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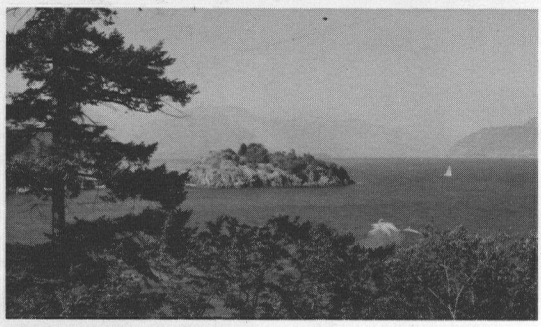

BOWEN ISLAND

A Landscape Analysis

H.E. Hirvonen

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Bowen Island : a landscape analysis.

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A Landscape Analysis

by

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Canadian Forestry Service

Pacific Forest Research Centre

Victoria, British Columbia

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RÉSUMÉ

Les caractéristiques tant du point de vue physique que du point de vue végétation de l'île Bowen sont décrites par l'auteur en termes d'unités de paysage; chacune des unités détaille un genre particulier de conditions du sol, de substances analogues, de topographie proprement dite et d'associations de plantes. Chaque unité est analysée quant à sa convenance pour fins de construction domiciliaire, et quant à ses possibilités dans les domaines des loisirs, de la faune, de l'agriculture et de la foresterie. L'auteur insiste sur les problèmes et les risques inhérents aux différentes unités, dans l'aménagement des bassins hydrographiques et des régions côtières.

ACKNOWLEDGMENTS

Special thanks are given to Ms. Robyn Addison of the planning unit of Islands Trust for her advice and consultation on the various aspects of this study. Mr. Barry Brown of the Canadian Forestry Service undertook the vegetation survey of the Island and developed the Common Plants Appendix of this report. The completion of this study was enhanced greatly by his contribution.

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INTRODUCTION

Bowen Island is located at the entrance of Howe Sound within reach of a 20-minute ferry ride from Horseshoe Bay. This Island, covering some 20 square miles (52 square kilometres) in area, is within a 2-hour commuting distance from most Lower Mainland points. Downtown Vancouver is less than an hour's drive during the off rush hour periods. With a population of nearly 2 million to draw from, one can visualize the pressures being exerted on Bowen Island's available land base for varying recreational and residential pursuits. The demand for private summer cottages or year-round homes within commuting distance of Vancouver have already given rise to several subdivisions in the last 10 to 15 years.

The Island's Advisory Planning Council, in co-operation with the Greater Vancouver Regional District and the Islands Trust, is thus engaged in the difficult task of balancing future residential growth with the desires of the recreationist and the Islanders themselves. There is an overriding desire to maintain the intrinsic attraction and sense of serenity of the Island. This landscape analysis packages much of the physical complexity of Bowen Island into workable units to aid in the planning process. It follows the pattern of similar studies carried out for Saltspring Island (Hirvonen et al. 1974) and the Highlands District of the Capital Regional District (Eis and Oswald 1975) by this Research Centre. Available information on the geology, topography, climate, soils, hydrology and plant and animal ecology was gathered and synthesized. With the aid of air photographs and associated field checks, landscape units were delineated. Essentially, these are composite units that take the foregoing parameters into account and express relative similarity or homogenity within the natural environment. Interpretations on positive and negative inherencies of these units for developmental purposes and other activities are offered.

This study was carried out on a scale of 1:15,840 (1 inch equals 1-quarter mile) from photo interpretation of black and white panchromatic aerial photography. A provisional soil map at a scale of 1:50,000 was provided by the B.C. Environment and Land Use Committee Secretariat and was used as the basis for much of the initial interpretation.

A general description of each landscape unit, with some guidelines for land use allocation purposes, is given. With this base established, the two major watershed areas and the coastline of Bowen Island are studied more closely. Emphasis is placed on possible problems and hazards inherent in the various units for watershed and coastline management.

GENERAL DESCRIPTION

Physiography and Soils

Bowen Island has a generally rugged topography, with much of the Island characterized by shallow soils with frequent bedrock outcrops. Intrusive igneous rock with greenstone and diorites in association with basalts form much of this bedrock. Pockets of graywacke and chert form minor outcroppings. Mount Gardner, with a top elevation of 2475 feet (754 metres) above sea level, is the highest point on the Island. Steep slopes with associated coastal rock bluffs characterize the coastline. Two main valleys dissect the Island. Terminal Creek valley extends across the breadth of the Island to Tunstall Bay from Deep Cove. This valley provides the major access to the west coast. The Killarney Creek valley, extending northward from Deep Cove to Grafton Bay, is a much broader valley and attains some 200 feet (60 metres) above sea level, whereas, at its highest point, the Terminal Creek valley floor rises to over 500 feet (150 metres) above sea level. Both valleys merge as they approach Deep Cove.

Some 12,000 to 15,000 years ago, ice poured out from Howe Sound and blanketed the Island to depths of several thousand metres.

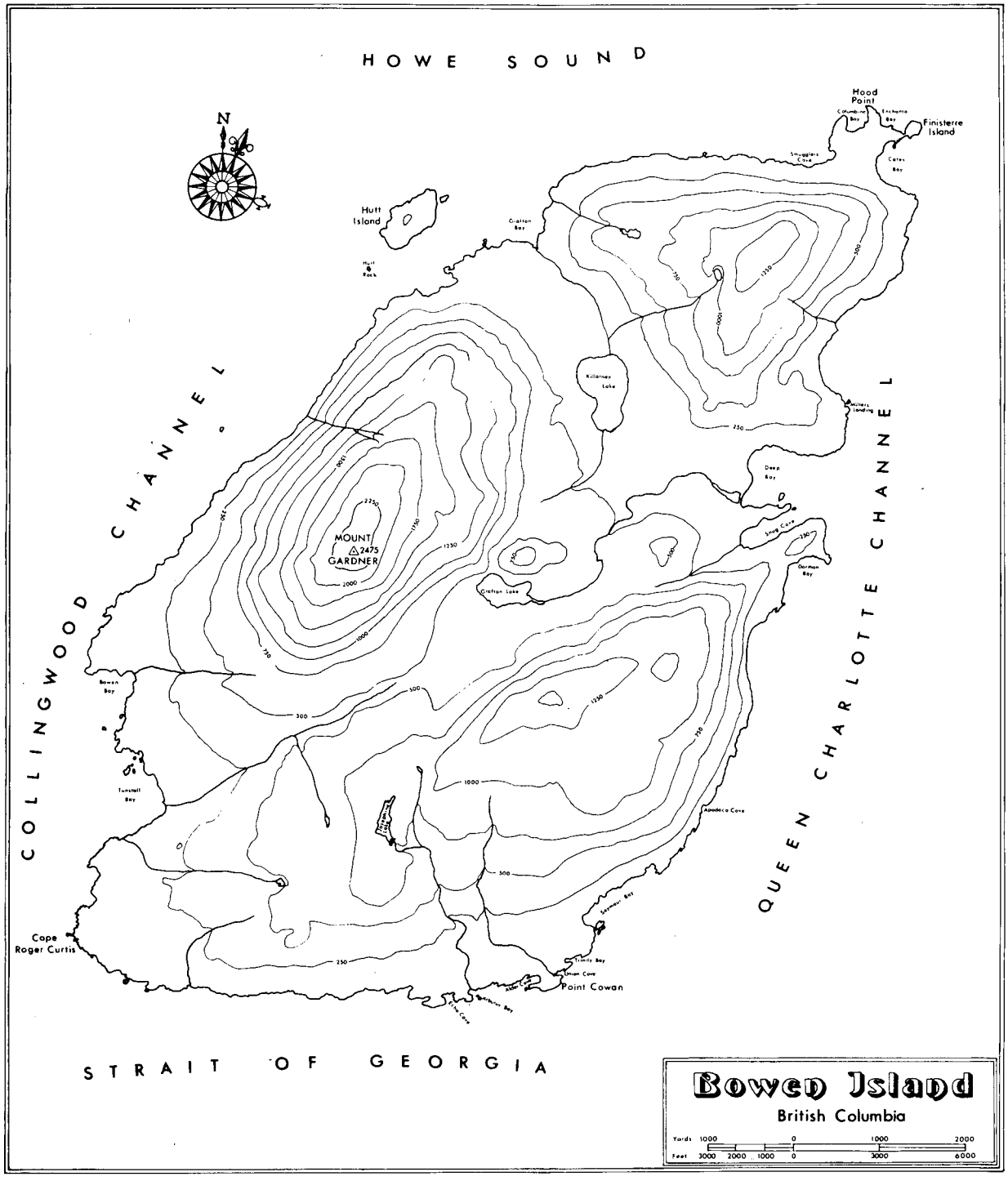

Fig. 1. General Topography of Bowen Island.

Much of the weathered soil mantle was stripped and peaks were shaped into rounded knolls and ridges. Under great pressures, valleys and side slopes were covered with glacial till and outwash.

As the Pleistocene ice age passed, lowland areas of Bowen Island were covered by the sea. Silts and sands settled down on bedrock or on previously deposited till. When the land began to adjust to the absence of the heavy ice weight, these areas emerged above sea level. Sand and gravels, occurring at times over 300 feet (100 metres) above sea level, give indications of past beach levels.

The highlands today are covered largely by shallow colluvial, till or marine deposits over bedrock. Small tracts of deep till do occur, particularly along lower slope positions. Deep colluvial deposits (loose material accumulated by various gravitational processes) have formed at the base of some of the steep slope areas.

Soils that have developed from these deposits generally show podzolic development. Under podzolization, the upper mineral soil surface is leached and often appears ash white. The leached minerals, oxides of iron, aluminum and magnesium, accumulate below this layer, forming a thin, rusty red coloration which grades to brownish and greyish tinges as the basal till or marine parent material is reached. These soils are coarse-textured and well-drained, but may often overlie a compact, relatively impermeable till which may occur at depths close to 3 feet (1 metre) from the surface.

Reflecting drier and warmer site conditions, podzolic development may not be very pronounced on westerly and southerly aspects at lower elevations. Poorly drained depressional areas and alluvial floodplains may have soils topped by an organic layer approaching 15 inches (35 cm) in thickness. The soils are greyish in color and show mottling throughout the profile, giving indication of saturated soil conditions for a good portion of the year.

Fens and fen-like areas have a limited distribution on Bowen Island. With few exceptions, they are restricted to the shallow bays and adjacent land of Killarney, Grafton and Josephine Lakes.

Vegetation

The vegetation of Bowen Island falls within the Strait of Georgia Section of the Coast Region (Rowe 1972) and within the interface area of the Coastal Western Hemlock and the Coastal Douglas-fir Biogeoclimatic zones of British Columbia (Krajina 1969). Because of cooler climatic conditions and higher annual precipitation, the Coastal Western Hemlock zone begins to affirm itself at elevations above 500 feet (150 metres) above sea level and at somewhat lower elevations on northerly aspects.

Presently, the prevailing forest consists of second growth Douglas-fir. Western hemlock is common at upper elevations and on mid-slope positions on northerly and easterly aspects. Valley floors contain a diversity of stand growth; Douglas-fir, western red cedar and western hemlock are the most common. Grand fir has a sporadic occurrence on these moist bottomlands. Broadleaf maple asserts itself on well-drained lower slope positions that receive seepage from the adjacent hillsides. Red alder proliferates along old logging roads and skid trails. Best growth is attained on moist alluvial soils. After disturbance, it dominates much of the midslope position, being a vigorous invader of newly formed growing space once the original stand is opened.

Arbutus and lodgepole pine are common associates of Douglas-fir on dry, exposed rocky slopes along the coastline. Similarly, these three species are found competing for available growing space on many of the inland rock knolls and ridges. Tree species that do occur in natural settings on the Island, but in a limited quantity, include western yew, mountain ash, bitter cherry, cascara and western white pine.

Salal and oregon grape dominate the ground vegetation of much of Bowen Island. Their best growth occurs on well-drained midslope positions. Often they occupy the deep pockets of soil amid rock outcrops. The rock outcrops, themselves, are carpeted with various dry land mosses, lichens and grasses.

Swordfern is rampant on valley bottom silts and sands that have a high water table. It is also an indicator of seepage sites on mid-slope and lower slope positions. On the wettest sites, it occurs in association with horsetails and skunk cabbage. Maidenhair fern, silver-green, miners' lettuce and foam flower are common, but not abundant, on moist shaded sites. Some devil's club is found, mainly along drainage channels.

After disturbance, stand composition can change greatly, As stated earlier, red alder is very prolific. On disturbed bottomland, it is often accompanied by a variety of shrubs including salmonberry, thimbleberry, blackberry and red elderberry. Midslope openings allow red huckleberry to assume prominence. Fireweed, foxglove, yarrow, bracken fern and pearly everlasting are conspicuous throughout the Island. Gorse, Scotch broom and patches of rhododendron are common along the roadsides. Foxglove and wild rose tend to be more conspicuous than most because of their striking flowering colors. Other noteworthy plants include the shooting star, stonecrop and larkspur. An appendix, listing common plants found on Bowen Island, is included at the back of this report.

LANDSCAPE UNITS OF BOWEN ISLAND

The landscape units are essentially composite units, incorporating topography, soils, landforms, climate, drainage, slope and vegetation. On Bowen Island, much of the initial work entailed delineating refinements to the provisional soils map provided by the Environment and Land Use Committee Secretariat (Luttmerding 1975).

An attempt was made to identify the more familiar or easily recognizable vegetation communities on the Island. These communities were then incorporated with the physical data gathered to describe the various landscape units. Small localized depressions, rock humps, till and marine pockets could not be mapped separately. Accordingly, each unit is likely to have minor inclusions not described in the analysis of that unit.

For land planning purposes, nine landscape units plus a "lake" designation were deemed sufficient to categorize the major terrain and biological variability occurring on Bowen Island. As the pressing concern on the Island is for sound direction of community growth with minimal environmental damage, each unit had emphasis placed on its inherent suitability to residential development. Possible developmental problems and hazards related to the environment are outlined for each unit. Alternative uses are suggested for unsuited units. Major conflicts that may arise with other resource uses such as agriculture, forestry, recreation, water and wildlife management are flagged.

Of the nine landscape units described, units one, three, four, eight and nine are considered unsuited to intensive residential development. Units two and five differ mainly in the proportion of bedrock that is situated close to the surface. Thus, subject to bedrock limitations, these units may be suited to development. Landscape units six and seven have inherent properties best suited to development, although conflicts do arise with other users of the land resource.

LANDSCAPE UNIT ONE (Figs. 2,3)

This unit characterizes the rugged rock coastline that occupies much of the perimeter of Bowen Island, as well as the hummocky rock knolls and ridges inland. Soil cover is minimal, usually less than 15 inches (45 cm) in depth, and moss-covered rock outcrops are common. The soil is typically coarse-textured, well-drained and of colluvial nature.

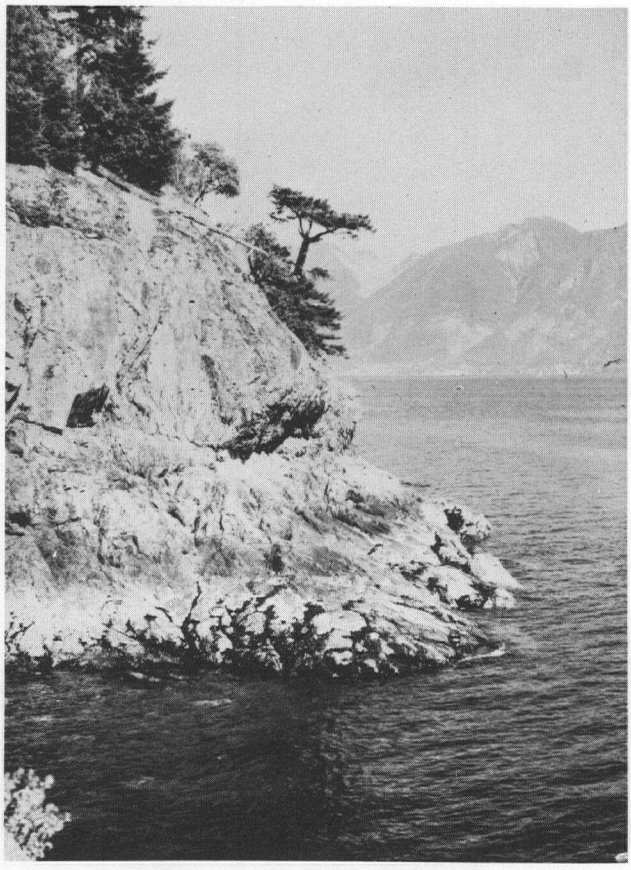

Fig. 2. **Much of Bowen Island's shoreline falls in landscape unit one. Scattered Douglas-fir, lodgepole pine and arbutus occur on very shallow soiled rock bluffs.**

Vegetation consists of scattered Douglas-fir, often in association with arbutus and lodgepole pine, where the soil is deep enough for roots to catch hold. Dry land mosses and grasses form a carpet over much of the unit. Ocean spray and pacific dogwood can be found clinging to local moisture pockets. Of all the units described, this unit offers the greatest diversity of spring flowers, which greatly enhance any hiking experience. Stonecrop, larkspur, blue-eyed Mary, bluebell, seablush and several others may be found in association or singly standing above the moss carpet.

Land use allocation considerations

1. The overpowering presence of bedrock nullifies this unit for intensive residential development. Cost of services would likely be prohibitive. Blasting would be essential. Suitable soil for septic fields would have to be brought in and even then suitable fill areas would be limited.

2. Any undue disturbance would cause irreversible damage to the fragile vegetative cover. Trampling will cause denudation of the rock.

Fig. 3 **A moss and grass covered rock knoll with scattered lodgepole pine and Douglas-fir. This is typical of inland ridges and knolls.**

3. Commercial timber values within this unit are low. Present vegetative cover should be maintained to prevent soil erosion and consequent site degradation.

4. The lack of a heavy underbrush and an amplitude of scenic views gives this unit value for extensive recreational activities such as hiking. Open-grown arbutus and Douglas-fir juxtaposed with various eye-striking flowers during spring and summer enhance its aesthetic appeal. Well-marked trails to direct traffic from the most sensitive sites should be considered.

5. If within a developmental proposal area, this unit should be considered for greenbelt or open space allotment.

LANDSCAPE UNIT TWO (Fig. 4)

This landscape unit is abundant throughout the Island. At least 60% of this unit is composed of bedrock outcrops or areas of shallow soil (less than 3 feet (1 metre) in depth) over bedrock. This is inseparably integrated with deeper pockets of soil. The shallowest of soils, those less than 15 inches (45 cm depth), are similar to those of landscape unit one. Some side slopes have soil depths to 1 metre and also tend to be of colluvial nature, well-drained and coarse-textured. Depressional areas may have soils developed on marine sands or silts often overlying a compact till base. Some seepage may occur.

Vegetation covers a spectrum from sparse Douglas-fir with camas and moss on very shallow soils to dense Douglas-fir, with oregon grape and salal on the intermediate sites. Individual seepage pockets may contain some hemlock and cedar with swordfern. Bracken fern along with several species of composites become abundant in disturbed areas.

Land use allocation considerations

1. The high proportion of shallow soils over bedrock is a limiting factor to intensive residential development. Septic field possibilities may exist for individual or small cluster residences in some of the deeper soil sites. Servicing would be expensive. Individual depressions between bedrock humps may become sewage "sinks", which would cause

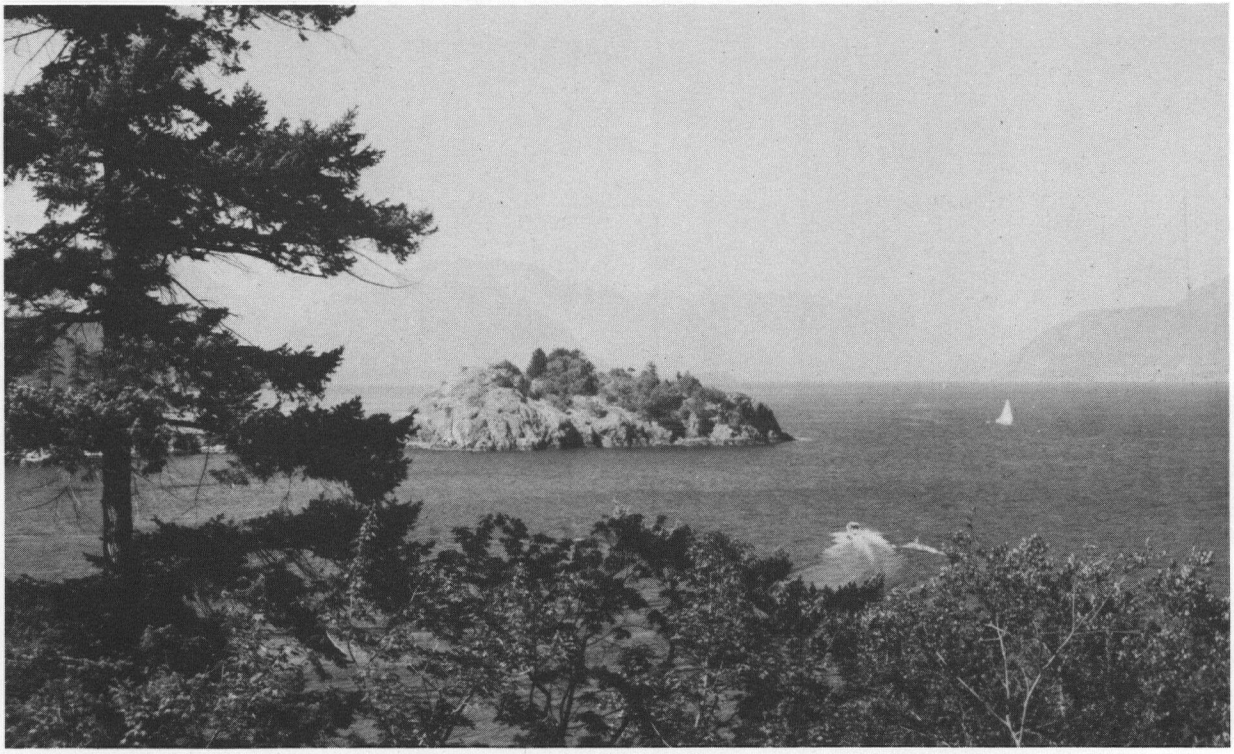

Fig. 4. Hiking along the upper reaches of Bowen Island offers many panoramic views of the surrounding sea and coast.

untold problems when soil conditions become saturated.

2. The lack of a heavy underbrush gives this unit value for extensive recreational activities such as hiking. As for unit one, well-marked trails should direct traffic away from the more fragile soil and vegetation sites inherent in this unit.

3. Timber values are relatively low and the resultant disturbance during extraction would most likely render environmental costs that would exceed timber revenues.

4. Greenbelt or open space activities are best suited to this unit. Within a developmental proposal area, consideration may be given to careful low density residential development.

LANDSCAPE UNIT THREE (Fig. 5)

All land situated on a slope of 30% or greater and which has a veneer of unconsolidated material less than 3 feet (1 metre) overlying bedrock is included in this unit. The soil is coarse-textured, well to rapidly drained and of colluvial origin. Pockets of deep colluvium may occur at the base of these slopes.

West and south facing slopes are dominated by Douglas-fir. Salal and oregon grape are major constituents of the ground vegetation. On the wetter and somewhat cooler north and east facing slopes, Douglas-fir shares the available growing space with hemlock and cedar. Swordfern makes a more frequent appearance on these aspects. Disturbed areas have been invaded by a variety of cover, including red huckleberry, ocean spray, bracken fern and scrubby red alder.

Land use allocation considerations

1. Adverse steep topography and shallow soils make this unit unsuited to residential development. Septic field possibilities do not exist.

2. Any removal of the vegetative cover would accelerate erosion. Any large-scale

Fig. 5 A logged over section of landscape unit three. Re-establishment is difficult and the erosional process has already removed much of the thin mantle of soil that remained after logging and slash burning.

disturbance may result in a decay of the root systems and changes in water regime, leading to local saturation which may cause slope failure.

3. Logging revenues would not compensate for the economic and environmental costs of harvesting these slopes. Slash, after harvesting, would create an extreme fire hazard, especially on westerly and southerly exposures, during the dry summer months.

4. Within its natural state, the covering vegetation provides soil stabilization, run-off control and aesthetic appeal.

LANDSCAPE UNIT FOUR

This unit encompasses the larger stream and runoff channels and adjacent slopes of the Island. The surficial material is generally bouldery and gravelly in nature. Frequent scouring to bedrock has occurred. Deeper accumulations of colluvial-alluvial material may occur in a fan-like shape near the outlets to major valleys or to the coast.

Constant seepage from adjacent slopes allows for a diverse array of vegetation cover. Alder and cedar along with Douglas-fir form much of the tree cover. Swordfern and scattered clumps of skunk cabbage characterize the ground vegetation. Devil's club makes a sporadic appearance. The relative abundance of cedar and alder often mark the boundaries of this unit with adjacent ones that tend to be solidly Douglas-fir. Active runoff channels are void of tree cover.

Land use allocation considerations

1. Development along or at the base of this unit can invite disaster. The risk of slope failure is always high. This threat is greatest during conditions of high precipitation when this unit may be enveloped by a torrent of runoff displacing soil and rock along the way.

2. This unit is a major drainageway for surface and immediate subsurface water flow. Restrictions, similar to those that safeguard against stream contamination, should be adhered to for this unit.

3. The standing vegetation is the main factor that maintains soil and slope stability during peak discharge periods.

4. This unit may be tapped as a source of local water supply, provided that flow is sufficient and safeguards against excessive runoff are made.

5. The unstable nature of this unit makes it unsuited to most recreational pursuits.

LANDSCAPE UNIT FIVE (Fig. 6)

This unit, along with landscape unit two, is the most commonly occurring unit on Bowen Island. The overall topography is hummocky, consisting of a complex of deep soils broken by bare rock outcrops and areas of shallow soil. Generally, some 60% of this unit has soils developed from basal till or coarse marine deposits extending greater than 3 feet (1 metre) in depth. These soils are coarse-textured, well-drained and show podzolic development, though this may be weak at times. Seepage may occur along the contact zone with the weathered till.

Douglas-fir with a ground vegetation of salal and/or oregon grape typify this unit. Arbutus makes a sporadic appearance. Red alder, red huckleberry and ocean spray are common after disturbance. Areas of seepage are often accentuated by the presence of swordfern. At higher elevations, western hemlock may form the main stand constituent.

Land use allocation considerations

1. The haphazard frequent occurrence of bedrock close to the surface would dictate high costs for installation of services for developmental purposes. The coarse textured nature of the surface soil and the relative impermeability of the underlying till may result in effluent seepage along the contact zone.

Fig. 6. A typical side slope situation located on deeper soils within landscape units five and six. Douglas-fir is growing in association with salal.

2. Fragile vegetation communities occur on the rock outcrop intrusions. Any disturbance should be directed to the more resilient areas of deep material.

3. This unit has an overall moderate forest productivity. Selective or patch logging methods may prove to be a sound practice on some of these units. Care must be taken to avoid wind-throw problems for uncut areas.

4. This unit may serve as a source of gravel.

LANDSCAPE UNIT SIX (Fig. 6,7)

This unit encompasses those areas containing soils developed on a compact till base exceeding 6 feet (2 metres) in depth. Included are side slope areas where water-worked marine sediments overlie this till. All the large areas of deep upland soils are characterized by this unit. Soils are coarse-textured, well-drained and show typical podzolic development. On lower slope west and south aspects, podzolic development tends to be weak.

Westerly aspects and much of the rolling topography below 500 feet (150 metres) above sea level are typified by Douglas-fir. Cooler, moister, north-facing slopes and areas above 500 feet (150 metres) above sea level have western hemlock as the major constituent of the stand. Western red cedar and red alder assume prominence along seepage sites. Red alder proliferates disturbed areas such as old skid trails and logging roads. Under closed canopy, ground vegetation is minimal. Open patches have been invaded by red huckleberry, salmonberry and a wide array of small forbs. Swordfern again shows itself on the moister sites.

Land use allocation considerations

1. Soil restrictions to intensive residential development are minimal. Seepage along the surface of the underlying till may cause local drainage problems for septic field use. Overall, the topography for this unit is gently sloping to gently undulating.

2. Vegetation communities represented

Fig. 7. Douglas-fir ready to be thinned on MacMillan Bloedel land. Salal and oregon grape occur in association with Douglas-fir on these well-drained soils. Swordfern depicts local seepage sites.

within this unit may be considered resilient to intensive recreational use. The lack of a diversity of vegetation and access to good viewpoints detracts somewhat from its hiking value.

3. Forest growth is good, with site indexes that approximate 130 feet (40 metres) at 100 years. Coarse soils would offer minimal trafficability problems. If harvested, restocking should commence immediately to reduce competition from less desirous shrubs and trees.

4. This unit may serve as a source of gravel.

LANDSCAPE UNIT SEVEN (Fig. 8)

This unit is representative of much of the better drained valley lands on the Island. Sandy or silty marine deposits predominate. Gravel deposits, characterized by numerous bands of sands and silts, occur along lower side slopes. These gravels are generally underlain by till. Soils are well-drained and coarse-textured.

The large gravel deposits are typified by Douglas-fir in association with salal, oregon grape or salmonberry. Where silt lenses hold water close to the surface, western hemlock, red alder and red cedar occur with swordfern. Broadleaf maple makes its best showing on this unit at lower slope well-drained positions. Bracken fern, red huckleberry, salmonberry and ocean spray often compete for available growing space in open stand situations.

Land use allocation considerations

1. Good foundation material, minimal erosion and slumping hazards and ease of service installations make this unit suited to residential development. Seepage along the

Fig. 8. Clumps of swordfern in lower slope positions depict seepage receiving areas typical of much of landscape unit seven.

interface with deep till, where it does occur near the surface, may be limiting to heavy septic tank use. Direct conflict with agriculture does occur.

2. This unit, along with landscape unit eight, includes some of the best agricultural lands on Bowen Island. Much of both of these units along the two major valleys fall within the Agriculture Land Reserve. Small bedrock intrusions and some of the gravels have minimal to marginal agriculture potential and may have higher value for other pursuits. Stoniness, topography and a poor water-holding capacity are major limitations of these latter sites for agriculture use. Larger blocks within the Agriculture Land Reserve that have a large proportion of rock have been designated to landscape unit five.

3. Forestry potential is high. Good growth of Douglas-fir, western hemlock and western red cedar can be attained with minimal input, once established, Site indexes would approximate 150 feet (45 metres) at 100 years.

4. This unit is a prime groundwater recharge unit.

5. This unit may serve as a source of gravel.

LANDSCAPE UNIT EIGHT (Fig. 9)

This unit occupies flat, depressional areas which are subject to constant seepage from adjacent slopes. The water table is near or at the surface during the wet winter months. Soils are developed on silts and fine sands of marine or alluvial origin. Often, as along Killarney Creek, recent alluvial deposits overlie deeper marine sands. Soils are characterized by a surface organic layer of variable thickness. Textures range from sandy loam to silt loam. In most cases, mottling occurs

Fig. 9. The floodplain of Killarney Creek, typified by red alder with horsetails, is representative of landscape unit eight.

throughout the soil profile, giving indication of periodic intense reduction. Such reduction reflects water saturated soil conditions for a good portion of the year.

Although this unit may contain glacial till and/or marine deposits at depth, the over-riding characteristic is the occurrence of a high water table and the threat of flooding during the wet season.

Vegetation is diverse and lush. Western red cedar, western hemlock and red alder are common constituents of the stand. Grand fir is a notable, though infrequent, species present. Swordfern, horsetails, spirea and skunk cabbage cover the ground. After disturbance, thimbleberries, salmonberries, red elderberries and huckleberries thrive. Red alder proliferates when stands are opened.

Land use allocation considerations

1. Constant seepage problems, a risk of flooding and unsuitable foundation material render this unit unsuited to intensive residential development. This unit is very susceptible to effluent seepage from adjacent development areas, which gives concern that it may become a pollution sink.

2. Alluvial flood plains and adjacent flat topography encompassed by this unit are particularly suited to agriculture. This unit has the best agriculture land on Bowen Island. Drainage may be needed locally to obtain maximum output.

3. Site indexes approaching 150 feet (50 metres) at 100 years can be attained for western hemlock, western red cedar and Douglas-fir. The abundant availability of free flowing water and nutrients from slope seepage allows for good tree growth. Extraction may be impeded by soil compaction and poor trafficability.

4. Haphazard opening of stands may create wind-throw problems, particularly under saturated soil conditions when tree roots tend to be loosely held.

5. With the aid of well-placed trails, this unit is suited to outdoor education purposes. A wide variety of plants and shrubs are available for study. Wet conditions would dictate the use of boardwalks along the pathways.

6. This unit is a prime groundwater recharge area.

7. The standing vegetation provides streambank stabilization and shade for the few suitable spawning streams on the Island. If within a developmental proposal area, this unit should be considered as a greenbelt area with adequate protection from adjacent residential complexes. The use of fertilizers, herbicides, pesticides and insecticides should be avoided to reduce the possibility of groundwater or surface water contamination.

LANDSCAPE UNIT NINE (Fig. 10)

This unit is of minor areal significance, but of prime wildlife and watershed value. Its most widespread occurrence is in the shallow

Fig. 10. Landscape unit nine at the north end of Killarney Lake. Dead cedar snags occur midst spirea, cattails, sweet gale and pond lilies.

bays around the three major lakes, the fen situated at the north end of Killarney Lake being the largest. These Fens consist of peat-covered or peat-filled surface material with a water table normally occurring at or near the surface. Often the fen vegetation forms a floating or quake peat mat encroaching on the water surface. The peat overlies a variable proportion of fine sands and silts of alluvial origin deposited by incoming streams during periods of high runoff. With respect to Killarney Lake, much of the fen origin can be traced to the damming of the original lake.

Sedges, cattails, bulrushes and spirea are common on these fens. Minor pockets of labrador tea and swamp-laurel are also restricted to this unit. These species blend into pond lilies and duckweed at the wettest extremities. Where the mineral soil approaches the surface, stunted cedar and willows gain a foothold.

Land use allocation considerations

1. A high water table, a relatively unstable subsurface material and the potential pollution of adjacent water bodies and streams are major limitations to residential development.

2. This unit has an inherently high wildlife value. It provides food and cover for a variety of birds and animals.

3. Flood control and streamflow regulation are an important function of this unit. As well, it is a prime groundwater recharge unit.

4. No commercial timber value exists.

5. This unit is best suited to open space or greenbelt consideration, with adequate buffering from areas of development. It is suited to outdoor education purposes for the study of both animal and plant life.

MAJOR WATERSHED AREAS

I Killarney Lake Watershed

(i) General Lake Description

Killarney Lake is approximately 90 acres (35 hectares) in size and is fed by numerous channelways from adjacent slopes, It is a relatively shallow lake, having a maximum depth of 15 feet (4.5 metres) and a general mean depth of 8 feet (2.5 metres). Drainage is to the southeast via Killarney Creek to Deep Bay. In the early 1920's, this creek was dammed as part of a project to utilize the lake for water storage. This dam nearly doubled the size of the original lake to its present size (Urban Programme Planners 1974).

Although the lake is shallow, it does not freeze sufficiently during winter or warm up to lethal temperatures in summer to affect adversely the fish population. The possibility exists that some bottom springs, as well as the incoming creeks, supply the necessary amount of fresh water for fish survival (Urban Programme Planners 1974). With the shallow fen conditions that surround much of the lake, a ready supply of food and cover is available for both fish and water birds. Species presently include sculpins, sticklebacks and trout. Spawning grounds seem to be a major limitation to the population growth of trout.

Apart from its value to wildlife, the lake is an invaluable stabilizing factor in flood control and stream regulation. Intensive recreational use of the lake cannot be envisioned. The surface area is not large enough for power boat use and shallow, marshy shores are not conducive to beach or swimming activities. Upgrading of trails along its perimeter would warrant consideration. As a source of water for future large-scale development, Killarney Lake has minimal value. With an elevation of only 100 feet (30 metres) above sea level, extensive

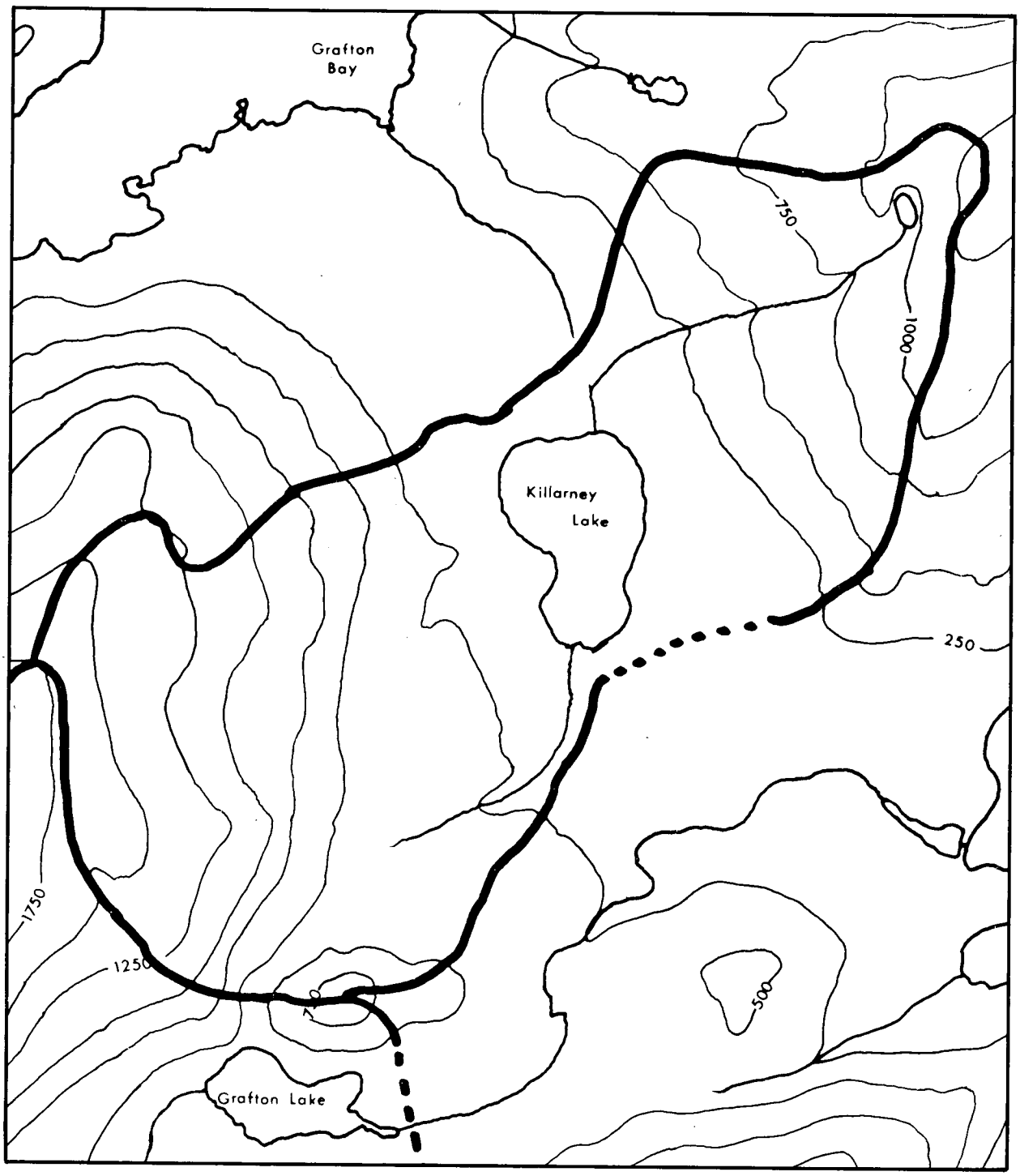

Fig. 11. Killarney Lake Watershed.

Fig. 12. Much of this fen area at the north end of Killarney Lake was formed when the original level of the lake was raised. This is a prime wildlife habitat area.

Fig. 13. Killarney Lake showing much of the low lying surrounding terrain. This backshore area is one reason why Killarney Lake is unsuited for water storage purposes.

Fig. 14. Open garbage strewn over the landscape is an unnecessary health hazard. This dump near Killarney Lake should be hauled away and buried.

pumping facilities would have to be provided. Gentle side slopes would render impoundment costs economically unattractive (G.V.W.D. 1973). As well, the ecological stability of the important fen areas (landscape unit nine) would be altered to the detriment of the present lake ecosystem.

(ii) Some Planning Considerations within the Watershed

Unlike Grafton Lake, which has potential as a major storage area for water, planning within this watershed has more flexibility. Careful consideration must still be given to the inherent ability of the watershed to sustain certain uses without undue detrimental effects to the environment. Protection of the wildlife values of Killarney Lake should be a high priority. This entails protection of the lake from possible effluent seepage and from the residue of pesticides, herbicides and fertilizers which may be utilized on adjacent agricultural lands and service right-of-ways.

Prime agricultural land is a scarce resource on Bowen Island. Thus, these lands, particularly landscape units seven and eight, should be considered for agricultural pursuits first and secondly for other resource uses. This need not necessarily mean solely crop or livestock production but should include the option of maintaining the current stand cover as is. The stress for these units along the valley should be to keep options open for the future.

Within the Agriculture Land Reserve, marginal agriculture lands do exist. Much of this land is depicted by landscape units two and five at the north end of Killarney Lake. Adverse topography and shallow soils over bedrock are the major limitations to agriculture use. Consideration for other uses may be warranted for these units.

Landscape unit six has development potential within the watershed. A coarse marine capping overlying the compact till may lead to seepage problems. Improper blockage of drainage may

result in slope slumpage. Consideration should also be given to the extension of the 100-feet minimal buffer zone between building construction and a natural water course. Because of the high permeability of the top soil and relative impermeability of the till, contamination of these water courses would be a real concern. Ideally, buffer zones should be tied to site conditions to allow for maximum flexibility in zoning.

An interesting connection of nature trails would be to join the old trail along the east side of Killarney Lake to the trail that follows Killarney Creek toward Deep Cove. Plant life and forest conditions from huge stump remnants of bygone logging days to a vast diversity of both introduced and endemic shrubs and trees would be encountered. Japanese knotweed, a very prolific shrub now rapidly extending its range along Killarney Creek, may prove to be a troublesome invader in the near future. It is hard to eradicate and is a vigorous invader of any stand opening.

II Grafton Lake Watershed

(i) General Lake Description

Grafton Lake, with a surface area of approximately 50 acres (15 hectares), is second to Killarney Lake in size of the four lakes on Bowen Island. As with Killarney Lake, it is a relatively shallow lake with fen vegetation surrounding much of its shoreline. Drainage is via Terminal Creek eastward to Deep Cove. Contrary to available information, the lake's western watershed boundary extends to the height of land east of the Tunstall Bay - Bowen Bay road junction (see landscape unit map). Its southward extension includes the small drainage area of the creek west of Josephine Lake.

Data on fish populations in the lake could not be obtained. However, one can surmise that the species present would be similar to those that inhabit Killarney Lake. Similarly, Grafton Lake is not suited to intensive recreation, being too small for power boats and having no suitable beach land.

However, unlike Killarney Lake, a reconnaissance survey of Bowen Island and the suitability of its water supply for future development suggest that the most suitable source of water would be Grafton Lake (G.V.W.D. 1973). With this in mind, the lake's watershed must be considered to have as its prime management task the preservation or improvement of the water quality and quantity. Necessarily, this would entail restricting public access within the watershed.

(ii) Some Planning Considerations within the Watershed

Protection of surface water quantity and quality is a necessity, not only within the Grafton Lake watershed but throughout Bowen Island. All public systems on the Island rely on either creeks or shallow wells. The water in these wells is from seepage rather than from aquifers and is considered as surface water (Thompson 1971). Deep groundwater reservoirs or aquifers have yet to be fully assessed, although aquifers in bedrock at depths of 200 feet to 500 feet (60 to 150 metres) have been encountered. Contamination of these aquifers is not considered a major hazard. Bedrock characteristics are such that minimal penetration of surface water through the rock would occur. However, contamination of surface and immediate subsurface flow is a valid possibility.

The role that the Grafton Lake watershed may play in the future water supply of the Islands dictates that future residential development within its boundaries should be sharply curtailed. Similarly, recreational pursuits should be restricted. Any growth in public access increases the chance of contamination of stream flow and subsurface flow. Agricultural capability exists within landscape units seven and eight along the valley adjacent to Grafton Lake. Agricultural practices should be pursued; however, some

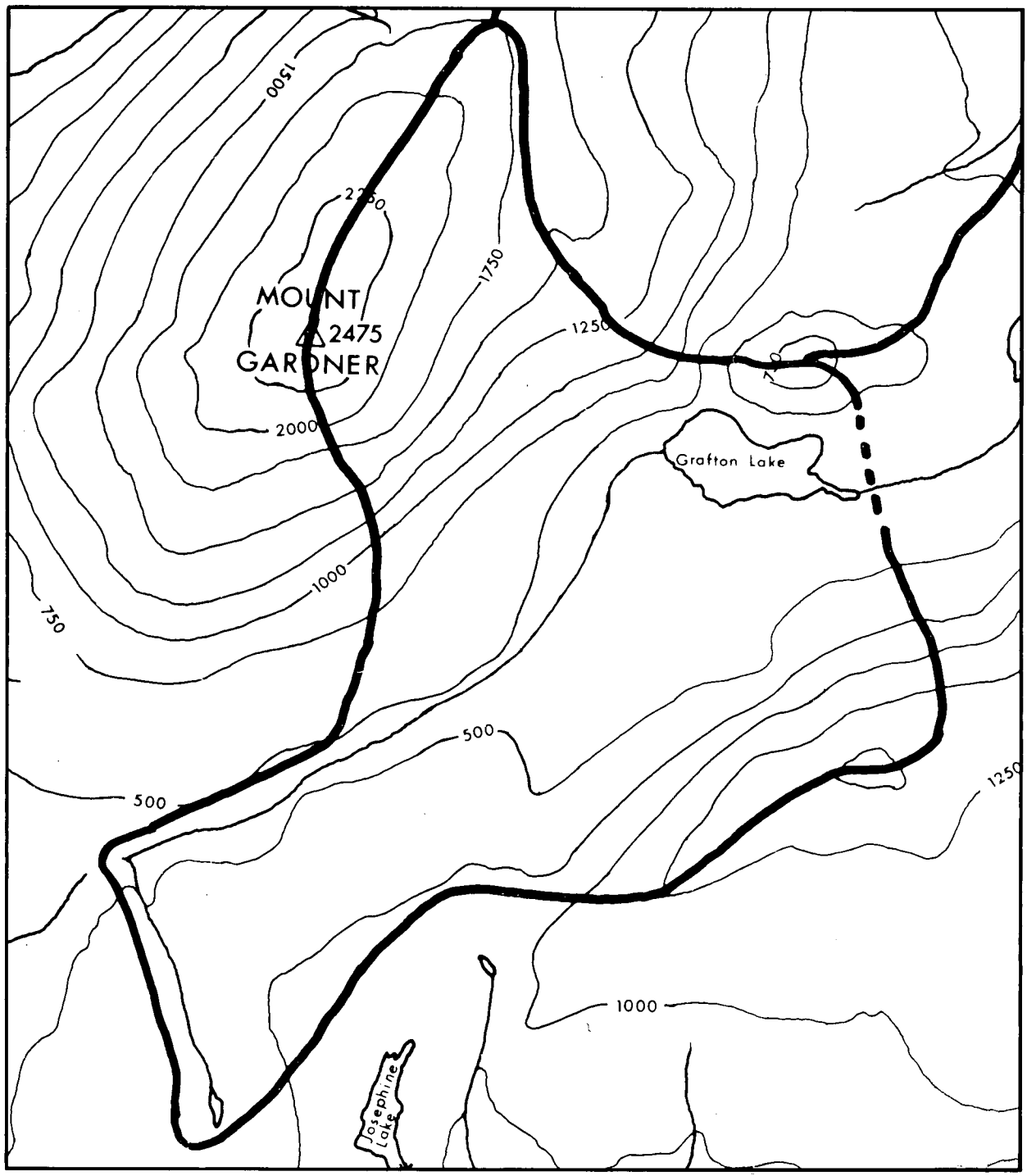

Fig. 15. Grafton Lake Watershed.

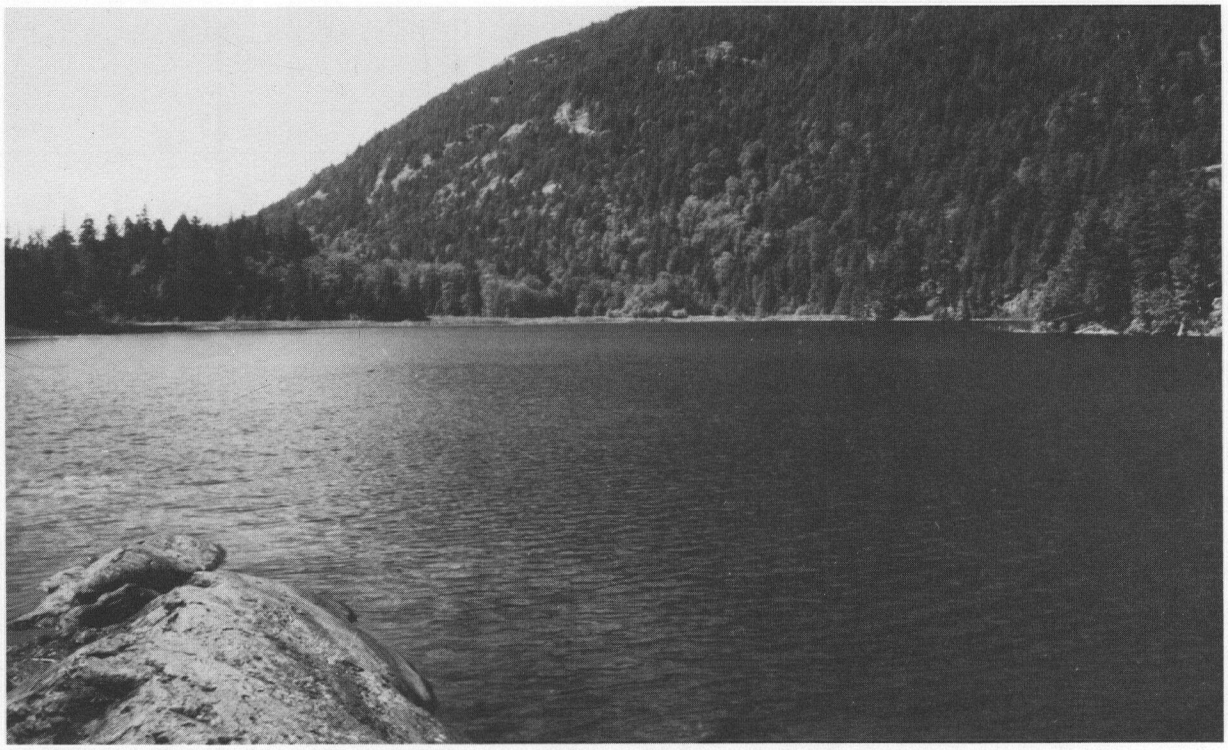

Fig. 16. An overview of Grafton Lake with landscape unit three forming much of the steep background. The scar on the hillside (upper right) is attributable to logging and subsequent slash burning.

restrictions should be placed on application of fertilizers and pesticides. Losses of fertilizers, such as nitrogen through leaching or percolation, which may have no economic significance to a farmer, can sufficiently increase the concentrations in surface water to permit eutrophy. Sandy and organic soils have a low capacity to absorb phosphorous. Thus, phosphorous may readily find its way to streams and Grafton Lake.

Groundwater recharge areas are important. Landscape units seven, eight and nine outline major recharge areas. Within unit seven, the prime infiltration sites are characterized by coarse-textured permeable gravels. Where silt lens cappings occur, seepage tends to become lateral along the seams. This, in turn, may create a slumpage hazard. Within units eight and nine, care should be taken to maintain the existing vegetative cover to reduce surface erosion and compaction which may lead to excessive surface flow.

With proper extraction techniques governed by a strong sense of environmental concern, patch logging may be permitted within the watershed. Two main problems must be resolved: surface erosion, including stream sediment buildup, and bacteriological contamination. This latter concern may be greatly reduced by employing closed system toilets on the work site and ensuring that no refuse dumping takes place within the watershed. Erosion control requires a more diverse approach. As road construction and maintenance is a major cause of soil disturbance, an obvious aim would be to minimize the amount of road building. Areas of steep slope and shallow soils should be avoided. This would ensure that landscape units three and two would remain untouched. All streamsides should be provided with a vegetated buffer strip from nearby roads. Landscape units eight and four outline only the major creek drainageways. Blockage of any of the smaller drainage channels should also be avoided.

Landscape units five and six are the most resilient to disturbance. Taking present stand structure into account, the best logging

opportunity perhaps exists in unit six, northwest of Josephine Lake. A relatively continuous cover of good second-growth hemlock with scattered Douglas-fir and cedar presently occupy the unit. Here, landscape unit eight should be avoided to protect the creekbed. The distribution of red alder outlines this unit quite well.

High wildlife values are associated with landscape units eight and nine. Unit nine plays an important role in the aquatic and immediate foreshore ecosystem of Grafton Lake. It has good capability to provide food and cover for both waterfowl and land birds. Unit eight provides browse and shelter for deer. In addition, it forms an integral part of the local stream ecology. Patch logging of unit six would open the existing stand and increase the "edge effect". This would undoubtedly enhance the habitat of most upland birds and animals, although the aesthetic quality of the unit might be diminished.

THE COASTLINE

The shoreline of Bowen Island is typified by steep rock cliffs and rounded knolls which abut directly to the sea. A sparse tree cover of Douglas-fir, lodgepole pine and arbutus, often broken by bedrock humps carpeted by a variety of dry land mosses and lichens, provides the shoreline with a multifarious scenic appeal. Small coves and inlets are not overly abundant, the southern shore perhaps exhibiting the highest concentration. Small gravelly beaches are associated with these coves.

In planning for shoreline development, many facets of the surrounding environment, both aquatic and terrestrial, should be considered. Aquatic studies, at the very least, should encompass information on the biological activity of the intertidal zone, the potential of aquaculture, the general mechanics of wave action and current action and storm occurrence. The gathering of these data would be vital when considering marina development or sewage outfall areas. If these outfalls are deemed necessary, this background information may stave off the deterioration of a bad practice to a calamitous result.

Terrestrial studies should include an assessment of shoreline and backshore landscapes as to their inherent capability to sustain uses of various kinds. Potential slump or erosion areas should be flagged. Fragile or unique vegetation communities need to be categorized. A search for, and the pinpointing of, any interesting archaelogical or historical sites should be carried out. Shell midden sites, in particular, are not an uncommon occurrence on many of the islands in the Strait of Georgia.

This section emphasizes the potential impact that shoreline development may have on the biological and physical traits of Bowen Island's coastline, particularly as it relates to the mapped landscape units. Social factors and pertinent data concerning the aquatic ecosystem fall outside the realm of this discussion.

I Coastal Zone Management Recommendations

An overview of the total coastline and of the individual landscape units that describe much of this coastline lends itself to the following salient recommendations. A more in depth analysis of these recommendations follows.

1. Landscape unit one should be considered as a buffer or greenbelt zone between the coast and any residential development.

2. Landscape unit three should remain in its natural state, if not already disturbed, for erosion and runoff control.

3. Landscape unit four should be noted as extremely hazardous for housing development.

4. Landscape units five, six and seven are suited to intensive development, with qualifications. The most favorable distribution

Fig. 17. Rock bluffs that abut sharply into the sea depict much of Bowen Island's coastline. These areas are suited to buffers between the sea and inland development.

Fig. 18. At low tide, many small rocky bouldery beaches offer the beach-combing enthusiast ample opportunity to search and seek.

Fig. 19. Starfish clustered and clinging to the rocks. This is a common sight along the Bowen Island coast, particularly at low tide.

Fig. 20. Overdevelopment of Bowen Island's coast should be avoided. Effluent disposal and destruction of the fragile vegetation are major problems that would occur if development progressed unhindered.

of these units occur in the Seymour Bay - Arbutus Bay backshore area, the south Tunstall Bay area, and sections of Bowen Bay and Grafton Bay. The Snug Cove - Deep Bay area is already almost totally utilized.

5. Sewage disposal is of major concern. Although initial costs may be high, serious consideration should be given to the installation of a sewer system with any new large-scale intensive development.

6. Present public access to the shoreline by land is limited and consideration should be given to rectifying this. Landscape units one and two are suited to picnicking if self-contained waste disposal units are provided.

7. Some of the small rocky beaches have sensitive intertidal zones which deserve some thought to maintenance in a natural state.

II Discussion of Recommendations

Landscape units one and two occupy much of the immediate backshore of Bowen Island. As described earlier, the overwhelming presence of bedrock would make costs of services phenomenal. As well, the thin soil mantle supports a fragile vegetation community that once removed cannot be readily re-established. The utilization of these units, particularly landscape unit one, as buffers seems to be a logical management step.

As a buffer between development and the shoreline, unit one would be suited to hiking and other forms of extensive recreation. Scenic coastline views abound. Many hidden coves and inlets are a beachcomber's delight. At the same time, protection from winter storms would be afforded to housing to the lee of this unit. Full utilization of the natural configuration of the landscape itself rather than some arbitrary setback rule of 100, 200 or 300 metres should be a goal to strive for. With this concept, buffer zones may extend half a kilometre or more inland to attain a more equitable balance with the environment. Any resulting development would meld with, rather than overwhelm the

surrounding landscape.

Landscape units three and four become very unstable when disturbed. A poignant example can be seen along the west coast between Bowen Bay and Grafton Bay. Upper slope logging activities in the past have triggered mass movement downhill to the extent that the water-course has been denuded to bedrock. The south slopes of Mount Gardner provide another graphic illustration, although inland, of mismanagement of steep terrain. Here, haphazard logging practices and subsequent slash burning have left a scar on the mountain side that detracts from the Island's visual beauty. Without sincere attempts at slope stabilization and runoff control, erosion will continue unchecked. Maintenance of a vegetative cover for watershed protection is essential. Any consequential change in normal drainage patterns increases the slumpage and resultant downslope hazard of these units.

Development potential exists south of Tunstall Bay and to the east of the coastal rock formations. If landscape unit one is left as a buffer zone where it abuts the coast, other inland units may be utilized for intensive development. Presently, much of this area is slightly depressional, containing red alder, with Douglas-fir generally outlining the shallow sites. Soils are coarse-textured, well-drained and, except for a few depressions, give no indication of a seasonal high water table. Seepage may be a problem and areas adjacent to the creek should be maintained in their present state.

At Seymour Bay, the topography is gently sloping and has been cleared at one time for farming. This area of deep, well-drained soil may be suited for a marina or residential development. Much of the inland area extending from Seymour Bay west for half a mile (1 kilometre) or so is characterized by deep, well-drained soils dotted with rock outcrops. Careful development can avoid excessive disturbance of the fragile rock areas and slopes of Josephine Creek. However, development considerations must be weighed against the economic and aesthetic loss of mature, well-developed western hemlock and Douglas-fir.

Both Grafton Bay and Bowen Bay have sections of terrain suited to intensive use. Most of the available space has already been allocated to cottage and residential use. Careful evaluation of the remaining landscape should be made to ensure that the carrying capacity of these areas is not exceeded. A point of significance concerning development along the valley to Killarney Lake is that a large portion of this land lies within the Agriculture Land Reserve.

This study pinpoints the above-mentioned shoreline areas as inherently most suited to development, given the distribution of landscape units that make up the coast. However, on-site evaluation is still imperative before any final developmental designs or options are carried out.

A major concern to all development is sewage disposal. Preliminary water availability surveys of the Island indicate that the Island could support modest population increases. Both groundwater and surface water sources may be tapped. Accordingly, effluent disposal, not water availability, seems to be the major limiting factor to community development.

The prevalence of coarse-textured soils overlying a relatively impermeable till can lead to septic field problems, particularly during wet conditions. Effluent seepage would be a major concern in concentrated development. In other areas, bedrock is a very limiting factor. A community sewer system is a definite alternative. If installed during the initial development stages when a community water system is being installed, costs in the long run would be substantially reduced. A switch-over from septic tanks to sewers and a treatment plant within an established community would be a more onerous task.

The Snug Cove - Deep Bay area is already reaching a crisis state as to its effluent problem. In this case, marine soils are absorbing and filtering as much effluent as they can handle. Further development linked to a septic field system may cause excessive pollution of the Bay and Cove areas.

A need for more access to the shoreline for recreational pursuits exists on the Island. Access to isolated beaches and coves has never been a problem by boat; however, access by land is difficult. The predominance of private land along the coast and the lack of good trails have limited public appreciation of some of Bowen Island's shoreline values. Perhaps the rugged, sometimes hidden trail from Snug Cove to Apodaca Cove could be resurrected with connections to the ecological reserve area. Buffer zones along the coast can be utilized as public corridors and may serve as access points to beach activities. Landscape unit two, in particular, may be suited to picnicking and other day activities, with access reached by means of trails. Road construction would destroy much of the aesthetic value of these areas.

The many small rocky beaches composed of cobbles, boulders and/or exposed bedrock deserve special mention. These beaches are usually more stable than sandy shores as the coarse material is permeable, allowing the attacking waves to sink into the beach. This, in turn, reduces the backwash effect. Yet, they tend to have more ecological significance than sandy beaches. These beaches are characterized by an intertidal zone containing various tidal pool communities. These pools have excellent educational value as well as being important constituents of the aquatic ecology of the beach area. Care should be taken to minimize the disturbance of these pools.

SUMMARY

The major physical limiting factor to increased development on Bowen Island is the prevalence of bedrock outcrops and of vast areas of a shallow soil mantle over bedrock. Disturbance of this fragile soil cover may cause irreparable damage to the site. Sensitive vegetative communities would be very hard or, at times, impossible to re-establish. It is these shallow soils that often contain the most aesthetically pleasing spring and summer flowers. Their destruction would undoubtedly detract from the inherent vibrant character of Bowen Island.

Shallow soils impose severe limitations to effluent disposal by means of a septic system. Sewer installation would carry with it a high economic cost. Costs of other services, in many cases, would be prohibitive. Consequently, housing developments should be directed to the areas of deeper soils on the Island. This would entail careful consideration of landscape units six and seven. Utilization of landscape units eight and nine would encounter severe limitations such as poor foundation material, a water table at or near the surface, and very high inherent values for agriculture or wildlife, or both.

The growth of residential communities that would rely on a septic field system for effluent disposal should be carefully scrutinized before implementation. The coarseness of the surface soil and the relative impermeability of the underlying till that characterizes much of the areas of deep soil on Bowen Island tend to discourage the employment of such a system. Such soil conditions are conducive to groundwater and downstream pollution. Although initial costs may be high, consideration should be given to utilization of a sewer system with any new community development.

The Grafton Lake drainage basin will probably be the major future source of water. As such, measures should be taken to ensure that the water quality and quantity does not deteriorate. This would necessitate imposing restrictions on recreational and residential activities within the basin boundaries.

The character of Bowen Island lies in its

shoreline. To maintain this character and to allow for a fuller public appreciation of it, management of the coastline should strive for a happy median between minimal landscape disturbance and public access. The utilization of landscape units one and, perhaps, two as buffer strips between inland development and the coastal ecosystem may be one approach to consider.

Many social and economic considerations can be linked to the physical and biological analysis of an area for land planning purposes. Obviously, such a landscape analysis is not all encompassing. Public participation is essential to surface all possible points and counterpoints of resource allocation for any one region. In the case of Bowen Island, this study provides background information on which the Bowen Island Advisory Committee, along with the Greater Vancouver Regional District and Islands Trust, can superimpose other pertinent information when considering plan alternatives. It does not represent a plan in itself.

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APPENDIX

LIST OF THE MORE COMMON PLANTS OCCURRING ON BOWEN ISLAND

I WOODY PLANTS

Arbutus	Arbutus menziesii
Blackberry	Rubus discolor
Blackcap	Rubus leucodermis
Bog Laurel	Kalmia occidentalis
Broadleaf Maple	Acer macrophyllum
Broom	Cytisus scoparius
Cherry	Prunus spp.
Devil's Club	Oplopanax horridum
Douglas Fir	Pseudotsuga menziesii
Dwarf Huckleberry	Vaccinium caespitosum
Evergreen Blackberry	Rubus lacinatus
False Azaela	Menziesia ferruginea
False Box	Pachistima myrsinites
Gooseberry	Ribes spp.
Gorse	Ulex europaeus
Grand Fir	Abies grandis
Hawthorn	Crataegus douglasii
Honeysuckle	Lonicera spp.
Japanese Knotweed	Polygonum cuspidatum
Labrador Tea	Ledum groenlandicum
Lodgepole Pine	Pinus contorta
Ninebark	Physocarpus capitatus
Ocean Spray	Holodiscus discolor
Oregon Grape	Berberis nervosa
Pacific Dogwood	Cornus nuttallii
Pacific Willow	Salix lasiandra
Red Alder	Alnus rubra
Red Elderberry	Sambucus racemosa
Red Huckleberry	Vaccinium parvifolium
Salal	Gaultheria shallon
Salmonberry	Rubus spectabalis
Saskatoon	Amelanchier alnifolia
Snowberry	Symphoricarpos albus
Spirea	Spiraea douglasii
Stink Currant	Ribes bracteosum
Sweet Gale	Myrica gale
Thimbleberry	Rubus parviflorus
Trailing Blackberry	Rubus ursinus
Twinflower	Linnaea borealis
Western Hemlock	Tsuga heterophylla
Western Red Cedar	Thuja plicata
Western Yew	Taxus brevifolia
Wild Rose	Rosa spp.
Willow	Salix spp.

II HERBACEOUS PLANTS

Alaska Onion-grass	Melica subulata
Avens	Geum macrophyllum
Beaked Sedge	Carex rostrata
Bedstraw	Galium spp.
Bleeding Heart	Dicentra formosa
Bluebell	Campanula rotundifolia
Blue-eyed Mary	Collinsia parviflora
Bog St. John's-wart	Hypericum anagalloides
Buckbean	Menyanthes trifoliata
Bunchberry	Cornus canadensis
Burdock	Articum minus
Buttercup	Ranunculus spp.
Campion	Lychnis dioica
Canada Mint	Mentha arvensis
Cat-tail	Typha latifolia
Common Horsetail	Equisetum arvense
Common Plantain	Plantago major
Common Rush	Juncus effusus
Coral Root	Corallorhiza spp.
Cow Parsnip	Heracleum lanatum
Fairy Slipper	Calypso bulbosa
False Lily-of-the-Valley	Maianthemum dilatatum
Fescue	Festuca spp.
Fireweed	Epilobium angustifolium
Foamflower	Tiarella trifoliata
Foxglove	Digitalis purpurea
Giant Horsetail	Equisetum telmateia
Giant Vetch	Vicia gigantea
Gumweed	Grindelia spp.
Hairy Cat's-ear	Hypochaeris radicata
Hedge Nettle	Stachys cooleyae
Larkspur	Delphinium spp.
Little Hairgrass	Aira praecox
Mannagrass	Glyceria spp.
Miner's Lettuce	Montia spp.
Parsley	Lomatium spp.
Pearly Everlasting	Anaphalis margaritacea
Pondweed	Potamogeton spp.
Pussytoes	Antennaria spp.
Rattlesnake Plantain	Goodyera oblongifolia
Rough Hairgrass	Agrostis scabra
Rush	Juncus spp.
Seablush	Plectritis congesta
Sedge	Carex spp.
Selaginella	Selaginella spp.
Self-heel	Prunella vulgaris
Sheep Sorrel	Rumex acetosella
Shooting Star	Dodecatheon spp.

Silvergreen	Adenocaulon bicolor
Skullcap	Scutellaria lateriflora
Skunk Cabbage	Lysichitum americanum
Small-fruited Bulrush	Scirpus microcarpus
Starflower	Trientalis latifolia
Stinging Nettle	Urtica dioica
Stonecrop	Sedum spp.
Strawberry	Fragaria spp.
Sundew	Drosera rotundifolia
Thistle	Cirsium spp.
Twayblade	Listera spp.
Violet	Viola spp.
Wall Lettuce	Lactuca muralis
Water Lily	Nymphaea odorata
Water Parsley	Oenanthe sarmentosa
Wild Onion	Allium spp.
Wintergreen	Pyrola spp.
Witchgrass	Panicum spp.
Wood Sorrel	Oxalis stricta
Yarrow	Achillea millefolium
Yellow Monkey-flower	Mimulus guttatus
Yellow Pondlily	Nuphar polysepalum
Youth-on-Age	Tolmiea menziesii

III FERNS

Bracken	Pteridium aquilinum
Deerfern	Blechnum spicant
Lady Fern	Athyrium filix-femina
Licorice Fern	Polypodium glycyrrhiza
Maidenhair Fern	Adiantum pedatum
Parsley Fern	Cryptogramma crispa
Woodfern	Dryopteris spp.
Swordfern	Polystichum munitum

IV MOSSES

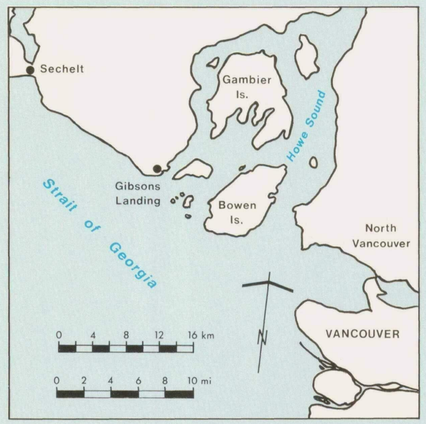
Dicranum spp.
Eurhynchium oreganum
Fontinalis antipyretica

Hylocomium splendens
Isothecium spiculiferum
Mnium spinulosum

Plagiomnium insigne
Plagiothecium undulatum
Pogonatum spp.

Polytrichum commune
Rhacomitrium canescens
Rhizomnium glabrescens

Landscape Units of
BOWEN ISLAND



0 1 2 km

0 1/2 1 mi

HOWE SOUND

Hood Pt.

Columbine Bay

Enchanta Bay

Smugglers Cove

Grafton Bay

Cates Bay

COLLINGWOOD CHANNEL

Killarney Lake

Millers Landing

Mt. Gardner △

Deep Bay

Tommal Cr.

Grafton Lake

Snug Cove

Dorman Bay

Bowen Bay

Road

Tunstall Bay

Explosive Cr.

Josephine L.

Josephine Cr.

Apodaca Cove

Cape Roger Curtis

Seymour Bay

QUEEN CHARLOTTE CHANNEL

Trinity Bay

Union Cove

Alder Cove

Arbutus Bay

Echo Cove

Pt. Cowan

N

Environment Canada / Environnement Canada
Forestry Service / Service des Forêts

Canadian Forestry Service
Pacific Forest Research Centre
506 West Burnside Road
Victoria, B.C.

1976

Landscape Unit One HUMMOCKY ROCK KNOLLS AND RIDGES ARE INCLUDED IN THIS UNIT. AS ARE ALL SHORELINE ROCK BLUFFS. SOIL COVER IS MINIMAL (LESS THAN 45 CM IN DEPTH). VEGETATION IS DOMINATED BY A MOSS CARPET OVER BEDROCK. SCATTERED DOUGLAS-FIR WITH ARBUTUS AND LODGEPOLE PINE VIE FOR AVAILABLE GROWING SPACE. OCEAN SPRAY AND PACIFIC DOGWOOD CLING TO LOCAL MOISTURE POCKETS.

Landscape Unit Two A COMPLEX OF BEDROCK OUTCROPS, AREAS OF SHALLOW SOILS AND POCKETS OF DEEPER SOIL CHARACTERIZE THIS UNIT. SIXTY PER CENT OR MORE OF THE UNIT HAS SOILS LESS THAN 1 METRE IN DEPTH. THE DEEPER DEPRESSIONAL AREAS MAY HAVE SOILS DEVELOPED ON A COMPACT TILL BASE OR ON A SANDY TO SILTY MARINE DEPOSIT. VEGETATION COVERS A SPECTRUM FROM SPARSE DOUGLAS-FIR WITH GRASS AND MOSS TO STANDS OF DOUGLAS-FIR CARPETED BY SALAL AND OREGON GRAPE. WESTERN HEMLOCK AND CEDAR WITH SWORDFERN INDICATE SEEPAGE SITES.

Landscape Unit Three HILLSIDES THAT HAVE A SLOPE OF 30% PER CENT OR GREATER WITH A VENEER OF COLLUVIUM OVERLYING BEDROCK CHARACTERIZE THIS UNIT. SOILS ARE NORMALLY LESS THAN 1 METRE IN DEPTH, AND ARE COARSE-TEXTURED AND WELL-DRAINED. THEY TEND TO BECOME UNSTABLE ONCE DEVEGETATED. WEST AND SOUTH FACING SLOPES ARE DOMINATED BY DOUGLAS-FIR, WITH SALAL AND OREGON GRAPE. COOLER AND SOMEWHAT MOISTER EAST-AND NORTH-FACING SLOPES HAVE HEMLOCK AND CEDAR SHARING THE AVAILABLE GROWING SPACE WITH DOUGLAS-FIR. ON THESE ASPECTS SWORDFERN IS FREQUENT.

Landscape Unit Four INCLUDED ARE THE LARGER STREAM AND RUNOFF CHANNELS AND ADJACENT SLOPES OF LAND. IN AREAS VOID OF A PROTECTIVE VEGETATIVE COVER, SCOURING TO BEDROCK HAS OCCURRED. THE SURFICIAL MATERIAL IS OFTEN VERY BOULDERY IN NATURE. RED ALDER AND CEDAR OCCUPY MUCH OF THESE CHANNELWAYS. SWORDFERN IS A COMMON GROUND VEGETATION CONSTITUENT.

Landscape Unit Five A COMPLEX OF DEEP SOILS BROKEN BY BARE ROCK OUTCROPS AND AREAS OF SHALLOW SOIL TYPIFY THIS UNIT. SIXTY PER CENT OR MORE OF THE SOILS ARE DEVELOPED FROM DEEP BASAL TILL OR COARSE MARINE DEPOSITS. THESE SOILS ARE GENERALLY WELL-DRAINED AND COARSE-TEXTURED. DOUGLAS-FIR, IN ASSOCIATION WITH SALAL AND / OR OREGON GRAPE, OCCUPY MUCH OF THE UNIT. AREAS OF SEEPAGE ARE ACCENTUATED BY THE PRESENCE OF SWORDFERN. AT ELEVATIONS HIGHER THAN 150 METRES ABOVE SEA LEVEL, DOUGLAS-FIR BEGINS TO GIVE WAY TO WESTERN HEMLOCK.

Landscape Unit Six ENCOMPASSED BY THIS UNIT ARE THOSE AREAS CONTAINING SOILS DEVELOPED ON A COMPACT TILL BASE EXCEEDING 2 METRES IN DEPTH. ALL THE LARGE AREAS OF DEEP UPLAND SOILS ARE CHARACTERIZED BY THIS UNIT. THESE SOILS ARE COARSE-TEXTURED AND GENERALLY WELL-DRAINED. COOLER, MOISTER NORTH-FACING SLOPES AND AREAS HIGHER THAN 150 METRES ABOVE SEA LEVEL GENERALLY INCLUDE WESTERN HEMLOCK AS THE MAJOR CONSTITUENT OF THE STAND. DOUGLAS-FIR PREDOMINATES AT LOWER ELEVATIONS. UNDER CLOSED CANOPY, GROUND VEGETATION IS MINIMAL. RED ALDER PROLIFERATES AFTER DISTURBANCE.

Landscape Unit Seven MUCH OF THE BETTER DRAINED VALLEY LANDS TYPIFY THIS UNIT. SOILS ARE DEVELOPED ON MARINE DEPOSITS THAT HAVE A VARIED COMPOSITION. IN LARGE PART, THEY CONSIST OF SANDS OR SILTS AT DEPTH. POCKETS OF WASHED AND SORTED GRAVELS OVER TILL THAT OCCUR FREQUENTLY ALONG THE LOWER SLOPES ARE INCLUDED. WHERE THE DRAINAGE IS RAPID, DOUGLAS-FIR OCCURS IN ASSOCIATION WITH SALAL OR OREGON GRAPE. WESTERN HEMLOCK, CEDAR AND ALDER ARE INDICATIVE OF MARINE DEPOSITS CONTAINING SILT LENSES THAT TEND TO HOLD WATER CLOSER TO THE SURFACE. BROADLEAF MAPLE IS A COMMON CONSTITUENT. BRACKEN FERN, RED HUCKLEBERRY AND SALMONBERRY INVADE DISTURBED AREAS.

Landscape Unit Eight THIS UNIT OCCUPIES FLAT, DEPRESSIONAL AREAS WHICH ARE SUBJECT TO CONSTANT SEEPAGE FROM ADJACENT SLOPES. SOILS ARE NORMALLY DEVELOPED ON SILTS AND FINE SANDS OF MARINE OR ALLUVIAL ORIGIN. TEXTURES RANGE FROM SANDY LOAM TO SILT LOAM. A YEAR-ROUND HIGH WATER TABLE EXISTS AND FLOODING MAY OCCUR DURING THE WET WINTER MONTHS. VEGETATION IS DIVERSE AND LUSH. WESTERN RED CEDAR, HEMLOCK, ALDER, GRAND FIR AND DOUGLAS-FIR ALL ATTAIN GOOD GROWTH. SWORDFERN, HORSETAILS, THIMBLEBERRIES AND RED HUCKLEBERRIES THRIVE.

Landscape Unit Nine THIS UNIT CONSISTS OF PEAT-COVERED OR PEAT-FILLED SURFACE MATERIAL WITH A WATER TABLE NORMALLY OCCURRING AT OR NEAR THE SURFACE. THE FEN VEGETATION MAY FORM A FLOATING QUAKE OR PEAT MAT ENCROACHING ON AN ADJACENT WATER SURFACE. NORMALLY, THE PEAT OVERLIES A VARIABLE PROPORTION OF FINE SANDS AND SILTS. SEDGES, CATTAILS, BULRUSHES AND SPIREA REPRESENT A MAJORITY OF PLANTS FOUND. STUNTED WILLOWS AND CEDARS OFTEN GAIN A FOOTHOLD AROUND THE PERIMETER WHERE THE MINERAL SOIL APPROACHES THE SURFACE

Water

Watershed boundary

Canadian Forestry Service
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