Executive Summary

Jedediah Island became a Class A Provincial Park in 1995, under the jurisdiction of the Strathcona District of BC Parks. The Island is located in the Sabine Channel, in the Strait of Georgia, 80 kilometres west of Vancouver. Neighbouring islands, Sheer, Circle and Paul are included in the study area. Jedediah is 243 ha in size with approximately seven kilometres of coastline characterised by rugged rocky bluffs and headlands. The interior of the island is comprised of forest ecosystems on marine and colluvial materials intermixed with rocky outcrops. Areas on marine soils have been cleared by past occupants to sustain pastures for grazing stock and sustenance farming.

Jedediah Island is situated within the Coastal Douglas Fir moist maritime (CDFmm) Biogeoclimatic (BGC) subzone. The CDFmm has a limited range and is one of the smallest forested subzones in British Columbia. Urban development and agricultural modifications have placed extreme pressures on ecosystems in this subzone and old growth forests now represent less than 1% of the area. Jedediah Island is located in the Georgia Depression Ecoprovince, which lies between the Vancouver Island Mountains and the Southern Coast Mountains. Jedediah lies at about the centre of the Strait of Georgia Ecoprovince, in the rainshadow of the Vancouver Island Mountains and the Olympic Mountains. Summers are dry and warm; winters are mild and wet.

In order to develop a management plan for Jedediah, BC Parks required a comprehensive inventory of the natural resources on the island. Terrestrial Ecosystem Mapping (TEM) with wildlife interpretations was chosen to chronicle these resources. TEM mapping stratifies the landscape into map units (polygons) based upon various ecological features including topography, soils surficial geology, and vegetation. Wildlife habitat mapping estimates the present and potential value of the island's ecosystems to support particular wildlife species. This enables park managers to direct activities to protect and enhance suitable habitats, or to preserve high capability sites and direct more intense activities, such as recreation activities, on less suitable habitat.

Mapping was completed at a scale of 1:5 000 using Resource Inventory Committee (RIC) survey intensity level one, following the Standards for Terrestrial Ecosystem Mapping in British Columbia (RIC. 1998). Because anthropogenic activities have disturbed the natural ecosystems on the island, several specific interpretations were required. These included an indication of the type and degree of disturbance to each polygon and information on areas that would be sensitive or limiting to park development. Naturalness ratings were established to appraise the ecological condition of each ecosystem unit by considering the degree of fragmentation, disturbance history and known threats. Viability was rated according to the likelihood of a given ecosystem remaining in the current state of naturalness over time if management strategies do not change. Additionally, the location of all trails and structures were mapped.

Preliminary terrain mapping and a working legend were completed during the summer of 1998. The first and most extensive field sampling phase took place in September 1998; the second and final phase was completed in April 1999. Eighty-seven percent polygon visitation was achieved. Mapping was completed during the winter with revisions incorporated after the spring sampling.

Three hundred and seventy-two polygons were mapped. Six forested site series; six previously un-described non-forested units, such as wetlands and forb dominated communities and six sparsely vegetated, non-vegetated, and anthropogenic units were mapped. One seral community, believed to be maintained at the seral stage by disturbance, was also mapped. Complete accounts for each ecosystem unit are provided in the expanded legend (Appendix 5).

Four vertebrate species were chosen for habitat suitability mapping: Columbian Black-tailed Deer, Pileated Woodpecker, Bald Eagle and Pelagic Cormorant. Observations were also collected on the feral goats and sheep on Jedediah Island. Feeding, security and thermal life requisites were assessed for Columbian black-tailed deer. These life requisites were then combined into a single general life requisite called "living" to develop a map of living requirements for the growing and winter seasons. For Pileated Woodpecker and Bald Eagle, feeding, reproducing and a combined assessment for security and thermal life requisites were made. A map for reproducing habitat was produced for these species. One day was spent surveying the coastal cliffs searching for suitable reproducing habitat for Cormorants. A final map was not produced for this species, as suitable habitat was not identified.

Past disturbance on Jedediah has included logging and small, low intensity fires. However, extensive grazing by feral goats and sheep has had the greatest impact on the island habitat. In September 1998, it was estimated that there were 70 goats and 40 sheep on the island. The presence of males, females and juveniles indicates that these feral animals are reproducing successfully on the island. No evidence of feral animals was observed on the neighbouring islets or Paul Island.

On Jedediah, every vegetative life form has been affected by the goats and sheep's activities. Shrub and herb layers were noticeably absent in most forested ecosystems and herbaceous openings, tree regeneration was minimal to absent where grazing occurred and abundance and vigour of all fern species has decreased. Half of the observed grass species were non-native. Several shrub and herb species that would normally be anticipated in the local flora were not found on Jedediah, although some were observed on the neighbouring islands where grazing has not occurred. The majority of the ecosystems (approx. 51%) were rated as marginal for naturalness and poor for viability. Approximately four percent of the ecosystems were rated as excellent in both categories, but most of these are located on Paul Island and the surrounding islets.

Jedediah Island has some excellent Columbian Black-tailed Deer habitat for both the growing and winter season. These sites have a high amount of palatable forage and good security values while also offering thermal habitat. Several polygons represented good Pileated Woodpecker habitat and feeding signs were common. Individuals were both seen and heard on the island. Jedediah Island had limited high value Bald Eagle habitat. No nests were found during field sampling although, Bald Eagles were heard on the island almost daily.

The goats and sheep are having a significant effect on the wildlife habitat on Jedediah Island. Dietary overlap limits the feeding opportunities for the small deer population. This is exacerbated as food resources are likely limiting on Jedediah Island, especially as the population of goats and sheep increases. It was less clear how the goats and sheep affect the other wildlife species rated in this project because habitat overlap is limited.

The sheep and goats may also negatively affect other wildlife species. A scarce shrub layer due to grazing may decrease the amount of suitable habitat for species that use shrubs for forage and security (e.g. some songbirds). Reduced or eliminated litter layer in some areas, diminishes the availability of litter-dwelling invertebrates that ground foraging birds, snakes, salamanders and some small mammals feed on, as well as decreasing the security habitat for many of these species.

Control of feral livestock populations and activities is integral to maintaining the natural ecosystems and wildlife habitat on Jedediah Island. To that end, several management options are presented. These are: 1) Removal of feral and domestic animals from the island, 2) Excluding the goats and sheep from particular sections of the island, and 3) Controlling the population of these animals. Each option must be weighed against park management objectives.

It is difficult to predict how ecosystems will respond if the disturbance source is removed. Management of the goats and sheep would eventually see the ecosystems return to some measure of normal succession, however the exact nature of the future ecosystems remains uncertain. Active restoration efforts may be required to see the natural distribution and abundance of the native vegetation return.

Acknowledgements

Jo-Anne Stacey provided project co-ordination with valuable assistance and advice from the following team for the Terrestrial Ecosystem Mapping of Jedediah Island. Corey Erwin and Carmen Cadrin completed the ecosystem mapping; Carmen Cadrin, Corey Erwin, Jo-Anne Stacey, Robert Maxwell and Sal Rasheed produced the report and expanded legend; Debbie Webb developed the formatting for these documents; and Brian Low at Pacific Forestry Centre completed the GIS mapping. The field crew consisted of ecologists, Carmen Cadrin, Corey Erwin and Jo-Anne Stacey; wildlife biologists, Lynne Bonner, Susan Holroyd and Sal Rasheed; bioterrain specialists, Christina Sinnemann and Robert Maxwell. Bryan Kreuger and Brian Low surveyed the trails on the island and provided boat operation and camp support.

The ecosystem map was submitted to Ted Lea, the provincial correlator, for review and to ensure provincial standards were followed. Tim Brierley at MELP ran quality assurance protocols against the GIS data. Terry Gunning at MELP ensured the databases met provincial data capture standards.

Special thanks to Rik Simmonds of BC Parks, Strathcona for arranging transportation of crews and equipment to and from the island and to the Jones Brothers of Lasquiti Island for their support throughout the field inventory.

Table of Contents

List of Figures

List of Tables

INTRODUCTION

LOCATION

Jedediah Island is located in the Sabine Channel in the Strait of Georgia, 80 kilometres west of Vancouver between Texada and Lasqueti Islands. Jedediah Island is the largest and most diverse in a chain of 30 islands and rocky islets located north and west of Lasqueti Island (Figure 1). Included in the study area are three small surrounding islands, Circle, Sheer and Paul Islands.

Jedediah is 243 ha in size with approximately seven kilometres of coastline. The interior of the island is comprised of forest ecosystems on marine and colluvial terrain intermixed with rocky outcrops. The shoreline is characterised by rugged rocky bluffs and headlands with only a few beaches. Areas on marine soils have been cleared to sustain pastures for grazing stock and sustenance farming for the families that have lived on the island. Forestry activities have been limited but fire and grazing have influenced ecosystem development on the island.

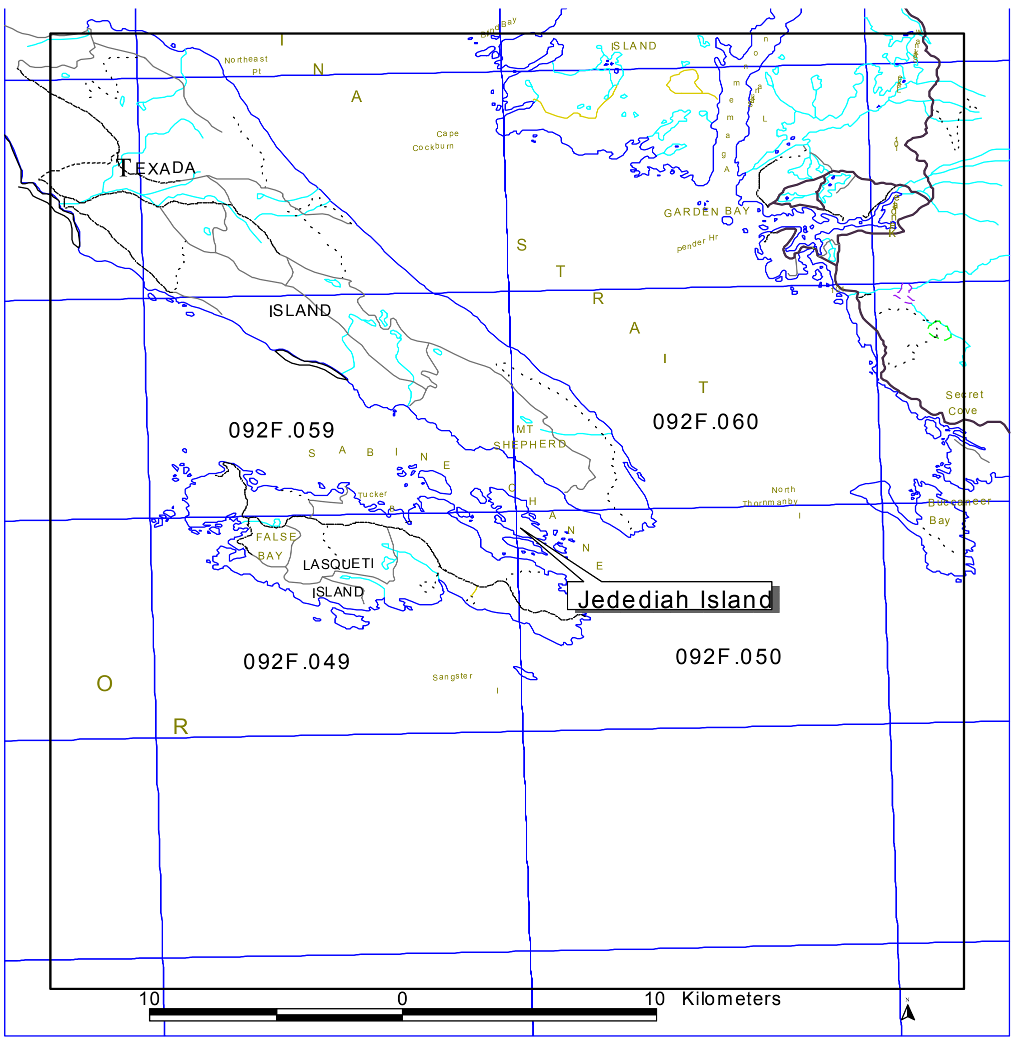

Figure 1: Jedediah Island located on four 1:20 000 mapsheets: 092F.049, 059, 050, and 060.

BACKGROUND

Jedediah Island became a Class A Provincial Park in 1995, under the jurisdiction of the Strathcona District of BC Parks. The purchase of Jedediah Island Marine Park was possible due to the help of numerous parties, including but not limited to: Al and Mary Palmer, past owners who petitioned for the island to be protected; The Friends of Jedediah Island, a group of interested islanders from neighbouring Lasqueti Island; outdoor and boating groups; various corporate and individual sponsors; and a substantial donation from the estate of Dan Culver intended specifically for the purpose of "...purchasing an ecologically sensitive property to be preserved for the good of the public." (Draft Parks Management Plan, 1999).

Jedediah Island is situated within the Coastal Douglas Fir moist maritime (CDFmm) Biogeoclimatic (BGC) subzone. The CDFmm has a limited range and is one of the smallest forested subzones in British Columbia. Urban development and agricultural modifications have placed extreme pressures on ecosystems in this subzone and old growth forests now represent less than 1% of the area. The conservation of the island augments the representation of this subzone in the Province's protected areas. The island also presents an example of early homesteading and settlement of the Gulf Islands. This cultural history adds much to its visitor appeal, yet the effects of this past use are compromising the ecological value of the park. Private ownership and farming activities such as land clearing, alteration of drainage patterns and extensive livestock grazing have resulted in disturbance to the natural ecosystems. Grazing by feral livestock has impacted the vegetation growth and species representation.

In order to develop a management plan for Jedediah, BC Parks required a comprehensive inventory of the natural resources on the island. Terrestrial Ecosystem Mapping (TEM) with wildlife interpretations was chosen as the method to chronicle these resources, and provide the baseline information required for park management.

BIOPHYSICAL SETTING

ECOREGION CLASSIFICATION

Jedediah Island is located in the Georgia Depression Ecoprovince, which lies between the Vancouver Island Mountains and the Southern Coast Mountains. Within this Ecoprovince, Jedediah lies at approximately the centre of the Strait of Georgia (SOG) Ecosection. The climate of this region is greatly influenced by patterned movement of coastal air masses. After these masses move over the Vancouver Island Mountains, they subside and create clearer and drier conditions than the coastal areas adjacent to the Pacific Ocean. The ocean and the Strait of Georgia modify temperatures throughout the area.

The Georgia Depression Ecoprovince is predominantly a semi-enclosed estuarine environment, strongly affected by freshwater discharge, especially from the Fraser River. A nearshore zone surrounds all the islets, islands and mainland, with an intertidal zone as the dominant interface between the land and sea. This Ecoprovince has only protected waters, but the Strait of Georgia is deep enough to have a mesopelagic zone as well as an epipelagic layer. The Ecosection is characterised as a collection of islands and inter-island channels and sounds that extend across the Strait of Georgia.

BIOGEOCLIMATIC CLASSIFICATION

Coastal Douglas Fir moist maritime (CDFmm) is the only biogeoclimatic subzone in the study area and is one of the smallest forested subzones in the BGC system. The CDFmm is found only within the Georgia Depression Ecoregion from sea level to approximately 150 m. It is limited to southeastern Vancouver Island, parts of the Gulf Islands south of Cortes Island, a small band along the Sunshine Coast near Halfmoon Bay and the western edge of the Fraser Lowlands. The CDF mm lies in the rainshadow of the Vancouver Island Mountains and the Olympic Mountains. Summers are dry and warm; winters are mild and wet, with a mean annual temperature from 9.2 to 10.5°C. Mean annual precipitation varies from 647 to 1263 mm with only about five percent falling as snow between April and November. Jedediah Island sits very near the transition from the CDFmm to the Coastal Western Hemlock very dry maritime subzone (CWHxm). This is a wetter and cooler subzone, which occurs just above the CDFmm and is also found to the east and north of the CDFmm at low elevations.

Coastal Douglas fir is the most common tree species. Western redcedar, grand fir, arbutus and red alder are often associated with Douglas fir. Vegetation of the CDFmm includes about 50 rare species restricted to this subzone. Urban development and agricultural modifications have placed extreme pressures on ecosystems in the CDFmm. As a result, alluvial forests and wetlands are rare. Old growth forests now represent less than 1% of the subzone.

Soils are generally derived from morainal, colluvial and marine materials. Soils on zonal sites are typically Dystric or Eutric Brunisols. With increased precipitation, soils tend towards Humo-ferric Podzols.

GEOLOGY, GLACIAL HISTORY, TERRAIN AND SOILS

Jedediah Island originates from basalt lava flows deposited about 200 million years ago in an island arc landscape, which lay far to the south east in the Pacific Ocean. These basalts, known as the Karmutsen Formation, are also very common on Vancouver Island. Jedediah was glaciated during the last ice advance, which moved down the Strait of Georgia about twenty thousand years ago. Flutings and whalebacks on the exposed bedrock indicate that the ice moved in a northwest to southeast direction. Many drumlin-shaped hills, with a stoss and lee profile, that cover the Island, also align to this ice flow direction. In a similar orientation, some of the square walled valleys and channels are incised into the ancient basalt. These channels are thought to have originally formed in the cracks and joints, which were later glacially modified by widening, deepening and polishing the sidewalls. Some of the walls are over six metres in height.

Ahead of the advancing ice, proglacial outwash likely filled the straits with sand. This deposit is known as the 'Quadra Sands'. The sand filled valleys of Jedediah may be associated with this deposit. During the stages of ice retreat, about twelve to fifteen thousand years ago, the island was inundated with sea water to an elevation of about 100 metres. This covered most of the land except the highest peaks. Marine flooding was also responsible for other marine deposits.

Some of the deposits associated with marine inundation occur as silty clay marine deposits. They rest at the lowest elevations, for example in stream reaches, to tideline at the head of Home Bay. The clayey marine sediments are parent materials for compact, silty clay loam, poorly drained, Gleysolic soils. From about three to 70 metres elevation, blankets of almost gravel free, fine to medium sands floor the wider main valleys. These sands are the parent materials for less compact, often loose, sandy loam textured soils, which are well to imperfectly drained and have Brunisolic and Podzolic soil development. Associated with these sand filled valleys and at slightly higher elevations (30 - 60m), there occur pockets and belts of sands, gravels and cobble materials thought to be of glaciomarine origin and possibly deposited in an ice marginal situation. They are stony, gravelly, rapidly drained soils with Brunisolic stony phase soil development. At slightly higher elevations, and also associated with these gravelly deposits, are more distinct glaciomarine beach strand deposits, consisting of granodiorite boulders and cobble fields. These bouldery strands commonly lie at about 40 to 70 metres elevation and occur in many of the narrow valleys which lead directly to the shoreline. These soils are also gravelly, bouldery and very rapidly drained. In summary, the gravelly, bouldery glaciomarine deposits are found along the upper margins of the sand deposits, and often near the 'height-of-land'. Glaciomarine sediments are laid down from suspension in a marine environment in close proximity to glacier ice.

Some of the most noticeable areas of seepage on the island are at the lower slope and toe of slope positions, associated with the sandy and clayey marine deposits. These sites are relatively small and often consist of alder, western redcedar and salmonberry. The abandoned, raised gravelly beaches located just up-slope of the many pocket beaches also seem to have seepage throughout the year; examples are found at Sand Beach, Codfish Bay, and Boom Bay. The two previous examples of lower slopes and pocket beaches are mainly located at the lower points of catchment basins and usually contain small drainages.

Two notable areas of relatively extensive moist to wet soils are in the flatter terrain above Deep Bay and the large 'cultivated' field west of Home Bay. The relatively extensive sand blankets in these level to convex basins, seem to collect soil water from the uplands and saturate during winter and spring. Seasonally saturated soils have evidence of strongly mottled (iron stained) soil layers. They are classified as poorly and imperfectly drained soils. A major source of this soil water is from rain, some of which runs off the bedrock hills, and finds its way under the porous marine sediments common in most valleys, and emerges in the lower landscape basins.

Rainwater, falling on the rolling basalt hills also likely moves through cracks and joints into the deeper bedrock. It was observed at a few locations that mineral rich seepage water emerged at the base of bedrock cliffs. The white precipitates, likely calcium or calcite (Figure 2), are mineral licks used by the feral goats, and possibly resident deer. Evidence of droppings and goat bones was found at these sites.

Figure 2: Mineral rich seepage at the base of basalt cliffs.

TERRESTRIAL ECOSYSTEM MAPPING

Terrestrial Ecosystem Mapping stratifies the landscape into map units according to a combination of ecological features, primarily climate, physiography, surficial material, bedrock geology, soil and vegetation. The mapping combines aspects of Biogeoclimatic classification (BEC) with Ecoregion classification. The ecosystem units are mapped using a bioterrain approach, a procedure that focuses on observable site and biological features assumed to determine the function and distribution of plant communities on the landscape. Four classifications are mapped: ecoregion (ecoregion units), zonal (biogeoclimatic units), site (site series), and vegetational development (structural stages and seral community types). Map units are delineated using a combination of aerial photograph interpretation and field sampling to verify ecosystem boundaries. Maps produced using this method are incorporated into Geographic Information Systems (GIS) (Resources Inventory Committee (RIC) 1998).

OBJECTIVES

Ecosystem Mapping

The purpose of the project was to complete ecosystem mapping with wildlife interpretations for Jedediah Island Marine Park in order to provide baseline information for park management purposes. Mapping was to be completed at a scale of 1:5 000 using Resource Inventory Committee (RIC) survey intensity level one, following the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC. 1998). Besides the standard suite of data collected for TEM mapping, Parks requested the inclusion of several additional attributes. These were an indication of the level and type of disturbance for all polygons (naturalness ratings) and information on areas that would be sensitive or limiting to park development. The location of all trails and structures were also to be mapped.

METHODOLOGY

Mapping was completed according to the methodology outlined in *Standard for Terrestrial Ecosystem Mapping* in British Columbia (RIC, 1998).

Terrain Mapping

Terrain units were pre-typed, prior to the beginning of field work, onto 1:5000 scale, black and white aerial photographs, following the standards outlined in the *Terrain Classification System for British Columbia* (Howes and Kenk, 1997) and the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC, 1998). Delineation of ecological polygons, based on surficial geology, topography and vegetation, while also taking into account soil drainage, aspect and exposure is the first step in the ecosystem mapping process. Terrain symbols, geomorphic processes, and soil drainage classes were placed on each polygon. Following the fieldwork, the ecological polygon lines, terrain symbols, and soil drainage classes were revised based on field data. Appendix 1 contains additional information regarding terrain mapping and the terrain symbology.

Ecosystem Mapping

Development of a Working Legend

A working legend was developed to ensure that all of the variability present in the study area was sampled. Using the terrain features mapped on the ecosystem polygons, in the pre-typing stage as a base, site series were matched to the terrain conditions most likely to support their development.

Field Sampling

Fieldwork was completed from September 15th to 24th 1998 and in April 1999. Fieldwork was split into two phases in order to properly sample and identify some of the early spring vegetation. The most extensive sampling occurred during the fall session with 3 crews collecting data. Each crew consisted of three members, a plant ecologist, a terrain/soil specialist and a wildlife biologist. Carmen Cadrin, Jo-Anne Stacey and Corey Erwin collected vegetation data; Bob Maxwell, Christina Sinnemann, and Corey Erwin collected soils data; Sal Rasheed, Susan Holroyd, Lynne Bonner and Debbie Webb collected wildlife data.

One two person crew, Carmen Cadrin (vegetation) and Corey Erwin (soils), completed the spring sampling. B.C. Parks Provincial botanist, Hans Roemer also attended the spring sampling session, in order to inventory the plant species present in the park. Combining Han Roemer's intensive spring botanizing and the extensive coverage achieved in the fall sampling session produced the list of species presented in Appendix 2.

Polygons were sampled using three types of plots; detailed ecological plots with site, soil vegetation and wildlife descriptions (FS882 forms), ground inspection plots (GIF), and visual inspections. *The Field Manual for Describing Terrestrial Ecosystems* (RIC 1998) provides a detailed methodology for data collection at detailed and ground inspection plots while The S*tandard for Terrestrial Ecosystem Mapping in British Columbia* (RIC, 1998) provides guidelines for data collection at visual sites. An abbreviated site conservation evaluation, adapted from the Draft Guidelines for Site Conservation Evaluation (B.C. Conservation Data Centre (CDC) 1998), was completed at each of the plots. A photo was taken at each of the detailed and ground inspection plots, as well as at most of the visual plots.

Colour photocopies of the original pre-typed black and white air photos were laminated and used in the field. The location of all detailed plots, ground inspections, and visuals were pin pricked on these photocopies with the corresponding plot number written on the back of the photo. The plot locations and numbers were then transferred to the original photos after the field session.

There are a number of existing trails on the island, all of which were used to gain access to much of the island. Remote coastal sites and some of the surrounding islands were not accessible via foot therefore a boat was used to gain access.

All of the main trails on Jedediah Island were mapped using the Global Positioning System (GPS). Bryan Krueger and Brian Low completed the trail mapping. The documenting of the trails and established routes on Jedediah Island was done using GPS differentially corrected to an acceptable accuracy. In areas where the density of the canopy prohibited accurate GPS data collection a Hip & Chain survey was employed. GPS waypoints were used to enhance the accuracy of this survey. At the time of correlation the Hip & Chain data was converted to X, Y & Z co-ordinates and adjusted for traverse closure and vertical exaggeration using standard survey methods. The data was then associated with the GPS data and input into ARCINFO as attributed line coverages. We would like to acknowledge Geographic Data BC for the loan of the Global Surveyor.

Rare Elements

It was expected that some rare species and plant associations (CDC, 1999) would occur on the island. The locations of any rare vegetation species or ecosystems were documented and any incidental observations of red or blue listed wildlife species were recorded. The site and occurrence of rare vegetation species were photographed and a voucher specimen submitted to the Conservation Data Centre botanist.

Naturalness Ratings

Naturalness ratings were established in order to appraise the ecological condition of each ecosystem map unit. At each plot location, naturalness, degree of polygon fragmentation, disturbance history and known threats to the ecosystem were recorded using a Conservation Evaluation Form (Appendix 4). Ratings were assigned to those polygons not visited based on the ecosystem unit, topography and adjacency to other ecosystem types and their known condition. Anthropogenic and non-vegetated units, such as cultivated fields and rock outcrops, were not assessed.

Each of the following parameters was used to rate the polygon on a scale, where 1 was excellent, 2 was good, 3 was marginal and 4 was poor.

<u>Quality</u>: Describes the degree to which the site represents the ecosystem within its known range of characteristics. Characteristics such as geographic size, presence of indicator species, and successional status are all considered.

<u>Condition</u>: Describes the degree of naturalness of the site and level of anthropogenic influences. Land use practices, resource extraction, introduction of non-native species (plant and animal) are considered.

<u>Viability</u>: Assesses the long-term prospects for the continued existence of the ecosystem at the indicted level of quality. Current land use of the site as well as the effects of surrounding land uses must be considered.

<u>Defensibility</u>: Assesses the degree to which the site can be protected from future anthropogenic influences given the current land use practices. Effects of current land use, buffering and formal protection measures are considered.

The naturalness ratings in the final database reflect a summary of these assessments. Quality and condition are combined as ‘Naturalness’, and viability and defensibility are joined as ‘Viability’.

Legend Development

Forested ecosystems were used directly from existing site series defined in the Ministry of Forests, Vancouver regional field guide (Green and Klinka, 1994). Non-forested units such as, wetlands, riparian areas, and rock outcrops were described based on the field data collected and mapped accordingly. Sample plots were used to describe all of the ecosystem units found in the park during the development of the expanded legend. The vegetation communities of structural stages that were not sampled were extrapolated based on known seral community types and plot information from other studies in similar areas.

Data Analysis

Upon completion of the fieldwork, the appropriate soils, vegetation and wildlife personnel reviewed the field forms. Data from the full plots was recorded in digital format using VENUS software, data from the ground inspections was recorded into GRAVITI, and data from the visuals was recorded into an Excel format spreadsheet. These databases were used to sort the plots into groups with similar physical attributes and ecosystem classifications. The range of environmental conditions, terrain units, and vegetation communities over which site series were distributed was obtained from these databases.

Plant Identification

Plants were identified in the field using field guides (Pojar, J. and A. MacKinnon. 1994.). Difficult plants were pressed and keyed out using the provincial botanical keys (Douglas et al., 1999). Where identification could not be made with confidence, voucher specimens were collected and sent for expert identification. Many of the island and surrounding islet plant species were collected and identified by Hans Roemer. His list was compiled with plot data to produce a comprehensive plant species list for the park (Appendix 2).

Ecosystem Unit Mapping

Ecosystem units were mapped according to the standards set forth in the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC. 1998). Each ecosystem is assigned an uppercase two-letter code that is equivalent to one recognized biogeoclimatic ecosystem classification (BEC) site series for each forested site. Site series have been identified according to Green and Klinka (1994). Labelling for all forested ecosystems follows the updated site series coding master list available on the Ministry of Environment, Lands, and Parks web site (RIC 1997). Where an ecosystem was not recognized as an official site series (wetlands or herbaceous meadows), new ecosystem units were proposed and two letter codes applied similarly. Sparsely vegetated, non-vegetated, and anthropogenic units follow the symbols outlined in table 3.1 of the TEM standards (RIC, 1998). One seral community type has been mapped. Seral community types represent ecosystems that are considered to be an earlier sere to the climax ecosystem unit resulting from disturbance. The seral community types are coded with a semi-colon and two lower case letters, they appear at the end of an ecosystem unit label.

Site modifiers were mapped with many of the ecosystem designations to more specifically describe the ecosystem (Table 1 and Figure 3). Up to two site modifiers may be present (in lower case letters) with each ecosystem unit. The site modifiers represent different site conditions than those of the typical environmental condition (typical situation), as defined by MELP, for each site series. Each site series has a set of assumed site modifiers under the typical situation. Hence, when a site series is mapped in its typical situation it will not need any site modifiers to be included in the map label. The site series code and/or site modifier(s) are followed by a numerical structural stage designation, 1 through 7 (Table 2). A structural stage modifier (a single lower case letter) further subdivides the structural stage designation. Where applicable, a stand composition modifier (a single upper case letter) (Table 4) is also applied.

Up to three ecosystem units were noted for each polygon. The percentage for each ecosystem unit present is indicated by deciles ranging from 1 to 10 (1=10%; 10=100%). Note, that 10 (100%) is not displayed in the map label, but it does appear in the database.

Site Modifiers

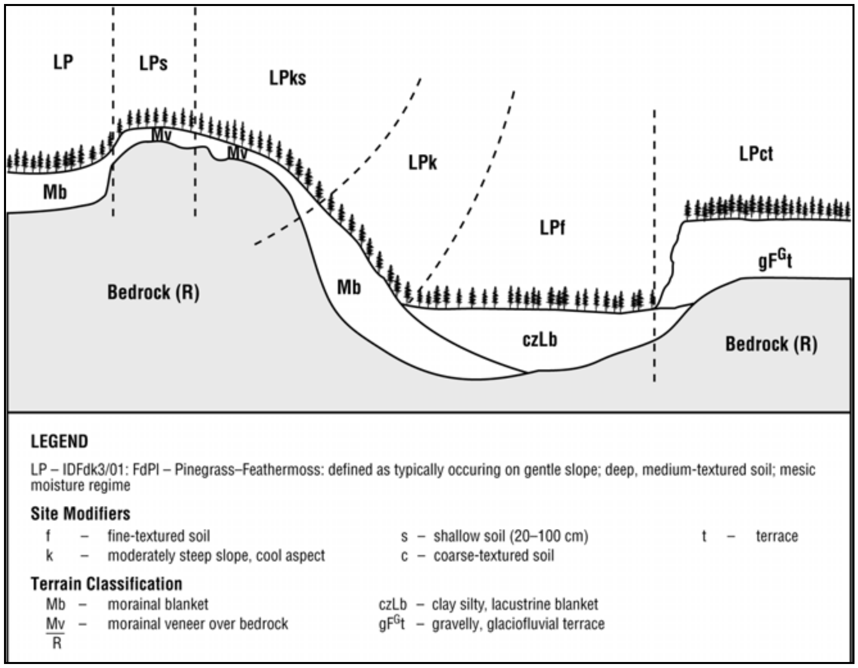

Figure 3: Use of site modifiers in mapping site series

The following is a list of TEM standard codes for site modifiers taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).

Table 1: Site modifiers for atypical conditions.

Code	Criteria
Topography	
a	active floodplain[1] – the site series occurs on an active fluvial floodplain (level or very gently sloping surface bordering a river that has been formed by river erosion and deposition), where evidence of active sedimentation and deposition is present.
g	gullying[1] occurring – the site series occurs within a gully, indicating a certain amount of variation from the typical, or the site series has gullying throughout the area being delineated.
h	hummocky[1] terrain (optional modifier) – the site series occurs on hummocky terrain, suggesting a certain amount of variability. Commonly, hummocky conditions are indicated by the terrain surface expression but occasionally they occur in a situation not described by terrain features.
j	gentle slope – the site series occurs on gently sloping topography (less than 25% in the interior, less than 35% in the CWH, CDF, and MH zones).
k	cool aspect – the site series occurs on cool, northerly or easterly aspects (285°–135°), on moderately steep slopes (25%–100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones).
n	fan[1] – the site series occurs on a fluvial fan (most common), or on a colluvial fan or cone.
q	very steep cool aspect – the site series occurs on very steep slopes (greater than 100% slope) with cool, northerly or easterly aspects (285°–135°).
r	ridge[1](optional modifier) – the site series occurs throughout an area of ridged terrain, or on a ridge crest.
t	terrace[1] – the site series occurs on a fluvial or glaciofluvial terrace, lacustrine terrace, or rock cut terrace.
w	warm aspect – the site series occurs on warm, southerly or westerly aspects (135°–285°), on moderately steep slopes (25%–100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones).

Code	Criteria
	(25%–100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones).
z	very steep warm aspect – the site series occurs on very steep slopes (greater than 100%) on warm, southerly or westerly aspects (135°–285°).
Moisture	
x	drier than typical (optional modifier) – describes part of the range of conditions for circummesic ecosystems with a wide range of soil moisture regimes or significantly different site conditions. For example, SBSmc2/01 (Sxw–Huckleberry) has three site phases described, and the submesic phase can be labeled with the "drier than average" modifier (e.g., SBx). This code should be applied only after consultation with the Regional Ecologist.
y	moister than typical (optional modifier) – describes part of the range of conditions for circummesic ecosystems with a wide range of soil moisture regimes or significantly different site conditions. For example, SBSmk1/06 (Sb–Huckleberry–Spiraea) is "typically" described as submesic to mesic. When this site series is found on subhygric or hygric sites, the "y" modifier is used (e.g., BHy). This code should be applied only after consultation with the Regional Ecologist.
Soil	
c	coarse-textured soils[2] – the site series occurs on soils with a coarse texture, including sand and loamy sand; and also sandy loam, loam, and sandy clay loam with greater than 70% coarse fragment volume.
d	deep soil – the site series occurs on soils greater than 100 cm to bedrock.
f	fine-textured soils[2] – the site series occurs on soils with a fine texture including silt and silt loam with less than 20% coarse fragment volume; and clay, silty clay, silty clay loam, clay loam, sandy clay and heavy clay with less than 35% coarse fragment volume.
m	medium-textured soils – the site series occurs on soils with a medium texture, including sandy loam, loam and sandy clay loam with less than 70% coarse fragment volume; silt loam and silt with more than 20% coarse fragment volume; and clay, silty clay, silty clay loam, clay loam, sandy clay and heavy clay with more than 35% coarse fragment volume.
p	peaty material – the site series occurs on deep organics or a peaty surface (15–60 cm)[3] over mineral materials (e.g., on organic materials of sedge, sphagnum, or decomposed wood).
s	shallow soils – the site series occurs where soils are considered to be shallow to bedrock (20–100 cm).
v	very shallow soils – the site series occurs where soils are considered to be very shallow to bedrock (less than 20 cm).

[1] Howes and Kenk 1997
[2] Soil textures have been grouped specifically for the purposes of ecosystem mapping.
[3] Canada Soils Survey Committee, 1987

Structural Stages

The following is a list of TEM standard codes for structural stages taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998). .

Table 2: Structural stages and codes[1]

Structural Stage	Description
Post-disturbance stages or environmentally induced structural development	
1 Sparse/bryoid[2]	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance less than 20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover less than 20%; total tree layer cover less than 10%.
Substages	
1a Sparse[2]	Less than 10% vegetation cover;

Structural Stage	Description
1b Bryoid[2]	Bryophyte- and lichen-dominated communities (greater than 1/2 of total vegetation cover).
Stand initiation stages or environmentally induced structural development	
2 Herb[2]	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover less than 10%, shrub layer cover less than or equal to 20% or less than 1/3 of total cover, herb-layer cover greater than 20%, or greater than or equal to 1/3 of total cover; time since disturbance less than 20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
Substages	
2a Forb-dominated[2]	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid-dominated[2]	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic[2]	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d Dwarf shrub[2]	Communities dominated (greater than 1/2 of the total herb cover) by dwarf woody species such as *Phyllodoce empetriformis, Cassiope mertensiana, Cassiope tetragona, Arctostaphylos arctica, Salix reticulata,* and *Rhododendron lapponicum*. (See list of dwarf shrubs assigned to the herb layer in the *Field Manual for Describing Terrestrial Ecosystems)*.
3 Shrub/Herb[3]	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover less than 10%, shrub layer cover greater than 20% or greater than or equal to 1/3 of total cover.
Substages	
3a Low shrub[3]	Communities dominated by shrub layer vegetation less than 2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 20 years for normal forest succession.
3b Tall shrub[3]	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
Stem exclusion stages	
4 Pole/Sapling[4]	Trees greater than 10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually greater than 10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually less than 40 years for normal forest succession; up to 100+ years for dense (5000–15 000+ stems per hectare) stagnant stands.
5 Young Forest[4]	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions.
Understory reinitiation stage	
6 Mature Forest[4]	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years for biogeoclimatic group A[5] and 80–250 years for group B.[6]
Old-growth stage	
7 Old Forest[4]	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and coarse woody debris in all stages of decomposition typical, as are patchy understories; understories

Structural Stage	Description
	may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally greater than 140 years for biogeoclimatic group A[5] and greater than 250 years for group B.[6]

1 In the assessment of structural stage, structural features and age criteria should be considered together. Broadleaf stands will generally be younger than coniferous stands belonging to the same structural stage.
2 Substages 1a, 1b and 2a–d should be used if photo interpretation is possible, otherwise, stage 1 and 2 should be used.
3 Substages 3a and 3b may, for example, include very old krummholz less than 2 m tall and very old, low productivity stands (e.g., bog woodlands) less than 10 m tall, respectively. Stage 3, without additional substages, should be used for regenerating forest communities that are herb or shrub dominated, including shrub layers consisting of only 10–20% tree species, and undergoing normal succession toward climax forest (e.g., recent cut-over areas or burned areas).
4 Structural stages 4–7 will typically be estimated from a combination of attributes based on forest inventory maps and aerial photography. In addition to structural stage designation, actual age for forested units can be estimated and included as an attribute in the database, if required.
5 Biogeoclimatic Group A includes BWBSdk, BWBSmw, BWBSwk, BWBSvk, ESSFdc, ESSFdk, ESSFdv, ESSFxc, ICHdk, ICHdw, ICHmk1, ICHmk2, ICHmw3, MS (all subzones), SBPS (all subzones), SBSdh, SBSdk, SBSdw, SBSmc, SBSmh, SBSmk, SBSmm, SBSmw, SBSwk1 (on plateau), and SBSwk3.
6 Biogeoclimatic Group B includes all other biogeoclimatic units (see Appendix C).

Structural Stage Modifiers

On Jedediah the 't' - two storied, structural stage modifier was used in stands where there were two distinct layers of trees. In particular, this modifier was used on ecosystem units with an abundant number of mature trees in the overstory and younger trees in the understory. Structural stage was applied to the unit according to which group of trees had the greatest percentage of cover. For example, if the site had 40% cover of mature trees and 20 % of younger trees, structural stage 6 was applied.

The following is a list of TEM standard codes for structural stage modifiers taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).

Table 3: Structural stage modifiers and codes[1]

	Modifier	Description
s	**single storied**	Closed forest stand dominated by the overstory crown class (dominant and co-dominant trees); intermediate and suppressed trees account for less than 20% of all crown classes combined[3]; advance regeneration in the understory is generally sparse.
t	**two storied**	Closed forest stand co-dominated by distinct overstory and intermediate crown classes; the suppressed crown class is lacking or accounts for less than 20% of all crown classes combined[3]; advance regeneration is variable.
m	**multistoried**	Closed forest stand with all crown classes well represented; each of the intermediate and suppressed classes account for greater than 20% of all crown classes combined[3]; advance regeneration is variable.
i	**irregular**	Forest stand with very open overstory and intermediate crown classes (totaling less than 30% cover), and well-developed suppressed crown class; advance regeneration is variable.
h	**shelterwood**	Forest stand with very open overstory (less than 20% cover) and well-developed suppressed crown class and/or advance regeneration in the understory; intermediate crown class is generally absent.

1 Structural stage modifiers should be used as in the following examples: 5s for young forest stage with single-storied structure or 7m for old forest with multistoried structure. The only structural stage modifier, other than single storied, generally applicable to structural stage 3 is "h" (for shelterwood). This can be used to describe recently regenerated stands with a very open overstory (less than 20% cover of mature trees or vets) and a (usually dense) understory of seedlings and saplings.
2 Based on either basal area or percent cover estimates.

Stand Composition Modifiers

The following is a list of the TEM standard codes for stand composition modifiers taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).

Table 4: Stand composition modifiers[1] and codes

Modifier		Description
C	coniferous	Greater than 3/4 of total tree layer cover[2] is coniferous
B	broadleaf	Greater than 3/4 of total tree layer cover[2] is broadleaf
M	mixed	Neither coniferous or broadleaf account for greater than 3/4 of total tree layer cover[2]

[1] Stand composition modifiers should be used as in the following examples: 6C for mature forest of coniferous composition, 7mM for old forest with multistoried structure and mixed composition, 3bC for tall shrub community dominated by coniferous saplings.
[2] Stand composition modifiers emphasize overstory and intermediate tree layers, since these are the most visible on aerial photographs.

Discussion of Map Reliability

Survey Intensity

All sites described have been identified in the field. Some sparsely vegetated and anthropogenic units, for example, RO (rock outcrop) and CL (cliff), were observed in the field and on the air photos but no plot data was collected. A total of 372 polygons were delineated. Eight detailed plots, 18 ground inspection plots, and 300 visuals inspections were completed. The plot location map (Appendix 3) indicates where each type of inspection was completed. Numerous polygons were visited without formal visual plot cards being completed. In these cases notes were made on photos and in notebooks to confirm airphoto pretyping and these are not included in the plot location map. Three hundred and twenty-six polygons were visited equating to a survey intensity of 87% (equivalent to level 1 under the RIC standards). All other areas were photo interpreted.

Air Photographs

Black and white aerial photographs, taken in 1986, at a scale of approximately 1:5000 were used for mapping the study area. The age of the photos made it difficult to interpret a few areas that appeared forested on the photos but had been cleared since the photos were taken. This aspect of the photography made it difficult for navigation during the field season as the forest edge seen on the photo was different than what was on the ground. With the black and white photographs it was at times difficult to distinguish between bare rock and some disturbed units that occurred in similar situations. The colour copies of the air photos proved to be very helpful for orientation during field sampling although the images were not as clear as those on the original photos which did result in some confusion.

Ecosystem Identification

Although the scale of the airphotos did allow for significant detail to be captured, many small 'pocket' ecosystem types were too small to be delineated or even complexed with other units. Examples of these include areas where water collected in bedrock basins often smaller than 2 metres square and small seepage pools. In these situations, small inclusions of ecosystems were noted in the comments field of the database.

Due to the lack of understory vegetation, many of the plant species normally used to support site series identification were not available on Jedediah. This was further complicated by the presence of many introduced species. As a result, emphasis was placed on the tree species present and site, soil and terrain features to determine forested site series.

Mapping Limitations and Considerations

Few mapping limitations were encountered as the mapping was completed at 1:5 000 scale and most of the study area was traversed by foot. Detailed soils information such as the location of pans or cemented soils horizons, and the distribution of variable surface or subsoil textures was not undertaken. However, some of this information exists on the plot cards where full soil data was collected.

RESULTS AND DISCUSSION

Site Series and Ecosystem Units

Jedediah Island is located wholly within the CDFmm Biogeoclimatic subzone. Table 5 lists the various ecosystem units mapped, the total area of each unit mapped and the percentage each represents of the total study area. Six site series were mapped ranging from mesic sites (01/DS) to the most dry and poor sites (02/DA). Of the richer site series only two were mapped, the FdBg – Oregon-grape (04/DG) and the CwBg - Foamflower (06/FR). Two fluctuating water table units, 12 (RV) and 14 (CS) were also mapped; six previously undescribed, non-forested units, such as wetlands and forb dominated communities; and six sparsely vegetated, non-vegetated, and anthropogenic units were also mapped.

Complete accounts for each ecosystem unit are provided in the expanded legend (Appendix 5). Each unit is described over two pages. The first includes a description of the ecosystem; the typical location, site, soil and terrain characteristics, and a photo showing the appearance of the unit. A small distribution map indicates all polygons where the unit is mapped in at least one of the three deciles, regardless of how small a component. The second page provides a summary of dominant, indicator and associate plant species at each developmental stage.

Dominant species are defined as those having 5% or higher cover and occurring in the unit with 75% frequency; indicators are those species found greater than 60% of the time; and associates are all others that occur with a minimum of 40% frequency. Six potential structural stages are listed for the forested ecosystem units. Structural stages that were not sampled are extrapolated from other developmental stages, known seral community types and plot information from other studies in similar areas. For the edaphic units only the herb or shrub stages are described. Notes to further describe the unit or explain how the findings on Jedediah may differ from sites found in other areas of the CDFmm are provided at the bottom of the table. Because vegetation has been highly impacted by disturbance on Jedediah, a species list is provided on the right hand side of the table to show the normal expected species in a mature, undisturbed, forested site series within the CDFmm. These list have been generated based upon the Ministry of Forests Environment and Vegetation tables (Inselberg, 1991).

Table 5: Ecosystem units mapped for Jedediah Island

Ecosystem Unit Code/Number	Ecosystem Unit Name	Ha[2]	% of study area
BE/00	Beach	1.93	0.62
CF/00	Cultivated Field	6.19	1.99
CL/00	Cliff	0.42	0.14
CO/00	Cultivated Orchard	0.94	0.30
CS/14	Cw[1] - Slough sedge	5.88	1.89
CV/00	Cladina - Wallace's selaginella rock outcrop	12.27	3.95
CV:dw/00	Cladina - Wallace's selaginella rock outcrop: Dicranum - Wallace's selaginella, seral community	50.18	16.17
DA/02	FdPl[1] - Arbutus	94.37	30.41
DG/04	FdBg[1] - Oregon grape	5.11	1.65
DS/01	Fd[1] - Salal	85.67	27.61
FC/00	Fescue - Camas rock outcrop	4.39	1.41
OR/00	Oceanspray - Rose	1.20	0.39
RF/06	CwBg[1] - Foamflower	15.02	4.84
RO/00	Rock outcrop	23.52	7.58
RR/00	Rural	0.65	0.21
RV/12	Cw[1] - Vanilla-leaf	2.29	0.74
SL/00	Sedge - Western lilaeopsis shoreline community	0.21	0.07
SS/00	Spiraea - Sedge wetland	0.08	0.03

[1] Bg – grand fir, Cw – western redcedar, Fd – Douglas-fir, Pl – lodgepole pine.

Three hundred and seventy-two polygons were mapped, 64 (17%) were mapped as pure units (i.e. only one ecosystem), the rest were complexes of two or three units. The most frequent complex was the DA/02 - FdPl - Arbutus with the CV/00 - Cladina - Wallace's selaginella or CV: dw/00. - Cladina - Wallace's selaginella: Dicranum - Wallace's selaginella, seral community type. These were found on gentle or hummocky slopes and crest positions. Common also were complexes of the DA/02 - FdPl - Arbutus and DS/01 - Fd - Salal site series with the DS unit usually in gullies within the polygon. In general the wetter units were more common at the northern end and central portion of the island whereas the drier units and those found on shallow soils were mapped more frequently on the rocky southern end.

One seral community type was mapped. The CV:dw seral community type is believed to exist due to disturbance of the ecosystem. Although animal use was not observed, many fecal pellets and overturned Cladina mats suggest that this unit may be maintained at the seral stage by extensive sheep and goat use on Jedediah Island. Many of these units are found on warm slopes supporting the concept that feral animals use these sites as loafing areas. Species composition and densities differ between the two bryoid communities. Cladina species were more common and of higher cover in the CV unit. Dominant moss species differ in each with more mosses present in the dominant vegetation for the CV: dw unit (see plot data and expanded legend for more details). A variety of spring wildflowers were commonly observed (> 60% frequency) in the CV unit whereas only one spring flower species is included in the associate species list for the CV: dw. More introduced species were noted in the seral unit. Occurrences of the seral unit on Paul Island have resulted from fire. No evidence of sheep or goats was noted on Paul Island.

One small Spiraea - Sedge wetland (SS/00) was found on Jedediah, in polygon 339, north and east of the homestead. This ecosystem, while less than one half hectare, is an example of a shrub swamp, dominated by hardhack (*Spiraea douglasii*) and slough sedge (*Carex obnupta*).

Disturbance History

Harvesting

Much of Jedediah Island was logged at the turn of the century. Numerous large stumps are present across the island, many showing a history of springboard logging (Figure 4) and other harvesting methods. Harvesting was concentrated in the main valleys; selective cutting appears to have occurred on the upper slopes. In most cases, the forested ecosystems have regenerated to young forests (stage 5) or mature forests (stage 6). Only about 4 % of the mapped ecosystems show old growth characteristics.

Figure 4: Tree stump shows history of springboard logging on Jedediah.

Fire

Small, low intensity ground or surface fires appear to have been a common event on Jedediah as evidenced by the high number of trees displaying burn scars. This is also supported by the frequent occurrence of veteran, fire scarred Douglas fir trees scattered throughout pole sapling and young forests. An intensive fire burned over most of the central and northern portions of Paul Island around 1972. Most forests on this island have reached the tall shrub (stage 3b) or pole sapling (stage 4) structural stages, between the ages of ten and 20 years, and 20 - 40 years respectively

Agriculture

Approximately 1.2 hectares of land were cleared on Jedediah to accommodate dwellings, farm buildings, gardens and a small orchard. These are located on the north side of Home Bay and at Long Bay. Two fields, totalling almost seven hectares, were cleared for grazing livestock, one in the centre of the island and the other south of Long Bay. Drainage ditches were constructed in these areas, altering natural drainage patterns, to control flooding. The pasture at Long Bay was not cultivated. It was mapped as the RV, Western redcedar - Vanilla Leaf unit and the RF, Western redcedar - Grand fir - Foamflower unit. If soil drainage was allowed to return to its natural state this area would eventually return to a moist rich forested site with moderate to poor drainage. The larger clearing in the centre of the island may have been a fen prior to alteration (Roemer, 1999) as evidenced by the ring of redcedar swamp (CS) that surrounds it. This is also supported by the 20 cm of Ah horizon (organic enriched mineral soil) present in this unit. Most of this clearing was mapped as a cultivated field (CF), due to the extent of alteration to the site.

Feral Animals

Extensive grazing by feral goats and sheep has greatly impacted the composition, abundance and vigour of the island's vegetation. The sheep appear to restrict themselves to the cleared fields and grazing maintains these ecosystems at the herbaceous stage (Figure 5). The goats however are able to access nearly all areas of the island and few sites are unaffected by their activities (Figure 6). Shrub and herb layers are noticeably absent in most forested ecosystems except where cliffs or water limit passage, for example polygons 104 and 105. Observations suggest that the portion of the island north of the central field is less impacted by grazing than the southern end.

Tree regeneration is minimal to absent where grazing occurs. Grazing on new growth of seedlings and trees less than one metre was consistently noted. In many cases, arbutus trees (less than 1 m) have been killed from repeated heavy grazing as have many salal patches (Figure 7).

Figure 5: Ecosystem maintained at herb stage due to extensive grazing by sheep.

Figure 6: Grazing by feral goats on Jedediah Island has negative impacts on vegetation.

Figure 7: Dead salal and arbutus shrubs resulting from grazing.

Figure 8 illustrates the differences within an ecosystem where grazing has eradicated the understory and where intensive grazing has not yet occurred. Note the distinct grazing line through the middle of the photograph. On the left, salal growth is healthy and robust while on the right the understory is non-existent.

Figure 8: Evidence of extensive grazing by feral goats is seen on the right side of the photo.

In addition to the detrimental results of grazing on vegetation abundance and vigour, species composition has also been affected. Species composition varies between Jedediah Island and the nearby smaller islands. This difference was particularly apparent during the spring sampling session where wildflowers (Seablush, common camas, nodding onion, monkey flower etc.) were common and widely distributed on Paul Island and the islets (Figure 9) while on Jedediah the only wildflowers observed were death camas *(Zygadenous venenosus)* (Figure 10) and small flowered blue - eyed Mary (*Collinsia parviflora*). In 1971, camas flowers were abundant according to Mary Palmer in her book "Jedediah Days" (1998). Few berries were observed during the fieldwork although they too were reported to be abundant during the seventies and before (Palmer, 1998). Absent from Jedediah but observed on the other islands were several species that would normally be anticipated in the local flora, kinnikinnick (*Artostaphylus uva-ursi*), fireweed (*Epilobiium angustifolium*), miner's lettuce (*Montia perfoliata*) and wild strawberry (*Fragaria virginiana*) (Roemer 1999). Many dominant and indicator vascular species of the CDFmm were also not found on Jedediah Island; fringecup (*Tellima grandiflora*), vanilla-leaf (*Achyls triphylla*), snowberry (*Symphoricarpos albus*), white fawn lily (*Erythroniun oregonum*), twinflower (*Linnaea borealis*), foamflower (*Tiarella spp*.), western flowering dogwood (*Cornus nuttallii*), western yew (*Taxus brevilfolia*), cascara (*Ramnus purshiana*) and Indian-plum (*Oemleria cerasiformis*) to name a few. While it may be impossible to confirm many of these species were historically present on the island, provincial vegetation tables for the subzone suggest they are common in other areas of the CDFmm. In 1996, a student group from Centennial School in Coquitlam, BC visited Jedediah to survey the vegetation. They reported occurrences of Western yew, Foamflower and a strawberry species. These species were not observed during the TEM field sessions. The demise of many of the above noted species may have occurred as recently as the last decade.

Figure 9: Spring wildflowers on the nearby islets.

Figure 10: Death camas *(Zygadenous venenosus)* on Jedediah Island.

Rare Elements

One rare plant, the great chain fern, *Woodwardia fimbriata* (Figure 11), was found on Jedediah Island at plot VCEJ17 (site series RV/12 - Cw - Vanilla-leaf). This plant is red listed at the Conservation Data Centre (CDC).

According to the CDC (1999), red listed plants usually occur in endangered or threatened habitats. Each red and blue listed species is ranked for global and provincial significance. *W. fimbriata* is ranked globally as secure (G5), but provincially as, imperiled (S2) This rank is defined as "imperiled" provincially because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Nineteen occurances of this species are documented with the CDC. The *W. fimbriata* plants on Jedediah were heavily grazed and sheep were present at the site. During the spring field session, the crew was unable to relocate the specimens.

Allium amlpectens, a species recently removed form the Provincial blue list, was found on the south west shore of Paul Island by Hans Roemer of BC Parks during the spring '99 sampling. The blue list includes vulnerable rare taxa that could become candidates for the red list in the foreseeable future. It also features plants that are suspected of being vulnerable, but for which information is lacking at this time.

Figure 11: Red listed Great chain fern *(Woodwardia fimbriata)* on Jedediah Island

Naturalness Evaluation on Jedediah Island

The Conservation Evaluation forms, a modified version of the Conservation Data Centre's Site evaluation form, were used to assess the naturalness of each polygon visited on Jedediah. The CDC typically completes site evaluations to determine if an area is suitable for conservation or to compare sites being considered for protection. However, the conservation evaluations were instead used in this study: 1) to determine if any areas or ecosystem units in the park were in an undisturbed condition; 2) to determine if certain areas or ecosystem map units were more or less damaged by grazing activities; and 3) to ascertain the extent of alien species invasion. Additionally, it was intended the evaluations would provide a guide to where restoration efforts could be most effective by evaluating the degree of naturalness for each polygon.

Plant Species

Observations on Jedediah suggest that every vegetative life form on the island is being negatively impacted by the grazing disturbance of feral animals (Figure 12). There is little tree regeneration; where seedlings occur, they are regularly browsed and were sometimes observed to be already dead or dying.

Shrubs are very reduced and many expected shrub species are not present, suggesting they may have been extirpated from the island. New growth on shrub species is consistently browsed, sometimes older growth has been so heavily grazed that the plants are dying. All fern species are decreasing in abundance (Roemer 1999); many individual plants are grazed down to ground level. The rare chain fern *(Woodwardia fimbriata)* was located in September 1998, but could not be seen in the same spot in May 1999. Few of the expected herbs are present in forested sites and herbaceous openings. Herbs from the lily family are particularly affected; the only lily species found in any abundance on the island was death camas *(Zygadenus venenosus)*, a species consistently avoided by grazing animals due to its toxic properties. Only twelve of the 24 grass species observed were native; one of these, *Koeleria macrantha*, was seen only on the smaller islets. Bryophyte species also appear to be negatively impacted. Where forest openings dominated by lichens and mosses occur on warm south facing aspects, the lichen/moss community has been replaced by a seral community type lacking in lichens and with increased numbers of introduced grasses and forbs (Figure 13). All ecosystem types have been affected by disturbance either through intensive grazing or physical damage by trampling and loafing activities.

Figure 12: FdBg – Oregon grape, structural stage 7 on coarse soils. Grazing disturbance is evident bythe lack of understory vegetation.

Figure 13: Dicranum - Wallace's selaginella seral community type (CV: dw) on south facing slope.

Rare Plant Associations

The Conservation Data Centre (CDC, 1999) tracks rare and endangered plant associations throughout the province. The list and rank of plant associations tracked by the CDC, which were mapped in the study area follows in Table 6. The rank reflects the rarity of plant association occurrences that have not been disturbed by humans or domestic animals, and are in a natural or "climax" state. In this mapping project the mapped ecosystem element is the "site series" with an indication of its structural development stage and specific features of the site. Because the site series is a member of a plant association, (the relationship may be exclusive or there may be many site series within one plant association) each site series reflects the rarity rank of its parent plant association. Hence, the site series mapped on Jedediah Island which have reach structural stage 6 (mature forest) or 7 (old growth) are considered to represent these rare plant associations.

Three previously undescribed community types were mapped: the Cladina - Wallace's selaginella (CV) and its seral association, Cladina - Wallace's selaginella: Dicranum - Wallace's selaginella (CV; dw), the estuarine marsh Western lilaeopsis - sedge wetland, and the Spiraea - sedge fen. As little is known of the distribution of these community types within the CDFmm, it is not possible to assign them a rarity rank. However, the low number of occurrences and level of disturbance on Jedediah Island suggest that they should be viewed as potentially rare and threatened on the island and within the CDFmm.

Table 6: Ratings of Plant Associations and relationship to Ecosystem Units mapped in the study area.

Plant Association	Common Name	Equivalent Site Series (map code)	CDC Ranking[1]	Prov. Listing
Abies grandis / Mahonia nervosa	Grand Fir / Dull Oregon-Grape	CDFmm/04 (DG)	S1S2	Red
Abies grandis / Tiarella trifoliata	Grand Fir / Three-Leaved Foamflower	CDFmm/06 (RF)	S1S2	Red
Alnus rubra / Carex obnupta [Populus balsamifera Ssp. trichocarpa]	Red Alder / Slough Sedge [Black Cottonwood]	CDFmm/14 (CS)	S1	Red
Pseudotsuga menziesii - Pinus contorta - Arbutus menziesii	Douglas-Fir - Lodgepole Pine - Arbutus	CDFmm/02 (DA)	S2S3	Blue
Pseudotsuga menziesii / Gaultheria shallon	Douglas-Fir / Salal	CDFmm/01 (DS)	S1S2	Red
Thuja plicata / Achlys triphylla	Western Redcedar / Vanilla Leaf	CDFmm/12 (RV)	S2	Red

[1]CDC ranking codes are explained on the CDC wessite – http://elp.gov.bc.ca/rib/wis/cdc

Naturalness Ratings

The ratings are, 1) Naturalness: a combination of quality and condition and 2) Viability: a combination of viability and defensibility. Naturalness provides an indication of conditions, as we found them in September 1998. It should be noted that these conditions are not stable and can deteriorate very quickly. Viability ratings provide some indication of future conditions if the present trends continue. They are only relevant if the disturbance regime remains unchanged. At the start of sampling the conservation evaluations were based on the field crews' knowledge of other areas of the CDFmm. As they became more familiar with the ecosystems and the overall conditions on Jedediah the evaluations became more relevant to the island and earlier ratings were adjusted as required.

Analysis of the naturalness and viability ratings show that there are very few units that were rated as excellent (1) or good (2) for naturalness with a high likelihood of remaining in that condition (viability = 1 or 2) if the present management situation were to continue. Eighty - two percent of the mapped units fell into the range of marginal (3) to poor (4) for naturalness and viability, with the majority (approx. 51%) being rated as marginal for naturalness and poor for viability. At the extremes of the scale, approximately four percent of the ecosystems were rated as excellent in both naturalness and viability. These are mostly located on Paul Island and the surrounding islets. Approximately eight percent were rated as poor in both categories.

The 14/CS - Western redcedar - Slough sedge has been heavily impacted. Ratings for this unit range only from 3 / 4 to 4 / 4 for naturalness / viability. Five percent of the 00/CV - Cladina - Wallace's selaginella had very high ratings (1 / 1) while 13% of this unit was mapped very poorly (4 / 4). The CV:dw - Dicranum - Wallace's selaginella, seral community type is by definition a highly disturbed site and represents approximately 80% of the bryophyte type ecosystems in the study area. The 00/FC, Festuca - Camas unit, was rated excellent in both categories eleven out of the 53 times it was mapped (21%) and the 00/OR, Ocean spray - Rose unit, was found in excellent condition five out of 12 times (42%). However it should be noted that the best ratings for the OR were found on the small islets while the instances on Jedediah were rated good to moderate with poor viability.

The red and blue listed plant associations found on Jedediah are forested ecosystems at developmental stage 6 or 7. Only two plant associations were mapped at structural stage 7: Pseudotsuga menziesii / Gaultheria shallon (01/DS) was mapped eight times and Abies grandis / Tiarella trifoliata (06/RF) only once. The highest rating, which was applied only twice, for the 01/DS was 1 for naturalness and 2 for viability; the 06/RF was mapped once as 3 and 4 respectively.

Several plant associations were mapped at structural stage six. Table 7 shows the highest ratings of each forested plant association at structural stage six and how often it was mapped at that rating.

Table 7: Naturalness and Viability Ratings for forested plant association at structural stage six

Plant Association	Equivalent Site Series/Map Code	Naturalness	Viability	Frequency
Abies grandis / Mahonia nervosa	04/DG	2	3	1
Abies grandis / Tiarella trifoliata	06/RF	1	4	1
Alnus rubra / Carex obnupta [Populus balsamifera Ssp. trichocarpa]	14/CS	3	4	1
Pseudotsuga menziesii - Pinus contorta - Arbutus menziesii	02/DA	1	2	2
Pseudotsuga menziesii / Gaultheria shallon	01/DS	1	2	3

As mentioned earlier, the CDFmm has few old growth sites remaining and development pressures are intense. With Jedediah Island's Class A Provincial Park designation certain assurances for protection are implied. As a result, the above units are probably good recruitment sites for endangered plant associations and as such may be good areas to emphasize protection and restoration efforts.

A tally of naturalness and viability ratings, sorted by structural stage for all units are provided in Appendix 6. An interpretive map (Appendix 7) displays naturalness and viability ratings for each polygon. These ratings are displayed by the first decile only and while there may be some variability when the other deciles are overlayed the general trend remains similar. However, when this information is layered over the first decile the map becomes difficult to interpret.

RECOMMENDATIONS

Restoration Options/Problems

The goats and sheep must be removed or contained in order for any of the ecosystems on Jedediah to return to natural conditions. The following discussions assume that the feral animals will be removed. Even after the livestock are removed it is likely that additional management methods will have to be instituted.

The draft management plan for the park states proposed objectives to include management actions to:

- restore and maintain the native plant communities and species, with special attention to sensitive, rare, threatened or endangered plants in the Natural Environment Zone.
- control invasive non-native species and discourage establishment of additional non-native species in the Natural Environment Zone.

In order to realize the former, the livestock must be removed or foolproof methods be designed to control their activities. This first goal will be impossible to affect in the face of ongoing disturbance.

To fulfil the latter objective, there are five principal control methods for dealing with alien plant species:

1. chemical herbicides,
2. physical removal,
3. prescribed burning,
4. biological agents, and
5. integrated or ecological pest management

Some of these, in particular herbicide applications, are not recommended for use in National Parks. It will be necessary to weigh the various options to determine how effective each method may actually be in controlling the targeted species and how detrimental the method may be to the habitat and further how those impacts will carry over to native vegetation. (Invasive Plants in Natural Habitats in Canada. Environment Canada. 1993). Finally there are fiscal considerations.

It is difficult to predict how the ecosystems will respond after the removal of the livestock from Jedediah. Normal successional patterns have been altered by repeated disturbance. Biodiversity may be permanently lost and the communities that result may be more simple than before. Recovery after disturbance is slower in coniferous forests than in deciduous forest (Forest Succession -Ed. West et al. 1981) and Jedediah is dominated by coniferous or mixed forests. As detritus is important in nutrient recycling in forest succession (Barbour et al., 1987.) and because most small plant matter has been eliminated by grazing activity on Jedediah, the normal rates of succession may be altered (slowed). The forest floor is nearly non-existent in many places and numerous nudum sites exist. Shrub and forb stock from less damaged areas of Jedediah Island or nearby islands could be planted to help initiate restoration.

Removal of the feral animals will initially allow increased vigour and and growth of all species present but may, in time, result in a broader distribution and greater abundance of non-native species. It is feasible that while grazing has destroyed the native vegetation it may also have forestalled invasive plants from totally occupying some sites. Bryoid communities and ecosystems on dry, shallow soils are particularly susceptible to encroachment by non-native grass species (Douglas, G. pers. comm.) and grasses appear to be one of the more preferred browse on these sites. It should be anticipated that these sites would also be the slowest to recover.

Little is known about the displacement abilities of alien species. However given the weeds affinity to populate disturbed sites and given Jedediah's modified conditions it is conceivable that without intervention, these species may become well established before conditions are conducive for native plant fecundity. Mechanical removal of non-native species, another form of disturbance, may result in the same alien species returning to an area due to viable seed stock. Planting of natives may be useful.

Forested sites will probably see the quickest recovery after disturbance. Moist ecosystems tend to recover more readily than drier sites. Although many of the dominant shrub species will likely recover relatively quickly, there may be additional competition between different life forms as each begins to be re-established. For example, salmonberry is a major competitor for conifers and may inhibit establishment of seedlings. Salal regenerates vegetatively, but may present some competition particularly during early stages of seedling development. Repeated cutting of bracken (esp. more than 3 times per year) has been used effectively as a control measure when this species becomes competitive to conifer development. Although the rhizome is usually not destroyed by cutting, the frequency and extent of disturbance in the study area has been excessive, and may reduce the chance of bracken re-establishing itself. Bracken is an important species for nutrient cycling because of the abundance of dead leaves added to the litter layer each year and also serves to provide fuel for natural fires. It has been shown to prevent natural regeneration and retard conifer growth (Haeussler and Coates. 1986).

Successful recovery of perennial varieties of native herbs, such as foamflower (*Tiarella trifoliata*) and broad-leaved starflower (*Trientalis latifolia*) should be observable after one to two disturbance free growing seasons. Regeneration of annuals will be dependent upon the availability of seed stock in the soil; ferns, dependent upon the viability of rhizomes. Perennial bulbs of the lily family, such as camas have been shown to come back after years of disturbance (Ussery, pers. com.). Restocking of native plants or supplying seed stock may be required to achieve the natural distributions and abundance.

Another consideration in the restoration process is where to emphasize efforts. It may be advisable to try to restore ecosystems that are least impacted while forsaking those with the most extensive damage. Some of the more damage sites may not be recoverable therefore financial resources may be wasted. On the other hand, the more impacted sites may also be the more endangered ecosystems and hence be a priority for restoration work. It is likely that human activities (recreation) will also have to be restricted in certain areas while restoration procedures are ongoing to allow the ecosystem to recover and to reduce the possibility of introducing other non-native species. Public education to make park users aware of the restoration plans, the importance of remaining out of recovering areas, staying on trails, avoiding sensitive vegetation and leaving the park intact are important aspects to a rehabilitation program. The use of on-site naturalists or park wardens, although costly, may prove helpful in enforcement. Ongoing monitoring of the restoration process should be implemented to determine which efforts are successful and where more management is required.

Park Development Recommendations and Limitations

Future Park development may include establishing campsites, building outhouses and maintaining or deactivating trails. Interpretation of TEM polygon attributes should point out areas that may be sensitive to or unsuitable for development. Interpretations can be made using Geographic Information Systems, on the distribution or abundance of an ecosystem unit, the type of vegetation found in the unit, moisture regime, terrain, site and soil characteristics or other attributes relevant to the type of development anticipated.

Ecosystem Considerations

Because disturbance has had such a strong influence upon the ecosystems on Jedediah, it is recommended that "as little as possible" be the governing strategy for park development. Unless demands by recreationists necessitate more sites, camping should be restricted to the two areas now used for this purpose, at Home Bay and Long Bay. In the event that more camping facilities are required certain ecosystem units should be avoided for development. These include all CV and CV: dw units, as well as, all wet units, such as the RF/06, RV/12 and CS/14. Old growth and older second growth forests should be avoided because of the rarity of these sites in the CDFmm in general and within the Park specifically. Any units rated as 1 or 2 for naturalness should be avoided. If necessary, more camping could be located at the end of Boom Bay in polygon 235. This polygon is already cleared, is heavily disturbed by introduced species, is fairly flat and has outhouse facilities near-by. The homestead area, for example the old orchard or pastures, would also be good choices. Consideration of the number of campsites and therefore, the island visitors, and their impact on the island should also be taken into account.

Old roadbeds and trails are well established throughout the low lands of the island and provide adequate access to camping areas and moorage sites. Many additional trails have been well used by the feral livestock and these provide hiking opportunities. The summits at Spyglass Hill and Gibraltar offer fabulous vantage points that people will pursue. Trails should follow the path of least resistance, as hikers will tend to use this route regardless of whether official trails exist here. As for campsite development, the same ecosystem units should be avoided when trail building. Trails that already exist should be used wherever possible, particularly when the more sensitive ecosystems must be traversed to reach the target destination. Interpretive signs should be installed to explain the importance of staying on trails and not damaging vegetation in any other manner. Trails that pass through the wetter ecosystem units should be deactivated wherever possible to allow these units to recover. Careful thought should then be given to later reopening these trails by weighing the degree of damage that is likely to be exerted on the unit versus the recreation opportunity made available by this action. Boardwalk trails may be useful in these situations.

Effort should be made to discourage recreational activity in any areas that have a high density of excellent or good naturalness ratings. For example, the northeastern portion of Jedediah has a pocket of relatively less disturbed polygons. The lay of the land (i.e. a high rock crest) and the steep rocky shoreline create a natural barrier to this part of the island and should be utilized to reduce access to maintain the present state. No additional trails should be built into this area.

Soil and Terrain Considerations

There are few soil and terrain limitations to park development on Jedediah Island due to the abundance of well drained sandy textured soils throughout the island. Trails, campsites, small building sites, and toilet facilities are likely future developments or improvements. Terrain interpretations for these activities are discussed.

Terrain and soil drainage symbols, used for these interpretations, are recorded for each Jedediah map unit and can be secured from the terrain portion of the ecosystem database. For example the poor and imperfectly drained map units, which pose some concerns, are recorded as **p** and **i** in the 'drainage' columns of the database. Other terrain information associated with each map unit provide some of the following information:

- terrain texture: informs whether the soils are sandy, silty , or clayey
- genetic or surficial material : indicates whether the soil parent materials are of marine, glacial till, colluvial origin or if mainly bedrock
- surface expression: informs whether the area is hummocky, steeply sloping or if the materials are deep (greater than one metre depth), or shallow (twenty to fifty centimeters depth), or very shallow (less than 20 cm depth),
- geological process: informs whether the land is washed by waves or has gullies, and
- soil drainage: indicates whether the map unit is poorly, imperfectly or well drained.

These classifications will help to do 'overview' planning when applied in a GIS mapping system, or when used manually with a data base and polygon number map. It is assumed Park officials will do on-site assessments of all developments. Each terrain term is explained, with definitions, in The Terrain Classification System for BC. 1996, and in the Field Manual for Describing Terrestrial Ecosystems, 1998, or on the government publications WEB site (http://www.publications.gov.bc.ca).

The main areas of concern for development include: areas with poor and/or imperfectly drained soils, areas of steep slopes occurring mainly on bedrock, and areas with very thin soil with lichens and mosses over rock.

The use of poorly drained areas (Figure 14 and 15) for trails campsites, toilette and building sites will result in erosion, compaction and muddy conditions; further, sediment will likely move into the small drainages over time. These areas are identified with the terrain symbols as **czWbv p - i** (meaning clayey silty Marine blankets and veneers with poor and imperfect drainage). Examples of these areas occur around the head end of Sandy Beach, Deep Bay and near the stream mouths entering Home Bay and Long Bay. Consideration should also be given to near surface soil and groundwater quality over time with the installation of particulary plumbed toilettes, on these poorly drained clayey sites. Leachate will eventually escape over the slowly permeable subsoil and into the surface water systems.

Figure 14: Poorly drained, marine sands at the head end of Long Bay. *Juncus* covers the wet soils

Figure 15: Soil profile of imperfectly drained marine sands - a Gleysol. Note the orange mottles, indicative of soil saturation during winter. (Long Bay area. Polygon # 249 labelled sWb I.)

Use of steeper rock slopes, cliffs and terrain covered with very thin lichen and moss (Figure 16) has safety and erosion concerns. Many very steep slopes occur. These are identified as Rs, Rks, Cx/Rks (meaning steep rock; steep and moderately steep rock; thin colluvial [10cm of soil] over rock with moderate and steep slopes). Managers should be aware of the hazards associated with locating trails through these sites or having people hiking freely on such steep areas. Some sites are wet, salal covered, have loose unstable rubble and poor visibility.

The very thin soils occurring on rock crests and hollows have lichen communities which are very sensitive to traffic. The soils are only thin pockets of reddish brown loam derived from the weathered basalt, and once the vegetative cover is worn off, the thin soil will wash and blow away. These areas are identified as **xsCx, Cx, zxCx** usually over bedrock i.e. **sxCx/Ram** (meaning silty rubbly colluvial, very thin veneer).

The use of the well drained sands and gravelly soils, common in many of the valley floors, pose little concern from a terrain and soil perspective. These areas are mapped as sWbv w – m (meaning sandy Marine blankets and veneers, well to moderately well drained; other combinations of similar symbols are recorded as zsWGbv m – w , or gsWvb w). These materials should be relatively stable over time, even under heavy use.

However the installation of plumbed toilettes, particularly in 'excessively' drained soils such as gravel, sandy gravel or rubble (Figure 17) could pose even more serious groundwater concerns over time, as the leachate will move rapidly through these soils potentially contaminating groundwater and well water. Examples of these terrain symbols are gWbv r or sgWGbv r – w, or rCvb r (meaning gravelly Marine sediments, rubbly Colluvial deposits all rapidly drained.)

Figure 16: Steep rock with very thin soil and lichens.

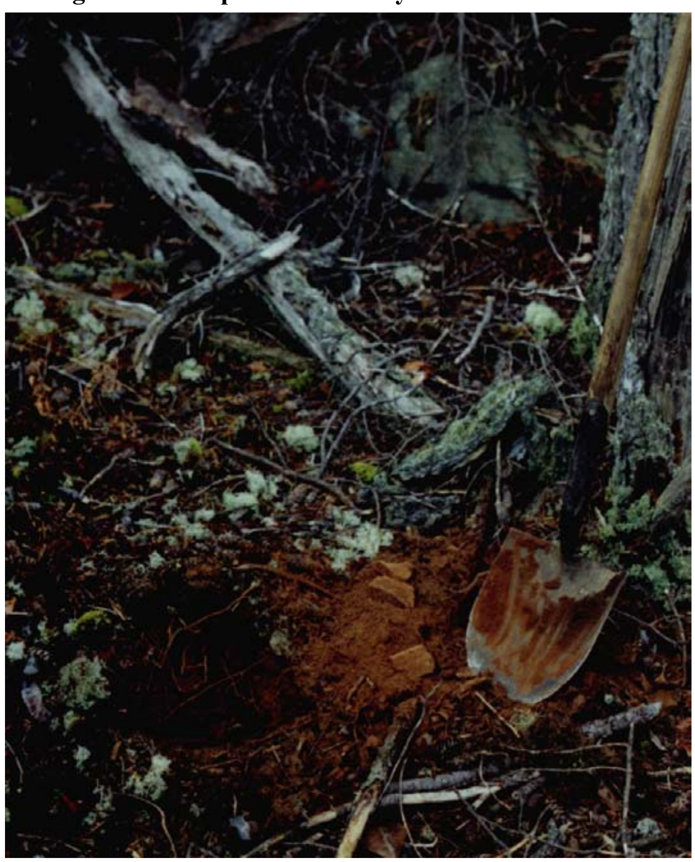

Figure 17: Sandy rubbly colluvium. Soils are rapidly to well drained and very porous.

WILDLIFE

INTRODUCTION

The Georgia Depression Ecoprovince has a diversity of endemic animal species, but the terrestrial ecosystems of the Strait of Georgia Ecosection are confined to islands with dry, mild climates such as Jedediah Island. The size and isolation of these islands have a major controlling influence on the occurrence and distribution of terrestrial vertebrate species.

The terrestrial vertebrate fauna of Jedediah Island is constrained by the island's small size and relative remoteness from the mainland and from Vancouver Island, which are the principle sources of species immigration. The only large native mammals consistently sighted on the island are Columbian Black-tailed Deer, which are common on most of the coastal islands and are known to swim readily between islands.

Medium-sized mammals such as raccoon, mink and river otter are regularly seen on Jedediah Island (MELP 1998a). These species are strongly associated with aquatic and coastal environments, feeding on shellfish and other intertidal vertebrates and invertebrates. Jedediah's extensive shoreline provides good foraging habitat for these animals.

There have been no documented bird surveys on Jedediah Island. The bird fauna of Jedediah is expected to reflect the island's size and location, with a diversity of marine bird species and to a lesser extent, forest-dependent species. The list of bird species on adjacent Lasqueti Island (Appendix 8) is most probably an indicator of the species occurring on Jedediah Island.

There have been no small mammal, reptile or amphibian surveys on Jedediah Island, so occurrence and abundance of these species remains uncertain. Because there are no permanent fresh water bodies on Jedediah Island, no freshwater fish or other stream and pond-dwelling species (e.g., Western Pond Turtle) occur here.

While seals, sea lions, whales and porpoises and many seabirds are present in the waters surrounding Jedediah Island, only animal species using the island habitats above the high tide line for feeding or reproducing were considered in this project.

OBJECTIVES

The objective of wildlife habitat mapping for Jedediah Island Marine Park is to provide input to the park management plan through estimating the potential value of the island's ecosystems to support particular wildlife species. Assessment of available habitat will enable park managers to direct management activities towards protecting and enhancing suitable habitats or enhancing habitats with a high capability, and allowing other, more intensive activities (e.g., recreation sites) on less suitable habitats. Habitat maps may also provide guidance towards development of wildlife viewing opportunities on or around the island.

METHODS

Habitat inventories assess available habitat, and do not provide an indication of species presence or abundance. Wildlife habitat capability and suitability maps are a product of habitat ratings that are applied to ecosystem maps. Capability is the ability of the habitat, under the optimal natural conditions for a species, to support a particular species, irrespective of the current condition of the habitat. Suitability is the ability of the habitat in its current condition to support a species[1]. Habitat ratings indicate the value of a habitat to support a particular wildlife species for a specified habitat use compared to the best habitat in the province (i.e., the provincial benchmark) (RIC, 1999).

Project Wildlife Species

To select the wildlife species for this habitat mapping project, the provincially red-listed (endangered or threatened) and blue-listed (vulnerable) species (CDC Tracking List, 1998) were reviewed. From this extensive list, a preliminary subset of red and blue-listed species that are most likely to occur on Jedediah Island was developed (Table 8). However, there have been no wildlife species inventories on Jedediah Island and it remains uncertain whether any of these species do actually occur on the island. Additional criteria other than provincial vulnerability were therefore needed to choose the species to be rated for this project. Specifically, the following criteria were used to select wildlife species for habitat mapping:

- the level of knowledge of the species' use of habitat;
- the ability of ecosystem attributes to capture the habitat features required by the species;
- the likelihood of the species occurring on Jedediah Island;
- the range of wildlife habitat available on Jedediah Island;
- the likelihood of the wildlife species being observed by the casual visitor.

Using these criteria, four vertebrate species were chosen for this habitat suitability mapping project:

1. Black-tailed Deer (*Odocoileus hemionus columbianus*).
2. Pileated Woodpecker (*Dryocopus pileatus*).
3. Bald Eagle (*Haliaeetus leucocephalus*).
4. Pelagic Cormorant (*Phalacrocorax pelagicus*).

Table 8. Some red- and blue-listed vertebrate species* that could occur on Jedediah Island.

Red-listed	Blue-listed
Baird's Cormorant (*Phalacrocorax pelagicus resplendens*)	Double-crested Cormorant (*Phalacrocorax auritus*)
Pelagic Cormorant (*Phalacrocorax pelagicus pelagicus*)	Great Blue Heron (*Ardea herodias*)
Peregrine Falcon (*Falco peregrinus anatum*)	Hutton's Vireo (*Vireo huttoni*)
Marbled Murrelet (*Brachyramphus marmoratus*)	Western Screech-Owl (*Otus kennicottii saturatus*)
Western Screech-Owl (*Otus kennicottii macfarlanei*)	Vancouver Island Pygmy-Owl (*Glaucidium gnoma swarthi*)
Purple Martin (*Progne subis*)	Townsend's Big-eared Bat (*Corynorhinus townsendii*)
Keen's Long-eared Myotis (*Myotis keenii*)	

(CDC Tracking List, 1998; Dave Fraser, pers. comm., 1998)
*Note: this is not an exhaustive list, but was an initial review to assess the species that would most likely occur on the island.

[1] For example, Pileated Woodpecker require a mature to old growth forest for nesting, so a clearcut is currently not very suitable for this species' reproducing habitat. However, given enough time, the clearcut site may have the potential to grow into a mature or old growth forest with a number of large, decadent trees capable of supporting a relatively high number of pileated woodpecker nests. The clearcut site would therefore have a low suitability, but a high capability for pileated woodpecker nesting habitat.

Species-Habitat Models

Wildlife habitat mapping for the Jedediah Terrestrial Ecosystem Mapping (TEM) project was conducted according to the standards outlined in *BC Wildlife Habitat Ratings Standards - Version 2.0* (hereafter referred to as the Standards). A species-habitat model for rating wildlife habitat, according to the Standards, consists of a species account, describing the habitat requirements and requisite natural history for the project species, and a preliminary ratings table. The preliminary ratings table, developed before field sampling, consists of an abbreviated table that provides habitat values for certain representative ecosystem units likely to occur in the project area. Essentially, it serves as a working hypothesis, for species-habitat values, which is tested during the field sampling. Ratings for Pelagic Cormorant habitat were not included in the ratings table because the majority of Jedediah Island terrestrial ecosystems represent completely unsuitable habitat for this species.

Using the preliminary ratings and plot data from field sampling, a final ratings table was developed. In the final ratings table, a rating for each species and habitat use is assigned to each unique ecosystem unit (i.e., combination of site series, site modifier and structural stage) on Jedediah Island (based on the TEM ecosystem database). Final species-habitat models were submitted to a Ministry of Environment, Lands and Parks provincial wildlife-habitat correlator in Victoria to ensure that the Standards were met, and the ratings corresponded to provincial broad ecosystem mapping. The final ratings table was then used to produce habitat maps.

Field Sampling

Field work for the wildlife habitat mapping was conducted in conjunction with the ecosystem mapping. Survey intensity level 1 (75-100% plot visitation) was used for Jedediah Island field sampling (RIC, 1998). Field work took place over 10 days from September 15 - 24, 1998, and sampling occurred on Jedediah Island, Paul Island and Circle Island. During field sampling, a wildlife biologist recorded habitat values on the Wildlife Habitat Assessment form (FS 882HRE 98/5). In the field, for Columbian black-tailed deer, we assessed feeding, security and thermal life requisites. For Pileated Woodpecker and Bald Eagle we assessed the feeding and a combined assessment for the security and thermal life requisites, because these latter life requisites are difficult to separate for these species. We also made an assessment of the reproducing life requisite for the Pileated Woodpecker and Bald Eagle. In addition, qualitative wildlife notes were also taken. Incidental wildlife-species observations (e.g., for provincially listed red and blue-listed species) were also recorded on the Wildlife Sighting form. On the final day of field sampling, an assessment for Cormorant (*Phalacrocorax* sp.) habitat was conducted. Cormorant habitat was assessed by circumnavigating the island by boat, and looking for suitable nesting habitat on the island's periphery. In addition to assessing habitat values for native wildlife, observations, such as behavior, numbers, locations, evidence of browse, evidence of reproduction, were also collected on the feral goats (*Capra hircus* Linnaeus) and sheep (*Ovis aries* Linnaeus) on Jedediah Island.

Wildlife Habitat Mapping

After the field session, the preliminary ratings table was converted to a final ratings table (i.e., field habitat assessments were incorporated, habitat values were confirmed, all unique, mapped ecosystem units were rated), and the species accounts were revised to incorporate any new information.

The final ratings table and the ecosystem database were then used to generate wildlife habitat maps for Jedediah Island. To develop a wildlife habitat map for a single life requisite (e.g., bald eagle reproducing habitat, Columbian Black-tailed Deer feeding habitat), polygons generated from the ecosystem map were used as a base layer, and each polygon was assigned a wildlife habitat value. In instances where the polygon only consisted of a single ecosystem unit, then the corresponding wildlife habitat value was assigned to the entire polygon. However, in an ecosystem map, each polygon can consist of up to 3 distinct components, and it is possible for each one of these components to have a different wildlife habitat value, based on the final ratings table. In instances where the map polygon consisted of more than a single component (i.e., complex polygon), the wildlife habitat value associated with the largest component of the complex polygon was assigned to the entire polygon. Also, for complex polygons there is the possibility that the largest component shares an equal value with another component (e.g., first component - 40 %, second component - 40%, third component - 20%). In such instances, the lower wildlife habitat value for the largest component was assigned to the entire polygon.

For Bald Eagle and Pileated Woodpecker a map for reproducing habitat was produced. For Columbian Black-tailed Deer, the feeding, security and thermal life requisites were combined into a single general life requisite called "living" to develop a map of living requirements for the growing and winter seasons. To generate this map, a separate map was generated for feeding, security and thermal habitat, and then each one of these separate maps was overlaid. The feeding habitat map was assigned twice the value of the security and thermal habitat maps because security and thermal values are likely less important constraining factors for deer on Jedediah Island. Also, for the final maps, only polygons that were moderate habitat or better were coloured. Given the results of the field inventory and the boat survey, a final map of Cormorant reproducing habitat was not generated.

RESULTS

Wildlife Species Habitat Models

Species Accounts

For simplicity, brief summaries of some important habitat requirements for each project species are included below. Complete species accounts can be found in Appendix 9.

Columbian Black-tailed Deer

On Vancouver Island, Columbian Black-tailed Deer require food, water and cover to ensure survival during the spring, summer and winter seasons. During spring, deer favour areas with early green up (e.g., low elevation areas with warm aspect on moderate to steep slopes). Summer habitat consists of areas with a suitable mix of young to old forest areas, with an adequate supply of forage and cover elements. Winter forces deer from high elevation habitat to low elevation areas, with south-facing, warm-aspect slopes or floodplain areas where snowpack is very low (i.e., CDFmm). Important forage species for Columbian Black-tailed Deer are outlined in Table 9. In general, old growth forests with a patchy conifer understory and most well- stocked stands of young trees with live branches satisfy security cover requirements. Canopy closure (i.e., stands, taller than 10 m, with greater than 60% crown completeness) exerts the most influence on snow interception, and creates areas with snow conditions that don't limit deer movement (Bunnell *et al.* 1985).

On Jedediah Island, spring and summer habitat is likely similar to Vancouver Island. However, snow conditions aren't likely a limiting factor for deer habitat on Jedediah Island because of low winter snowfall. Regardless, on Jedediah Island deer likely use similar winter habitat as described above to shelter from rain, wind and other energetically-expensive weather conditions.

For mapping purposes, Class 1 habitat will be assigned for each season when the above habitat conditions are observed. Habitat will be rated Class 2 when habitat is slightly less suitable, for example, if there is less diversity and/or abundance of forage plant species, and/or if canopy closure of less than 60%, and/or if stem density does not offer good security cover.

Table 9. Some important forage plants for Columbian Black-tailed Deer in southern British Columbia (taken directly from Nyberg & Janz 1990).

	Winter forage	Spring forage	Summer forage
TREES:	Douglas-fir western hemlock western redcedar	bigleaf-maple Douglas-fir	red alder
SHRUBS:	Alaskan blueberry five-leaved bramble oval-leafed blueberry red huckleberry rose spp. salal saskatoon twinflower willow spp.	*Rubus* spp. (salmonberry, blackberry, thimbleberry, raspberry, bramble) salal willow spp.	salal willow spp.
FERNS	deer fern	bracken	
HERBS	bunchberry grass spp. kinnickinnick	bunchberry fireweed grass spp. hairy cat's-ear horsetail pearly everlasting	fireweed grass spp. hairy cat's-ear pearly everlasting
ARBOREAL LICHENS	*Alectoria* *Bryoria* *Lobaria oregana* *Usnea* spp.		

Pileated Woodpecker

Wood-dwelling insects are the primary diet of Pileated Woodpeckers throughout the year, and carpenter ants are a major food item in all seasons (Beckwith and Bull 1985; Bull *et al.* 1992). In winter, Pileated Woodpeckers use deep excavations in sound wood, whereas summer food occurs near the wood surface precluding deep excavations. In coastal forests, pileated woodpeckers prefer logs ≥ 50 cm dbh, and snags with dbh ≥ 45 cm, and ≤ 5% bark remaining as foraging habitat (C. Hartwig pers. comm.). In the interior of the province and in Alberta nest tree dbh ranges from 29 to 33 cm dbh (Conner *et al.* 1976, Bonar & Bessie 1996), however, nests trees in coastal forests are much larger, and average 85 cm (Hartwig 1999). Nests usually are located in high (≥ 4 m) branch-free portions of the main trunk. In coastal forests, most nest trees were western hemlock (Aubry & Raley 1992), but Douglas-fir and western redcedar are also used (Hartwig 1999)

Class 1 reproducing habitat is assigned when plots have, on-average, trees with dbh ≥ 85 cm. Class 2 habitat represents habitat with lower abundance of suitable diameter trees and/or trees in the stand with average dhb less than 85 cm. Habitat with trees averaging less than 30 cm dbh will be rated class 6 for reproducing habitat.

Bald Eagle

Most Bald Eagles breed and nest where suitable nest trees are available, adjacent to aquatic foraging habitat (e.g., along the coast, near estuaries, broad intertidal zones, island and reef complexes, near seabird colonies and sites with strong tidal currents). Old growth forests and younger forests with outstanding decadent wildlife trees provide the most suitable nest sites. In recent work on Vancouver Island, 81% of the located nests were placed in Douglas-fir (*Pseudotsuga menziesii*) trees, and smaller proportions of the nests were placed in western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), black cottonwood (*Populus balsamifera*) and western redcedar (*Thuja plicata*) trees. (Deal & Setterington 1999).

Habitat with large Douglas-fir trees (e.g., dbh > 65 cm dbh) with suitable branch architecture to support large platforms will be rated as class 1 bald eagle reproducing habitat. Habitat with low numbers of suitable trees and/or large live trees with unsuitable nesting locations will be rated class 2 bald eagle reproducing habitat.

Pelagic Cormorant

Pelagic Cormorants are colonial nesters. Unlike larger cormorant species, they are not able to defend nests and young against aerial predators but rely on inaccessibility of cliff-nesting habitat to deter predators (Ehrlich *et al.* 1988). Pelagic Cormorants use cliffs on forested and grassy, rocky islands and headlands. Nests are positioned on narrow ledges of cliffs, within sea caves or on faces near the top of small rocky islets at elevations ranging between 1.8 and 25 metres above the high tide line. Nests vary in size depending on the substrate and are constructed of seaweed, grasses and marine debris, although eggs are sometimes laid on bare rock. In the Georgia Strait, nests may be used for several successive seasons.

Class High Pelagic Cormorant reproducing habitat is steep cliffs with narrow ledges adjacent to coastal waters. Cliffs, taller than 8 m high, that minimize predation pressure will also contribute to a High reproducing habitat rating. Cliffs with few suitable nesting surfaces will be assigned Moderate Pelagic Cormorant reproducing habitat

Final Ratings Tables

The final ratings table appears in Appendix 10. In Appendix 10, the final ratings table uses codes in the column headings. For clarity these codes are defined below.

ECO_SEC	**Ecosection**
BGC_ZONE	Biogeoclimatic Zone
BGC_SUBZONE	Biogeoclimatic Subzone
BCG_VRT	Biogeoclimatic Variant
BGC_PHASE	Biogeoclimatic Phase
SITE_S	Site Series
SITEMC_S	Site Series Map Code
SITE_MA	Site Modifier A
SITE_MB	Site Modifier B
STRCT_S	Structural Stage
STAND_A	Stand Association
MODHC_FDW	Columbian black-tailed deer - Feeding Habitat - Winter
MODHC_FDG	Columbian black-tailed deer - Feeding Habitat - Growing
MODHC_SHW	Columbian black-tailed deer - Security Habitat- Winter
MODHC_SHG	Columbian black-tailed deer - Security Habitat – Growing
MODHC_THW	Columbian black-tailed deer - Thermal Habitat – Winter
MODHC_THG	Columbian black-tailed deer - Thermal Habitat – Growing
BBAEA_RE	Bald Eagle - Reproducing Habitat
BPIWO_FDA	Pileated Woodpecker - Feeding Habitat - All Season
BPIWO_STA	Pileated Woodpecker - Security/Thermal Habitat - All Season
BPIWO_RE	Pileated Woodpecker - Reproducing Habitat

Wildlife Habitat Maps

Wildlife habitat maps for Jedediah Island are included as Appendix 11.

Wildlife Species at Risk

It is unknown what sensitive, rare, threatened or endangered animal species occur on Jedediah Island. To determine the presence and/or abundance of these species, it is recommended that species inventories be undertaken. Peregrine Falcon, Western Screech-Owl, Vancouver Island Pygmy Owl, Purple Martin, and Hutton's Vireo (see Table 8) as well as other bird species, could be detected with breeding bird surveys in the spring. At the same time, bat surveys may determine whether Townsend's Big-eared Bat, Keen's Long-eared Myotis or other bat species occur on the island.

With more data from these species inventories, additional species-habitat models could be developed and applied to the Jedediah Island terrestrial ecosystem database. Habitat maps for these additional wildlife species could then be produced.

DISCUSSION

Wildlife Habitat

Columbian Black-tailed Deer

Jedediah Island currently has some excellent Columbian Black-tailed Deer habitat for both the growing and winter season. For example, habitats (polygons 284, 285 and 269), at the northern end of Jedediah Island, are excellent growing and winter habitat for deer. For the growing season, for example, Douglas fir-salal habitats at structural stage 6 and 7 (polygon 284) provide a high amount of palatable forage (e.g., salal, Douglas-fir, blackberry, oceanspray), good security values (e.g., large trees and coarse woody debris), and also offer thermal habitat for both the growing and winter seasons (i.e., interception of precipitation/snow and solar radiation). In general, the northern half of Jedediah Island offers more suitable habitat for Columbian Black-tailed Deer, than the southern portion. Habitats at the extreme northern portion of Jedediah Island also appear to be less used by the sheep and goats than the southern end with relatively less goat and sheep trails, browse and pellet groups (S. Rasheed, pers. obs). Less frequent visitation by the domestic sheep and goat likely makes the northern end of Jedediah Island more suitable for Columbian Black-tailed Deer because of more available forage.

A large buck was observed foraging in habitat (polygon 269) which is rated as having a high suitability, at the north-western section of the island. Several females were also observed foraging in the orchard beside the abandoned homestead (polygon 139), and likely use the adjacent suitable habitat (i.e., polygon 170, 248) as cover. Two deer skeletons and two deer skulls were found on the island, however the cause of death of these animals was uncertain. All four of these skeletons were very bleached and eroded, and there was significant tooth wear on two of the skulls suggesting that these indivduals were old. Other than direct observations, it was difficult to assess deer use on Jedediah Island because the grazing and movement of the sheep and goats masked any obvious deer sign (e.g., deer beds, deer trails, deer pellet groups, deer browse). However, given the abundance of suitable habitat and the absence of predators on Jedediah island, it is very likely that removing the goats and sheep from Jedediah Island will result in an increase in the numbers of deer on the island.

Currently, the deer population on Jedediah Island is likely limited by the amount of available forage. Available forage is probably first browsed by the sheep and goats, which is evidenced by the lack of any new vegetation in the understory, and the high goat and sheep sign occurring throughout the island.

Pileated Woodpecker

Pileated Woodpeckers use forests with large diameter trees as reproducing habitat. Large trees, wildlife trees and coarse woody debris are also suitable foraging and roosting habitat. Typically, older coastal forests serve as highly suitable habitat, given that in coastal habitats, Pileated Woodpeckers use trees with an average dbh of 82 cm (± 16 Standard Error:SE) (Hartwig 1999). On Jedediah Island, only one polygon was rated Class 1 (high) Pileated Woodpecker reproducing habitat; however, several polygons were rated as Class 2 (moderately high) woodpecker reproducing habitat. Polygons rated as Class 2 had a lower density of adequate roosting trees. Regardless, numerous polygons had typical Pileated Woodpecker feeding sign (e.g., elongated circular excavations in live and decomposing wood) and a Pileated Woodpecker was heard drumming on several occasions. In fact, a Pileated Woodpecker was seen on three separate occasions, twice foraging in a mature forest stand adjacent to the field near Home Bay (S. Rasheed, S. Holroyd; pers.obs.), and once at Boom Bay in a mature Douglas-fir forest (S.Rasheed, J. Stacey, pers. obs).

Individual Pileated Woodpecker home ranges vary in size from 200 - 1586 hectares. As a result, Jedediah Island, at 243 hectares, has the capacity to harbour at least one breeding pair of Pileated Woodpeckers.

Bald Eagle

Bald Eagles typically use trees of large diameter and height within a forest stand as roost trees, and generally, roost trees are within 200 m of the coastline. Trees have to be large enough to support the massive weight and size of bald eagle nests. Several polygons on Jedediah Island were rated as class 2 or better Bald Eagle reproducing habitat. No class 1 habitat was identified on Jedediah Island because no suitable nest trees (e.g., trees large enough to support a bald eagle nest) were located. No eagles or nests were seen during field sampling for this project, although previous owners on the island have recorded the occurrence of eagle nests just north of Home Bay (Palmer 1998). During our field visit we did not encounter these nests trees, nor did we encounter any trees with evidence of old bald eagle nests. However, Bald eagles were heard on the island almost everyday during the field sampling session (S. Rasheed pers.obs.).

Pelagic Cormorant

Our visual assessment of the periphery of Jedediah Island showed that there is limited Class High or even Moderately High Pelagic Cormorant reproducing habitat. In general cormorants require bare areas of rocky islands, either on top of low islands or on slopes of higher ones. In fact, Jedediah Island offers little reproducing habitat that could be considered similar to the nesting Pelagic Cormorant colony on Mitlenatch Island, the reproducing habitat provincial benchmark for this species. Many of the available cliffs and rocky headlands on Jedediah Island are either too smooth-faced, or don't offer any protection from disturbance by the feral ungulates on the island. During the boat survey, almost all suitable cormorant nesting habitat on Jedediah Island had some sign of being disturbed by the goats and/or sheep. Egg predation from raccoons is probably an additional deterrent to cormorant nesting on any suitable cliffs on Jedediah Island.

On Jedediah Island, there were some cliff faces (i.e., polygon 265) on Wind Bay that had the potential to be Class Moderate Pelagic cormorant reproducing habitat. Also, the southern rocky slopes (i.e., polygons 298, 299, 305) of Paul Island did have some potential cormorant reproducing habitat, specifically steep, ridged cliffs, away from disturbance. However, none of the visited polygons on either Jedediah or Paul Island had any sign of cormorant nesting activity.

Other Wildlife Species

Very few other wildlife species were directly observed on Jedediah Island. A red-tailed hawk (*Buteo jamaicensis*) was observed on several occasions hunting over Jedediah Island, as well as perching on trees near the coast. In fact, a nest located on Jedediah Island was similar to other red-tailed hawk nests (S.Rasheed pers.obs). In addition there were several bird species observed and heard on Jedediah Island, and in all likelihood all the bird species found on Lasqueti Island (Appendix 8) also occur on Jedediah Island, either as residents or transients. Common garter snake (*Thamnophis sirtalis*) was seen on several occasions and bats (species unknown) were seen coming out of the Roger Mattice's house at Long Bay, and foraging over both Long Bay and Home Bay. However, without a more comprehensive, systematic wildlife-species inventory, the occurrence of other wildlife species on Jedediah Island remains unclear.

Feral Goats and Sheep

Observations on the Feral Goats and Sheep

Goats and sheep were observed foraging and loafing at several locations on the island. However, in general, the goats were found at the southern end of the island, whereas the sheep was almost always seen in the northwest corner of the big field adjacent to the original homestead. During the evenings, goats were observed foraging in a smaller field at the mouth of Long Bay. It was estimated that there were 70 goats and 40 sheep on the island (S. Rasheed pers.obs). Both the goat herd and the flock of sheep consisted of males, females and juveniles indicating that these feral animals are reproducing successfully on the island. In fact, during a recent spring 1999 visit to the island, 10-15 more sheep and goats were observed on the island than during the original visit in September 1998, and in particular, more juveniles were observed.

Several observations indicate that goats and sheep use Jedediah Island extensively. Goat and sheep trails were scattered throughout the island. These trails were often worn and very well used, with no vegetation either on the trail or within one metre adjacent to the trail. Ungulate fecal pellet groups were found in *every visited polygon on Jedediah Island.* In fact, in certain polygons (e.g., rock outcrop polygons 163, 166, 181) fecal pellet groups covered approximately 40% of the ground. The abundance of the pellet groups and the few deer spotted on the island suggest that the pellet groups originated from the goats and sheep (it was impossible to differentiate between pellet groups between goats and sheep). It is likely that these polygons were used as loafing areas by the feral goats and sheep. Vegetation on these sites was significantly reduced, and moss cover on the rocks was damaged (S. Rasheed, pers. obs). Although there was no obvious predation or hunting pressure on the island, the goats and sheep are highly sensitive to human presence. Typically, humans were allowed to approach as near as 50 m before the entire herd bolted for cover. Four male goat skulls were also found on the island. These skulls all occurred on a rocky outcrop or adjacent to a steep cliff, and so were likely a result of senescence or an accidental fall.

Impacts of the Feral Goats and Sheep on Wildlife Habitat

The goats and sheep are having a significant effect on the wildlife habitat on the Jedediah Island. In particular, the feral goats and sheep influence the feeding habitat of Columbian Black-tailed Deer. The diet of these feral animals overlaps with the diet of Columbian Black-tailed Deer, as has been found in other situations when habitat is grazed simultaneously by domestic sheep, domestic goats and other native herbivores (MacCracken & Hansen 1981, Nelson 1982, Beck *et al.* 1996). Dietary overlap between the domestic ungulates and Columbian Black-tailed Deer is exacerbated because food resources are likely limiting on Jedediah Island, especially as the population of goats and sheep increases. Dietary overlap limits the feeding opportunities for the small deer population currently on the island.

In addition to consuming similar forage species, the goats and sheep are probably affecting the plant succession on Jedediah Island. Excessive grazing can alter plant community succession and therefore change the potential development of ecosystems (Beck *et al.* 1996). However, effects on plant species composition would certainly be dependant on a suite of factors, such as plant community composition and individual plant species resiliency to grazing pressure. Regardless, grazing by domestic animals can lower the diversity and abundance of available above-ground forage species (Bowns & Bagley 1986). Indeed, the goats and sheep appear to be significantly reducing the amount of above ground forage available for Columbian Black-tailed Deer on Jedediah Island.

It was less clear how the goats and sheep affect the other wildlife species rated in this project (i.e., Bald Eagle, Pileated Woodpecker and cormorant) because habitat overlap is limited. However, the goats and/or sheep could disturb these wildlife species. For example, a roaming herd of goats and sheep would influence the amount of time a woodpecker would spend foraging on the forest floor. Also, for the cormorant, most of the assessed rock outcrops had evidence that they had been visited by goats and/or sheep. This disturbance, especially during the breeding season, would limit suitable breeding habitat and opportunities on Jedediah Island for cormorants.

Other wildlife species that were not assessed for this project may also be negatively affected by the sheep and goats. The scarcity of a shrub layer in many of the island's habitats resulting from over-browsing by goats may decrease the amount of suitable habitat for species that use shrubs for forage and security (e.g. some songbirds). Trampling by goats and sheep has reduced or eliminated the litter layer in some areas, which diminishes the availability of litter-dwelling invertebrates that ground foraging birds, snakes, salamanders and some small mammals (e.g., shrews) feed on, as well as decreasing the security habitat for many of these species.

In summary, the goats and sheep were never observed to directly interact with any wildlife species on Jedediah Island. However, it is apparent that the large herd of goats and sheep displace Columbian Black-tailed Deer from suitable habitat and reduce the habitat suitability not only for the deer, but some other wildlife species as well.

MANAGEMENT RECOMMENDATIONS

Ecosystem management can have five specific goals endorsed by ecological researchers: 1) maintain viable populations of all native species in situ; 2) represent, within protected areas, all native ecosystem types across their natural range of variation; 3) maintain evolutionary and ecological processes (i.e., disturbance regimes, hydrological processes, nutrient cycles and so forth); 4) manage over periods of time long enough to maintain potential species and ecosystems; and 5) accommodate human use and occupancy within these constraints. (Grumbine 1994.)

Moreover the vision statement in the Management Plan for Jedediah Island Marine Park (MELP 1998b) anticipates that in ten years, "*The island's natural evolving ecosystems have been re-established except in the Home Bay area.*"

Within this context of maintaining natural ecosystems and populations on Jedediah Island, the following management recommendations provide some options for influencing native wildlife species and their habitats.

Option 1. Remove the feral and domestic animals from the island.

The sheep and goats on Jedediah Island are clearly influencing the vegetation communities and wildlife habitat on the island. The benefit of removing the feral goats and sheep is that habitat will become available for other wildlife species. For example, it's entirely likely that the numbers of Columbian Black-tailed deer will increase over time as more suitable habitat and forage becomes available. Moreover, the impact to native vegetation would be controlled over the short-term, as the immediate impact of the feral animals would be removed. Removal of these feral animals would also be a humane solution, as we observed that the coats of all the sheep were in very poor condition. The poor condition of the coats of the sheep may compromise their thermoregultory ability. Removal of the goats and sheep could either be conducted by relocating them to suitable homes/farms, or alternatively by harvesting them. Regardless of removal strategy, this option will require careful planning given the broad distribution of the goats and sheep within the island, and their sensitivity to human approach. A likely scenario would be to corral the animals with herding dogs into a pen or barge.

Option 2. Exclude the goats and sheep from particular sections of the island.

The wildlife habitat maps identify suitable wildlife habitat on Jedediah Island. For example, the northern section of Jedediah Island represents more suitable habitat than the southern section. As a result, based on the habitat suitability maps certain sections of Jedediah Island could be fenced off. The benefit of this option would be that it would provide habitat for both native wildlife and the feral goats and sheep. As a result, this option would allow BC Parks to retain some of the cultural heritage of Jedediah Island. However, fencing off portions of the island would be costly, labour intensive, logistically difficult and would likely require periodic monitoring and maintenance. Also, this option would not guarantee the exclusion of the goats and sheep from certain portions of the island. Moreover, this solution could also end up excluding other wildlife species from suitable portions of the island.

Option 3. Control the population of feral goats and sheep.

The impact on native vegetation could be minimized through population control, using current hunting regulations. Numerous parks in British Columbia allow hunting within park boundaries. In particular, Sidney Spit Marine Park in the Vancouver Island Region allows a Limited Entry Hunt (LEH) for fallow deer. This LEH has several regulations to ensure the safety of the public, while maintaining close monitoring of the park area. For example, for any period of time only 2 authorizations are allowed, hunters must register with the South Vancouver Island Parks District prior to entering the park, hunters must receive an information package at the time of registration, and hunters must possess all necessary hunting licenses, including a valid Gulf Islands Special Area Hunting License. (MELP 1999). Public safety could be ensured by clear notification, limited season, and/or by allowing hunting during winter months when public visitation to the park is low. To control population numbers of the feral goats and sheep on Jedediah Island, a similar situation could be established. The benefit of this approach would be that the numbers of feral goats and sheep would be controlled, and impact on native vegetation on the island would be lessened. However, this approach would entail considerable administration and enforcement, and the associated costs.

While the desirable outcome of all these management options is to increase the available habitat for native wildlife species, consideration should also be given to the possibility of the deer population increasing to the point where these animals may also have an impact on the recovery of the natural ecosystems.

REFERENCES

Agriculture Canada Expert Committee on Soil Survey. 1987. The Canadian System of Soil Classification. 2nd ed. Agric. Can. Publ. 1646. Supply and Services Canada. Ottawa, Ont. 164 pp.

BC Conservation Data Centre. 1998. Draft guidelines for site conservation evaluation. BC Ministry of Environment, Lands and Parks. Victoria, BC.

BC Ministry of Forests and BC Ministry of Environment. 1997. VENUS: Vegetation and Environment NExus. BC Min. For., Research Branch. Victoria, BC.

______. 1998a. Field manual for describing terrestrial ecosystems. BC Min. For. and BC Min. Environment, Lands and Parks, Victoria, BC.

______. 1998b. GRAVITI: Ground and Visual Inspection TEM Interface. BC Min. For., Research Branch. Victoria, BC.

______. 1999. Ed. Douglas, G.W. *et al*. Illustrated Flora of British Columbia. Province of British Columbia. Victoria, BC.

Beck, J.L., J.T. Flinders, D.R. Nelson, C.L Clyde, H.D. Smith and P.J. Hardin. 1996. Elk and domestic sheep interactions in the north-central Utah aspen ecosystem. United States Department of Agriculture, Forest Service, Intermountain Research Station, Research Paper INT-RP-491.

Beckwith, R.C. and E.L. Bull. 1985. Scat analysis of the arthropod component of Pileated woodpecker diet. Murrelet 66:90-92.

Blood, D.A. and G.G. Anweiler. 1994. Status of the Bald Eagle in British Columbia. Wildlife Working Report No. WR-62. Wildlife Branch, Ministry of Environment, Lands and Parks. Victoria, BC.

Bonar, R. and W. Bessie. 1996. Pileated woodpecker (*Dryocopus pileatus*) year-round habitat, draft habitat suitability index (HSI) model. in B. Beck, J. Beck, W. Bessie, R Bonar and M Todd (eds) 1996. Habitat suitability index models for 35 wildlife species in the Foothills Model Forest. Draft report. Foothills Model Forest. Hinton, Alberta.

Bowns, J.E. and C.F. Bagley. 1986. Vegetation responses to long-term sheep grazing on mountain ranges. J. Range Mgmt., 39:431-434.

Bull, E.L., and R.S. Holthausen. 1993. Habitat use and management of Pileated woodpeckers in northeastern Oregon. J. Wildl. Manage. 56:786-793.

Bull, E.L., R.C. Beckwith and R.S. Holthausen. 1992. Arthropod diet of Pileated woodpeckers in northeastern Oregon. J. Wildl. Manage.,73:42-45.

Bull, E.L.. and J.E. Jackson. 1995. Pileated Woodpecker (*Dryocopus pileatus*). In The Birds of North America, No. 148 (A.Poole and F.Gill, eds). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Bunnell, F.L., R.S. McNay, and C.C. Shank. 1985. Trees and snow: the deposition of snow on the ground. A review and quantitative synthesis. BC Min. Environ. and Min. For., Victoria, BC. IWIFR-17.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The Birds of British Columbia. Vol. 2. Nonpasserines: Diurnal birds of prey through woodpeckers. Royal BC Museum, Victoria, BC.

Conner, R.N., O.K. Miller Jr, and C.S. Adkisson. 1976. Woodpecker dependence of trees infected by fungal heart rots. Wilson Bull., 88:575-581.

CDC (Conservation Data Centre). 1997. CDC Web site. http://www.elp.gov.bc.ca/rib/wis/cdc

Deal, J.A and Setterington, M. 1997. Nimpkish Bald Eagle Nest Inventory: Final Results 1995-1997. Unpublished report. CANFOR, Woss, BC.

Demarchi, D.A. 1995. Ecoregions of British Columbia (Fourth Edition). 1:2 000 000 Map. BC Min. Environment., Lands and Parks. Victoria, BC.

______. 1996. Introduction to ecoregions of British Columbia. Ministry of Environment, Lands and Parks, Wildlife Branch. Victoria, BC (available on MOE website).

Douglas, G.W., D. Meidinger, and J. Pojar. 1999. Illustrated flora of British Columbia. BC Ministry of Forests and BC Ministry of Environment. Victoria, BC.

Ehrlich, Paul R., David S. Dobkin and Darryl Wheye. 1988. The birder's handbook. Simon and Schuster Inc. New York, New York.

Green, R.N. and K. Klinka. 1994. A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region. Land Manage. Handbook. 28. BC Min. For. Victoria, BC.

Grumbine, R.E. 1994. What is ecosystem management? Conserv. Biol. 8:27-38.

Haeussler, S. And D. Coates. 1986. Autecological characteristics of selected species that compete with conifers in British Columbia: a literature review. BC Ministry of Forests and Canada/British Columbia Economic and Regional Development Agreement. Victoria, BC.

Hartwig, C.L. 1999. Effect of forest age, structural elements and prey density on the relative abundance of Pileated woodpecker (*Dryocopus pileatus abieticola*) on south-eastern Vancouver Island. M.Sc. Thesis. University of Victoria.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press. Seattle.

Howes, D.E. and E. Kenk (ed.). 1988. Terrain Classification System for British Columbia. Revised Edition. MOE Manual 10. BC Min. Environ. and BC Min. Crown Lands. Victoria, BC.

Inselberg, Alex. 1991. Data files for the coastal classification (CDF). Unpublished report. Vancouver, BC.

Kremsater, L.L. 1987. Influences of habitat interspersion on habitat use by Columbian black-tailed deer. M.Sc. thesis. Univ.B.C., Vancouver, B.C.

MacCracken, J.G. and Hansen, R.M. 1981. Diets of domestic sheep and other large herbivores in southcentral Colorado. J. Range Mgmt., 34:242-243.

McNay, R.S. & D.D. Doyle. 1987. Winter habitat selection by black-tailed deer on Vancouver Island: A job completion report. BC Min. Environ. and Min. For., Victoria, BC. IWIFR-34.

MELP (Ministry of Environment, Lands and Parks) 1998a. Jedediah Island Marine Park, Background Report. Draft. Ministry of Environment, Lands and Parks, January 1998. http://www.elp.gov.bc.ca:80/bcparks/protect/mgmtplns/jedediah/jedmp/jedediah.htm

______. 1998b. Management Plan for Jedediah Island Marine Park. Draft. Ministry of Environment, Lands and Parks, September 1998 http://www.elp.gov.bc.ca:80/bcparks/protect/mgmtplns/jedediah/jedmp/jeddraft.pdf

______. 1999. British Columbia Limited Entry Hunting Regulations Synopsis 1999-2000.

Nelson, J.R. 1982. Relationships of elk and other large herbivores. Pages 415-441 in J.W. Thomas and D.E. Toweill, eds. Elk of North America: Ecology and Management. Stackpole Books, Harrisburg, Pa.

Nyberg, J.B. & D.W. Janz. (technical editors) 1990. Deer and elk habitats in coastal forests of southern British Columbia. BC Min.For., BC Min. Environ., Wildl. Hab.Can., Council of For. Indust. BC., Victoria, BC.

Palmer, M. 1998. Jedediah Days. Harbour Publishing, Madeira Park, B.C.

Parker, K.L. Effects of heat, cold and rain on coastal black-tailed deer. Canadian Journal of Zoology 66:2475-2483.

Pojar, J. and A. MacKinnon. 1994. Plants of Coastal British Columbia. Lone Pine Publishing. Vancouver, B.C. pp 526.

Resources Inventory Committee (RIC). 1997. Provincial site series mapping codes and typical environmental conditions. Ecosystems Working Group. Victoria, BC. http://www.publications.gov.bc.ca

______.1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Ecosystem Working Group, Terrestrial Ecosystems Task Force. Victoria, BC.

______. 1999. BC Wildlife Habitat Rating Standards. Version 2.0. May 1999. Wildlife Interpretations Subcommittee. Victoria, BC.

Robertson, I. 1974. The food of nesting double-crested and pelagic cormorants at Mandarte Island, B.C., with notes on feeding ecology. Condor 76: 346-348.

Roemer, H. 1999. Jededaiah Island, Assessment of Vegetation based on fieldwork May 10-12, 1999. unpublished report.

______. 1999a. Jededaiah Island, Annotated Plant List. unpublished report.

Smith, F.W. & J.N. Long. 1987. Elk hiding and thermal cover guidelines in the context of lodgepole pine stand density. West. J. Appl. For. 2:6-10.

Sullivan, T.M. 1998. The timing of breeding in double-crested cormorants (*Phalacrocorax auritus albociliatus*) : its effects on clutch size, nestling growth, diet and survival. MSc Thesis, University of British Columbia, March 1998.

Walmo, OC. 1981. *Mule and Black-tailed Deer of North America*. University of Nebraska Press, Lincoln.pp. 599.

Yorath C.J. and H.W. Nasmith. 1995. The Geology of Southern Vancouver Island. Orca Book Publishers. Victoria, BC.

PERSONAL COMMUNICATIONS

Brunt, Kim - Regional Biologist (Nanaimo region).

Chatwin, Trudy - Rare and endangered species specialist (Nanaimo region).

Demarchi, Dennis - Provincial wildlife habitat correlator

Douglas, George - Conservation Data Centre, Botanist

Ferris, Chris - Lasqueti Island naturalist

Flynn, Samantha - Conservation Data Centre, Assistant Ecologist

Fraser, Dave - Provincial Endangered Species Specialist

Hartwig, Carol - Pileated Woodpecker species expert

Hatter, Ian - Provincial Ungulate Specialist
Ray, Sheila - Lasqueti Island naturalist
Sullivan, Terry - Cormorant species expert
Ussrey, Joel – CRD Parks

Appendix 1: Terrain Legend

The terrain legend is usually attached to a published terrain map which includes all mapped symbols. This map was not produced for the Jedediah Island Project. All the spatial (digital linework) and associated data bases are available to do this in a GIS system.

The legend is presented to facilitate someone who wishes to make a terrain map and more importantly to provide the reader with a list of definitions for the many terms and symbols used in this report.

Terrain Unit Symbol

One or more groups of letters are used to describe each terrain unit. The relative position of a letter within its group indicates the characteristic that it represents.

EXAMPLE

$spF^{A}pf\text{-}BA$

In this symbol '**s**' and '**p**' represent texture; '**F**' superscript '**A**' represents an active fluvial surficial material; '**p**' and '**f**' represent surface expression; and '**B**' and '**A**' represent geomorphological processes.

Composite Terrain Unit Symbol:

Terrain units that include two or three different kinds of terrain are indicated by two or three groups of letters. The groups are always arranged in decreasing order of importance and the components are separated by a number that indicates the percentile representing approximate proportions.

EXAMPLE

^{8} Mb ^{2} gFt means that there is roughly 80% 'Mb' and 20% 'gFt'

Any kind of terrain that constitutes less than 10% of a terrain unit is normally not included in the terrain unit symbol.

Stratigraphic Information:

Where two or more kinds of surficial material are superimposed, or where the surface expression of buried bedrock is shown, a stratigraphic symbol is used.

EXAMPLE

$\frac{rCw}{Mb}$ means that 'rCw' (Colluvial) material overlies 'Mb' (morainal) material

Texture of Surficial Material

Symbol	Name	Description	Within the Study Area
a	blocks	angular particles <256 mm	Blocks in the study area are derived from the eroding basalt cliffs, they are found at the base of cliffs and range in size from 25 to 100cm, with occasional blocks reaching 3 to 4 metres.
b	boulders	rounded and subrounded particles >256 mm	Boulders in the study area are largely granodiorite erratics in glaciomarine deposits.
k	cobbles	rounded and subrounded particles 64-256 mm	Cobbles in the study area are mainly granodiorite and volcanic, some cobble fields exist in the glaciomarine deposits.
p	pebbles	rounded and subrounded particles 2-64 mm	Pebbles are mainly in the marine deposits, associated with some active beaches and the inland marine sand and the glaciomarine deposits
g	gravels	rounded and particules, greater than 2mm in size, a mixture of pebbles and cobbles	Gravels are in many deposits, on the active beaches and in the marine and glaciomarine sediments usually as beach strands.
s	sand	particles 2-.062 mm	Extensive sand deposits are found in the main valleys of the study area, the grain size includes fine to medium sand. The eroding basalt hills include pockets of iron rich fine sand in a matrix of rubble.
z	silt	particles .062-.002 mm	Silt particles in deposits of the study area, were of minor extent and found at the lower elevations in silty clay marine deposits and wet settling basins.
c	clay	particles <.002 mm	Clays in the study area were encountered rarely, and only in the silty clay marine deposits, near the mouth of some streams.
r	rubble	angular particles 2 - 256 mm	Rubble is common in the study area, and is associated with the eroding basalt cracks, walls and cliffs, it ranges in size from 5 to 25cm.
m	mud	mix of clay and silt particles <.062	Mud in the study area is not common, it is similar to the silty clay marine deposits
h	humic	decomposed organic material; 10% identified after rubbing	Humic material is common in the study area on the poorly and imperfectly drained sands. It forms a layer 10 to 25 cm thick, and is derived mainly from slough sedge (*carex obnupta)* and associated redcedar slough forest floor.

Surficial (Genetic) Materials

Surficial materials are classified according to their mode of formation because this indicates their physical characteristics such as texture, structure, cohesion, and compactness. These characteristics influence the engineering properties of surficial materials and their erodability and stability on slopes.

Symbol	Name	Description
A	Anthropogenic	Man-made or man-modified material; these deposits include middens of black sandy shell materials (skAbv) on raised beaches at the head of bays, which have sandy muddy tidal flats. Some sites were too small to map. Other sites may include abandoned log dumps and roads with deeper cut and fill slopes.
A1	Anthropogenic (special type 1)	Blanket of logs on beach; this class identifies the extensive drift pile of logs plugging the head end of Driftwood Beach
C	Colluvial	Materials deposited as a result of downslope movements due to gravity. Includes loosely packed, coarse, angular material. This material is very common throughout the Island. It occurs in strips and pockets associated with the eroding basaltic hills, valleys and walls. It occurs mainly as three textural types; in the notches and crevasses of the rolling and hummocky hills it forms very thin veneers and has a rubbly sandy or sandy rubbly texture **(rsCxv)** and **(srCvx)**; along the base of slopes larger rubble is common and exists in talus and blanket forms **(srCbvc), (sarCbvc)**; at the base of larger jointed eroding, cliffs 5 to 15m high, block fall is common here the colluvial consists of very large particles, 3 to 4 metres, **(raCb,c).** The latter blocky deposits may support cover for wildlife.
F	Fluvial	Materials deposited by streams, only small pockets of fluvial were seen and they were too small to map. They were mainly silty sand textures.
M	Morainal	Materials deposited by glaciers; little morainal or till was found on the island, perhaps much of it eroded off the steeper hillsides and now exists as colluvial.
O	Organic	Material resulting from the accumulation and decay of vegetative matter. Very few bog deposits are thought to be on the Island, only one small narrow deposit was found in a large rock joint on the top of a rock ridge.
O1	Organic (special type 1)	Humic organic deposits from decayed terrestrial vegetation; 10 to 20 cm deep overlying marine deposits, in seepage sites of redcedar and slough sedge.
R	Rock	Outcrops mainly and rock covered by a thin (<40cm) mantle of colluvium. The glaciated rock on the Island is basalt know as the Karmutsen Formation. Numerous drumlin shaped hills with steeper slopes, cliffs and rolling hilltops are the dominant terrain type on the Island.
W	Marine	Sediments deposited in salt or brackish water bodies by settling from suspension and submarine gravity flows. The main marine deposits are medium sands which blanket most of the larger valley floors. These sands may be proglacial outwash deposits known as the Quadra Sands.
W^G	Glaciomarine	Sediments of glacial origin laid down from suspensiion in a marine environment in close proximity to glacier ice. They include materials originating from submarine gravity flows and settled particules released from melting of both floating ice and ice shelves. The deposits on the Island appear to be mostly gravelly and cobbly beach strands. Located at the height of land in some valleys are strands of larger cobbles and granitic boulders.

Surface Expression

Surface expression is the topography or shape of the land surface. The terms listed below provide information that augments those provided by the contours of the topographic base map.

Symbol	Name	Description
a	moderate slope	unidirectional surface; 16 to 26^{o} (26 to 50%)
b	blanket	a mantle of unconsolidated materials; >1 m thick
h	hummocky	hillocks and hollows, irregular plan; 15 to 35^{o} (26 to 70%)
j	gentle slope	unidirectional surface; 4 to 15^{o} (5 to 26%)
k	moderately steep	unidirectional surface; 27 to 35^{o} (50 to 70%)
m	rolling	elongate hillocks with slopes 3 to 15^{o} (5 to 26%)
p	plain	unidirectional surface; 0 to 3^{o} (3 to 5%)
s	steep	steep slopes; >35^{o} (>70%)
r	ridge(s)	steeper elongated hillocks 15 to 35^{o} (26 to 70%)
t	terraced	step-like topography
v	veneer	mantle of unconsolidated material; 10 cm to 1 m thick
x	thin veneer	similar to veneer (2-20 cm thick)

Geomorphological Processes

These processes are either active at the present time or former processes that may be reactivated by disturbance of the environment. Many of these processes constitute potential hazards or constraints to land use.

Symbol	Name	Description
-W	washing	wave washing on rocky shoreline or beaches
-W1	washing (special type 1)	salt spray zone above high tide line (the -W area)
-E1	channelled	channels of various sizes in bedrock (4 -30 m wide); mode of formation unknown, possibly jointing enhanced by glaciation(s). Sometimes portions of walls are polished. Walls frequently shattered and eroding. Flat channel bottoms often filled with marine sands, gravels, and rubble. Major trend is northwest/southeast.
-V1	gully erosion (special type 1)	gullied drainages in rock outcrops

Description of Soil Drainage Classes

x **very rapidly drained:** Water is removed from the soil very rapidly in relation to supply. Water source is precipitation and available water storage capacity following precipitation is essentially nil. Soils are typically fragmental skeletal, or both.

r **rapidly drained:** Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Water source is precipitation. Soils are generally coarse textured.

w **well drained:** Water is remover from the soil readily, but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Water source is precipitation. On slopes, subsurface flow may occur for short duration, but additions are equalled by losses. Soils are generally intermediate in texture and lack restricting layers.

m **moderately well drained:** Water is removed from the soil somewhat slowly in relation to supply because of imperviousness or lack of gradient. Precipitation is the dominant water source in medium-to fine-textured soils; precipitation and significant additions by subsurface flow are necessary in coarse textured soils.

i **imperfectly drained:** Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is the major source. If subsurface water or groundwater (or both) is the main source the flow rate will vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface or groundwater flow (or both) increases as available water storage capacity decreases. Soils generally have a wide range of texture, and some mottling is common.

p **poorly drained:** Water is removed so slowly in relation to supply that the soil remains wet for much of the time that it is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface or groundwater flow (or both), in addition to precipitation, are the main water sources. A perched water table may be present. Soils are generally mottled and/or gleyed.

v **Very poorly drained:** Water is removed from the soil so slowly that the water table remains at or near the surface for most of the time the soil is not frozen. Groundwater flow and subsurface flow are the major sources. Precipitation is less important, except where there is a perched water table with precipitation exceeding evapotranspiration. Typically associated with wetlands.

Appendix 2: Vegetation Species List

Abies grandis	grand fir
Acer macrophyllum	big-leaf maple
Achillea millefolium	yarrow
Adenocaulon bicolor	pathfinder
Agoseris grandiflora	large-flowered agoseris
Agrostis scabra	hair bentgrass
Agrostis sp.	bentgrass
Agrostis stolonifera	creeping bentgrass
Aira caryophyllea	silver hairgrass
Aira praecox	early hairgrass
Allium amplectens	slimleaf onion
Allium cernuum	nodding onion
Alnus rubra	red alder
Amelanchier alnifolia	saskatoon berry
Anthoxanthum odoratum	sweet vernalgrass
Aphanes arvensis	field aphanes
Apiaceae	Apiaceae
Arabis hirsuta	hoary rock-cress
Arbutus menziesii	arbutus
Arctostaphylos uva-ursi	kinnikinnick
Aspidotis densa	Indian's dream fern
Asplenium trichomanes	common spleenwort
Aster sp.	Aster sp.
Athyrium filix-femina	lady fern
Atriplex sp.	orache
Blechnum spicant	deer fern
Brachythecium frigidum	
Bromus carinatus	California brome
Bromus hordeaceus	soft brome
Bromus vulgaris	Columbia brome
Bryum sp.	Bryum sp.
Callitriche sp.	water starwort
Camassia leichtlinii	great camas
Camassia quamash	common camas
Campanula rotundifolia	common harebell
Cardamine occidentalis	western bitter-cress
Cardamine oligosperma	little western bitter-cress
Carex hoodii	Hood's sedge
Carex kelloggii	Kellogg's sedge
Carex deweyana	Dewey's sedge
Carex obnupta	slough sedge
Carex viridula	green sedge
Castilleja hispida	harsh paintbrush
Cerastium arvense	field chickweed
Cerastium vulgatum	mouse-ear chickweed
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Cladina arbuscula ssp. mitis	
Cladina portentosa	coastal reindeer lichen
Cladina rangiferina	grey reindeer lichen
Cladonia chlorophaea	peppered pixie-cup
Cladonia parasitica	
Cladonia scabriuscula	
Collema sp.	tarpaper lichens
Collinsia parviflora	small-flowered blue-eyed Mary
Crepis tectorum	annual hawksbeard
Dactylis glomerata	orchardgrass
Danthonia californica	California oatgrass
Danthonia intermedia	timber oatgrass
Daucus pusillus	American wild carrot
Dicranum fuscescens	curly heron's-bill moss
Dicranum scoparium	broom moss
Dicranum sp.	Dicranum sp.
Dicranum spadiceum	Dicranum spadiceum
Digitalis purpurea	common foxglove
Dryopteris expansa	spiny wood fern
Elymus glaucus	blue wildrye
Epilobium angustifolium	fireweed
Epilobium watsonii	Watson's willowherb
Epilobium paniculatum	tall annual willowherb
Epilobium sp.	willowherb
Equisetum arvense	common horsetail
Equisetum pratense	meadow horsetail
Equisetum sylvaticum	wood horsetail
Eriophyllum lanatum	woolly sunflower
Erythronium oreganum	white fawn lily
Eurhynchium oreganum	
Festuca occidentalis	western fescue
Festuca rubra	red fescue
Festuca sp.	fescue
Festuca subulata	bearded fescue
Festuca subuliflora	crinkle-awned fescue
Fragaria chiloensis	beach strawberry
Fragaria sp.	strawberry
Fragaria vesca	wood starwberry
Fragaria virginiana	wild strawberry
Fritillaria lanceolata	chocolate lily
Galium aparine	cleavers
Galium palustre	marsh bedstraw
Galium trifidum	small bedstraw
Galium triflorum	sweet-scented bedstraw
Gaultheria shallon	salal
Geranium bicknellii	Bicknell's geranium
Geum macrophyllum	big-leaved avens
Gnaphalium microcephalum	slender cudweed

Gnaphalium sp.	cudweed
Goodyera oblongifolia	rattlesnake-plantain
Geranium molle	dove-foot geranium
Gratiola ebracteata	bractless hedge-hyssop
Grindelia integrifolia	Puget Sound gumweed
Heuchera micrantha	small-flowered alumroot
Hieracium albiflorum	white-flowered hawkweed
Holcus lanatus	common velvet-grass
Holodiscus discolor	oceanspray
Hylocomium splendens	step moss
Hypericum anagallidifolium	bog St.John's wort
Hypericum sp.	Hypericum sp.
Hypochaeris glabra	smooth cat's ear
Hypochoeris radicata	hairy cat's-ear
Juncus articulatus	jointed rush
Juncus balticus	Baltic rush
Juncus covillei	Coville's rush
Juncus effusus	common rush
Juncus sp.	rush
Juncus tenuis	slender rush
Juniperus scopulorum	Rocky Mountain juniper
Kindbergia oregana	Oregon beaked moss
Koeleria macrantha	junegrass
Lactuca muralis	wall lettuce
Lactuca sp.	lettuce
Leucolepis acanthoneuron	palm tree moss
Lilaeopsis occidentalis	western lilaeopsis
Lilium columbianum	Columbia lily
Listera caurina	northwestern twayblade
Lithophragma parviflora	woodland star
Lonicera ciliosa	western trumpet honeysuckle
Lonicera hispidula	hairy honeysuckle
Lonicera sp.	honeysuckle
Lotus micranthus	small-flowered birds-foot trefoil
Luzula multiflora	many-flowered woodrush
Luzula parviflora	small-flowered woodrush
Lycopus uniflorus	northern water-horehound
Madia madioides	woodland tarweed
Madia minima	small-headed tarweed
Madia sp.	tarweed
Mahonia aquifolium	tall Oregon-grape
Mahonia nervosa	dull Oregon-grape
Malus fusca	Pacific crab apple
Melica subulata	Alaska onion-grass
Mentha arvensis	field mint
Mentha pulegium	pennyroyal
Mimulus "sookensis"	monkeyflower (new sp.)
Mimulus alsinoides	chickweed monkeyflower
Mimulus guttatus	common monkeyflower
Moehringia macrophylla	big-leaved sandwort
Monotropa uniflora	Indian pipe
Montia fontana	blinks
Montia parvifolia	small-leaved montia
Montia perfoliata	miner's lettuce
Montia sibirica	Siberian spring beauty
Montia spathulata	pale montia
Myosotis scorpioides	common forget-me-not
Myosotis sp.	Myosotis sp.
Nemophila parviflora	small-flowered nemophila
Oenanthe sarmentosa	Pacific water-parsley
Opuntia fragilis	prickly-pear cactus
Orthocarpus pusillus	tiny owl-clover
Osmorhiza chilensis	sweet cicely
Pachystima myrsinites	false-box
Panicum occidentale	western witchgrass
Panicum scribnerianum	Scribner's witchgrass
Pentagramma triangularis	golden-back fern
Philonotis fontana	spring moss
Physocarpus capitatus	Pacific ninebark
Pinus contorta	lodgepole pine
Pinus contorta var. contorta	shore pine
Placopsis gelida	Placopsis gelida
Plagiomnium insigne	coastal leafy moss
Plagiomnium sp.	Plagiomnium sp.
Plantago elongata	dwarf plantain
Plantago lanceolata	ribwort plantain
Plantago major	common plantain
Plantago maritima	seashore plantain
Platanthera orbiculata	large round-leaved rein orchid
Platanthera unalascensis	Alaska rein orchid
Plectritis congesta	sea blush
Plectritis congesta ssp. brachystemon	sea blush
Poa annua	annual bluegrass
Poa compressa	Canada bluegrass
Poa pratensis	Kentucky bluegrass
Polypodium glycyirrhiza	licorice fern
Polystichum munitum	sword fern
Polytrichum juniperinum	juniper haircap moss
Polytrichum piliferum	awned haircap moss
Polytrichum sp.	Polytrichum sp.
Polytrichum strictum	bog haircap moss
Populus tremuloides	trembling aspen
Potentilla anserina ssp. pacifica	Pacific silverweed
Prunella vulgaris	self-heal
Prunus emarginata	bitter cherry
Pseudotsuga menziesii	Douglas-fir
Pteridium aquilinum	bracken fern
Pyrus fusca	Pacific crabapple
Racomitrium canescens	grey rock moss

Racomitrium lanuginosum	hoary rock moss
Ranunculus flammula	lesser spearwort
Ranunculus repens	creeping buttercup
Ranunculus sp.	buttercup
Ranunculus uncinatus	small-flowered buttercup
Rhizomnium sp.	Rhizomnium sp.
Rhytidiadelphus loreus	lanky moss
Rhytidiadelphus triquetrus	electrified cat's-tail moss
Ribes sanguineum	red flowering currant
Rosa acicularis	prickly rose
Rosa gymnocarpa	baldhip rose
Rosa nutkana	Nootka rose
Rubus laciniatus	evergreen blackberry
Rubus parviflorus	thimbleberry
Rubus discolor	Himalayan blackberry
Rubus spectabilis	salmonberry
Rubus ursinus	trailing blackberry
Rumex acetosella	sheep sorrel
Rumex obtusifolius	dock
Sagina procumbens	procumbent pearlwort
Salix scouleriana	Scouler's willow
Salix sitchensis	Sitka willow
Salix sp.	willow
Sambucus racemosa	red elderberry
Sanicula crassicaulis	Pacific sanicle
Satureja douglasii	yerba buena
Saxifraga ferruginea	Alaska saxifrage
Saxifraga rufidula	rusty-haired saxifrage
Sedum oreganum	Oregon stonecrop
Sedum spathulifolium	broad-leaved stonecrop
Selaginella wallacei	Wallace's selaginella
Senecio sylvaticus	wood groundsel
Sherardia arvensis	spurwort
Silene gallica	French catch-fly
Silene sp.	Silene sp.
Sisyrinchium californicum	golden-eyed-grass
Sonchus arvensis	field sowthistle
Sonchus asper	prickly sow-thistle
Spiraea douglasii	hardhack
Stellaria crispa	crisp starwort
Stellaria media	chickweed
Stellaria sp.	starwort
Symphoricarpos albus	snowberry
Taraxacum officinale	common dandelion
Tellima grandiflora	fringe-cup
Thuja plicata	western redcedar
Trientalis latifolia	broad-leaved starflower
Trifolium microcephalum	woolly clover
Trifolium oliganthum	few-flowered clover
Trifolium repens	white clover
Trifolium tridentatum	tomcat clover
Trifolium variegatum	white-tip clover
Triteleia hyacinthina	fool’s onion
Tsuga heterophylla	western hemlock
Typha latifolia	cat-tail
Urtica dioica	stinging nettle
Vaccinium ovalifolium	oval-leaved blueberry
Vaccinium ovatum	evergreen huckleberry
Vaccinium parvifolium	red huckleberry
Veronica arvensis	Wall speedwell
Veronica officinalis	common speedwell
Vicia americana	American vetch
Vicia gigantea	giant vetch
Vicia sp.	vetch.
Vulpia bromoides	barren fescue
Vulpia microstachys	small fescue
Vulpia myuros	rattail fescue
Woodwardia fimbriata	great chain fern
Xanthoparmelia cumberlandia	questionable rockfrog
Zygadenus venenosus	death camas

Agronomics

Colchicum sp.	colchicum
Corylus avellana	European hazelnut
Ficus carica	fig tree
Hyacinthus sp.	hyacinth
Juglans nigra	black walnut
Juglans regia	English walnut
Laburnum anagyroides	laburnum
Lamium purpureum	purple dead-nettle
Lotus corniculatus	yellow birdsfoot trefoil
Myosotis discolor	yellow-blue forget-me-not
Narcissus pseudonarcissus	daffodil
Prunus armeniacum	apricot
Prunus avium	sweet cherry
Prunus domestica	plum or prune
Pyrus communis	pear
Pyrus malus	apple
Scilla non-scripta	English bluebells
Syringa vulgaris	lilac

Appendix 3: Plot Locations

Appendix 4: Conservation Evaluation Form

Terrestrial Ecosystem Mapping		
Conservation Evaluation		
Air Photo #	Gr. Photo #.	Date
Mapsheet	Plot #	Poly #
UTM	Lat./North	Long/East
Aspect	Elev.	Slope
Mesoslope	Soil drainage	Soil Texture

ECOSYSTEM COMPONENT 1: __________
(use additional sheet for additional component/s)

% Fragmentation

- ❑ Unfragmented (< 5% of polygon)
- ❑ Partly Fragmented (5 - 25 % of polygon)
- ❑ Highly Fragmented (> 25% of polygon)

Disturbance History (Anthropogenic)

❑ Logging	❑ Grazing	❑ Agriculture
❑ Construction	❑ Recreation	❑ Other

Disturbance History (Natural)

❑ Fire	❑ Windthrow	❑ Disease
❑ Wildlife Use	❑ Erosion	❑ Other

Adjacent Land Use:

Known Threats:

Other Factors:

Evaluation Summary:

Quality	❑ Excellent	❑ Good	❑ Marginal	❑ Poor
Condition	❑ Excellent	❑ Good	❑ Marginal	❑ Poor
Viability	❑ Excellent	❑ Good	❑ Marginal	❑ Poor
Defensibility	❑ Excellent	❑ Good	❑ Marginal	❑ Poor

)OMINANT / INDICATOR VEGETATION SPECIES								
TOTAL	A:		B:		C:		D:	
SPECIES	L	%	SPECIES	L	%	SPECIES	L	%
COMPLETE ❒ PARTIAL ❒								

Tree Mensuration											
		Ht Calculation to DBH									
Spp	DBH	To	Bo	S D	HD	SL	HT	Ht to DBH	Total HT	BH Age	Pat Y/N

NOTES (site diagram, exposure, gleying, etc.)

Appendix 5: Expanded Legend

Complete accounts for each ecosystem unit are provided in the expanded legend (Appendix 5). Each unit is described over two pages. The first includes a description of the ecosystem; the typical location, site, soil and terrain characteristics, and a photo showing the appearance of the unit. A small distribution map indicates all polygons where the unit is mapped in at least one of the three deciles, regardless of how small a component. The second page provides a summary of dominant, indicator and associate plant species at each developmental stage.

Dominant species are defined as those having 5% or higher cover and occurring in the unit with 75% frequency; indicators are those species found greater than 60% of the time; and associates are all others that occur with a minimum of 40% frequency. Six potential structural stages are listed for the forested ecosystem units. Structural stages that were not sampled are extrapolated from other developmental stages, known seral community types and plot information from other studies in similar areas. For the edaphic units only the herb or shrub stages are described. Notes to further describe the unit or explain how the findings on Jedediah may differ from sites found in other areas of the CDFmm are provided at the bottom of the table. Because vegetation has been highly impacted by disturbance on Jedediah, a species list is provided, on the right side of the table, to show the normal expected species in a mature, undisturbed, forested site series within the CDFmm. These list have been generated based upon the Ministry of Forests Environment and Vegetation tables (Inselberg, 1991).

Appendix 6: Frequency of Naturalness and Viability ratings by Ecosystem Unit and Structural Stage

The following table indicates the ecosystems map units that were rated for naturaness and viability. Naturalness provides an indication of conditions, as they were found in September 1998. Viability ratings provide indication of the expected future conditions if the present trends continue.

The ratings are defines as: 1 – excellent
2 – good
3 – marginal
4 – poor

Frequency of Naturalness and Viability ratings by Ecosystem Unit and Structural Stage

Number of Occurrences	Naturalness	1				2			3			4	
	Viability	1	2	3	4	2	3	4	2	3	4	4	
Ecosystem Unit	Structural Stage												Grand Total
CS	2											2	2
	3										2	1	3
	5											1	1
	6										1		1
CV	1	9	7			14	8	18		8	107	26	197
DA	2											1	1
	3					6	2	2			3		13
	4		1			2							3
	5	3	2			14	15	18	2	4	88	1	147
	6		2			10	12	5		2	41		72
DG	5										1	1	2
	6						1				5		6
DS	2									1		4	5
	3							1					1
	4						2	1		2			5
	5					1		3		1	7	1	13
	6		3			7	10	12		2	53	3	90
	7		2	1		1					4		8
FC	2	11				15	5	8			14		53
OR	3	5				3	1	1			2		12
RF	2											3	3
	3										1	1	2
	5									1	1	5	7
	6				1						4		5
	7										1		1
RV	2											1	1

Number of Occurrences	**Naturalness**	1				2			3			4	
	Viability	1	2	3	4	2	3	4	2	3	4	4	
Ecosystem Unit	**Structural Stage**												**Grand Total**
CS	2											2	2
	3										2	1	3
	3										1		1
	4											1	1
	5											2	2
SL	2										1	1	2
SS	3					1							1
Grand Total		28	17	1	1	74	56	69	2	21	337	56	662

Appendix 7: Naturalness and Viability Ratings by Decile One

Appendix 8: Checklist of Lasqueti Island Bird Species[2]

(Compiled December, 1987)

Red-throated Loon	*Gavia stellata*
Pacific Loon	*Gavia pacifica*
Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Red-necked Grebe	*Podiceps grisegena*
Eared Grebe	*Podiceps nigricollis*
Western Grebe[R]	*Aechmophorus occidentalis*
Doubled-crested Cormorant[B]	*Phalacrocorax auritus*
Brandt's Cormorant[R]	*Phalacrocorax penicillatus*
Pelagic Cormorant	*Phalacrocorax pelagicus*
Great Blue Heron[B]	*Ardea herodias*
Cattle Egret	*Bubulcus ibis*
Tundra Swan	*Cygnus columbianus*
Snow Goose	*Chen caerulescens*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
Ring-necked Duck	*Aythya collaris*
Harlequin Duck	*Histrionicus histrionicus*
Oldsquaw[B]	*Clangula hyemalis*
Black Scoter	*Melanitta nigra*
Surf Scoter[B]	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Bufflehead	*Bucephala albeola*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Northern Goshawk[R]	*Accipiter gentilis*
Red-tailed Hawk	*Buteo jamaicensis*
Merlin	*Falco columbarius*
Blue Grouse	*Dendragapus obscurus*
Ruffed Grouse	*Bonasa umbellus*
Ring-necked Pheasant	*Phasianus colchicus*
Band-tailed Pigeon	*Columba fasciata*
Virginia Rail	*Rallus limicola*
American Coot	*Fulica americana*
Killdeer	*Charadrius vociferus*
Black Oystercatcher	*Haematopus bachmani*
Greater Yellowlegs	*Tringa melanoleuca*
Spotted Sandpiper	*Actitus macularia*
Black Turnstone	*Arenaria melanocephala*
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
Short-billed Dowitcher	*Limnodromus griseus*
Bonaparte's Gull	*Larus philadelphia*
Mew Gull	*Larus canus*
Herring Gull	*Larus argentatus*
Thayer's Gull	*Larus thayeri*
Glaucous-winged Gull	*Larus glaucescens*
Common Tern	*Sterna hirundo*
Arctic Tern	*Sterna paradisaea*
Common Murre[R]	*Uria aalge*
Pigeon Guillemot	*Cepphus columba*
Marbled Murrelet[R]	*Brachyramphus marmoratus*
Rhinoceros Auklet	*Cerorhinca monocerata*
Western Screech-Owl[R]	*Otus kennicottii*
Great Horned Owl	*Bubo virginianus*
Great Gray Owl	*Strix nebulosa*
Common Nighthawk	*Chordeiles minor*
Black Swift	*Cypseloides niger*
Vaux's Swift	*Chaetura vauxi*
Anna's Hummingbird	*Calypte anna*
Rufous Hummingbird	*Selasphorus rufus*
Belted Kingfisher	*Ceryle alcyon*
Lewis' Woodpecker[B]	*Melanerpes lewis*
Red-breasted Sapsucker	*Sphyrapicus ruber*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Olive-sided Flycatcher	*Contopus borealis*
Western Wood-Pewee	*Contopus sordidulus*
Violet-green Swallow	*Tachycineta thalassina*
Cliff Swallow	*Hirundo pyrrhonota*
Barn Swallow	*Hirundo rustica*
Northwestern Crow	*Corvus caurinus*
Common Raven	*Corvus corax*
Black-capped Chickadee	*Parus atricapillus*
Chestnut-backed Chickadee	*Parus rufescens*
Red-breasted Nuthatch	*Sitta canadensis*
Brown Creeper	*Certhia americana*
Bewick's Wren	*Thryomanes bewickii*
Winter Wren	*Troglodytes troglodytes*
House Wren	*Troglodytes aedon*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Swainson's Thrush	*Catharus ustulatus*
American Robin	*Turdus migratorius*
Varied Thrush	*Ixoreus naevius*
Cedar Waxwing	*Bombycilla cedrorum*
European Starling	*†Sturnus vulgaris*
Solitary Vireo	*Vireo solitarius*
Hutton's Vireo[B]	*Vireo huttoni*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Tennessee Warbler	*Vermivora peregrina*

[2] Note: the original checklist was provided by Chris Ferris and Sheila Ray; provincial status has been added and is indicated by: [R] (Red-listed) [B] (Blue-listed)

Orange-crowned Warbler	*Vermivora celata*
Yellow-rumped Warbler	*Dendroica coronata*
Black-throated Gray Warbler	*Dendroica nigrescens*
Townsend's Warbler	*Dendroica townsendi*
Western Tanager	*Piranga ludoviciana*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
White-crowned Sparrow	*Zonotrichia leucophrys*
Dark-eyed Junco	*Junco hyemalis*
Red-winged Blackbird	*Agelaius phoeniceus*
Pine Grosbeak	*Pinicola enucleator*
Purple Finch	*Carpodacus purpureus*
House Finch	*Carpodacus mexicanus*
Red Crossbill	*Loxia curvirostra*
Pine Siskin	*Carduelis pinus*
American Goldfinch	*Carduelis tristis*

Appendix 9: Species Accounts for Project Wildlife Species

A1.0 Columbian Black-tailed Deer

Scientific Name: *Odocoileus hemionus columbianus*
Species Code: M-ODHE
Status: Yellow-listed (Any indigenous species or subspecies (taxa) which is not at risk in British Columbia).

Distribution

- **Provincial Range**

Occurs in the southwestern corner of British Columbia, on most islands south of Rivers Inlet, including Vancouver Island, and ranges east to near the summits of the Cascade and Coast ranges. Their range extends south into the United States where the deer range through Washington and Oregon, into California.

- **Provincial Context**

The Columbian black-tailed Deer occurs commonly throughout their range. Populations in BC are stable, and currently approximately 180 000 Columbian black-tailed Deer (Ian Hatter pers. comm.) reside in BC.

- **Project Area:** **Jedediah Island Marine Park (approximately 250 ha)**
  Ecoprovince: Georgia Depression
  Ecoregions: Eastern Vancouver Island
  Ecosections: Leeward Island Mountains (LIM)
  Biogeoclimatic Zones: CDFmm
  Elevational Range: Sea-Level to Subalpine Habitat, although elevations greater than 1000 m are rarely used as winter habitat.

- **Project Map Scale: 1:5,000**

Ecology and Key Habitat Requirements

- **General**

Columbian black-tailed Deer are a subspecies in interior mule deer, however Columbian black-tailed deer have smaller bodies, smaller ears and a largely black tail surrounded by a smaller white rump patch.

Columbian black-tailed Deer require food, water and cover to ensure survival during the spring, summer and winter seasons. During spring, deer favour areas with early green up (e.g., low elevation areas with warm aspect on moderate to steep slopes). Summer habitat consists of areas with a suitable mix of young to old forest areas, with an adequate supply of forage and cover elements. Winter forces deer from high elevation habitat to low elevation areas, with south-facing, warm-aspect slopes or floodplain areas where snowpack is very low (i.e., CWHxm).

Plant material comprises a significant portion of Columbian black-tailed Deer diet. Although deer are capable of digesting a wide variety of plants, forage preferences are determined, in part, by seasonal variations in forage digestibility and protein content, and by the nutritional requirement of the animals (Nyberg & Janz 1990). Optimum growth occurs in the spring when plant proteins are easily digestible, whereas fall and winter represent periods of maintenance.

Columbian black-tailed Deer breed during November and early December. Fawns are born during the first half of June. Females, 2 years and older have higher rates of conception, than younger females.

It remains unclear whether specific habitats are used for Columbian black-tailed Deer reproduction habitat. Reproduction habitat will not be rated separately.

Columbian black-tailed Deer populations can have either resident or migratory individuals.

Average annual home range for migratory deer in the moderate snowpack zone is 1770 ha, whereas the home range for resident deer in the same zone is 140 ha (Nyberg & Janz 1990).

Habitat Use - Life Requisites

- **Living**

The Living life requisites for Columbian black-tailed Deer is satisfied by the presence of suitable feeding and security habitat which are described in detail below.

- **Feeding Habitat**

Feeding requirements for Columbian black-tailed Deer are tied closely to food availability and season. During spring, deer favour areas with early green up (e.g., low elevation areas with warm aspect on moderate to steep slopes). Important spring forage species include fireweed, pearly everlasting, bunchberry, *Rubus* species, *Vaccinium*, willow and many herbs and grasses (Nyberg & Janz 1990). Summer habitat consists of areas with a suitable mix of young to old forest areas, with adequate supply of forage and cover elements. Key summer forage species include fireweed, pearly everlasting, salal, *Rubus* species, *Vaccinium*, willow and alder (Nyberg & Janz 1990). Forage quality and variety is reduced in summer, although summer forage is typically greater in quantity (Walmo 1981). Winter forces deer from high elevation habitat to low elevation areas, with south-facing, warm-aspect slopes or floodplain areas where snowpack is very low (i.e., CWHxm). The height of key browse species, such as salal and huckleberry, is important on winter ranges. During severe winters, arboreal lichens (e.g., *Alectoria*, *Bryoria*, and *Usnea*) and branches of Douglas-fir and western redcedar are major food sources. Key winter forage species include western redcedar, Douglas fir, red huckleberry, salal, deer fern and arboreal lichens (Nyberg & Janz 1990). Salal is only digestible when eaten in combination with other species. Table 1A illustrates important forage plants for Columbian black-tailed Deer.

Table A1. Important forage plants for Columbian black-tailed Deer in southern British Columbia (taken directly from Nyberg & Janz 1990). The most important or preferred species are in bold type.

	WINTER FORAGE	SPRING FORAGE	SUMMER FORAGE
TREES	**Douglas-fir** western hemlock **western redcedar**	bigleaf-maple **Douglas-fir**	red alder
SHRUBS	Alaskan blueberry five-leaved bramble kinnickinnick oval-leaved blueberry **red huckleberry** rose spp. **salal** saskatoon twinflower vine maple willow spp.	***Rubus* spp**. (salmonberry, blackberry, thimbleberry, raspberry, bramble) salal **willow spp**.	**salal** willow spp.
FERNS	**deer fern**	**bracken**	
HERBS	bunchberry grass spp.	bunchberry **fireweed** grass spp. hairy cat's-ear horsetail **pearly everlasting**	**fireweed** grass spp. hairy cat's-ear **pearly everlasting**
ARBOREAL LICHENS	***Alectoria; Bryoria*** *Lobaria oregana* ***Usnea* spp**.		

- **Security Habitat**

Security habitat for Columbian black-tailed Deer conceals deer from hunters and predators. Foliage and trunks of trees provide the best security cover, however Columbian black-tailed Deer may also use short, dense vegetation, logs or take advantage of topography (e.g., swales) as security cover. Very dense stands of young trees (e.g., sum of basal diameter exceeding 311 m (Smith & Long 1987)) may form adequate security habitat, as they do with elk. For mule deer, a slightly larger but similar species, the most effective security cover hides 90% of the animal at a distance of 60 m or less, and security cover patches need to be 180 m or more in diameter. In general, old growth forests with a patchy conifer understory and most well-stocked stands of young trees with live branches satisfy security cover requirements. Deer forage more often in clearcuts within 100 m of cover (Kremsater 1989).

Thermal Habitat

Thermal habitat allows deer to expend less energy to maintaining body temperature, allowing allocation of conserved energy to growth and reproduction. Thermal habitat can vary daily, seasonally, with prevailing weather conditions, and age, size and nutritional condition of the animal. In general, nighttime thermal cover should trap longwave radiation and maintain warmer air temperatures (occurring under a closed canopy above a deer's head or above 3 m), reduce wind at deer height (occurring in a forest stand or dense underbrush) and intercept precipitation (occurring under a closed canopy and large crown volume). In general, daytime thermal requirements are met by areas that gather heat (on or near rock bluffs, in clearcuts) or intercept excessive solar radiation (canopy closure) (Parker 1988).

♦ **Thermal Habitat in Winter**

Winter, particularly associated energetic costs of maintaining body temperature and moving through snow, represents a critical season for Columbian black-tailed Deer. Forest cover influences snow depth, density and surface hardness (Nyberg & Janz 1990), and deer typically expend most energy walking through crustless, dense, deep snow (i.e., sinking depths greater than 25 cm). Conditions that produce favourable snow conditions for Columbian black-tailed Deer include dense young-growth (>10 m tall) and old-growth forests (Nyberg & Janz 1990). Canopy closure (i.e., stands, taller than 10 m, with greater than 60% crown completeness) exerts the most influence on snow interception, and creates areas with snow conditions that don't limit deer movement (Bunnell *et al.* 1985).

Seasons of Use

Columbian black-tailed Deer require thermal, security and feeding habitat differentially throughout the year. Table A2 summarizes the life requisites for Columbian black-tailed Deer for each month of the year.

Table A2. Monthly Life Requisites for Columbian Black-Tailed Deer.

LIFE REQUISITE	MONTH	SEASON*
Living	January	Winter
Living	February	Winter
Living	March	Winter
Living	April	Early Spring
Living	May	Late Spring
Living	June	Summer
Living	July	Summer
Living	August	Summer
Living	September	Fall
Living	October	Fall
Living	November	Winter
Living	December	Winter

*Seasons defined for Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC 1999, Appendix B).

For the final ratings table, ratings will be provided for the Growing (an amalgamation of Early Spring, Late Spring, Summer and Fall seasons), and Winter seasons.

Winter Season (November - April)

Growing Season (May - October)

Separate ratings will be assigned for thermal cover (TH); security cover (SH); and feeding habitat (FD).

Habitat Use and Ecosystem Attributes
Table A3 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics)

Table A3. Terrestrial Ecosystem Mapping (TEM) Relationships for each Life Requisite for Columbian Black-tailed Deer.

LIFE REQUISITE	TEM ATTRIBUTE
Living habitat (feeding)	• site: site disturbance, elevation, slope aspect, structural stage • soil/terrain: bedrock, terrain texture, flooding regime • vegetation: % cover by layer, species list by layer, cover for each species for each layer,
Living Habitat (security)	• site: elevation, slope, aspect, structural stage • soil/terrain: terrain texture • vegetation: % cover by layer • mensuration: tree species, dbh, height
Living Habitat (thermal)	• site: elevation, slope, aspect, structural stage • soil/terrain: terrain texture • vegetation: % cover by layer • mensuration: tree species, dbh, height

Ratings
There is a detailed level of knowledge of the habitat requirements of Columbian black-tailed Deer in British Columbia to warrant a 6-class rating scheme.

➢ **Provincial Benchmark**
Ecosection: Leeward Island Mountains (LIM)
Biogeoclimatic Zone: CWHxm1
Habitats: Critical habitat varies with season and snowpack conditions. Table A4 shows a summary of important habitat features on different seasons and different snowpack conditions.

➢ **Ratings Assumptions**
1. Structural stage 1-4 have minimal winter value (suitability ≤ 4) for food, security and thermal values. Although these stands may be available to deer in low elevation subzones, heavy snowpack will not allow access to these habitats. Structural stage 4 may provide limited winter thermal/security habitat depending on adjacent habitat.
2. Young forests (structural stage 5) may provide security and thermal habitat (suitability ≤ 2) depending forage availability, subzone and snowpack.
3. Mature forests (structural stage 6) provide high winter habitat (suitability = 1) because of the combination well developed shrub layers, arboreal lichen abundance, and canopy closure.
4. Old forests (structural stage 7) provide the best food availability in winter, however, because of the presence of canopy gaps offer limited thermal habitat. Regardless, with the appropriate slope, aspect, and adjacency with uneven-aged stands, old forests can be excellent Columbian black-tailed Deer winter habitat (suitability = 1).
5. Structural stage 2 and 3 should provide abundant forage and be rated high (suitability = 1), when adjacent to security habitat.
6. Structural stage 5-7 provide adequate thermal and security cover for deer during the living season, however, value of the stand increases with age so that mature forests are rated highest (suitability = 1).
7. Riparian habitat should provide high habitat throughout the living season (suitability = 1).

Table A4. Important habitat features for different seasons and snowpack conditions for Columbian Black-tailed Deer (Nyberg & Janz 1990).

SEASON/SNOWPACK	HABITAT FEATURE
winter/shallow snowpack	• topographic features that reduce snowpack • patches of cover with shrub understory • small clearcut or burned openings (less than 400 m across)
spring	• topographic features that encourage early growth • openings that encourage early growth of herbaceous forage • cover near forage (i.e., within 200m)
summer	• abundant forage, especially herbs and shrubs • patches of cover interspersed with food.

- **Final Ratings Table**

see Appendix 10

A2.0 Pileated Woodpecker

Scientific Name: *Dryocopus pileatus*
Species Code: B-PIWO
Status: Yellow-listed (Any indigenous species or subspecies (taxa) which is not at risk in British Columbia).

Distribution

➢ **Provincial Range**

Pileated Woodpeckers are widely distributed in southern British Columbia, becoming relatively sparse across central BC, north through the Peace Lowlands to the northeastern regions of the province. Breeding likely occurs throughout their range (Campbell *et al.* 1990).

➢ **Provincial Context**

Pileated Woodpeckers occur more commonly in southern BC than in northern parts of their range.

➢ **Project Area:** Jedediah Island Marine Park (approximately 250 ha)
Ecoprovince: Georgia Depression
Ecoregions: Eastern Vancouver Island
Ecosections: Leeward Island Mountains (LIM)
Biogeoclimatic Zones: CDFmm
Elevational Range: Sea-Level to Sub-Alpine

➢ **Project Map Scale: 1:5,000**

Ecology and Key Habitat Requirements

➢ **General**

Pileated Woodpeckers are the largest woodpecker in North America (40-49 cm long; 250-350 g body mass). This species occurs in mature, coastal and interior Douglas-fir and western hemlock forests, including adjacent logged and second growth areas, to the open deciduous and mixed woods of the Chilcotin-Cariboo Basin (Campbell *et al.* 1990). Breeding occurs in a variety of different forest types from open deciduous forests to dense, mature coniferous stands (Campbell *et al.* 1990). This species excavates its own nest cavities and nests occur mostly in deciduous trees, however conifers and man-modified structures (e.g., power poles) may also be used. Nests typically occur in the main trunk of large live trees (i.e., >25 cm DBH). The breeding period extends from April to early June. The Pileated Woodpecker feeds primarily on carpenter ants which it extracts from large diameter logs, stumps or standing dead trees. This species requires large territories and takes advantage of late successional stages of coniferous or deciduous forest, but also younger forests that have scattered, large, dead trees (Bull & Jackson 1995).

Territory size can be variable. Studies in Oregon show that territory size of individual birds varies from 200 - 1586 ha, with pair territories slightly larger than either partner (Bull & Holthausen 1993)

Pileated Woodpeckers are year-round residents, although growing season and winter behaviour can be distinguished.

Habitat Use and Life Requisites

➢ **Living**

The Living life requisite for Pileated Woodpeckers is satisfied by the presence of suitable feeding and security (roosting) habitat, which are described in detail below.

♦ **Feeding Habitat**

Wood-dwelling insects are the primary diet of Pileated woodpeckers throughout the year, and carpenter ants are a major food item in all seasons (Beckwith and Bull 1985; Bull *et al.* 1992). Carpenter ants are particularly important in winter, when they form the majority of the diet. Diet can vary seasonally, with woodpeckers making excavations in fairly sound wood to access carpenter ant colonies in winter. Foraging in summer can be excavations in soft wood, surface gleaning and probing. Pileated Woodpeckers can be opportunistic taking advantage of outbreaks in western spruce budworm larvae, as well as berries, nuts ands fruits. In winter Pileated woodpeckers use deep excavations in sound wood, whereas summer food occurs near the wood surface precluding deep excavations. On southeastern Vancouver Island, Pileated woodpecker used large snags and defective trees (mean dbh ± SE; 56 ± 3cm), decayed snags, with less remaining bark (49% ± 4% SE), and foraged in the upper and main canopy strata (Hartwig 1999).

♦ **Security (Roosting/Reproduction) Habitat**

Eggs are laid in late April or early May and hatch after an 18 day incubation. Fledged young remain with the parents for most of the summer and leave in August or September. Reproductive habitat contains suitable trees for nesting. Pileated Woodpeckers almost always excavate their own cavity, and only trees with main trunks large enough to hold a large cavity high above the ground are used for nesting. In Alberta, minimum nest tree dbh ranges from 29 to 33 cm dbh (Conner *et al.* 1976, Bonar and Bessie 1996). Recently, in southeastern Vancouver Island, Hartwig (1999) found Pileated woodpeckers nesting in much larger (mean±SE; 82 ± 16 cm), taller trees (22 ± 5.2 m), with 91% (± 9%) remaining bark. Nests are usually located in high (≥ 4 m) branch-free portions of the main trunk. In coastal forests, most nest trees were western hemlock (Aubry & Raley 1992), although western redcedar and Douglas-fir are also used (Hartwig 1999). Pileated Woodpeckers show a preference for trees with fungal-softened heartwood at the cavity location, as softer hardwood is easier to excavate, and fungal respiration may heat the cavity.

Pileated Woodpeckers are closely associated with tree cover for nesting, roosting and foraging. In spring and summer, habitat use occurs in both open and closed canopied areas. In winter, use of open areas declines as logs and stumps are unavailable due to snow cover. However, given that Jedediah island has primarily CDFmm habitat, and snow cover doesn't govern habitat use to the same extent as elsewhere, ratings for the growing and winter season will not be differentiated. Pileated Woodpecker habitat will be rated for the entire year only.

Seasons of Use

Pileated Woodpeckers are year round residents of the project area. Table A5 summarizes the life requisites required for each month of the year, although for this project a habitat rating for security/thermal habitat and feeding habitat will be provided for the entire year.

Table A5. Monthly Life Requisites for Pileated Woodpecker

LIFE REQUISITE	MONTH	SEASON*
Living	January	Winter
Living	February	Winter
Living	March	Growing
Living	April	Growing
Living	May	Growing
Living	June	Growing
Living	July	Growing
Living	August	Growing
Living	September	Growing
Living	October	Growing
Living	November	Winter
Living	December	Winter

*Seasons defined for Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

A single rating, for the entire year (All season) will be assigned to Pileated Woodpecker habitat because suitable habitat availability on Jedediah Island should not differ between seasons. In addition, a rating for the Reproducing Season will also be assigned.

Ratings will be assigned for feeding habitat (FD) and security/thermal (ST) habitat. For Pileated Woodpecker security/thermal habitat will be equivalent to roosting and reproducing habitat.

Habitat Use and Ecosystem Attributes
Table A6 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics)

Table A6. Terrestrial Ecosystem Mapping (TEM) Relationships for each Life Requisite for Pileated Woodpecker.

Life Requisite	TEM Attribute
Living Habitat (Feeding, Security/Thermal)	• site: structural stage • soil/terrain: flooding regime • vegetation: % cover by layer, coarse woody debris (CWD) (dbh, decay class, abundance) • tree species, dbh, height, wildlife tree characteristics

Ratings
A 6-class rating scheme will be used for Pileated Woodpecker habitat. Although the 'BC Wildlife Habitat Ratings Standards' (RIC 1999) recommends a 4-class rating scheme, 1:5 000 mapping scale should allow habitat discrimination into 6 classes.

➢ **Provincial Benchmark**
Ecosection: Shuswap Highland (SHH); Nanaimo Lowland (NAL)
Biogeoclimatic Zone: ICHmw, CWHxm
Habitats: mature - old growth forests with high abundance of large diameter trees and high abundance of CWD on the forest floor.

➢ **Ratings Assumptions**
1. Units with large trees (≥ 70 cm dbh), such as mature and old-growth coniferous forests will be rated high roosting and reproducing habitat (class = 1). Abundance and average suitable tree diameter will govern ratings lower than class 1.
2. Units without large diameter trees will generally be rated low (≤5), and abundance of large diameter, usable nest and feeding trees will govern ratings >5.
3. Units with high coarse woody debris abundance will be rated as high feeding habitat.
4. Units with closed canopy will be rated higher than units with open canopy.
5. Units with high amounts of Pileated Woodpecker feeding sign will be rated as high feeding habitat.

Table A7 summarizes the habitat requirements for Pileated Woodpeckers in the study area for the seasons and life requisites being modeled.

Table A7. Summary of habitat requirements for Pileated Woodpeckers in the study area.

SEASON	LIFE REQUISITE	STRUCTURAL STAGE	REQUIREMENTS
Growing Season/ Winter Season	Feeding (FD)	2-3, 5-7	Mature and old-growth coniferous forests (high abundance of CWD) Mixed conifer/deciduous mature forest. Shrub cover >50% and canopy closure >66%.
Growing Season/ Winter Season	Security/ Thermal (TH)	2-3, 5-7	Mature and old-growth coniferous forests. Mixed conifer/deciduous mature forest. Shrub cover >50% and canopy closure >66%.

➢ **Final Ratings Table -** See Appendix 10

A3.0 Bald Eagle

Scientific Name: *Haliaeetus leucocephalus*
Species Code: B-BAEA
Status: Yellow-listed (Any indigenous species or subspecies (taxa) which is not at risk in British Columbia, but are of management concern).

Distribution

➢ **Provincial Range**

Bald Eagles are widely distributed throughout the province. Bald Eagles breed from northwestern Alaska and central Canada south to the southern United States and Baja California.

➢ **Provincial Context**

Bald Eagles occur throughout the province and are uncommon to fairly common resident along the coast of Vancouver Island, the Queen Charlotte Islands, and the adjacent mainland. Seasonally and locally they are very common to abundant. Coastal BC provides habitat for both breeding and wintering Bald Eagles. Bald Eagles are primarily associated with aquatic habitats including seashores, lakes, rivers, sloughs, and marshes, although they have been found in almost all habitats from sea level to 2,380 m elevation (Campbell *et al.* 1990)

➢ **Project Area:** Jedediah Island Marine Park (approximately 250 ha)
Ecoprovince: Georgia Depression
Ecoregions: Eastern Vancouver Island
Ecosections: Leeward Island Mountains (LIM)
Biogeoclimatic Zones: CDFmm
Elevational Range: Sea-Level to 2 380 m

➢ **Project Map Scale: 1:5,000**

Ecology and Key Habitat Requirements

➢ **General**

The Bald Eagle is one of the largest eagles found in British Columbia. This species is widely distributed throughout the province, but is primarily associated with aquatic habitats. Habitat preferences vary with season, however, are basically governed by prey (i.e., predominantly fish) availability and abundance (Campbell *et al.* 1990). For example, summer aggregations of eagles occur along the coast in response to herring and surface-feeding fish. In the fall, bald eagles will take advantage of salmon spawning and forage along rivers and estuaries. Bald Eagles have also been known to take advantage of large mammal carcasses and garbage dumps as a food source.

Bald Eagles typically nest sometime between February and June. Bald Eagles nest primarily in coniferous forests, and nests typically occur within 200 m of the shore. Nests generally have an unobstructed view of the surrounding area. Nests are massive structures, made from branches and twigs up to 9 cm in diameter. Nests are typically located in the crook of a tree, and can be up to 3.6 m in outside diameter. Nest trees have to be large enough to support this kind of nest.

Bald Eagle occurrence in an area is likely governed by the availability and abundance of prey species. Success and occurrence of bald eagles during the breeding season is likely governed by prey abundance and availability of suitable nesting habitat (Blood & Anweiler 1994).

Habitat Use and Life Requisites

The Reproducing life requisite for bald eagles is satisfied by the presence of suitable nesting habitat near (within 200 m) feeding habitat. Reproducing habitat is described in detail below.

♦ **Reproducing Habitat**

Most Bald Eagles breed and nest where suitable nest trees are available, adjacent to aquatic foraging habitat (e.g., along the coast, near estuaries, broad intertidal zones, island and reef complexes, near seabird colonies and sites with strong tidal currents). Nests are commonly built on one of the tallest, largest diameter at breast height (dbh) tree in the forest stand. As a result, old growth forests provide the most suitable nest sites, but where there are no trees, the birds have nested on cliffs or rock pinnacles. Breeding abundance is highest along the coast, where dense populations are found in the Queen Charlotte Island and Gulf Islands. Bald Eagles breed primarily in coniferous forests, but nests also occur in deciduous and mixed woodlands, near seashores, lakes, large rivers, and marshes, and on islands. Along the coast most nests are within 200m of the shore.

In recent work on Vancouver Island, 81% of the located nests were placed in Douglas-fir (*Pseudotsuga menziesii*) trees, and smaller proportions of the nests were placed in western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), black cottonwood (*Populus balsamifera*) and western redcedar (*Thuja plicata*) trees. (Deal & Setterington 1999).

Bald Eagle nests were located in exposed parts of the tallest trees of the surrounding habitat. In the Nimpkish Valley, nests were most likely to be found in tall, veteran old-growth (>250 yr old) Douglas-fir trees, in exposed parts of the canopy that provided visibility to the surrounding areas. Nest sites were often near a section of a river with a slow rate of water flow (wide areas, or gravel bars), at the junction of a main channel and a tributary, near the mouth of a river or creek where it enters a lake; and within 350 m of shoreline (Deal & Setterington 1999).

Seasons of Use
Table A8 summarizes the life requisites required for each month of the year, although for this project a habitat rating for only reproducing habitat will be provided.

Table A8. Monthly Life Requisites for Bald Eagle.

LIFE REQUISITE	MONTH	SEASON*
Living	January	Winter
Reproducing	February	Winter
Reproducing	March	Growing
Reproducing	April	Growing
Reproducing	May	Growing
Reproducing	June	Growing
Living	July	Growing
Living	August	Growing
Living	September	Growing
Living	October	Growing
Living	November	Winter
Living	December	Winter

*Seasons defined for Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

A single rating, for the reproducing season will be assigned to bald eagle habitat because reproducing habitat is likely most limiting for this region.

A rating will be assigned for security/thermal (ST) habitat, which is equivalent to the nesting/reproducing life requisite.

Habitat Use and Ecosystem Attributes
Table A9 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics)

Table A9. Terrestrial Ecosystem Mapping (TEM) Relationships for each Life Requisite for Bald Eagle.

LIFE REQUISITE	TEM ATTRIBUTE
Reproducing Habitat (Security/Thermal)	• site: structural stage • vegetation: % cover by layer, coarse woody debris (CWD) (dbh, decay class, abundance) • mensuration: tree species, dbh, height, wildlife tree characteristics

Ratings

Although the Standards recommend a 4-class rating scheme, a 6-class rating scheme will be used for bald eagle habitat. This ratings scheme will be used because the 1:5 000 mapping scale should allow habitat to be discriminated into 6 classes.

➢ **Provincial Benchmark**

Ecosection: Nanaimo Lowland (NAL)
Biogeoclimatic Zone: CWH
Habitats: The best coastal nesting habitats usually have one or more of the following features: high shoreline length per unit area due to many islands, channels or inlets; a broad intertidal zone and/or many offshore reefs exposed at low tide; presence of estuaries or mudflats; proximity to strong tidal currents; regularly used herring spawning habitats nearby and seabird or Great Blue Heron nesting colonies in the vicinity. In BC tree size, form and location are more important than tree species. Nest trees are usually dominant or co-dominant specimens (in size) in the stand in which they occur, have developed sturdy branches and a fairly open branch structure, and are located at or near shorelines. The Coastal Western Hemlock (CWH) Zone in the Coast and Mountains Ecoprovince contains by far the most extensive and important nesting habitat. The Coastal Douglas-fir (CDF) and CWH zones of the Georgia Depression are also important, but less extensive

➢ **Ratings Assumptions**

1. Units with large Douglas-fir trees (≥ 60 cm dbh), and within 200 m of water will receive a class 1 rating for reproducing habitat. Abundance and diameter of suitable nest trees will govern ratings less than class 1.
2. Units with large diameter trees, other than Douglas fir, will also receive a class 2 or better reproducing habitat rating. For example, on the coast, 95% of 511 nests were located in living or dead coniferous trees, including Sitka spruce (74%), Douglas-fir (19%), western redcedar, western hemlock, and lodgepole pine. Deciduous trees (n=26) included black cottonwood (24 nests), red alder and willow (Campbell *et al.*, 1990).
3. Units without large diameter trees will generally be rated low (≥5), and abundance of large diameter, usable nest trees will govern ratings better than class 5.
4. Units greater than 200 m from feeding habitat (i.e., open water) will be rated less than class 2 reproducing habitat. Distance from water will govern habitat ratings poorer than class 2.

Table A10 summarizes the habitat requirements for Bald Eagle in the study area for the seasons and life requisites being modeled.

Table A10. Summary of habitat requirements for Bald Eagle in the study area.

SEASON	LIFE REQUISITE	STRUCTURAL STAGE	REQUIREMENTS
Growing Season	Reproducing	2-3, 5-7	Mature and old-growth coniferous forests Mixed conifer/deciduous mature forest. Shrub cover >50% and canopy closure >66%.

➢ **Final Ratings Table**

See Appendix 10

A4.0 Pelagic Cormorant

Scientific Name: *Phalacrocorax pelagicus*
Species Code: B-PECO
Status: Blue/Yellow-listed

There are two subspecies of Pelagic Cormorant in British Columbia: *P.p.pelagicus* [blue-listed] breeds from the Queen Charlotte Islands northward but is found along the south coast in winter. *P.p. resplendens* [yellow-listed] is found along the south coast and northward for an undetermined distance (Campbell *et al.* 1990). Although it is most likely to be *P.p. resplendens* that breeds in the vicinity of Jedediah Island, no distinction will be made between the two subspecies in the habitat ratings.

Distribution

- **Provincial Range**

The Pelagic Cormorant breeds from Alaska to California and is a common resident along the inner and outer coastal areas of British Columbia. It rarely occurs very far up inlets, and there are no records from freshwater locations. (Campbell *et al.* 1990)

- **Provincial Context**

In British Columbia, Pelagic Cormorant populations are centred on the south coast and 55% occur in the Strait of Georgia (Campbell *et al.*, 1990). These birds are found mostly at sea-level.

- **Project Area:** Jedediah Island Marine Park (approximately 250 ha)
  Ecoprovince: Georgia Depression
  Ecoregions: Eastern Vancouver Island
  Ecosections: Leeward Island Mountains (LIM)
  Biogeoclimatic Zones: CDFmm
  Elevational Range: Sea-Level

- **Project Map Scale: 1:5,000**

Ecology and Key Habitat Requirements

- **General**

The Pelagic Cormorant prefers rocky coasts and forages in bays, harbours, lagoons, surge narrows and coves. It feeds in the littoral benthic zone and its diet is largely comprised of Pacific Sandlance, Pacific Staghorn Sculpin, Shiner Perch, Rockfish and Pacific Salmon (Sullivan, 1998). It is a colonial nester, sometimes nesting with other cormorant species (such as the Double-crested Cormorant), but prefers the highest, steepest, least accessible rocky cliffs facing water.

Habitat Use and Life Requisites

The Reproducing life requisite for Pelagic Cormorant is satisfied by the presence of suitable nesting habitat near coastal waters. Reproducing habitat is described in detail below.

♦ **Reproducing Habitat**

Pelagic Cormorants are colonial nesters. Unlike larger cormorant species, they are not able to defend nests and young against aerial predators but rely on inaccessibility of cliff-nesting habitat to deter predators (Ehrlich *et al.* 1988).

Pelagic Cormorants use cliffs on forested and grassy, rocky islands and headlands, but colonies may also be located on caves, beached driftlogs and man-made structures such as navigation beacons, bridge pylons, empty ship hulls and abandoned towers. All large colonies are on cliffs.

Nests are positioned on narrow ledges of cliffs, within sea caves or on faces near the top of small rocky islets at elevations ranging between 1.8 and 25 metres above the high tide line. Nests vary in size depending on the substrate and are constructed of seaweed, grasses and marine debris, although eggs are sometimes laid on bare rock. In the Georgia Strait nests may be used for several successive seasons. Breeding individuals remain in the colony during the day, non-breeding individuals return in the evening (Ehrlich *et al*. 1988).

Eggs are laid from late April to late August and young are hatched from mid-June to mid-October. If the first clutch is destroyed a second clutch may be laid, which probably accounts for the wide range in breeding dates recorded.

Seasons of Use
Spring migration occurs in March and April, while autumn movements take place in September and October. Most movements are related to seasonal changes in fish availability. As noted above, reproduction occurs from late April to mid-October. The period of time that will be considered for rating Reproducing habitat will be May through September.

Table A11. Monthly Life Requisites for Pelagic Cormorant.

LIFE REQUISITE	MONTH	SEASON*
Living	January	Winter
Living	February	Winter
Living	March	Growing
Living	April	Growing
Reproducing	May	Growing
Reproducing	June	Growing
Reproducing	July	Growing
Reproducing	August	Growing
Reproducing	September	Growing
Living	October	Growing
Living	November	Winter
Living	December	Winter

*Seasons defined for Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

A single rating, for the reproducing season will be assigned to pelagic cormorant habitat because reproducing habitat is likely most limiting for this region. A rating will be assigned for security/thermal (ST) habitat, which is equivalent to the nesting/reproducing life requisite.

Habitat Use and Ecosystem Attributes
Table A12 outlines how each life requisite relates to specific ecosystem attributes. Because cliffs and rocky islets are the most significant habitat feature for Pelagic Cormorant, slope and bedrock type will be the most important ecosystem attributes to be rated. Cliffs must be adjacent to coastal waters.

Table A12. Terrestrial Ecosystem Mapping (TEM) Relationships for each Life Requisite for Pelagic Cormorant

LIFE REQUISITE	TEM ATTRIBUTE
Reproducing Habitat	• site: elevation, slope, aspect, • soils/terrain: bedrock type

Ratings
There is an intermediate level of knowledge on the habitat requirements of Pelagic Cormorant in British Columbia and so, a 4-class rating scheme will be used.

➢ **Provincial Benchmark**

Ecosection: Strait of Georgia
Biogeoclimatic Zones: CDFmm;

Location:: Mittlenatch Island (25 km SE of Campbell River)
Habitats: Cliffs, rocky islets

The provincial benchmark for Pelagic Cormorant reproducing habitat is Mittlenatch Island because it has the most recent highest densities recorded (T. Sullivan, pers. comm.), about 600 nests in 1982.

➢ **Ratings Assumptions**

1. Based on the reproducing colonies on Mittlenatch Island, the following ratings scheme will represent potential nest densities for pelagic cormorant colonies.

% OF PROVINCIAL BEST	POTENTIAL NEST DENSITIES FOR PELAGIC CORMORANT COLONIES (BEST = 600 NESTS)	RATING	CODE
100 - 76%	400 - 600	High	H
75 - 26%	150-600	Moderate	M
25 - 1%	6 - 30	Low	L
0%	0	Nil	N

2. Cliffs that are not immediately adjacent to and facing coastal waters will be rated nil.
3. Cliffs higher than 10 m will be rated up to high for reproducing habitat.
4. Sheer cliffs with narrow ledges will be rated up to high for reproducing habitat, whereas less steep or terraced cliffs will be rated low to nil for reproducing habitat.
5. Vegetated cliffs will be rated nil to moderate for reproducing habitat.
6. Sea caves with steep high walls (greater than 5 m) and narrow ledges will be rated moderate to high for reproducing habitat

Appendix 10: Final Ratings Table

Appendix 11: Wildlife Habitat Maps for Jedediah Island

Appendix 12: Ecosystem Map