arbutus, included Douglas-fir, western redcedar, patches of red alder (*Alnus rubric*), bigleaf maple (*Acer macrophyllum*), a few grand fir (*Abies grandis*), and an understory of salal, red huckleberry, oceanspray (*Holodiscus discolor*), trailing blackberry, vanilla-leaf (*Achlys triphylla*), broad-leaved starflower, and wall lettuce (*Lactuca muralis*). Most of the bigleaf maple observed on Savary Island have a columnar growth of tall, unbranched trunks rising high before branching out into the canopy, the result of competition for light with other trees in this dense forest.

Houses built along the edge of the high bank, and associated openings, create gaps in an otherwise continuous forest. New clearings are evident along this edge. Openings, whether anthropogenic or natural, alter the landscape. These openings may facilitate the establishment of non-native species, especially when occurring next to a house, road, or trail, or they may simply provide opportunities for native species that favour these conditions. A semi-open area on the bluff at the west end of the sand dunes, that was at least partly created by the establishment of a nearby house and garden plot, supports an abundance of bitter cherry amongst a dense undergrowth of salal (80 per cent cover) and a few arbutus.

The high bluff represents edge habitat along the top of the bank. This edge habitat is typically different in terms of plant species composition and growth. Wind, sunlight and precipitation have a greater influence on plants along the edge than those in the interior of the forest. Light and moisture levels are different between the two areas. As the high bluff area retreats, this forest edge will be lost, but a new edge will be established within an area of the current interior forest. The current interior forest will therefore be subjected to new elements and environmental pressures. Features such as forest insularity will be lost and reduced, but new opportunities for plants and animals will be also created.

In addition to providing valuable resources for animals, the vegetation along the bluff crest is crucial for maintaining the physical integrity of this landform. The vegetation provides the only means of soil stabilization and may prevent or delay the earth from sliding or slumping (Myers 1993). The largest trees and shrubs provide a network of roots that penetrate the soil much deeper than do the roots of small shrubs and herbaceous vegetation.

The preservation of bluff crest vegetation will help reduce erosion and the potential for slope failure, though ultimately, since the bluffs are being undercut by wave action, their failure is inevitable. Vegetation along the bluff slope will have similar benefits but the same ultimate fate. Bluff crest vegetation also provides a screening affect, reducing the penetration of wind-born sand to the interior portion of the island.

4.1 Plant Restoration and Maintenance: Bluff Crest and Slope

Restoring vegetation on the bluff crest is much easier than restoring vegetation on a bluff slope. A slope greater than 1.5:1, or 33 per cent, is too steep for successful restoration. Slopes less than this can be planted with herbaceous species, shrubs and small trees. Large trees are not recommended for planting on the slope. If large trees are blown over, their rootwads create areas of loose, open soil that may greatly exacerbate erosion problems.

Slope stabilization with plants should incorporate plant species native to Savary Island. Although introduced species may perform well, they tend to displace native plants and reduce opportunities for native animals. (See discussion of Scots broom, Section 2.4, Steep Non-forested slopes.) Table 3 lists a few suitable native trees and shrubs for restoring vegetation on bluff slopes and crests. Nursery stock should be obtained from plants grown in the area. Early spring and late fall, while the plants are dormant, are the best times for planting.

Table 3. Some suggested plant species for bluff slope and bluff crest plantings.

common name	scientific name	crest	slope
Trees			
Douglas maple	*Acer glabrum* var. *douglasii*		•
bigleaf maple	*Acer macrophyllum*	•	
red alder	*Alnus rubra*	•	
Pacific crab apple	*Malus fusca*	•	•
shore pine	*Pinus contorta* var. *contorta*	•	
bitter cherry	*Prunus emarginata*	•	•
Douglas-fir	*Pseudotsuga menziesii*	•	
western yew	*Taxus brevifolia*	•	
Shrubs			
Saskatoon	*Amelanchier alnifolia*	•	•
kinnikinnik	*Arctostaphalos uva-ursi*		•
oceanspray	*Holodiscus discolor*	•	•
tall Oregon-grape	*Mahonia aquifolium*	•	•
mock-orange	*Philadelphus lewisii*	•	•
red-flowering currant	*Ribes sangineum*	•	•
Nootka rose	*Rosa nutkana*	•	•

common name	scientific name	crest	slope
thimbleberry	*Rubus parviflorus*	•	•
salmonberry	*Rubus spectabilis*	•	•
Sitka willow	*Salix sitchensis*	•	•
coastal red elderberry	*Sambucus racemosa* ssp. *pubens* var. *arborescens*	•	•
evergreen huckleberry	*Vaccinium ovatum*	•	•

Some degree of plant restoration in clearings will occur naturally. Decisions will have to be made regarding the suitability of certain plants that establish naturally. For example, Douglas-fir growing on slopes may not be suitable and will have to be monitored and possibly removed. Due to the size of Douglas-fir, it should be monitored on crest plantings, and preferably established inland from the crest edge. Exotics (non-native plants) such as Scots broom that begin to establish (seedlings, etc.) should be removed. Well-established exotic plants on the crest and the slope contribute to soil and slope stability and therefore should not be removed without careful consideration. The best option in such a case may be to inter-plant with native species.

Commercially available "wildflower" mixes should not be used because they contain a high percentage of weedy, non-native plants that establish well under a broad range of conditions. They are therefore a great potential threat to the native plants of Savary Island. Rose campion (*Lychnis coronaria*), an example of such a plant, was seen in a number of foredunes, and at the edge of the abandoned airstrip. It is an attractive ornamental that often escapes gardens or is planted to liven up "barren" areas such as the foredunes, which upon closer inspection are often not barren at all. Many of the plants that grow in these difficult conditions are simply small and sparsely distributed, and no less beautiful than their big, bold exotic surrogates.

Fertilizer in the form of spikes or pellets inserted into the soil beside the root mass may help the early establishment of planted trees and shrubs. Commercially available broadcast fertilizers (granular fertilizers) may help herbaceous plants but will likely provide the most benefit to non-native weed species, resulting in a proliferation of exotic plants at the expense of native species. It could completely change the natural plant species composition within sand and dune areas in which important native species with special adaptations to low nutrient and moisture requirements thrive. Any application of fertilizer must therefore be considered very carefully. The best course to follow is simply to plant and encourage native species that are suited to the conditions present.

Myers (1993)[13] offers wise advice regarding prevention: "No amount of slope disturbance followed by replanting should replace rational site planning when it comes to avoiding slope disturbances. Should you have the option, maintain all the native vegetation you can and potentially accept the natural retreat of the slope crest. Accordingly, you should plan the location of your residence carefully. Maintaining a greenbelt along slope crests is good

[13] See Section 10.0 Literature Cited for internet access to this publication and its companion publication (Menashe 1993).

practice. Do not assume cutting trees to "unweight" your slope is beneficial to slope stability – often it is not. Also, remember as a general rule, do not introduce water onto or into your slope."

5.0 Indian Springs

Indian Springs (DG-4) is located just west of the central dunefield in one of the most narrow sections of Savary Island (~ 450 m). Its boundaries, as indicated on the Development Guideline Areas Map, run between the north and south banks of the island, between Cunningham Road on the west, and Henderson Road on the east. This area comprises approximately 6.75 ha, but its actual size and its boundaries are difficult to confirm.

The land slopes sharply upwards to the west of Indian Springs. The general trend is a decrease in elevation from the south and the west towards the north and the east. The north and south edges of the island are steep bluffs with heights of approximately 40 m on the south, and 24 m on the north.

The actual spring outlet is located on the face of the north bluff. Water seeps into a small pool which drains through a plastic pipe. Two trails from the top of the bank lead to this water source where locals come to fill their buckets. One local resident wondered about the water quality and how it might be affected by the recent introduction of septic fields on nearby lots. A large portion of Savary Island Road, which runs along the top of this bluff, has collapsed.

Trees along the bluff on either side of the spring outflow are predominantly deciduous, suggesting recent and possibly intermittent disturbance. The understory and shrub vegetation is typical of abundant ground water. Red alder, some as large as 0.75 m dbh, is the most common tree along the bank in the Indian Springs area where the forest is rather uniform in species and structure. A large western redcedar and a large Douglas-fir are present there, and they become the dominant species on the bluff to the west and the east. This deciduous-dominated forest extends approximately 75 m on either side of the spring outflow pipe. Salmonberry dominates the understory from mid-level to the bottom of the bank, while salal is abundant in the top portion. Thimbleberry (*Rubus parviflorus*) and coastal red elderberry (*Sambucus racemosa* ssp. *pubens* var. *arborescens*) are also present in the lower portion.

The small understory plants observed in the area near the spring outflow are indicative of moist, water-receiving and water-draining sites: miner's lettuce (*Claytonia perfoliata*), Siberian miner's lettuce (*Claytonia sibirica*), wall lettuce, mountain sweet-cicely (*Osmorhiza chilensis*), sweet-scented bedstraw (*Galium triflorum*), fringecup (*Tellima grandiflora*), common horsetail (*Equisetum arvense*), spiny wood fern (*Dryopteris expansa*), and sword fern (*Polystichum munitum*). Mosses found near the outflow are typical of the wet conditions: *Plagiothecium denticulatum*, *Rhizomnium glabrescens*, and *Eurynchium praelonga*.

Approximately 50 to 75 m east of the spring outflow is an area of dense shrubs and few trees. A few logs and recently felled western redcedars are scattered on the slope. It appears that this area has either naturally sloughed away or has been cleared of trees which exacerbated sloughing and caused blow-down. Salal and thimbleberry are abundant in the upper levels of the bank, while salmonberry and coastal red elderberry are common in the mid and low levels. Douglas maple (*Acer glabrum* var. *douglasii*) is also present in the lower area at the west edge of this clearing.

The upland portion of Indian Springs adjacent to and south of Savary Island Road is a dense forest consisting primarily of very tall Douglas-fir, with a few tall red alder and bigleaf maple. Small western hemlocks (~ 3 m) are very abundant in the understory. The shrub layer and understory consists mainly of salal, red huckleberry and sword fern. Western buttercup (*Ranunculus occidentalis*), wall lettuce, mountain sweet-cicely and pathfinder (*Adenocaulon bicolor*) are present at the forest edge. Other portions of the forest comprising DG-4 consist of large western redcedar, western hemlock, Douglas-fir and bigleaf maple. Common understory plants include salal, dull Oregon-grape, evergreen huckleberry, sword fern, bracken fern and vanilla leaf.

Based on this cursory examination of the area, it is difficult to determine specific ecological features that may define the Indian Springs upland (DG-4) and differentiate it from surrounding areas. Differences in plant species composition in the forest may provide clues, such as an increase in the number of western redcedar, but rigorous, systematic sampling is required to make reliable inferences. The lack of arbutus within DG-4, and the presence of western redcedar, western hemlock, red alder and bigleaf maple, may help to distinguish this area from others such as the dune ridges, but not from other areas of the island with similar species composition.

The abundance and concentration of plants associated with high levels of soil moisture found along the north bluff, was not observed elsewhere on the island. It is one of the few areas dominated by deciduous trees. (Red alder dominates some forests on the island, such as the area near Savary Shores, but understory vegetation is different and less diverse, consisting mainly of sword fern.)

6.0 Indian Point

The Development Guideline Areas Map shows an Ecologically Sensitive Area (DG-2-E) at the northeast tip of Indian Point. Field investigation revealed an area in the backshore with a dense growth of dunegrass (*Leymus mollis*) and open areas of large-headed sedge, entire-leaved gumweed, northern wormwood, and American searocket (*Cakile edentula*) near the backshore-foreshore interface. The area of greatest open sand (60-70%) and greatest abundance of large-headed sedge, entire-leaved gumweed, and northern wormwood, extends approximately 75 m northwest from the forest at the south end of the east side of Indian Point. Dunegrass and American searocket are most abundant along the ridge between the foreshore and backshore. Beyond this 75 m, stretching around to the north point, dunegrass and Scots broom become dominant, although intermittent small open areas with large-headed sedge persist.

The residents in homes fronting this area have created tidy, narrow trails to the beach which restricts traffic and prevents trampling of vegetation in the sensitive areas between them. The dune species persist in the areas between the paths, but many of the species noted in the foredunes along the south shoreline (such as D.L. 1375) were not noted at Indian Point.

An early successional dune area that is not marked on this map is located along the west side of Indian Point (Bawtinheimer and Roemer 2000; BC Government Air Photos). Roemer (Bawtinheimer and Roemer 2000) describes this site as gently sloping, 60-80 per cent open sand, with nearly flat dunes in the earliest stage of dune succession. From air photos, it appears to extend approximately 500 m from the northwest tip of Indian Point and reaches its greatest width of 50 m within the south half, but its exact characteristics were not confirmed in the field. Nonetheless, because of the fragility and rarity of these dune formations, its extent should be confirmed, and it should be considered for designation as an Ecologically Sensitive Area (DG-2).

7.0 Mace Point Rock Outcrop

The only area of outcropping bedrock on Savary Island is at Mace Point (formerly Green's Point) at the northeast tip of the island. It comprises less than 2 ha. (Eis and Craigdallie 1977). Rock outcrops support distinctive vegetation communities that are easily damaged by trampling. Some plants recorded here such as grassland saxifrage (*Saxifraga integrifolia*), small-flowered alumroot (*Heuchera micrantha*), and fern-leaved desert parsley (*Lomatium dissectum*) (Stanley 1980) may not be present elsewhere on the island. The only recorded garry oak (*Quercus garryana*) on the island is located on this rock outcrop. Savary Island is close to the northern limit of this species' range.

A forest dominated by large Douglas-fir extends to the outermost open areas of the rock outcrops. At this forest's edge, in the shallow soil of the slopes and between the rock outcrops, salal, oceanspray, and tall Oregon-grape are very abundant. Trailing blackberry, sword fern, and bracken fern also occur in this area, and in depressions between rock outcrops with Saskatoon (*Amelanchier alnifolia*) and common snowberry (*Symphoricarpos albus*). Sword fern, Indian-pipe (*Monotropa uniflora*), Pacific sanicle (*Sanicula crassicaulis*), and wall lettuce (*Lactuca muralis*) grow in the forest edge.

Scots broom and sweet vernalgrass grow together in great abundance on some of the outer rock outcrops. Other plants observed among the rock outcrops included red columbine (*Aquilegia formosa*), coastal strawberry (*Fragaria chiloensis*), nodding onion (*Allium cernuum*), and harvest brodiaea (*Brodiaea coronaria*). A variety of mosses grow on the bare rock of the rock outcrops and rock faces, while others thrive on small accumulations of organic matter on rock or in depressions within and between the rocks (Table 4). Wallace's selaginella (*Selaginella wallacei*) is present amongst the mosses.

Table 4. Mosses growing on the rock outcrops.

on bare rock
Bryum capillare, Dicranum scoparium, Eurhynchium sp., Hypnum cupressiforme*, Isothecium stoloniferum, Racomitrium aciculare, Ulota phyllantha**
on organic matter
Bryum capillare, Dicranum scoparium, Ditrichum heteromallum, Eurhynchium oregana, Isothecium stoloniferum, Leucolepis acanthoneuron, Plagiothecium denticulatum, Polytrichum commune, Polytrichum juniperinum, Eurynchium praelonga, Racomitrium canescens (s.l.), Racomitrium lanuginosum, Rhizomnium glabrescens, Rhytidiadelphus loreus, Rhytidiadelphus triquetris

* - confirmed by Dr. Wilf Schofield, Professor Emeritus, UBC Department of Botany

False lily-of-the-valley (*Maianthemum dilatatum*) is very abundant on the lower slopes of the northeast portion of the point. In the lowest areas along the shoreline in the northeast portion of Mace Point, yellow monkey-flower (*Mimulus guttatus*), coastal pearlwort (*Sagina maxima*), miner's-lettuce, and seashore bluegrass grow in the crevices of the rock face. Pacific hemlock-parsley (*Conioselinum pacificum*), entire-leaved gumweed, and the introduced perennial sow-thistle (*Sonchus arvensis*) and broad-leaved peavine (*Lathyrus*

latifolia), are present at the base of the rock face. Sea plantain (*Plantago maritima* ssp. *juncoides*) grows on low ledges just above the shoreline.

Despite signs of disturbance, the rock outcrop supports a variety of native vascular plants and bryophytes that form plant communities restricted to coastal rock outcrops. Further study would help to reveal its ecological significance within Savary Island, the CDFmm, and the surrounding area. This area should be considered for designation as an Ecologically Sensitive Area because of its uniqueness and fragility.

8.0 Animals

No formal surveys were conducted for animals. All observations of animals were noted during field work by SEC. These included animals observed along the shore (birds, mammals, reptiles), offshore (birds, mammals), and along the coastline and interior of the island (birds, mammals and reptiles). The sandy substrate of the interior and foreshore dune areas provided excellent sunning sites for garter snakes (*Thamnophis sp.*). They were very abundant in May along the sandy trails in the dunes near the airstrip, on the bluff to South Beach, and along the lower edge of the foredunes (DG-2-F and DG-2-G). Garter snakes (probably western terrestrial garter snake (*Thamnophis elegans*)) also frequent the south shore where one was seen among the shoreline rocks and water, and an unfortunate individual (~0.6 m) was causing problems for great blue heron (*Ardea herodias*) attempting to swallow it head first. The heron eventually won the battle!

Numerous holes are present in the vertical and near-vertical, sandy bluff faces on the south and north shores. Belted kingfishers (*Ceryle alcyon*) and northern rough-winged swallows (*Stelgidopteryx serripennis*) use these burrows for nesting. Although no belted kingfishers were seen entering or exiting the burrows, the large diameter of the burrows, the way in which the earth was worn around the hole, and the presence of stains extending beneath the hole, indicate probable nesting. A cliff swallow was observed exiting a hole near Second Point. The hole was probably excavated by a kingfisher.

The numerous large Douglas-firs on Savary Island provide excellent nesting and perching trees for bald eagles. A number of nests were noted on the island, and these are indicated on local maps highlighting natural features. An impressive graphical map highlighting the natural features of Savary Island was produced by the Savary Island Land Trust and is present on their web site (www.silt.ca). It features some plants and animals not noted in this report.

The following lists provide selected information on the animals observed on Savary Island during field work for this study conducted by SEC May 6 - 9, 2002, and from supplemental information gathered during an informal visit (vacation) to Savary by SEC's principal, July 13 to 20, 2002. Additional information is available in other studies which are cited, and their lists of animals are not reproduced here. Other sources of information such as personal communications are noted.

8.1 Birds

No formal surveys of birds were conducted during field work for this report, but all birds observed were recorded. Birds listed in Appendix 3 were recorded during May and July of 2002 by SEC. Their occurrence on Savary Island during these periods is described as *very common*, *common*, or *uncommon*. These descriptors are not associated with specific ranges of abundance, but represent an estimate of commonness (likelihood of being observed) based on a limited number of observations from these two periods.

8.2 Mammals

The two mammals seen most frequently are black-tailed deer (*Odocoileus hemionus columbianus*) and Douglas' squirrel (*Tamiasciurus douglasii*). Harbour seals (*Phoca vitulina*) were common on haul-out rocks along the south shore. A river otter (*Lontra canadensis*) was also seen in the water off the south shore. A female and young bat (possibly little brown myotis (*Myotis lucifugus*)) were reported roosting in a cabin.

8.3 Reptiles

In May, garter snakes (*Thamnophis* sp.) were very abundant in open sandy areas of the dunes, the bluffs, and along the shoreline. Fewer were observed in July, and most of these were observed foraging amongst the rocks on the beach. Common garter snake (*Thamnophis sirtalis*) and northwestern garter snake (*Thamnophis ordinoides*) are the species most likely to occur on Savary Island, but western terrestrial garter snake (*Thamnophis elegans*) may also occur.

Liz Webster (pers. comm.) reported seeing a northern alligator (*Elgaria coerulea*) on the south meadow of DL 1375.

8.4 Amphibians

No amphibians were seen during field work for this report.

8.5 Invertebrates

Numerous seashore organisms were seen during field work: cnidarians (jellyfish); mollusks (Japanese mud snails (*Batillaria attramentaria*), bivalves (oysters, mussels, clams)); arthropods (crustaceans: crabs); and echinoderms (sand dollars, starfish).

Dunster (2000) lists four Red- and Blue-listed butterflies which may occur on Savary Island based on information regarding their distribution, habitat, and plant preferences. None of these has been recorded there. Other species of butterflies and invertebrates such as dragonflies and damselflies, might be discovered with further field work.

Sherman (1931) notes the presence of a fly (*Cuterebra froutauella*) which he believed to be parasitic on Douglas' squirrel. He believed that this fly and domestic cats introduced by summer residents, were decimating the population of Douglas' squirrels. The status of the fly is unknown, but the squirrels persist!

The B.C. Conservation Data Centre has no records of Red- or Blue-listed animals for Savary Island.

9.0 The Future

The distinct vegetation communities and viable populations of native plants and animals may persist as the shores of Savary Island are slowly eroded. Areas of open, unconsolidated sands in the backshore will be washed away, but new, similar, areas will be created by erosion and the sloughing of the uplands. The failure of the slopes that support herbaceous species, shrubs and trees will result in barren areas — slopes, mounds, and sand flats — that plants from adjacent and nearby sites will colonize.

The greatest threat to the ecology and biodiversity[14] of Savary Island in the short term (~100 years) is people. The persistence of communities of native organisms, and the natural restoration of disturbed sites resulting from shoreline failure, will be influenced greatly by the people on the island through physical processes such as trampling and vegetation clearing, and ecological processes such as the introduction of non-native organisms, particularly plants. This point is not intended to suggest that people be excluded from the ecosystems of Savary Island (although this may be appropriate for small areas of greatest sensitivity), and it is not intended to heap all the blame on people. Natural processes play a major role through small and catastrophic events that influence the ecology of Savary Island. The key point is that humans, *like other organisms*, influence their environment, and that humans, *unlike other organisms*, can exert a conscious influence on how they do so.

[14] biodiversity – literally, the "diversity of life." The word has been used in many different ways. "The difficulties in defining biodiversity 'originate' from the general character of the term: it is a descriptive, but simultaneously an abstract and descriptively complex term." (Haila and Kouki 1994). The key to the term is "heterogeneity" a characteristic implicit in e cosystems (Haila and Kouki 1994). The three oft-cited components of biodiversity are genetic, species, and ecosystem. Scale is also an important component of biodiversity. From Soule and Terborgh (1999):

> *Biodiversity is the "variety and variability among living organisms and the ecological complexes in which they occur" (U.S. Office of Technology Assessment 1987). The term encompasses not only all species everywhere, but the variations in the compostion, structure, and functional process of the ecosystems in which they live. Noss (1990) described an integrated biological hierarchy for biodiversity that recognized four components: genetic; population-species; community-ecosystem; and landscape or regional.*

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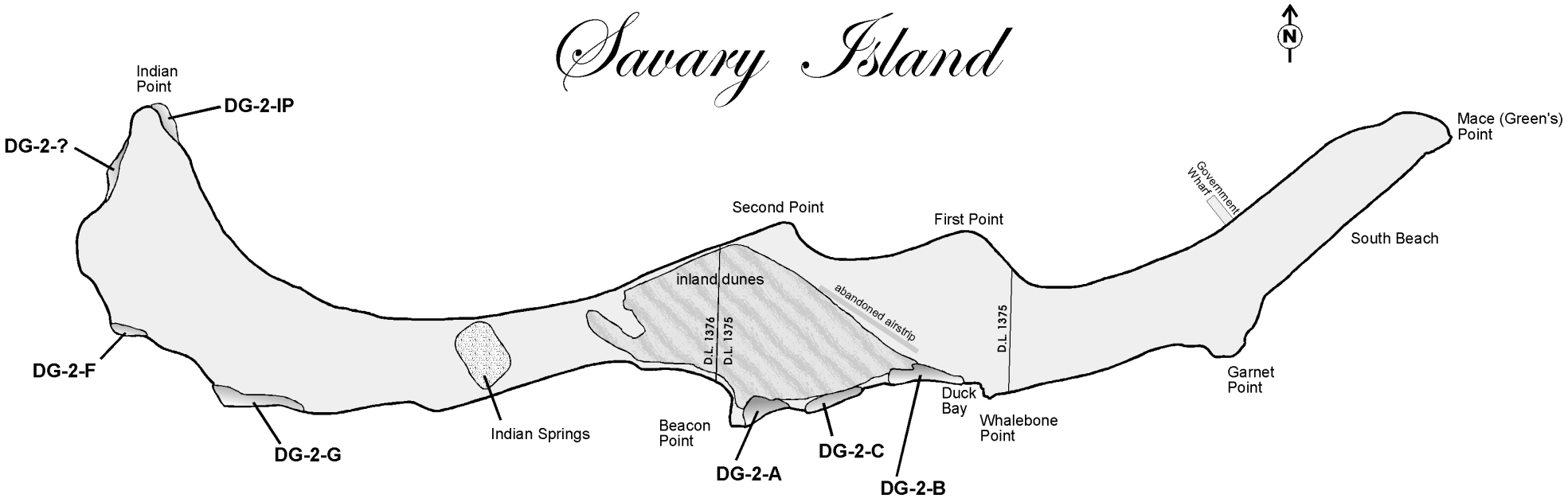
Appendix 1 – Map



Appendix 2 – Elementary Statistical Details, Vegetation Plots

Inland Dune Area (DG-3)

Average depth for 8 plots
6.8, 7.0, 7.2, 2.2, 6.0, 4.6, 6.8 and 5.8 cm.

Total average depth for 8 plots (n = 40)
5.8 cm

Standard Deviation for 8 plots (n = 40)
4.4 cm

Range of depth for 8 plots
1 to 20

Non-Dune Area (2 plots northeast of dunefield, 1 plot west of dunefield)

Average depth for 2 NW plots
11.8, 14.2 cm

Total average depth for 2 NW plots (n = 10)
13 cm

Standard Deviation for 2 plots (n = 10)
6.1 cm

Range of depth for 2 plots
3 to 20

Average depth for 2 NW and 1 W plots:
11.8, 14.2, 6.8 cm

Total average depth for 2 NW and 1 W plots:
11.2 cm

Standard Deviation for 3 plots (n = 14):
6.0 cm

Range of depth for 8 plots:
3 to 20

Appendix 3 – Birds Observed on Savary Island, May 6-9 and July 13-20, 2002.

common name	scientific name	when observed	where observed	frequency of observation
American pipit	*Anthus rubescens*	*May*	*south shoreline*	uncommon (1 seen)
American robin	*Turdus migratorius*	*May, July*	*various*	very common (seen, heard)
bald eagle	*Haliaeetus leucocephalus*	May, July	adults and immatures seen frequently, mostly along shoreline, nests present	common (seen, heard)
barred owl	*Strix varia*	July	– two immature – hissing call from near Eric and Juanita's house (east central island)	uncommon (seen, heard)
belted kingfisher	*Ceryle alcyon*	July	various – mostly along shoreline – excavated nest holes in vertical face of bluff (not observed using holes)	common (seen heard)
Bewick's wren	*Thryomanes bewickii*	May, July	various – forest edge airstrip	uncommon (heard)
black-throated gray warbler	*Dendroica nigrescens*	May	various – forest	common (in May) (seen, heard)
Cassin's vireo	*Vireo cassinii*	July	various – forest – southeast of Indian Point	uncommon (heard)
chestnut-backed chickadee	*Poecile pubescens*	May, July	various – forest, forest edge	common (seen, heard)
common loon	*Gavial dimmer*	May	offshore	uncommon (seen)
common merganser	*Merges merganser*	May	offshore	uncommon (seen)
common raven	*Corvus corax*	May	forest	uncommon (seen, heard)
European starling	*Sturnus vulgaris*	May	forest	uncommon (1 seen)
glaucous-winged gull	*Lars glaucescens*	May, July	beach	common seen, heard
golden-crowned kinglet	*Regulus satrapa*	May	forest	uncommon (seen, heard)
great blue heron	*Ardea herodias*	July	south shore, feeding among rocks, seen individually	common (not abundant) (seen)
greater or lesser yellowlegs (probable)	*Tringa melanoleuca* or *Tringa flavipes*	May	south shore	uncommon (1 seen at great distance)
hairy woodpecker	*Picoides villosus*	May	forest	uncommon (1 heard)
harlequin duck	*Histrionicus histrionicus*	May	south shore - offshore	common (in May) (seen)
Hutton's vireo	*Vireo huttoni*	May	forest - Indian Springs area	uncommon (1 heard)
killdeer	*Charadrius vociferus*	July	south shore, Duck Bay	common (one area) (max of 6 seen together)
least sandpiper	*Calidris minutilla*	July	south shore, Duck Bay mud flats and among rocks	common (one area) (10 seen)
long-billed dowitcher	*Limnodromus scolopaceus*	July	south shore, Duck Bay (July 20) 2 feeding in the soft mud/sand and vegetation along the high tide line	uncommon (fall migrant) (seen, heard)
merlin	*Falco columbarius*	July	Indian Point (July 20) very noisy (disturbed), flying above large trees	uncommon (seen, heard)
northern flicker	*Colaptes auratus*	May, July	various – near airstrip	common (not abundant) (seen, heard)
common name	**scientific name**	**when**	**where observed**	**frequency of**

		observed		observation
northern rough-winged swallow	*Stelgidopteryx serripennis*	July	various – airstrip, north and south shore. 1 seen flying out of hole (~10 cm) in sand bank near Second Point	common (seen)
northwestern crow	*Corvus caurinus*	May, July	various	very common (seen, heard)
orange-crowned warbler	*Vermivora celata*	May	airstrip	uncommon (1 heard)
Pacific-slope flycatcher	*Empidonax difficilus*	May, July	forest, throughout the island	very common (heard, seen)
pigeon guillemot	*Cepphus columba*	July	offshore, N of Indian Point	uncommon (seen)
pileated woodpecker	*Dryocopus pileatus*	May, July	abundant sign (excavations) throughout island	common (not abundant) (heard in May) (sign)
pine siskin	*Carduelis pinus*	May, July	throughout island	common (seen, heard)
red crossbill	*Loxia curvirostra*	July	conifer forests throughout island	common (seen, heard)
red-breasted nuthatch	*Sitta canadensis*	May, July	throughout island	uncommon (heard)
ruby-crowned kinglet	*Regulus calendula*	May	forest, uncommon	uncommon (heard)
rufous hummingbird	*Selasphorus rufus*	May, July	various, airstrip, interior openings	uncommon (seen, heard)
savannah sparrow	*Passerculus sandwichensis*	May	south shore	uncommon (seen, heard)
song sparrow	*Melospiza melodia*	May, July	shrubs and small trees along shore and bluff crest 1 seen carrying food July 13th at bluff crest E of Duck Bay	common (seen, heard)
spotted towhee	*Pipilo maculatus*	May, July	throughout island 1 immature and adult seen on bluff crest E of Duck Bay, July 13	very common (seen, heard)
Townsend's warbler (?)	*Dendroica townsendii*	July	possibly – heard July 20th in forest of Indian Point	unconfirmed observation (heard ?)
turkey vulture	*Cathartes aura*	July	observed circling over north shore, July 18 and over Indian Point, July 19	uncommon (seen)
varied thrush	*Ixoreus naevius*	May	forest	common (not abundant) (heard)
warbling vireo	*Vireo gilvus*	July	forests, inland	uncommon (heard)
western sandpiper (?)	*Calidris mauri*	May	flock on shores of Indian point (probable)	unconfirmed (seen at distance)
willow flycatcher	*Empidonax trailii*	July	airstrip	uncommon (seen, heard)
winter wren	*Troglodytes troglodytes*	May, July	forest, various locations	common (heard)
yellow-rumped warbler	*Dendroica coronata* ("Audubon's")	May, July	forest, shoreline	uncommon (seen, heard)

Appendix 4 – BC Conservation Data Centre Report

Georgia Basin Ecosystem Initiative.
B.C. Conservation Data Centre Site Report
Savary Island Dunes
Source file (savary-sbr.doc) provided March 6, 2002 by BC Conservation Data Centre.