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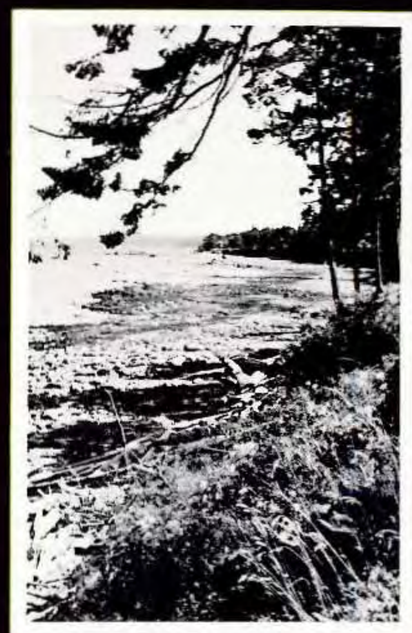

GABRIOLA ISLAND

AND NEIGHBOURING ISLANDS
.... A LANDSCAPE ANALYSIS

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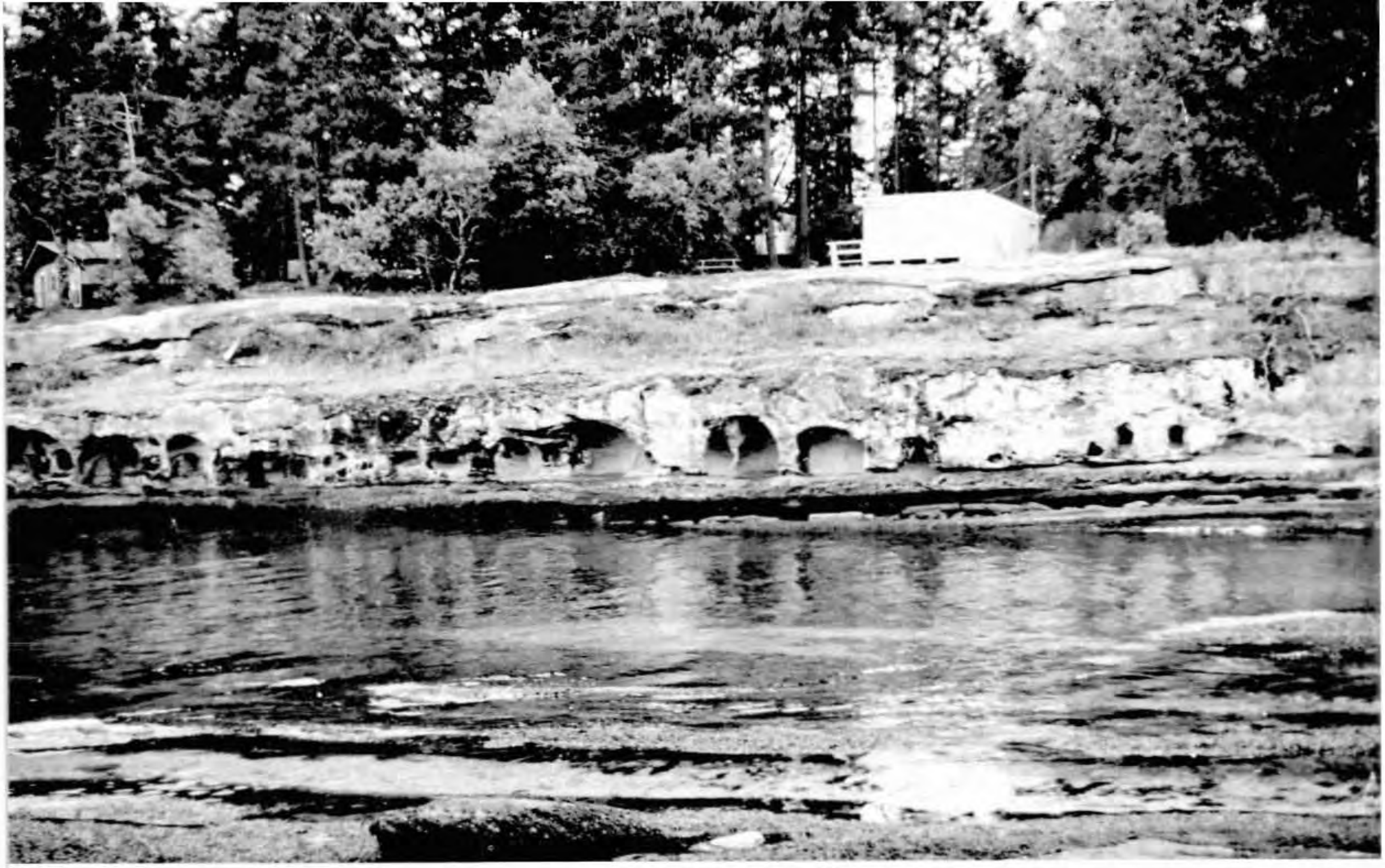
ABSTRACT

The intrinsic physical and biological properties pertinent to land use were analyzed on Gabriola Island and the Flat Top and DeCourcy groups, located in the Strait of Georgia. Ten landscape units, plus a designation for water bodies, were depicted on a map. Each landscape unit was described according to its capability to support various land uses. Since the primary purpose of the study was to provide background information for developmental planning, emphasis was placed on factors relevant to residential development. The open space concept can allow a certain amount of residential development, while maintaining aesthetically pleasing habitation and providing recreational activities for residents and visitors. Domestic water supply, especially during the summer, will be a primary factor limiting residential expansion. Gabriola Island has some natural petroglyphs that should be available for public viewing, but safeguarded from vandalism.

RÉSUMÉ

On a analysé les propriétés physiques et biologiques intrinsèques afférentes à l'aménagement spatial dans l'île Gabriola et les archipels de Flat Top et de DeCourcy, situés dans le détroit de Goergie. Dix sites plus une indication des étendues d'eau, ont été cartographiés. Chaque site a été décrit d'après sa capacité à se prêter à divers usages du terrain. Etant donné que le but primordial de l'étude était d'obtenir des renseignements de fond sur la planification du développement, l'accent a été mis sur des facteurs relatifs au développement domiciliaire. Le plan d'aménagement spatial peut permettre le développement résidentiel jusqu'à un certain point, tout en maintenant une habitation esthétiquement agréable et en pourvoyant à certaines activités récréatives à l'intention des résidents et des visiteurs. L'approvisionnement en eau potable, spécialement au cours de l'été, constituera un important facteur de limitation du développement domiciliaire. L'île Gabriola renferme quelques pétroglyphes naturels qui devraient etre exposés à la vue du public mais préservés de tout vandalisme.



FIGURES 1 & 2 - Galleries carved in sandstone by wave action that served as places for Spanish explorers to cache goods. The banks provide attractive lots for residential development. Means to preserve the galleries from vandalism should be established.

INTRODUCTION

Gabriola Island was known to the Indians before the time of Christ and to Spanish explorers since the early eighteenth century (Figs. 1 and 2). Settlement, however, did not begin until the latter portion of the nineteenth century, when farming and forestry endeavors attracted attention. Around 1930, a factory produced millstone wheels from consolidated sandstone east of Descanso Bay (Figs. 3 and 4), and another produced bricks from shale along False Narrows. The demand for semi secluded and private habitation gained emphasis during the last decade and the population increased considerably. The current population is about 1150, and has increased over 20% since 1971. During the summer, when off-island property owners and visitors come to enjoy the splendors and relaxation afforded by island living, the population may triple.

This island, about 5106 ha in size, is approximately 14.5 km long and 4 km wide, and is located in the Strait of Georgia at about 49° 09′ N latitude and 134° 48′ W longitude (Fig. 5). Some smaller nearby islands that could be affected by certain types of development on Gabriola Island are included in this survey. They are the DeCourcy Group, containing Mudge (about 243 ha), Link (about 33 ha) and DeCourcy (about 210 ha), and the Flat Top Group, containing Carlos, Gaviola, Vance, Acorn, Tugboat and Sear, which range in size from 1.5 to 15 ha.

Gabriola Island is accessible from Vancouver Island by a 20-minute ferry ride from Nanaimo and from the mainland of British Columbia by ferries to Vancouver Island from Horseshoe Bay, downtown Vancouver and Tsawwassen. No scheduled ferry service exists to the other islands included in this survey. However, they are easily accessible by private or chartered boats, which increases the demand for water front properties on these islands.

These islands are readily accessible not only to over two million residents of southwestern British Columbia, but also to visitors and prospective seasonal or permanent settlers from the United States. Heavy pressure has been placed on the islands for residential and recreational pursuits, as well as some industrial enterprises. A proposal has recently been made to establish a major ferry terminal on Gabriola Island, which would necessitate a road with bridges connecting Gabriola and Mudge islands with Vancouver Island. This would bring with it a certain complement of residential development, as well as increasing the accessibility to the islands.

FIGURES 3 & 4 - Millstone wheels were cut out of consolidated sandstone, leaving basins that hold water and serve as habitat for numerous organisms.

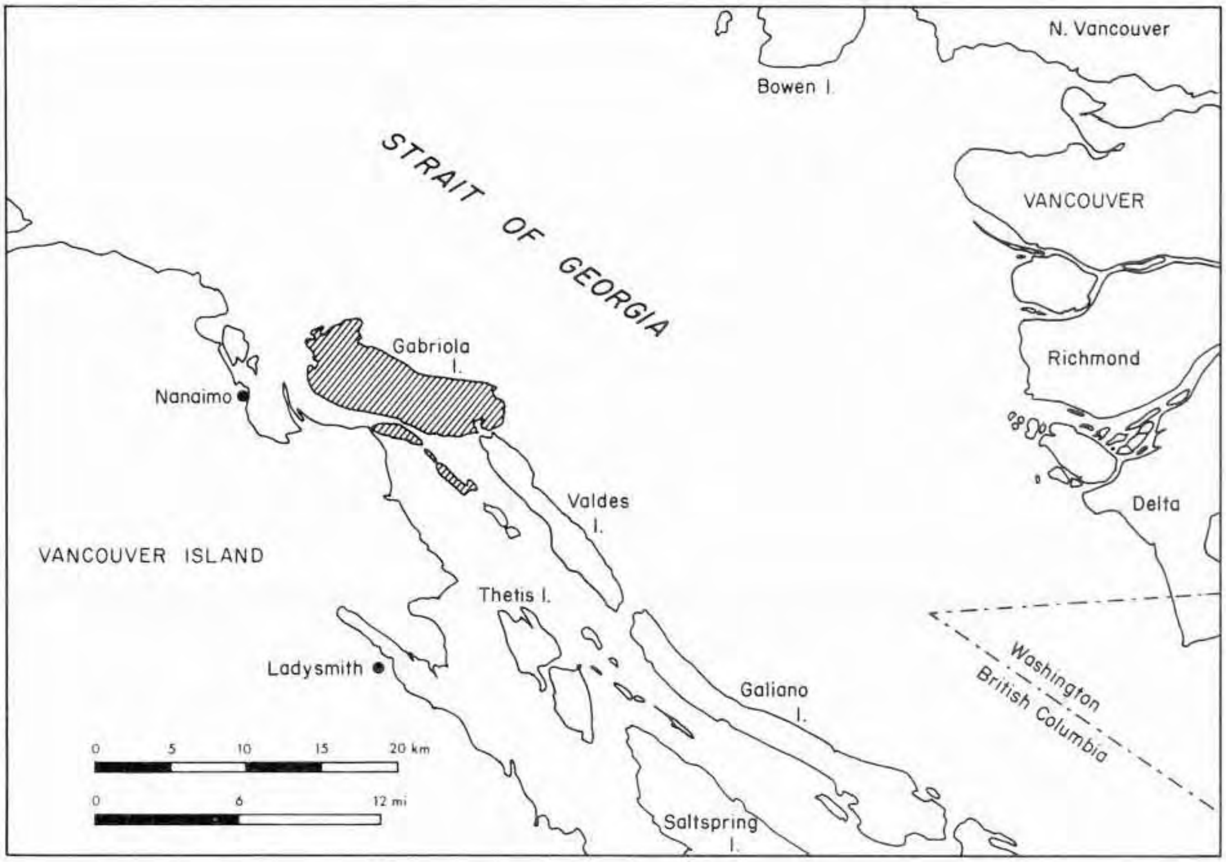


FIGURE 5 - Location of the islands studied in relation to Vancouver Island and the mainland of British Columbia.

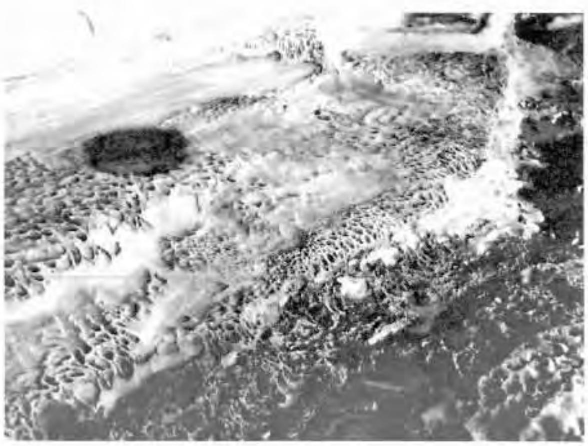


FIGURE 6 - Sandstone pitted by salt water splash.

It may be easy for a person to make suggestions or demands on the type of use a piece of land should be put to, but such choices may be biased according to the interests or position of the person. These often do not include consideration of important environmental aspects for the development of the land. A hodgepodge of development, with eventual serious consequences, would result from uncontrolled development of a landscape. The arduous task of balancing the demands for recreational, residential and industrial development, within the confines of a relatively small land base, and retaining as much of the intrinsic beauty (Figs. 6, 7 and 8) as possible falls on the Islands Advisory Planning Commission in cooperation with the Nanaimo Regional District Board and the Islands Trust. A survey of the inherent landscape features was requested by Islands Trust to aid in planning development. The Pacific Forest Research Centre undertook the study, using established methods (Hirvonen et al. 1974; Eis and Oswald 1975; Eis et al. 1976; Hirvonen 1976).

The biophysical complexity of the islands was analyzed by reviewing available information on the geology, vegetation, soil, climate and hydrology, and conducting field work with the aid of aerial

FIGURE 7 - Some bedrock remnants, although pitted, are resistant to erosion and add variety and appeal to the shoreline.

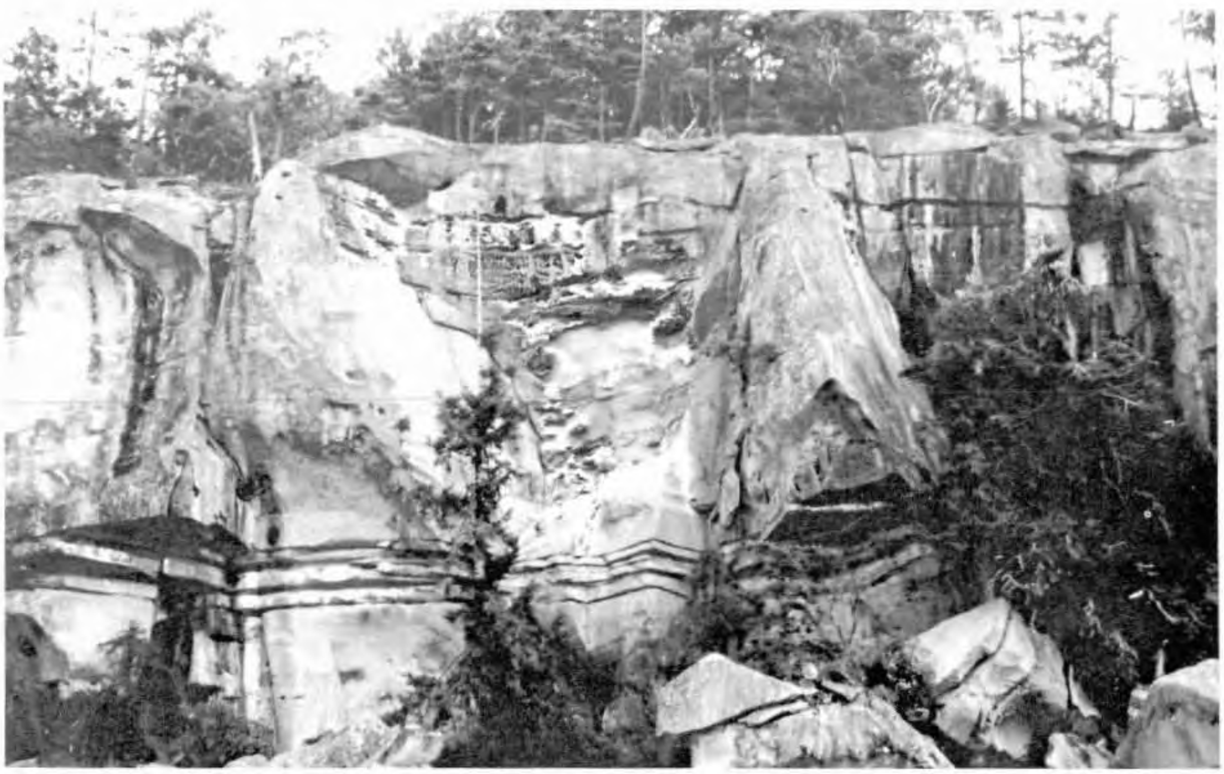


FIGURE 8 - Cliffs of sandstone provide nesting sites for a variety of shore birds. Note the fracture pattern and the degradation.

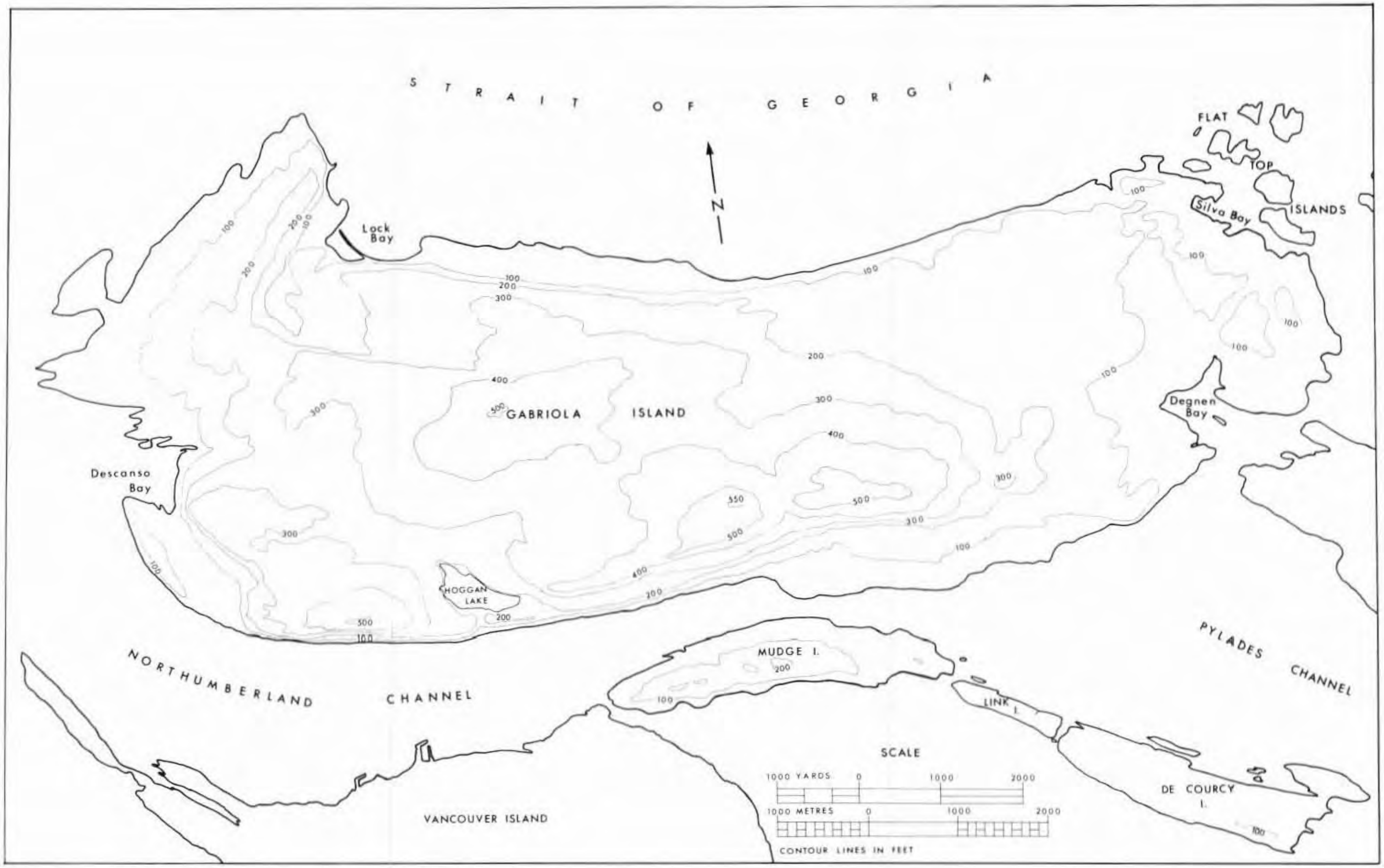


FIGURE 9 - Topographic map of study area.

photographs. Over 100 field examinations were made on Gabriola Island to verify interpretations of aerial photographs. Modal landscape types, defined in terms of their vegetation, soils, geology and topographic position, and other inherent properties pertinent to land use are investigated. Some interpretations of the landscape types are made concerning their suitability for various land assignments. The delineated landscape units often consist of more than one landscape type that are too intricately associated, or are too small in aerial extent, to delineate separately at the scale of mapping. Even so, the composite units are sufficiently homogeneous in most physical attributes that a more detailed description would be necessary only for site-specific development.

The landscape units are initially delineated on black and white aerial photographs at a scale of 1:15 840 and, after field checking, were transferred to a base map at the same scale. The final working map was reduced to a scale of about 1:26 000 for publication.

GENERAL DESCRIPTION

Physiography and Soils

The sedimentary rocks forming what is now Gabriola Island and the other islands included in this survey were formed during four episodes of Upper Cretaceous time approximately 80-million years ago (Muller and Carson 1970). They have since been weathered and eroded to form the present topography. The most recent major erosion occurred during the Pleistocene ice age 12 000 to 15 000 years ago, when massive ice filled the Strait of Georgia and depressed the land mass of the Nanaimo area some 143 m below current sea level. Ice movement scoured the surfaces and conceivably caused the general eastward sloping surface that presently exists on Gabriola Island. While the land mass was depressed, oceanic water inundated several areas and marine sediments accumulated in locations well above the present sea level. The highest land is about 170 m above sea level (Fig. 9).

Sandstone, conglomerate, shale and siltstone are the primary bedrock constituents of the islands and are easily eroded. On Gabriola Island, a sandstone ridge forms a prominent bank (Fig. 8) rising abruptly from the sea along the south side of the island, except along False Narrows, where the ridge is separated from the sea by a band of shale. The same

FIGURE 10 - Sandstone overlain by conglomerate.

FIGURE 11 - Shale bedrock. Note the progressively smaller plates from bottom to top of the rock profile.

type of sandstone forms a ridge along the north side of the island, but here it is only about 30 m above sea level and is prominent only along the east-central section. Another outcropping of shale separates this sandstone ridge from the sea east of Lock Bay. The sandstone and conglomerate sequence (Fig. 10) occurring at the east and west ends of Gabriola Island, and the Flat Top Islands, is younger in age than the previous sandstone, and has been undercut, especially at the west end, by wave action. A mixture of sandstone, conglomerate, siltstone and shale occurs through the middle of Gabriola Island. The DeCourcy Group consists of sandstone that is geologically different from that on Gabriola Island, but the physical properties are much the same (Muller and Carson 1970).

Erosion subsequent to glaciation left the island virtually free of glacial debris, except for meltwater sediments deposited in some valleys. Consequently, the soils are derived from the underlying bedrock and are shallow over most of the islands. Soil development is mostly through podzolization.

The sandstone and conglomerate have weathered at the surface, and erosion has modified the mantle so that some areas are devoid of unconsolidated material, while other areas have accumulated more than 120 cm. The soils derived from these types of bedrock are coarse-textured and well-drained. The underlying bedrock is usually fractured, allowing penetration of roots and water. Soil development is not pronounced because of the generally dry conditions during the summer. The soils are identified as Dystric Brunisols (Canada Soil Survey Committee 1974) and are separated into Orthic Dystric Brunisols if the soil depth is greater than 50 cm, or Lithic Dystric Bunisols if the depth is less. The degradation products of these rocks are normally silicates, although conglomerate may contain other ingredients that are released upon weathering.

In areas where the bedrock consists of shale, the depth of soil material is frequently greater, owing to the easier weathering of shale in comparison to the other local sedimentary rocks. Soils derived from shale are usually dark in color, have a medium- to fine-texture and are often imperfectly drained. They are frequently mottled at lower depths, because of a persistent fluctuating water table. The bedrock immediately below the soil is often highly fractured into pieces that crumble easily (Fig. 11). Below this, a more platy structure prevails. A characteristic in the soil development is the mixing of surface mineral soil with decomposing organic material by soil fauna, which results in a Sombric Brunisol soil (Canada Soil Survey Committee 1974).

Siltstone is often mixed in at the abutment of sandstone and shale or in association with sandstone and conglomerate sequences. This type of rock gives rise to light colored, fine-textured soil that is imperfectly drained. Only one area was found that contained a predominance of siltstone-derived soil; however, others may occur. Small plates of siltstone can be found on or near the soil surface in several areas.

Wetlands occur in depressions where drainage is impeded, either by bedrock or a combination of bedrock and nonporous mineral material. Fine-textured marine deposits form impermeable layers, giving rise to a Gleysol soil. Organic matter accumulates in depressions, in part, because of the high quantity of vegetation material deposited in them and, in part, to retarded decomposition resulting from anaerobic conditions within the saturated environment. Often the wetlands, which originally may have been shallow ponds, fill in with organic debris to the point where free water occurs at the surface only seasonally or not at all. The advanced stage in the sequence occurs when the surface materials are elevated above the water table and allow dryland plants to grow. Although wetlands, and the organic terrain of former wetlands that have been drained, are of limited extent on the islands included in this study, they do constitute important elements for water storage and agricultural.

Climate

The climate of the islands is cool maritime, with relatively warm, wet winters and cool, dry summers. The only available meteorological datum from the islands is precipitation at a location on west-central Gabriola Island at 111 m above sea level. Ten years of data at this site indicate an average annual precipitation of about 909 mm, December being the wettest month and August the driest. This agrees with extrapolations from surrounding meteorological stations (Fig. 12) that have 25 or more years' data (Chapman 1952; Environment Canada 1950-1976). About 30% of the precipitation comes during the six-month period of April through September. About 40 cm of snow can be expected during the winter. Examination of the vegetation suggests that the north side of Gabriola Island is wetter than the south side. This may be due to the drainage conditions resulting from the northward tilt of the island or to an increase of precipitation.

The extrapolated annual temperature is about 10°C. January is the coldest month, and July and August the warmest, with average mean monthly temperatures of 3.5°C and 18°C, respectively (Fig. 12).

Wind is funneled along the Strait of Georgia by mountain ranges on Vancouver Island and the mainland coast. Consequently, most winds come from the southeast and northwest, with the most frequent and strongest from the southeast (Kendrew

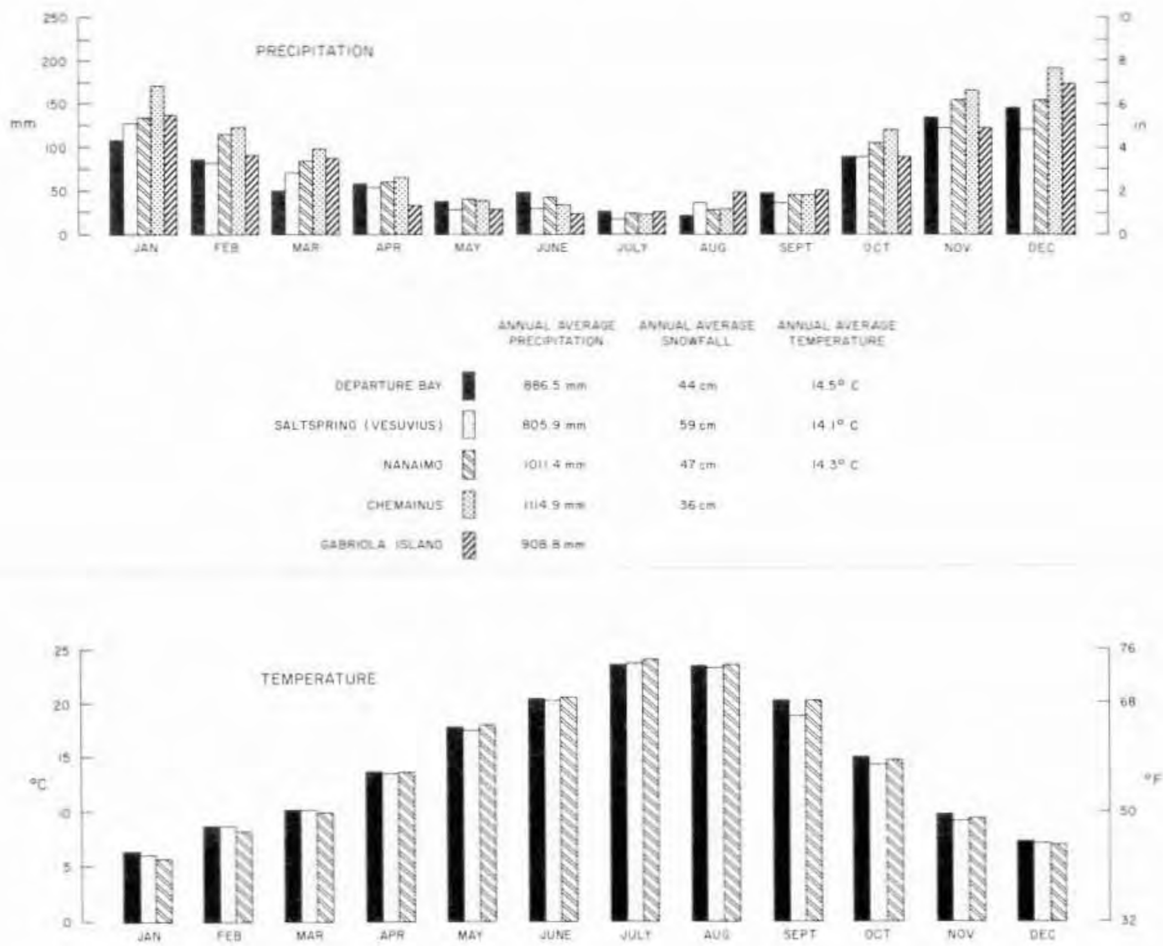


FIGURE 12 - Precipitation and temperature data from the study area.

and Kerr 1955). Mean wind speeds are highest in winter. The effect of the wind is noticeable on the vegetation, especially by the pronounced windswept flagtrees near Orlebar Point on Gabriola Island.

Vegetation

The islands under study lie within the Strait of Georgia Section of the Coast Forest Region of Rowe (1972), and very near the border line between the Drier (Garry Oak - Douglas-fir) and Wetter (Arbutus - Douglas-fir) Subzones of the Coastal Douglas-fir Biogeoclimatic Zone of Krajina (1969). The predominant tree species are Douglas-fir (see Appendix for scientific plant names) and western hemlock, which occur in second growth stands following logging. Because the forests were logged, the current stands are proceeding through various stages of succession. Development is toward forests with western hemlock as the prevailing species, but with Douglas-fir and arbutus in drier situations, and red cedar and bigleaf maple in wetter areas.

Other tree species are present which add variety and increase the aesthetic appeal of the forests. Arbutus, the only broad-leafed evergreen tree species in Canada, enhances rocky shores and areas with shallow soils. Western yew adds variety to these sites, but is of limited occurrence. Lodgepole pine, also of limited distribution, occurs sporadically on shallow soils, and is most common toward the west end of Gabriola Island. Garry Oak is currently most prevalent on shale deposits along False Narrows, but occasionally occurs on sandstone at the eastern end of Gabriola Island. In more moist situations, red cedar and grand fir flourish, and flowering dogwood is often present among Douglas-fir and western hemlock. Seepage channels and borders of wetlands support red alder, bigleaf maple, Pacific crabapple and black cottonwood. Willows may assume the stature of trees in these areas.

Vegetation under the tree canopy is dominated by salal and, to a lesser extent, by Oregon grape, twinflower, juniper and evergreen huckleberry on drier sites and by swordfern, vanilla leaf and salmonberry on moist sites. The most lush swordfern occurs on the fine-textured soils derived from shale and siltstone. A variety of other shrubs, ferns and mosses are present in both the drier and wetter conditions. The greatest abundance of spring ephemerals occurs on shallow soils with an open tree canopy, and includes camas, blue-eyed Mary, shooting star and sea blush.

Meadows are characteristic of imperfectly drained areas. They often occur on sites with a high organic matter content or where fine-textured marine sediments are near the surface. Such areas support grasses, sedges, bulrushes and other similar plants, and provide forage locations for wild and domestic animals. Most meadows of sufficient size are utilized for hay production and some are cultivated.

Wetlands that have free water at or near the surface for part or all of the growing season support thickets of spirea. The density of this species is usually so great that few other species occur on these sites. Bulrushes, sedges, cattails and bracken may be present. Where the water depth is greater for a significant part of the year, plant growth is usually restricted to a few emergent species, such as buttercups, pond lilies, cattails and reeds.

LANDSCAPE UNITS

The landscape units defined during this survey are discrete in that they possess different physical characteristics and support different types of vegetation. However, they frequently have diffuse boundaries that prevent delineation of discrete units at the scale of mapping (1:15 840). Consequently, the mapping units presented are composite landscape units incorporating topography, soils, landform, climate, drainage, physiography and vegetation. Any delineated unit is likely to have inclusions of landscape types other than the one indicated. This is particularly true in delineating the Shallow Soil Landscape Unit from the Moderately Deep Soil Landscape Unit because of the gradation from one to the other. Many of the boundaries separating these two units are subjectively placed, attempting to depict the most common landscape unit within the area. Landscape types other than those described may be present, but are too small or too intricately associated to be mapped separately. Some of these are mentioned in the landscape unit discussions.

Ten landscape units (Table 1), plus a designation for water bodies, were considered sufficient to categorize the major terrain features. The intrinsic features of each landscape unit are portrayed. Since the primary purpose of this report is to serve as an aid to sound community planning, emphasis has been placed on interpreting the inherent suitability of each landscape unit to support development at a minimal loss of environmental quality. Any modification of the landscape carries with it an alteration in the environment; however, such modifications are not necessarily devastating. In fact, they can improve the landscape for aesthetic appeal. As the human population evolves, social values change; therefore, land use planning cannot be static.

Major escarpments are indicated on the map because they have special features pertinent to land use assignment. The crests provide vantage points for desirable view lots; however, the soils at these points are shallow, the underlying bedrock essentially impervious, and installation of service facilities may be difficult and expensive. The face of the escarpment usually has a blanket of coarse-textured colluvial material that is shallow near the crest and increases in thickness toward the bottom. This material is loose and disturbances, especially when the vegetation is removed, will result in erosion of the material.

"Residential development", as used in this report, means the provision of housing plus light commercial and institutional establishments, such as local stores, post offices, banks and schools. "Commercial or industrial establishments" refers to areas designed for heavy or concentrated commercial or industrial use, such as shopping centres and major industrial sites. "Green belt" is used in a restricted sense to refer to land left in its natural state. The "open space system" refers to land designated for uses, such as agriculture, forestry and recreation, as well as land designated as green belt for aesthetic purposes, which do not require construction of permanent structures. Alternative uses are discussed for landscape units lacking suitable qualities for housing or industrial development.

◄ FIGURE 13 - Bedrock exposed or with a very thin cover. Trees become rooted in crevices. Numerous spring ephemerals, such as blue-eyed-Mary, camas, shooting star and sea blush, flourish with the advent of warm weather.

Shallow Soil Landscape Unit

(3480 ha, Figs. 13 and 14)

The Shallow Soil Landscape Unit is characterized by the presence of less than 45 cm of soil derived from sandstone or conglomerate. The soil is coarse-textured, sand to sandy loam, and is well- to excessively-drained. Rock fragments may constitute a significant proportion of the soil volume, especially in the lower horizons. Soil development is weak and only a slight alteration in color can be detected. The underlying bedrock is often vertically and horizontally fractured, forming plates near the contact between soil and rock, but in some areas consolidated rock occurs very near the surface. The cracks serve as discharge avenues for percolating water and also allow roots to penetrate, thereby increasing the effective depth of soil.

Table 1. Intrinsic properties and interpretations of the landscape units.

Landscape Unit	Area ha	Bedrock type	Soil depth	Soil texture	Water regime
Shallow Soil	3480	Sandstone (Conglomerate)	0-45 cm	coarse	well-drained but may be restricted by underlying bedrock
Moderately Deep Soil	849	Sandstone Conglomerate Siltstone	45-120 cm	coarse	well-drained
Shale	324	Shale Siltstone	30-150 cm	medium to fine	moderately well to imperfectly drained
Deep Soil	110	Sandstone Conglomerate Siltstone	more than 120 cm	coarse to medium	well-drained
Alluvial Channel	101	Mostly Sandstone	variable	usually coarse but may be underlain by fine	usually well-drained
Marine Clay	208	Not applicable	variable, capping less than 45 cm deep	fine, capping may be coarse	impervious to poorly drained
Organic Soil	93	Not applicable	greater than 45 cm	usually medium	imperfectly to poorly drained
Ponded Wetland	25	Not applicable	Not applicable	Not applicable	restricted drainage
Littoral Sand and Shore Rock		Mostly sandstone	Not applicable	Not applicable	tidal

Potential for residential construction	Limitations	Suitability for septic fields	Erosion potential	Utilization potential
Moderate to Low	Shallow soils that may be underlain by impervious bedrock. Costly service lines	poor	low on gentle slopes, high on steep slopes	1. Green belt 2. Recreation 3. Dispersed residential
High to Moderate	Domestic water source	good	low except on denuded slopes	1. Concentrated residential 2. Orchards 3. Forestry
Moderate to low	Unstable soils. Domestic water source	poor	moderate	1. Market gardening 2. Grazing 3. Dispersed residential
High except in confined pockets	Domestic water source, possible runoff pooling	good	low	1. Concentrated residential 2. Commercial 3. Forestry or orchards
Very low	Flooding and erosion hazard	very poor	high	1. Green belt 2. Irrigation & livestock water source 3. Flood control
Very low	Unstable, flooding hazard	very poor	high for capping, low for clay	1. Farming & grazing 2. Market gardening 3. Green belt
None	Unstable; flooding hazard; high water table	very poor	low unless saturated	1. Market gardening 2. Green belt 3. Flood control
None	Flood hazard, high water table	very poor	variable, usually no problem	1. Wildlife 2. Education & recreation 3. Utility water sources
None	Erosion & flooding hazard	should be avoided	high	1. Green belt 2. Education & recreation 3. Commercial mollusk

FIGURE 14 - Where soil has accumulated on bedrock, open stands of Douglas-fir occur with an understory of salal and Oregon grape.

This landscape unit is the most prevalent on the islands and occupies both upland, especially on convex and sloping surfaces, and coast areas. Because of its topographic position, erosion and colluvial action are important factors in forming a large part of the variation in the unit. Some areas are essentially devoid of soil and the bedrock is either exposed or covered with a thin vegetation mat and accumulated organic matter. Pockets or indentations within the unit serve as collecting reservoirs for material transported by water and wind, and the soil mantle is deeper in such situations. The intricate distribution of sites possessing virtually no soil with those having deeper soil, along with the fact they can not be recognized reliably on aerial photographs, prevents a more refined delineation of these landscape types.

Douglas-fir and arbutus are the most common and characteristic tree species, although lodgepole pine, western hemlock, western yew, red cedar and, occasionally, grand fir, Garry oak and flowering dogwood are present. Although growth is slow, the trees root into crevices in the bedrock and, in many areas, support a cover indicative of deeper soil. Under the forest canopy, salal, Oregon grape, twinflower, ocean spray, evergreen huckleberry, honeysuckle, juniper and Pacific blackberry occur in variable proportions. Those areas with exposed bedrock may support only dryland mosses, such as Rhacomitrium canescens, Rhytidiadelphus triquetrus and Polytrichum piliferum, or a few grasses and forbs, such as early hair-grass, starflower and yarrow. Where the soils are approaching the maximum depth for this unit, rose, strawberry, wild lily-of-the valley, bedstraw and the mosses Eurhynchium oreganum, Hylocomium splendens, Polytrichum juniperinum and Rhytidiadelphus loreus are important contributors to the ground cover.

The shallow soil of this landscape unit detracts from its suitability for residential development (Fig. 15). Although the bedrock would form an adequate foundation support, the installation of service facilities would be costly. The possibility of locating wells of sufficient capacity to supply water all year would be limited; consequently, water would most likely have to be imported from some distant source. Septic fields would often require hauling in suitable material. Great care would be required in placing the septic fields so that effluent would not reach local water supplies through cracks in the rocks. Upon these premises, this landscape unit should be considered for other types of use. Only in the more favorable portions, areas with deeper soils, could residential development be considered. Even then the lot size should be large enough to ensure a safe separation of water source and septic field, within the developed lots. Cognizance of the long-term accumulation of effluent in the septic field would be necessary.

The forestry potential is low and a viable sustained commercial timber operation could not be expected. Selective logging could be conducted periodically, but clearcutting should not be considered because of the subsequent erosion hazard. Similarly, the capability for livestock pastures is low and animal densities would have to be restricted to prevent overgrazing.

This landscape unit, therefore, should be reserved primarily for use as open space, with other well-spaced development restricted to the more favorable sites. Selected pathways (Fig. 16) could be provided to scenic locations and points of interest to prevent indiscriminate denudation of vegetation by unorganized trampling that could lead to accelerated erosion.

FIGURE 15 - House built on bedrock.

FIGURE 16 - Public access can be provided to scenic areas to aid in controlling denudation and subsequent erosion.

Moderately Deep Soil Landscape Unit

(849 ha, Figs. 17 and 18)

The Moderately Deep Soil Landscape Unit is characterized as possessing soils of 45 to 120 cm deep that are derived from sandstone and conglomerate. The soils are coarse- to medium- textured (sand to loam), are well-drained and usually have gently sloping surfaces except on faces of escarpments. Rock fragments may constitute a significant proportion of the soil volume. The underlying bedrock is usually fractured, but indications are that the degree of fracturing declines with depth. Soil development is weak, but usually more advanced than in the previous landscape unit, probably due,

FIGURE 17 - Soil greater than 45 cm depth allows western hemlock and Douglas-fir to form stands with closed canopies. Salal and Oregon grape are major species in the understory. Fairy slipper, rattlesnake orchid and trillium add pleasant variety.

in part, to the somewhat more moist condition resulting from seepage water. Also, the forest canopy is denser than in the previous unit, which increases the internal site moisture and moderates the temperature.

This landscape unit has the second highest coverage. While it occurs most frequently on lower slope positions that have served as catchment locations for material eroded or sloughed from upslope areas, it also occurs in bedrock depressions in upper slope positions. As a result, it intergrades imperceptibly with the previous unit.

The forest vegetation consists of Douglas-fir and western hemlock, with variable proportions of red cedar, grand fir, bigleaf maple and flowering dogwood. The original forests have all been logged and the current forests are in moderately early stages of succession, with most stands less than 75 years old. This accounts for the species diversity. The understory vegetation consists predominately of salal, Oregon grape, broom, snowberry, ocean spray, rose, blueberry and a few forbs and mosses. The variety of species in the ground layer is not as great as in the previous unit because the forest canopy is denser, which reduces light penetration and moderates the temperature regime. Eurhynchium oreganum and Hylocomium splendens are major constituents of an often lush moss layer. Where the canopy is open, several species of grass flourish.

FIGURE 18 - Some areas with moderately deep soil are used for orchards.

This unit has few limitations to development for residential purposes and could be used for commercial establishments. The soil depth, along with the fragmented upper bedrock layers, is sufficiently deep to allow basement installation, if such is desired. The bedrock under the fragmented mantle is adequate for foundation support. Service lines can be installed without difficulty. Installation of septic fields should not be difficult, provided consideration is given to possible seepages in the bedrock that could reach water sources. The primary limitation inherent within this unit is the location of suitable domestic water sources that will provide an adequate supply throughout the year. Because of the generally lower slope position of this unit, it may lack the aesthetic appeal for residential development that locations which allow better views would have.

Forestry operations on this unit are limited primarily by the amount of land available. The capability for producing merchatable timber, especially Douglas-fir, is moderately high, with an expected rotation age of about 75 years. However, the small area of this unit would not allow continued sustained production except on a small operational basis. If cleared, the property could be utilized for orchards or grazing, but some irrigation would be required for optimal production. Most of the natural vegetation is sufficiently resilient to allow moderately intensive recreational use. The primary loss would be the more delicate flowering plants in intensively used areas. Because the unit generally lacks aesthetically scenic areas, the type of recreation facility would probably necessitate a high degree of disturbance in specific sites. Camp grounds and picnic sites would be feasible, and could include such features as play grounds, ball parks, tennis courts, etc.

FIGURE 19 - Much of the Shale Landscape Unit has been cleared for pastures, leaving a few Garry oak trees that at one time were probably more prevalent. These areas currently add aesthetically pleasing variations to the landscape.

Shale Landscape Unit

(324 ha, Figs. 19 and 20)

The Shale Landscape Unit is defined more on the presence of shale as a major constituent of the parent material than on depth of soil because of the intrinsic properties of the shale. Often the upper portion of the shale bedrock is very crumbly so that the effective depth for construction purposes, water percolation and plant growth is greater than the actual depth of the soil. Also, it is very difficult to distinguish shallow from deep soils on aerial photographs. Of primary concern is the finer texture and difference in chemical constituents of soils derived from shale as opposed to sandstone. Some of the chemicals brought into solution during the weathering of shale, chiefly sulphur and iron oxides, produce an unpleasant taste or smell in domestic water if they reach the water source.

This landscape unit is primarily located in lowland areas southeast of Descanso Bay, east of Lock Bay and along False Narrows on Gabriola and Mudge Islands, although outcrops too small to delineate occur at other locations. In some places, a thin band of shale may occur between sandstone

FIGURE 20 - Drainage is often a problem in the Shale Landscape Unit. Stumps from a previous forest are visible on the left side of the picture.

and conglomerate or between layers of sandstone.

This soil is capable of supporting good stands of coniferous species, mostly red cedar, western hemlock and grand fir. Douglas-fir can persist for many years, but would eventually be replaced by shade-tolerant species if disturbance to the tree canopy did not occur. These stands frequently have a lush understory of swordfern, vanilla leaf and moss. Garry oak, broadleaf maple and red alder are prevalent remnants of forest stands in some areas, such as along False Narrows, but the original forests have largely been destroyed. Much of this unit has been utilized for residential development (Fig. 21), farming or gardening. Grasses and weedy forbs, such a quack grass, thistle and raspberry, are dominant species in abandoned agricultural lands. Garry oak occurs in few places other than along False Narrows and care should be exercised to maintain the remaining trees.

This landscape unit presents several problems for residential development. The soil is fine-textured and difficult to work with when wet. Road beds and similar facilities are difficult to stabilize, but this can usually be accomplished by adding gravel, cobble, crushed rock, etc. Foundations would require the provision of a drainage system (Fig. 22) around the base with a suitable outflow path. Wells that will produce potable water in sufficient quantity for domestic use are difficult to locate. Sewage drain fields would most likely require excavation and filling with sands, gravels or rocks because of the restricted drainage inherent in the fine-textured, shale-derived soils. Once these problems are circumvented, however, landscaping can be done relatively easily. Lawns aid in stabilizing the soil and would be resilient to moderately heavy foot-trampling. Numerous species of trees, shrubs and flowering plants can be grown.

Forest capability is moderately high on slopes, but is low in most valleys, where the water table is high throughout most or all of the year. Douglas-fir and western hemlock stands could be managed, but would require control of competing species of trees and shrubs. The potential for development of orchards and market gardens is moderately high. They would require the addition of organic matter, nitrogenous fertilizers and possibly irrigation for optimal production. Liming may also be necessary where the sulphur content is high. Use as pasture lands could be economically feasible, but care would have to be exercised to maintain the desirable species of grass that are palatable to livestock. Pastures maintained in a parkland setting could provide an aesthetically pleasant variation to the landscape in an open space system.

FIGURE 21 - A trailer court established on the Shale Landscape Unit. Note the drainage channel along the road.

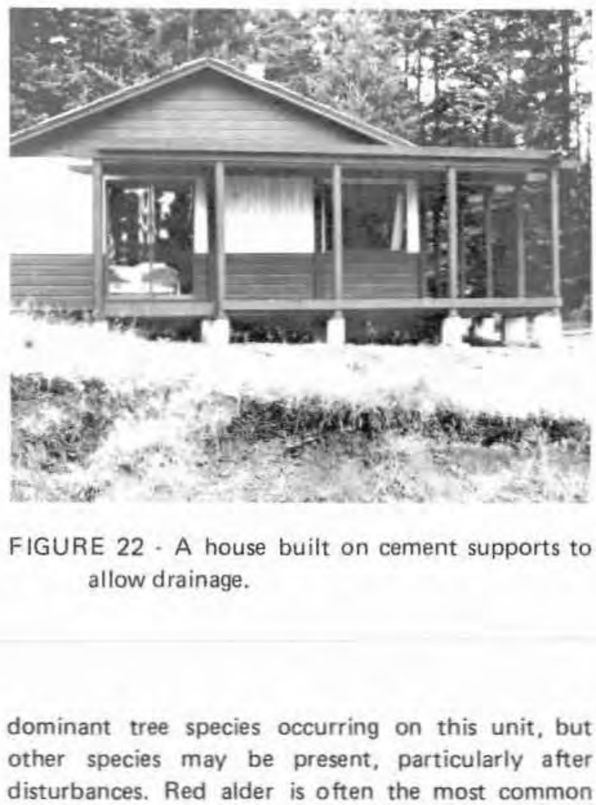


FIGURE 22 - A house built on cement supports to allow drainage.

Deep Soil Landscape Unit

(110 ha, Figs. 23 and 24)

The Deep Soil Landscape Unit is heterogeneous. It was defined to include areas of sand greater than 120 cm deep that were deposited during deglaciation, but also includes alluvial sands which may overlay marine clays, and beach deposits that occur between Taylor Bay and Pilot Bay and at Lock Bay. Often no soil development is observed (Regosolic soil) in the recent alluvial deposits. In deposits that have been stable since deglaciation, a weak development has produced Brunisolic soils. The soils are well- to rapidly-drained and the water table is well below the surface. The depressional position common to this unit allows protection from evaporation so that moisture is not normally limiting under a tree canopy. Some areas also have spring-fed seepage water in or near them.

Douglas-fir and western hemlock are the dominant tree species occurring on this unit, but other species may be present, particularly after disturbances. Red alder is often the most common invader of cut-over areas, especially where seepage water enters the unit from surrounding areas. Sword-fern forms a lush understory where moisture is available during most of the year. Salal, Oregon grape, twinflower, snowberry and blueberry dominate drier portions. The vegetation is resilient to moderate trampling, especially when the soils are wet, but abrasion by loose sand particles, when dry, can sever rootlets.

FIGURE 23 - Very productive forests occur on the Deep Soil Landscape Unit. The current successional stand consists of grand fir, Douglas-fir and western hemlock with an understory of swordfern. Note the stumps of a previous forest.

FIGURE 24 - In depressional areas the Deep Soil Landscape Unit supports red alder, bigleaf maple and red cedar with a lush undergrowth of swordfern.

This unit, with the exception of beach areas, offers suitable locations for residential or industrial development unless seepage from external sources creates limitations. The loose soil material can easily be excavated for installation of service lines, basements, etc., yet is sufficiently stable for foundation support. Some areas are used as sources of borrow (Fig. 25). Drainage around structures and location of septic fields should not pose problems. The probability of locating suitable water wells is higher than in the previous units. The main limitations for development are the limited extent of the unit and the lack of viewing potential created by the depressional position.

This unit has the highest forest potential of any landscape unit on the islands, and Douglas-fir and western hemlock could be grown successfully. Orchards may be successful; however, no examples were seen. Market gardening would be limited by the availability of irrigation water. Grazing pastures may be difficult to maintain because of the balance between grazing and the invasion of undesirable species. Sensitive areas should be protected from intense disturbance because of the ensuing erosion, but other areas can be used for many recreational activities.

FIGURE 25 - A deep deposit of alluvium. Note the tilted layers deposited while the island was depressed and the overlying layer of outwash material. This is a source of borrow material for construction purposes.

Alluvial Channel Landscape Unit

(101 ha, Figs. 26 and 27)

The Alluvial Channel Landscape Unit consists of present or past drainage channels of sufficient size to be delineated at a scale of 1:15 840. They often have intermittent streams, but some may have flowing water throughout the year. The depth of the cumulated sediments is variable and ranges from none, where bedrock is exposed, to pockets of deep sand and gravels. At several points, especially at lower elevations, the sands may be underlain by marine clay.

The current stream channels are usually devoid of vegetation, except for moss in some places. Alluvial deposits adjacent to the channels often support a tree cover dominated by red alder, but broadleaf maple, red cedar, Pacific crabapple and western hemlock may be present. Trees usually form a closed canopy over the stream channels. The understory vegetation may be dominated by sword-fern where the sediments are more than 45 cm deep and flooding rarely occurs. Horsetails dominate areas flooded almost every year. Between these extremes, a variety of plant groups may occur that contain rose, salmonberry, raspberry, ocean spray, snowberry, sedge, grass and bulrushes, among many other species.

This unit has no value for construction sites or residential development because of the frequency or hazard of flooding. It could, however, be very desirable as a potential water source and could serve to enhance landscaping schemes, residential areas, parks or recreation facilities. Great care should

FIGURE 26 - The middle floodplains of the Alluvial Channel Landscape Unit are occasionally flooded and support stands of red alder with an undergrowth of sedge and bulrush.

FIGURE 27 - Lower floodplains along alluvial channels are flooded annually and support horsetails.

be exercised to prevent raw sewage from entering these channels because the entire channel below would be contaminated and pools would become open septic fields.

Use of these channels should be designated so as not to adversely affect the flow of water (Fig. 28) or destroy the vegetation. They can be utilized as green belt, with alterations in areas where their utility or aesthetic value could be improved. Some may be used as water sources, either by impoundment of small pools or by installing wells, but a year-round water supply could not be guaranteed. Few areas exist that have a potential of being developed into a reservoir.

Marine Clay Landscape Unit

(208 ha, Figs. 29 and 30)

Marine clays were deposited in bays or depressions when the islands were submerged relative to their present state. These deposits are flat to very gently sloping and are capped by glaciofluvial and alluvial sediments of more recent origin or by an accumulation of organic material. The material overlying the marine clay is not over 45 cm thick. The clay is mostly blue-grey in color, owing to persistent saturation, but may be mottled near the surface where the watertable fluctuates. Because water percolation is very slow to non-existent in clay, except through small pores or cracks, drainage usually occurs over the impervious surface. Impediments to surface drainage result in the formation of water bodies. The overlying material is not stable, especially on sloping topography, and movement can occur during periods of saturation. Plant roots are the primary natural stabilizing factor and their preservation should be ensured.

The natural vegetation is dependent upon the type of material overlying the clay and the specific water regime. Where the capping is coarse-textured, well-drained and about 45 cm deep, trees, such as red alder, bigleaf maple, red cedar, western hemlock and Douglas-fir, flourish. Where the capping is thin and rich in organic material, sedges and grasses predominate. Wetter areas, usually where surface drainage is impeded, support spirea, sedges, bulrushes, cattails and skunk cabbage.

FIGURE 28 - An erosion channel formed where a road crossed the Alluvial Channel Landscape Unit.

a

FIGURE 29 - The Marine Clay Landscape Unit has mostly been cleared of trees and (a) used for hay meadows where the water table is near the surface, or (b) for cultivation where heavy farm equipment can operate. Provision of drainage channels is normally required.

Because of the incidence of flooding and the instability of the soil material, this unit should be avoided for any type of residential development. Any foundation support would have to be placed on bedrock underlying the clay because the clay is not stable when wet. Septic outlets should be diverted away from this unit.

b

Where the overlying material consists primarily of mineral soil and is about 30 cm or more deep, this unit is capable of supporting agricultural endeavors, such as cultivation, hay meadows and grazing; however, provision of drainage channels is often required. Several of the existing farms occur on this landscape unit. The primary limitations include difficulty of operating machinery when the soil is wet and the possibility of drought during summer. Market gardening (Fig. 30) could be a viable operation on those sites too rich in organic matter to allow the operation of heavy equipment, provided that irrigation water is available. The wetter areas

FIGURE 30 - A large garden located on marine clay with a capping of organic-rich material. Nets were necessary to keep birds out.

FIGURE 31 - Organic material accumulates in poorly drained lowlands. Drainage trenches were dug in some.

that have a high water table throughout most or all of the year provide wildlife habitat and could be left as green belt in the open space system. Recreation facilities, such as nature trails, where participants are not concentrated, could be located within these areas. In general, it is not suitable for types of recreation requiring the installation of a hard level surface, such as concrete or asphalt, because of the difficulty in stabilizing the sites to withstand periods of saturation.

Organic Soil Landscape Unit

(93 ha, Figs. 31 and 32)

The Organic Soil Landscape Unit is characterized by the presence of organic material, or mineral material with a high organic matter content, greater than 45 cm in depth underlain by bedrock, alluvial material or marine clay. It is a wetland type that normally occurs in depressions. At one time these were shallow bodies of water or areas saturated by water most of the year. Some occur at edges of current water bodies, and one area at Lock Bay is partially inundated by oceanic water during high tides. These areas normally have a high water table and the surface material dries out only for short periods during the year. Although the surface is normally wet, saturation occurs only during periods of high precipitation.

Natural vegetation is most often dominated by spirea. Willows, salmonberry, raspberry and bracken may occur in drier portions of the unit, and sedges, bulrushes and skunk cabbage in the wetter portions. Occasionally, red cedar, western hemlock, grand fir, red alder or bigleaf maple may be present, but growth is retarded by the wet, unfertile soil condition.

Because of the instability of the organic material, the lack of good drainage and the risk of flooding, this unit should be excluded from any residential development considerations. Water could probably be obtained from relatively shallow wells, but it may not be potable or desirable for human consumption because of the decomposition products of the organic matter. It could be used as irrigation water for gardening purposes. Any sewage discharge system must be diverted away from this unit.

The organic material is often deficient of

FIGURE 32 - Some poorly drained lowlands with thick organic matter accumulations support dense spirea.

essential nutrients and is generally not suitable for the intensive operation of most farm equipment. Farming practices could be limited to areas with an adequate mixture of organic and mineral material suited to market gardening. The substrate is too wet most of the year to permit good tree growth and orchards would require the provision of drainage. Usage as grazing pastures or hay meadows is feasible. This would require removal of spirea, planting of desirable grasses and, usually, installation of drainage. Some areas have a potential for peat mining sites with the concurrent development of ponds. Such an endeavor would have to be conducted on a small scale because of the limited resources available. The unit is well suited to the open space system and can be used for wildlife habitat and some agricultural pursuits.

Ponded Wetland Landscape Unit

(25 ha)

The Ponded Wetland Landscape Unit is similar to the previous landscape unit, but differs in having a perpetual water table at or above the surface throughout the year. The water in most occurrences on Gabriola Island is stagnant, except during flushing periods associated with high precipitation, and is not deep enough, or the areas large enough, to be considered lakes. Organic material accumulates in the shallow water and is often augmented by siltation from incoming drainage. This unit is often the forerunner to the Organic Soil Landscape Unit and grades into it over a period of time under natural conditions. The impermeable material is most often bedrock or marine clay.

The vegetation consists of sedges, bulrushes, cattails and, occasionally, skunk cabbage and pond lilies where the water table is very near the surface most of the year. Few ponds were observed to have water too deep to permit rooted vegetation from becoming established. In the drier parts of the unit, spirea, salmonberry and buttercups may be dominant. Trees are confined to the banks, and often form canopies that cover a high proportion of the wet areas. Red alder, bigleaf maple, crabapple and red cedar are the most common trees, but western hemlock, grand fir and Douglas-fir may be present.

FIGURE 33 · Some bays have beach sands and gravels overlying the bedrock and have high recreation capabilities. Beach deposits greater than 120 cm in depth belong to the Deep Soil Landscape Unit, but are often too narrow to be indicated on the map.

This unit has no potential for residential development because of the flooding hazard, the instability of the material and the perpetually wet conditions. It is doubtful that potable domestic water could be obtained from these areas because of the stagnant nature of the water. The exceptions are areas with a deep accumulation of mineral soil, either at the bottom or along the sides, that would serve as filters to purify the water. Wells, at least for nonconsumptive use, could possibly be located on the banks a short distance from the pond. Septic drains should never be allowed to enter these areas.

Where water occurs above the surface during most or all of the year, this unit can serve as water sources for irrigation purposes and for domestic animals. Some have currently been dredged to increase their usefulness as water supplies for livestock. A variety of wildlife utilizes the marsh areas for nesting and feeding grounds. These wetland areas are also useful in serving as flood control basins by slowing water movement. Based on these considerations, this unit may best be suited to the open space system, and utilized for educational and recreational purposes by designating paths to observe wildlife. Excavation to form water sources for livestock may be satisfactory, but the risk of perpetuating introduced communicable diseases is fairly high because the ponds are seldom adequately flushed.

Littoral Sand Landscape Unit

(Figs. 33 and 34)

The Littoral Sand Landscape Unit is delineated to reveal those portions of the coast that have shallow beach materials, usually sands and gravels, covering the shore line rocks. It includes the intertidal zone plus areas of shallow oceanic water. Such areas usually occur at the distal ends of drainage channels or where beach deposits accumulate in bays. In a few cases, marine clays occur under the more recent coarse-textured deposits. The areas are influenced by tide and wave action and are perpetually wet.

Vascular plants cannot maintain a foothold in this unit where tide and wave action display their full force. However, a vast array of marine life, both animal and plant, thrives or has the potential of thriving here.

No development, either residential or otherwise, that would be detrimental to the stability of the submerged materials or harmful to the marine life should be allowed to infringe on this unit. Sewage effluent, in particular, should be diverted away to mitigate the pollution that currently has most bays and estuaries on Gabriola Island contaminated.

This unit could serve as an aesthetically pleasing addition to the open space system. It has capability of providing educational facilities for observing and studying marine life. Some sites have adequate beach for recreational purposes; however, the current contaminated condition detracts from use for wading and swimming. Marine mollusks, such as clams and oysters, could be grown in several areas and commercial development of such an industry is feasible, but would be limited by the space available and the pollution problem (Arney and Kay 1975).

FIGURE 34 - Along much of the shoreline, the Littoral Sand Landscape Unit interfingers with the Shore Rock Landscape Unit.

FIGURE 35 - Bedrock that slopes gently into the ocean is kept clean of beach materials by wave and tide action. Marine plants sometimes become established, such as the dark tone on the left side of the photograph.

FIGURE 36 - The Shore Rock Landscape Unit harbors algae, barnacles and mussels. Sand and gravel collect in depressions. A drainage channel crosses the center of the photograph. The residential property could be flooded during extreme high tides.

Shore Rock Landscape Unit

(Figs. 35 and 36)

The Shore Rock Landscape Unit is delineated to reveal that portion of the rocky shoreline that grades into the ocean and is kept devoid of vegetation and beach material by tide and wave action. It consists predominantly of sandstone bedrock, but occasionally conglomerate, and rarely shale and siltstone, may be present. Soil material may be trapped in crevices, but the amount is negligible. Marine organisms may become attached to the rock.

This unit should not be considered for any type of development that would disrupt its natural features. It serves as a buffer zone to intercept and disperse waves and tides. The force of the salt water splash has eroded the sandstone, forming natural petroglyphs which, in some places, are spectacular and should be protected from human destruction. They add to the scenic attraction of the coast line and inclusion of the better developed petroglyphs in the open space system would be enjoyed by many visitors, as well as residents. Small pools formed between rocks often harbor a variety of marine life that could be enjoyed by the public and used as educational material. Sewage outflows and moored boats (Fig. 37) should not be allowed to contaminate these areas.

FIGURE 37 - Protected bays are attractive docking sites for pleasure boats.

WATERSHEDS AND HYDROLOGY

Domestic water supply is a primary concern for residential development on these islands, as it is for most of the other Gulf Islands. Therefore, it is essential that every precaution be exercised to conserve a sustained supply for the resident population and to prevent contamination of the groundwater by domestic sewage effluent, pesticides, herbicides and other noxious or poisonous chemicals. The quantity of local potable water available will be a primary limiting factor to population density unless the residents are willing to pay the cost of importing water from another source. The major portion of fresh water comes from direct precipitation, although this may be augmented by a minor amount that comes by underflow from Vancouver Island (Brown and Erdman 1975).

Currently, the normal source of domestic water is from private wells. Most wells are drilled into fractured bedrock to a depth necessary to obtain an estimated adequate productive capacity of 3 gpm (Brown and Erdman 1975). Depths range from about 7 m to over 60 m (one is more than 160 m), most being about 30 m deep. Productive capacities range from 0 to 20 gpm (one has a capacity of 54 gpm) with little correlation to bedrock type. Highest capacities occur in association with fault lines. Capacities are frequently low at the east and west ends of Gabriola Island. In these areas, some industrious residents collect rain water to augment well water.

Precipitation enters the ground water supply by percolating through the soil and entering crevices in the fractured bedrock. Any portion of the land the water passes through or over has an effect on the quality of the water and its potability. Decomposition, detoxification or absorption of contaminants picked up in the surface soil are normally filtered out at a lower depth; however, there is a gradual movement of the contaminants toward the water storage basin. The possibility exists for the filtering system to become saturated. This is particularly important when the contaminants enter in large

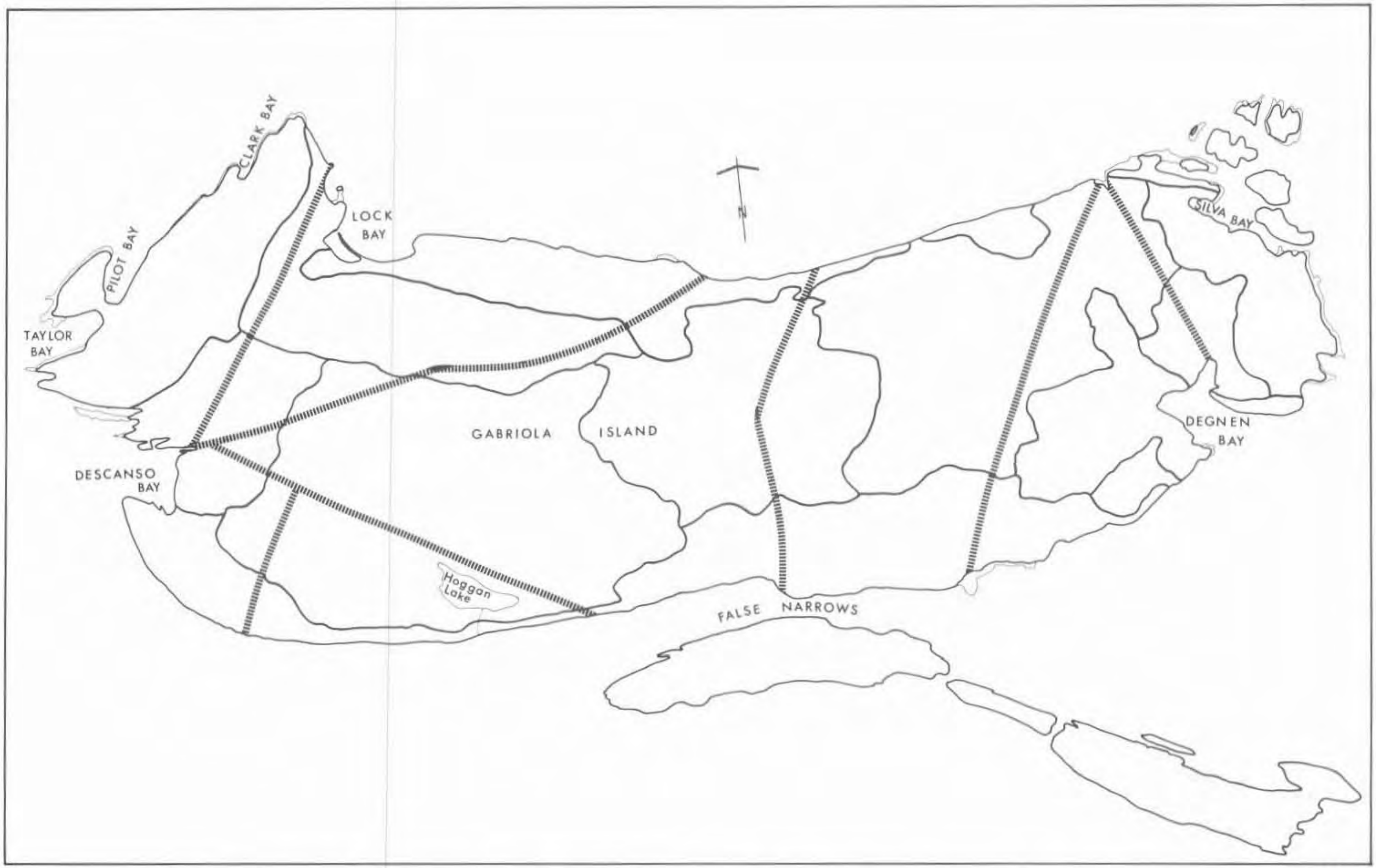


FIGURE 38 - The watersheds of Gabriola Island are delineated with a solid line. The slashed lines indicate fault zones.

quantities or at points near the storage site. Consequently, knowledge of the water flow is essential in planning land utilization. Since fault zones have the greatest potential as a source for community water systems (A.E.S.L. 1975), protection of, and access to, these should be ascertained in any community development plan.

Gabriola Island can be partitioned into several watersheds (Fig. 38), but most are not well defined. All tend to drain toward the ocean, but only surplus water after all reservoirs are fully charged actually reaches the ocean except, perhaps, following heavy precipitation when overland flow exceeds infiltration. It would be difficult and expensive to develop reservoirs large enough for more than adjacent local use in most watersheds.

Only one watershed in the mapping area possesses a surface catchment basin of sufficient size to be considered a lake. Hoggan Lake (Fig. 39) was formed by the construction of a dam about 11 m high for the production of electricity in the early 1900s. The resulting lake covers approximately 24 ha and is about 13 m deep. Much of the periphery supports a floating mat of vegetation (Fig. 40). The lake has the potential of serving as a major water supply for the southwest corner of Gabriola Island. The elevation of the lake is about 53 m above sea level, whereas most of the surrounding terrain is above 90 m. The outlet of the lake passes through a narrow strip of land with low potential for development before emptying into the ocean. For these reasons, pumping to residential areas would be necessary to realize the water potential of the lake for domestic use.

The recreational capability of Hoggan Lake is limited by the size of the lake and the floating vegetation around it. Fish are currently stocked privately, but the sports fishing potential is low, because of the limited volume of water. The potential of the lake as a water source should be a primary concern. Precautions should be imposed on any type of development of the lake, as well as a surrounding buffer zone and the drainages to the lake, to ensure the quality and quantity of water. Public access should, therefore, be restricted. The lake is privately owned, which may complicate any control over preservation, amelioration and access for a water source.

FIGURE 39 - Hoggan Lake was formed by the construction of a dam that backed water into a previous wetland supporting sedges and bulrushes. This vegetation persists as a floating mat around much of the lake shore (Fig. 40).

FIGURE 40 - The Organic Soil Landscape Unit occupies much of the periphery of Hoggan Lake. The vegetation mat is floating, especially near the open water.

CONCLUSIONS AND RECOMMENDATIONS

Of the ten landscape units recognized in this survey, four have reasonable capability for residential or industrial development, two have potential agricultural capabilities, two serve as potential water control areas and two serve as a buffer zone between land and ocean.

LANDSCAPE UNITS WITH CAPABILITIES FOR RESIDENTIAL OR INDUSTRIAL DEVELOPMENT

I. Moderately Deep Soil Landscape Unit 849 ha

a) Desirable Properties

1. Segments occur of sufficient size to permit intensive development.

2. Coarse-textured soils provide adequate drainage, and erosion is a minimal problem.

3. Foundation support can be obtained either on the unconsolidated material or on the underlying bedrock.

4. Depth of unconsolidated material is sufficient for installation of service lines and septic fields.

5. Vegetation is resilient to moderate trampling.

6. Landscaping normally would only require addition of organic material, topsoil, fertilization and irrigation.

b) Limitations

1. The general lower slope position provides few scenic views.

2. Some areas have slope gradients that may pose problems for access and retention of level pads.

3. Capability for agriculture and forestry is moderately high.

II. Deep Soil Landscape Unit 110 ha

a) Desirable Properties

1. Coarse-textured soils provide very good drainage, good foundation support and are resistant to erosion.

2. Unconsolidated material is sufficiently loose to be easily excavated and is thick enough to allow installation of septic fields and, in some cases, removal of borrow material.

3. Vegetation is resilient to trampling.

4. Landscaping can be easily achieved but may require addition of organic matter, topsoil, fertilization and irrigation.

b) Limitations

1. The unit often occurs in small scattered pockets that would not allow intensive concentrated development.

2. Aesthetically pleasant views are rare because of the lowland position of this unit.

3. Capability for forestry is often high.

4. It sometimes occurs in association with fault zones that may be required for community water sources.

III. Shale Landscape Unit 324 ha

a) Desirable Properties

1. Pieces of sufficient size to accommodate intensive development occur adjacent to the ocean, which permits aesthetically pleasant views.

2. Unconsolidated material is usually deep enough to allow installation of service lines, and foundation support can be achieved if drainage is provided.

3. Erosion is usually not a problem.

4. Vegetation is resilient to trampling.

5. Landscaping could easily be accomplished but would require irrigation and possibly topsoil.

b) Limitations

1. The soil usually lacks sufficient internal drainage for septic fields without the addition of coarse material.

2. The soil becomes unstable when saturated, so drainage systems would normally be required.

3. Flooding hazard is high in depressions.

4. Capability for agriculture and forestry is moderate to high.

IV. Shallow Soil Landscape Unit 3480 ha

a) Desirable Properties

1. The upslope position of the unit normally allows aesthetic and panoramic views, and has a very low flood hazard.

2. Soils are coarse-textured, which allows good drainage.

3. Foundation support can be achieved on bedrock by removal of the soil.

4. Capability for agriculture and forestry is low.

b) Limitations.

1. Depth of unconsolidated material is normally insufficient for landscaping, installation of service lines and septic fields.

2. Vegetation is susceptible to severe damage from trampling and the erosion hazard is high in denuded areas.

3. Essentially impervious bedrock occurs in some areas.

4. Desirable view sites are often exposed to storms.

5. Potential for viewing and dispersed recreational facilities for the public is high.

LANDSCAPE UNITS WITH CAPABILITY FOR AGRICULTURE

I. Marine Clay Landscape Unit 208 ha

a) Desirable Properties

1. Level to gently sloping land occurs in parcels large enough to operate equipment.

2. Usually it has good tilth properties when the marine material is mixed with the coarser textured overburden.

3. Fertility is normally good, depending on mixture of overburden, marine material and organic matter, although fertilization may be required for sustained optimal production.

b) Limitations

1. Some areas lack a sufficient capping of coarse-textured material so that tillage and drainage are restricted.

2. Depressed areas may flood frequently unless drainage is provided.

3. Erosion hazard is high on tilled sloping land.

II. Organic Soil Landscape Unit 93 ha

a) Desirable Properties

1. Tilth properties are good where there is a mixture of organic and mineral soil.

2. Soil moisture is usually adequate, but may require control by a drainage system.

3. The organic matter, although often intrinsically low in fertility, can retain added fertilizers.

b) Limitations

1. Installation of drainage systems is normally required.

2. Often the content of mineral material is not adequate to permit tillage with heavy equipment.

3) Orchard trees may not be able to establish adequate root systems to prevent wind-throw in areas low in mineral material.

LANDSCAPE UNITS WITH POTENTIAL AS WATER CONTROL AREAS

I. Alluvial Channel Landscape Unit 101 ha

This unit primarily serves to carry run-off water to some receiving basin. Current channels are normally narrow and are located within the flood plain of wider channels. During flood stages, the wider channels serve to contain the water. Few sites suitable for reservoir construction exist.

II. Ponded Wetland Landscape Unit 25 ha

These areas are collecting basins for run-off water. They are normally small and drain through channels, although drainage may occur only during periods of high water. Water often becomes stagnant because adequate flushing does not occur. Livestock and wildlife utilize the ponds for drinking. In some locations, the ponds can be enlarged, but the probability of developing them for consumptive domestic use is very low.

LANDSCAPE UNITS THAT SERVE AS BUFFER ZONES

I. Littoral Sand Landscape Unit

This landscape unit can be used for mollusk beds, recreation and education. Pollution, primarily from sewage outflows is one of the major limiting factors for utilization (Arney and Kay 1975).

II. Shore Rock Landscape Unit

This unit consists of exposed bedrock and, therefore, has capabilities different from the Littoral Sand Landscape Unit. It can be used for some types of recreation and educational purposes. The natural petroglyphs offer viewing diversification and aesthetic appeal.

With the increasing affluence and mobility of the North American society comes the desire for space and facilities to allow people to gain freedom from the tensions and routines created by urban living. The desires for exercising this freedom differ with different segments of the population, and often are dependent on the financial position, social status, employment routine or proximity of working, living and recreation areas. A portion of the working force place a high value on semi secluded and private places to live and are willing to sacrifice easy commuting for this. Other people enjoy a retreat for only a portion of the year. Still others find satisfaction and fulfillment by merely visiting different areas and enjoying whatever a particular place has to offer. A further complication to land use planning and development is the fact that people are living healthier, longer lives and retirement is coming at an earlier age so that facilities are also required for this increasing segment of the population. The type of facilities required to satisfy each of these population groups differs, which makes land use planning a formidable task if more than one group is to be accommodated.

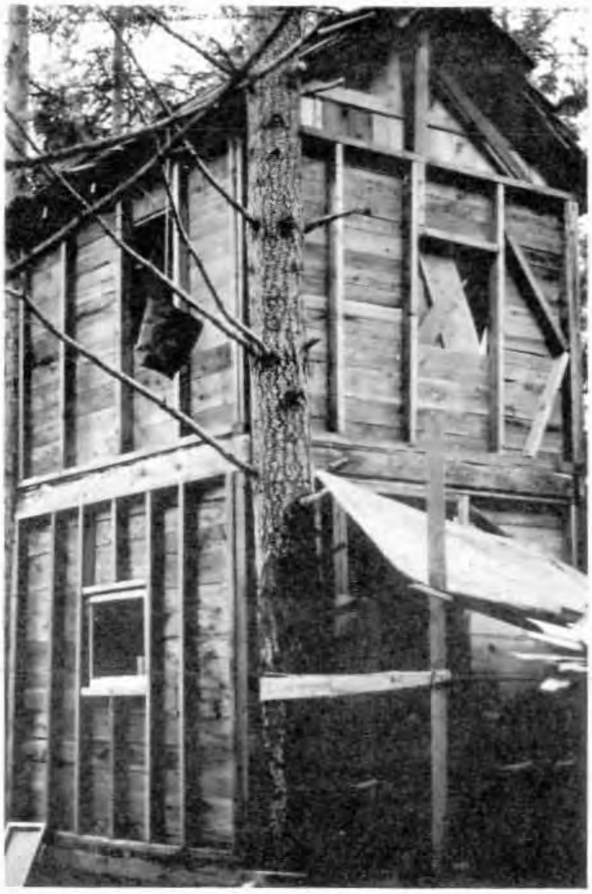


FIGURE 41 - A variety of residential dwellings exist on Gabriola Island.

In striving to meet the various demands of the population (Fig. 41), consideration must be given to maintaining, or minimizing the degradation of, the environment. If this is not done, all is lost because the population will have no interest in a despoiled (Fig. 42) and polluted area where a certain standard or quality of living or enjoyment cannot be realized. Also, it often is the quality of the environment that regulates the type of people inhabiting an area. The primary environmental elements pertinent to human habitation include the quality and quantity of domestic water and fresh air, adequate sewage and garbage disposal facilities and space. Other desirable elements include recreation facilities, aesthetically pleasant settings and views, accessibility, arable land, privacy and seclusion. Most of these elements can be adequately provided and maintained on the islands included in this study by a combination of concentrated and dispersed residential facilities amalgamated into an open space plan. Some elements, however, cannot be controlled for a small area without recognition of conditions existing in areas somewhat remote from the area. For example, the emissions from the pulp mill at Harmac will certainly affect the air and coastal water quality of the islands in this study.

Concentrated development could be allowed in areas where all necessary characteristics are favorable and services could be provided. Of utmost importance is the provision of domestic water and the treatment of sewage. The remainder of the area could be developed into a combination of dispersed residential areas, with a minimum lot size adequate to allow installation of wells and septic fields, recreational and educational facilities, and agricultural pursuits in an open space system. Such a system would provide attractions for a wide variety of people, including permanent and part-time residents, as well as visitors. The number of residents will be limited first by space and then by the provision of services, unless people become willing to live in multiple unit dwellings in areas they have sought out for the peace and tranquility they wish to find outside of urban centres.

FIGURE 42 - Garbage strewn along trails spoils the aesthetic appeal of the landscape and can create health hazards.

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APPENDIX

LIST OF PLANTS COMMON IN THE STUDY AREA

TREES

Douglas-fir	*Pseudotsuga menziesii*
Grand fir	*Abies grandis*
Lodgepole pine	*Pinus contorta*
Red cedar	*Thuja plicata*
Western hemlock	*Tsuga heterophylla*
Western yew	*Taxus brevifolia*
Arbutus (Pacific madrone)	*Arbutus menziesii*
Bigleaf maple	*Acer macrophyllum*
Black Cottonwood	*Populus balsamifera*
Flowering dogwood	*Cornus nuttallii*
Garry oak	*Quercus garryana*
Pacific crabapple	*Malus fusca*
Red alder	*Alnus rubra*
Willow	*Salix* spp.

SHRUBS

Blueberry	*Vaccinium* spp.
Broom	*Cytisus scoparius*
Evergreen huckleberry	*Vaccinium ovatum*
Honeysuckle	*Lonicera* spp.
Juniper	*Juniperus* spp.
Oceanspray	*Holodiscus discolor*
Oregon grape	*Mahonia nervosa*
Pacific blackberry	*Rubus ursinus*
Rose	*Rosa* spp.
Salal	*Gaultheria shallon*
Salmonberry	*Rubus spectabilis*
Spirea	*Spiraea douglasii*
Twinflower	*Linnaea borealis*

HERBS

Bedstraw	*Galium* spp.
Blue-eyed May	*Collinsia* spp.
Bracken	*Pteridium aquilinum*
Bulrush	*Scirpus* spp.
Buttercups	*Ranunculus* spp.
Camas	*Camassia quamash*
Cattail	*Typha latifolia*
Early hair-grass	*Aira praecox*
Fairyslipper	*Calypso bulbosa*
Horsetail	*Equisetum* spp.
Pond-lily	*Nuphar lutea*
Rattlesnake orchid	*Goodyera oblongifolia*
Sea blush	*Plectritis congesta*
Sedge	*Carex* spp.
Shooting star	*Dodecatheon* spp.
Starflower	*Trientalis latifolia*
Strawberry	*Fragaria* spp.
Swordfern	*Polystichum munitum*
Thistle	*Cirsium* spp.
Trillium	*Trillium ovatum*
Vanilla leaf	*Achlys triphylla*
Wild Lily-of-the-valley	*Maianthemum dilatatum*
Yarrow	*Achillea millefolium*
Grass	Includes several species of the Poaceae family
Reeds	A collective term for members of the Juncaceae, Cyperaceae and a few Poaceae.

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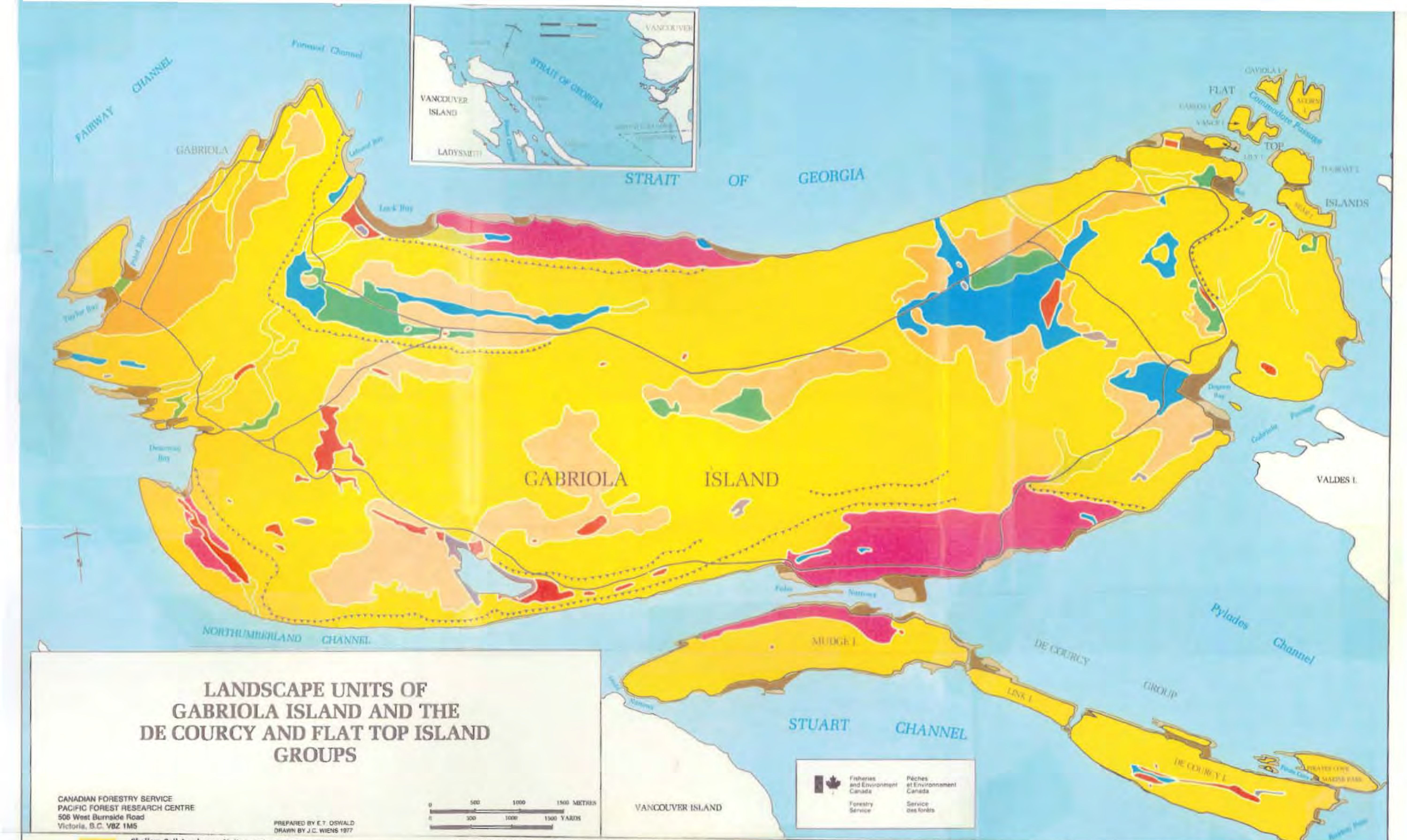

LANDSCAPE UNITS OF GABRIOLA ISLAND AND THE DE COURCY AND FLAT TOP ISLAND GROUPS

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Shallow Soil Landscape Unit. 3480 ha. Soils derived from sandstone and conglomerate are shallow, less than 45 cm deep, coarse-textured, well-drained and overlie fractured bedrock. Pockets of deeper soil may be included but constitute less than 25% of the area, and in some areas the bedrock occurs at the surface. The vegetation consists of open growing arbutus, Douglas-fir, lodgepole pine, western hemlock and occasionally western yew and red cedar with an understory of salal, Oregon grape, ocean spray, evergreen huckleberry, twin-flower, honeysuckle, Pacific blackberry and dryland mosses (*Rhacomitrium canescens, Rhytidiadelphus triquetrus, Eurhynchium oreganum* and *Polytrichum juniperinum*).

Moderately Deep Soil Landscape Unit. 849 ha. Soils are 45 - 120 cm deep, well-drained, coarse-textured and have developed from sandstone and conglomerate. The underlying bedrock is fractured and permits percolation of water. Rock particles may constitute a significant portion of the soil material. Douglas-fir and western hemlock are common, but red cedar, grand fir, bigleaf maple and flowering dogwood may be present. The understory vegetation consists of salal, ocean spray, rose, blueberry, snowberry, star flower and a variety of forbs and mosses.

Shale Landscape Unit. 324 ha. Soils developed on shale are usually 30 - 150 cm deep, medium- to fine-textured and moderately well-drained. The underlying bedrock is fractured and rock particles may constitute a significant portion of the lower soil horizons. Siltstone may be present. The vegetation has been disturbed in most places, but red cedar, western hemlock, grand fir, red alder, bigleaf maple, Garry oak, and sometimes Douglas-fir may be found with an understory of swordfern, vanilla leaf, bedstraw, grass, Pacific blackberry and mosses (*Eurhynchium oreganum, Rhizomnium globrescens* and *Plagiothecium* spp.)

Deep Soil Landscape Unit. 110 ha. Soil is more than 120 cm deep, medium- to coarse-textured, well-drained and often contains a high amount of organic matter near the surface. Sandstone and conglomerate form the primary parent materials for the soil, but shale or siltstone derived material is present in some localities. This unit usually occurs in lowlands that have received material eroded from higher grounds. The vegetation generally consists of western hemlock, red cedar, grand fir, red alder and bigleaf maple with an understory dominated by swordfern and vanilla leaf with few other species.

Alluvial Channel Landscape Unit. 101 ha. Drainage channels are variable in amount and type of alluvial material retained. Several contain marine clays and probably served as meltwater channels during deglaciation. Recent alluvium has capped most marine and meltwater deposits. The bedrock may be exposed where the discharge velocity of water is high. The vegetation is often dominated by red alder and bigleaf maple but other tree species may be present. The understory vegetation consists of swordfern, bracken, wood fern, salmonberry, vanilla leaf, skunk cabbage, horsetails and bedstraw.

Marine Clay Landscape Unit. 200 ha. This unit includes areas where marine clays occur very near the surface in places other than alluvial channels. The clay is frequently overlain by coarser-textured sediments, organic material or a combination of these materials, to a depth of up to 45 cm. Most of these areas are utilized for agricultural purposes, such as grazing, hay meadows or cultivation, and the original or natural vegetation is uncertain. Presumably graminoid vegetation (grasses, sedges, etc.) dominated these areas, but those with a capping rich in organic matter often support spirea, salmonberry and willows.

Organic Soil Landscape Unit. 93 ha. Organic Material, to a depth greater than 45 cm, occurs in depressions that at one time were probably ponded wetlands, but have filled in with organic material that is often mixed with some mineral sediments. Free water occurs at the surface only during and immediately following periods of heavy precipitation. The substrate material never dries out except perhaps for a few centimeters at the surface. The organic material may be underlain by bedrock, alluvium or marine clays. Spirea forms thickets which allow few other species to grow. Willows, salmonberry, sedges skunk cabbage, bulrushes and bracken may sometimes by present.

Ponded Wetland Landscape Unit. 25 ha. Free water occurs at or above the substrate surface throughout most or all of the year. This usually occurs in depressions where outflow is impeded by consolidated bedrock or dammed by fine-textured material. These depressions are often used as water sources for domestic animals. The vegetation is often disturbed, especially along the banks, but red cedar, red alder, bigleaf maple and crabapple frequently occur around the ponds and spirea, willow, salmonberry or sedge extend into the saturated or shallow water areas. Water lilies may be present.

Littoral Sand Landscape Unit. Littoral-sand deposits occur in bays and protected areas along the shore and are inundated by waves and tides. They are separated from the Beach Rock Landscape Unit by the accumulation of sediments consisting mostly of sands and gravels, but occasionally may have finer-textured material. These sediments are underlain by bedrock, mostly sandstone, but marine clay may occur between the bedrock and sand in some places. They contain a wide variety of marine life which is influenced by septic pollution.

Shore Rock Landscape Unit. This consists of exposed bedrock, mostly sandstone, along the shores that is kept denuded by wave and tide action. Marine life may occur in crevices or, to a limited extent, on the rocks.

Lakes and Ocean

Prominent escarpments that have a steep face and an accumulation of colluvium at the toe and, to some extent, on the face. This does not include steep banks and cliffs abutting the ocean.