GOLDSTREAM PROVINCIAL PARK

NATURAL HISTORY THEMES

Prepared by:

Juan de Fuca Environmental Consultants

For:

B.C. Ministry of Parks
South Coast Region
North Vancouver, B.C.

March, 1989

1 INTRODUCTION

1.1 LOCATION AND SETTING

Goldstream Provincial Park is located 19 kilometers northwest of Victoria on the Trans Canada Highway. The highway bisects the park which occupies the valley bottom of the lower Goldstream River at the head of Finlayson Arm. The park features a number of highly significant natural features in close proximity to a large metropoltan centre.

1.2 MAJOR NATURAL HISTORY THEMES

Goldstream Park has a great diversity of significant and high quality natural and cultural themes concentrated in a relatively short area.

The most evident natural history themes are the river's annual salmon runs and stream life. Other major themes are found at the estuary with its unique assemblage of plants and animals and interesting ecologic features associated with the interface of marine, freshwater and terrestrial environments. The park also has an outstanding variety of plant communities and habitats featuring examples of the driest to moderately moist associations of the Coast Douglas-fir Biogeoclimatic Zone. Goldstresam Park also lies within an area of complex bedrock geology and interesting examples of Pleistocene ice age landforms are common.

Secondary natural history themes include terrestrial animals and bird life and their association with the varied habitats, estuary and salmon runs. The park is also central to the mildest climate in Canada as reflected in the existing plant cover.

Goldstream Park does not contain any archaeologic or notable historic sites. However, the valley has been an important focus for both Indian and white cultural activities and several historic themes can be presented. The river is a traditional fishing ground for the Saanich people, members of the Lkongeneng language group of the Coast Salish Indians. An early gold rush, construction of the E&N Railway and Malahat Road and use of the Goldstream River for power generation provide cultural themes for the more modern era.

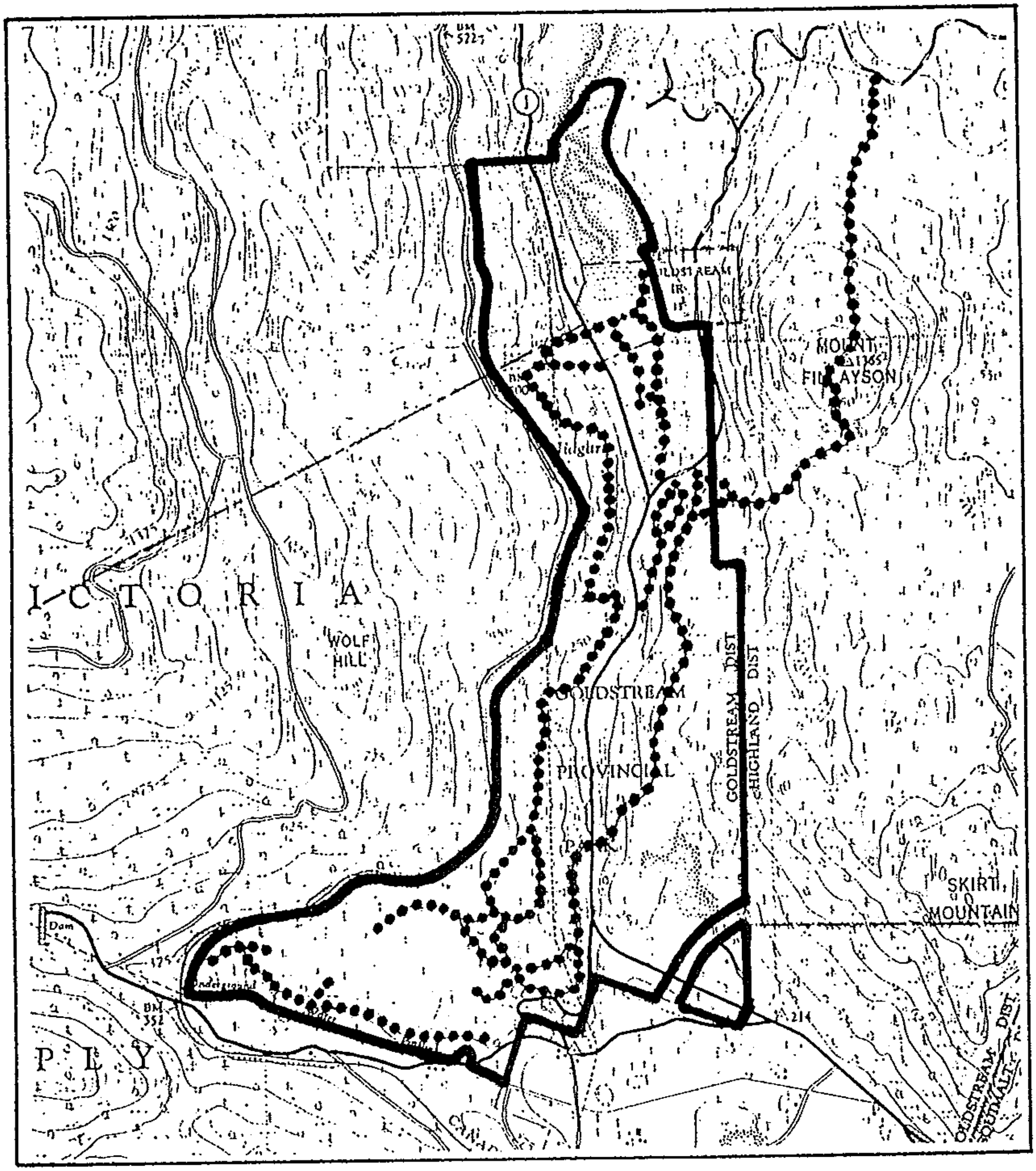


Figure 1.1 GOLDSTREAM PARK
1:25,000

Park Boundary

Trails

TABLE OF CONTENTS

Continued.....

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

To Be Written

1.3 PARK FACILITIES AND USE

The park facilities are mainly associated with three areas: the Freeman King Nature House, a parking lot/day-use centre adjacent to the highway and the campsite at the southwest end of the park. There are three other small parking areas adjacent to the highway. Approximately 16 kilometers of developed trails provide access throughout the park. Major trail destinations include Niagara Falls, the Niagara Creek railway trestle, an old gold mine and locations along the Goldstream River. Although outside the park, a major destination for hikers is the summit of Mount Finlayson which provides an excellent vista of the park and surrounding terrain. Goldstream Park has 159 campsites and 55 day use tables.

Use of Goldstream Park is very high. From 1980 to 1984 the park received an average of more than 17,000 camper party nights and 86,000 day-use party days per annum. Use in the park is on a twelve-month basis although most day-use is associated with the fall salmon runs and camping is concentrated in the months of July and August.

1.4 ROLE OF GOLDSTREAM PARK

1.4.1 Conservation Role

Goldstream Park plays a major role in the conservation of several natural themes, especially the salmon run, estuary area and botanic features (mature trees, variety of plant communities and occurrence of a wide range of plant species).

Secondary conservation roles include the protection of geologic features, soil resources and wildlife.

1.4.2 Recreation Role

The major recreation role of Goldstream Park is the provision of outdoor education opportunities and non-consumptive activities such as viewing, hiking and nature appreciation. It also plays an important role as a destination campground for the region.

1.5 SCOPE AND LIMITATIONS OF DOCUMENT

This Natural History Themes Document was completed by reference primarily to readily available reports, publications and file information. For certain subjects such as bedrock geology there is considerable published material. However, this material is often overly detailed and is sometime contradictory between different sources. For other subjects such as invertebrate fauna there is relatively little information pertaining to Goldstream Park. Many of the sources such as for soils, climate and history are presented at an overview level and interpretations must be made to relate the information specifically to the park area. This process of interpretation has probably resulted is some errors of fact and incorrect conclusions being made in this document.

The following notes identify the major weaknesses in the background data and subjects requiring further study.

GEOLOGY

There is considerable confusion about the region's geology because different sources use different terminology and appear to contradict one another over certain items. Use of a geologist to better summarize rock structures and geologic history might be warranted.

PLEISTOCENE ICE AGE

The account of the Pleistocene ice ages has been simplified in this document. The complex series of stades and local ice tongues described in much of the literature is considered to be confusing and probably not that valid by certain recent authorities such as Howes.

SOILS

Soil information is derived from 1:100,000 soil association mapping. The boundaries of these maps are not expected to be accurate enough for precise delineation of soil types in a small area such as Goldstream Park. Use of a soil specialist might be desireable to refine soil unit boundaries and to relate soils more closely with biologic features, especially plant communities.

FLORA

The description of plant communities by Inselberg appears to be relatively comprehensive. Some effort to correlate the plant communities with soil types and wildlife habitats would be useful.

FAUNA

Information for invertebrate fauna specific to the park appears to be limited. Certain topics are partially covered (such as Meade's list of spiders) but other groups of animals warrant further study. Also, knowledge about marine life specific to the park is very limited.

2. GEOLOGY

2.1 PHYSIOGRAPHIC SETTING

Goldstream Park lies within the Nanaimo Lowland, a physiographic subdivision of the Georgia Depression. The Georgia Depression lies partly submerged beneath the Strait of Georgia and Puget Sound and, along with the Gulf Islands, forms coastal lowlands along eastern Vancouver Island, the Lower Mainland and Fraser Valley. The depression is a structural feature separating the Insular Mountains of Vancouver Island to the west and the Coast Mountains to the east. The depression was a major pathway for Pleistocene Ice advances and its depressed nature was intensified by ice erosion. Much of the Nanaimo Lowland is underlain by sedimentary rocks. However, towards the south in the vicinity of Goldstream Park, bedrock structures include a complex of rock types of various geologic age.

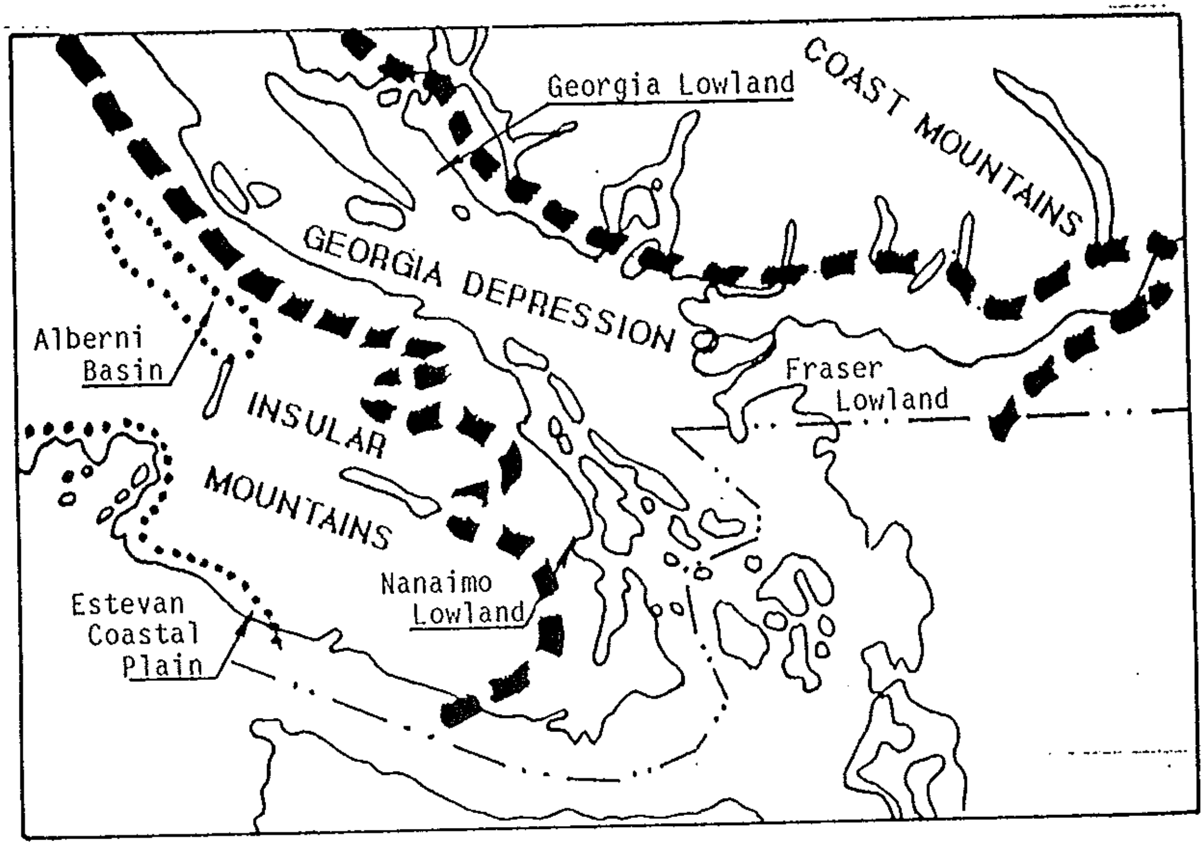


Fig. 2.1 PHYSIOGRAPHIC REGIONS (from Holland, 1964)

2.2 GEOLOGIC HISTORY

The bedrock geology and geologic history of coastal British Columbia is relatively complex. This is particularly true on southeast Vancouver Island where a variety of rock types meet and overlap and where several significant faults occur. In addition, various authorities present a variety of theories regarding the origin of coastal British Columbia.

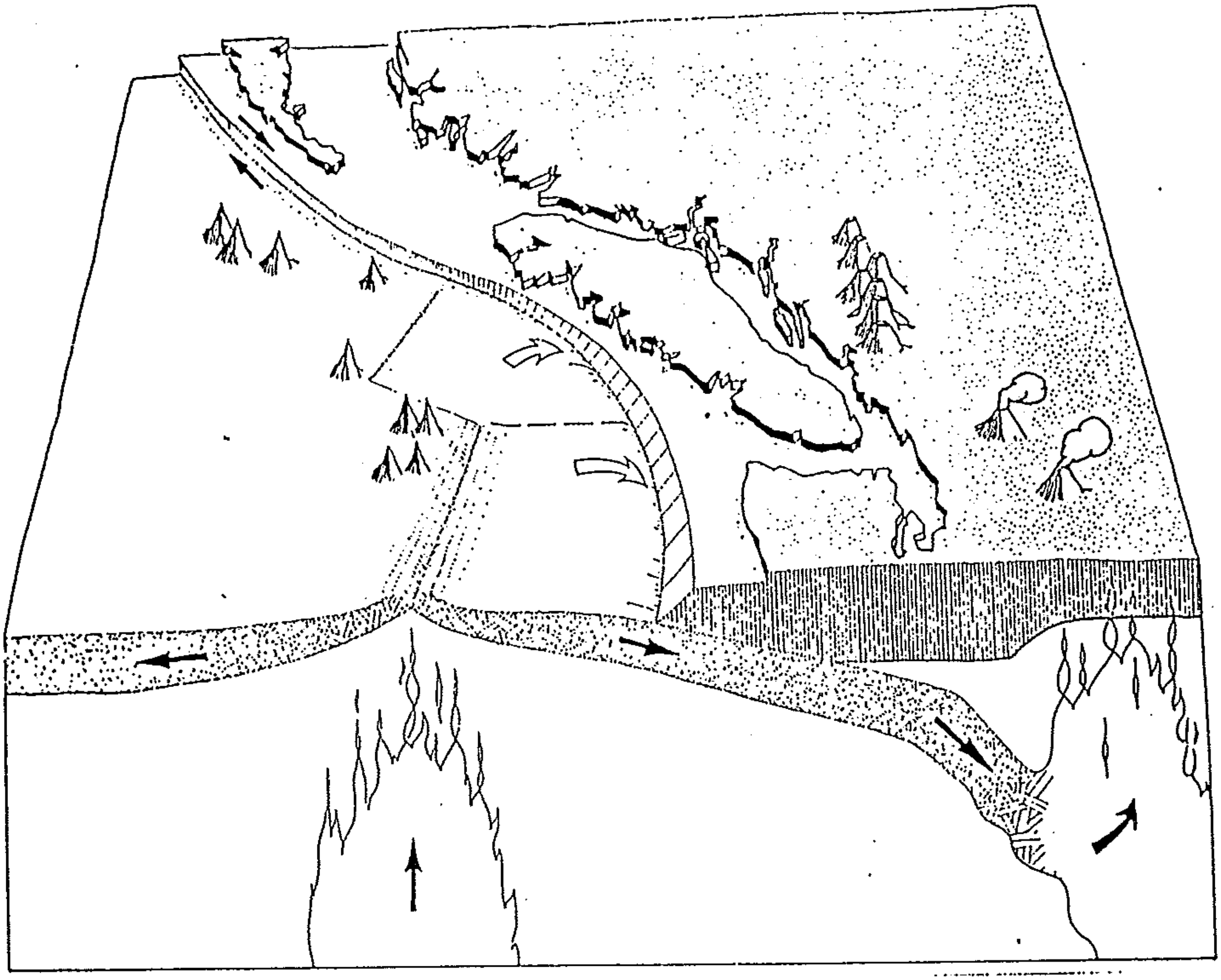
Most of what is known of as British Columbia did not exist before the Jurassic Period approximately 155 million years ago. Holland (1964) suggests that much of the orogeny (mountain building) that led to the development of the province's mountain ranges took place between the early Jurassic (155 million years ago) and the Lower Cretaceous (70 million years ago). These mountains experienced extreme deformation both during and after their formation including folding, faulting and volcanism as well as millions of years of erosion and glaciation.

Muller (1975) suggests an even more complex geologic history for southern Vancouver Island. The region features a mixture of Paleozoic, Mesozoic and Tertiary rocks of all types (igneous, sedimentary and metamorphic).

The general process by which the Insular Mountains of Vancouver Island might have been formed is portrayed by Figure 2.2. The Juan de Fuca Ridge which lies parallel off the coast southward from the Queen Charlotte Islands is a craggy mountain range lying 2 000 meters below the Pacific Ocean. The centre of this ridge is like a crack which separates two of the earth's crustal plates. The two plates are moving apart and presently appear to be separating at a rate of two to six cm per year.

The eastward moving plate, the Juan de Fuca Plate, is moving towards Vancouver Island where it is deflected downwards under the North American Plate. This process is referred to as subduction. Presently, the Juan de Fuca Ridge System and associated faults form Canada's most active earthquake zone.

This process of subduction appears to have been a factor in the early formation of the Insular Mountains. In the late Cretaceous between 65 and 95 million years ago the ocean floor was driven beneath the continent's western margin probably resulting in the formation of the Coast Mountains, Georgia Depression and the Insular Mountains.



A diagramatic section of Recent Cordilleran plate interactions off Canada's west coast.(from R.P. Riddihough and L.G. Carnes, Victoria Geophysical Observatory, September 1976 unpublished). The cones on the left of the spreading ridges are seamounts (volcanic cones). Arrows indicate vector movement and the smaller arrow on the less extensive Explorer plate signifies relatively slower subduction; hence the Garibaldi volcanoes are not as active as the Cascade arc. (Riddihough, personal communication 1976).

Figure 2.2 PLATE INTERACTIONS OFF CANADA'S WEST COAST
(from Inselber, 1976)

NAMES OF PLATES

Table 2.1 GEOLOGIC TIME CHART

ERAS	PERIODS	TIME STARTED (millions of years ago	FEATURES
CENOZOIC	QUATERNARY	1+	Successive ice ages cover southern Vancouver Island Development of modern man
	TERTIARY	60	Peak development of mammals; Leech River Fault
MESOZOIC	CRETACEOUS	120	Formation of Insular Mtns Extinction of dinosaurs Leech River Formations ? Development of B.C. Mtns
	JURASSIC	155	Age of Dinosaurs First birds Bonanza Volcanics
	TRIASSIC	190	Appearance of Dinosaurs
PALEOZOIC	PERMIAN	215	Development of reptiles
	CARBONIFEROUS	300	Major coal formations and fossil fuels
	DEVONIAN	350	Age of fishes First amphibians
	SILURIAN	390	First terrestrial life forms
	ORDOVICIAN	480	Primitive fishes
	CAMBRIAN	550	Abundant invertebrates
PRE-CAMBRIAN		2000+	Earliest known rocks

These uplifted rocks appear to have had a complex origin as far back as the Paleozoic Era several hundred million years ago. The original rocks appear to have formed from a complex of ocean sediments and volcanic formations laid down on the ocean's floor. A variety of sedimentary and volcanic sequences were laid down one on the other between the early Paleozoic and late Jurassic about 155 million years ago.

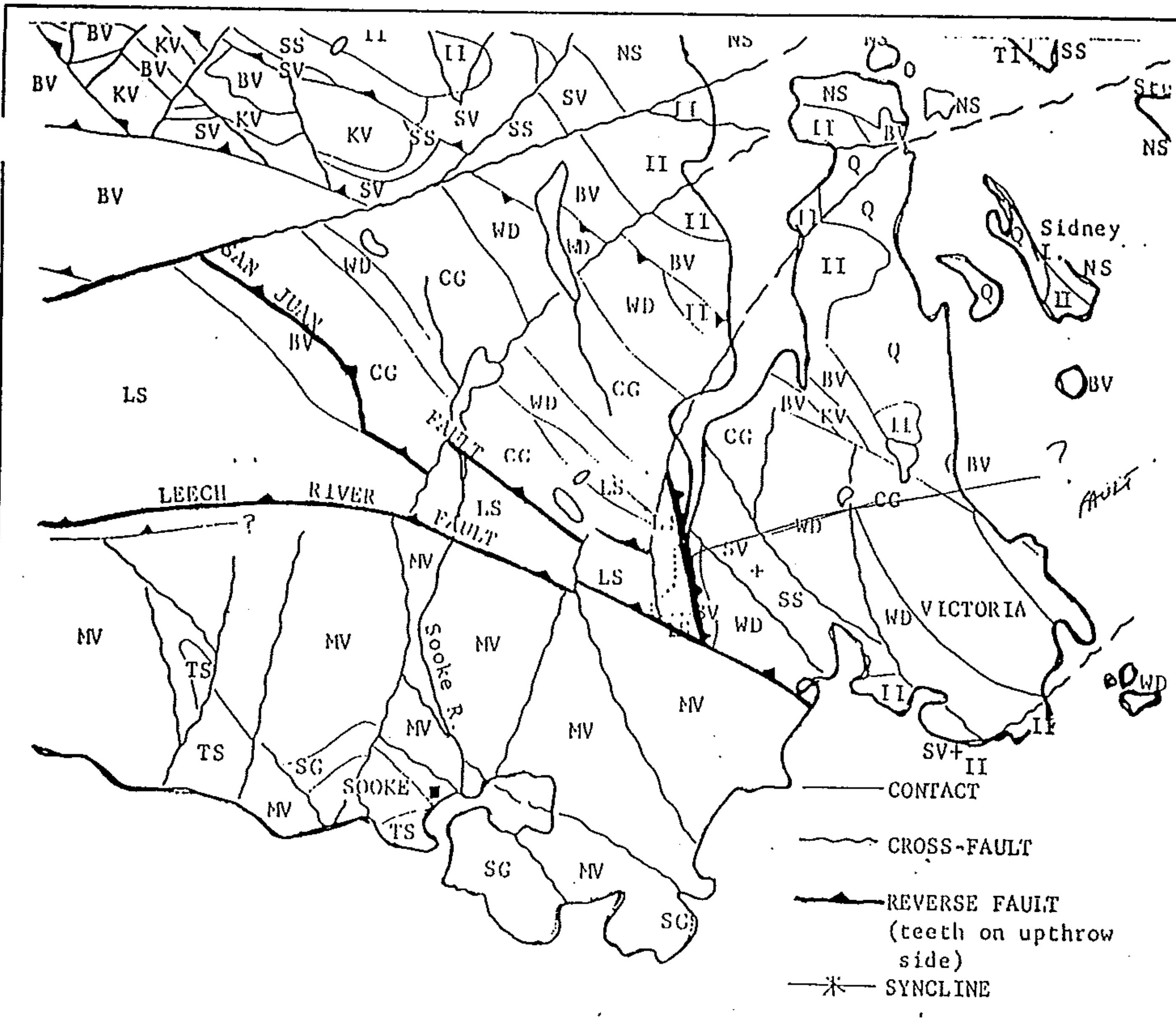
Near Goldstream Park several faults occur. The Leech River Fault is a significant east-west structure of southern Vancouver Island which crosses Goldstream Park and contains the eastward flowing portion of the Goldstream River. A tributary fault, the San Juan Fault also crosses the park in a southerly direction more or less following the axis of the south end of Finlayson Arm and lower Goldstream River, (see Figure 2.3).

North of the Leech River Fault mainly Mesozoic and Paleozoic rocks are found as described above. South of the fault however, younger Tertiary rocks, mainly volcanics, occur which extend southward into California.

During the tertiary from about 12 to 60 million years ago the uplifted surfaces were extensively eroded mainly by surface water action. This resulted in the current general outline and contours of the region's landscape which were further modified by the Pleistocene ice advances during the last few million years.

2.3 ROCK FORMATIONS

In addition to the complicated geologic history, the description of rocks in the vicinity of Goldstream Park vary somewhat from one source to another. Muller (1975) describes and classifies the rocks of southern Vancouver Island of which two types have general distribution in and around the park: (1) the Leech River Sediments and (2) the Bonanza Volcanics.



SG	SOOKE GABBRO	Q	QUATERNARY	CENOZOIC
MV	METCHOSIN VOLC'S	TS	SOOKE SED'S	
LS	LEECH RIVER SED'S	NS	NANAIMO SED'S	LATER MESOZOIC
II	ISLAND INTR'S	BV	BONANZA VOLC'S	EARLIER MESOZOIC
TI	TYEE INTR'S	KV	KARMUTSEN VOLC'S	
CG	COLQUITZ GNEISS	SS	SICKER SED'S	PALEOZOIC
WD	WARK DIORITE	SV	SICKER VOLC'S	

Kilometres 0 5 10   Miles 0 5 10   .... Goldstream Park

A portion of the Victoria Map-area (92B) bedrock geology map.

(modified from Muller 1975 and Muller 1976 (personal communication))

Figure 2.3 BEDROCK GEOLOGY

(from Inselberg, 1976)

2.3.1 The Leech River Sediments

The Leech River Sediments (or Leech River Schists) have widespread distribution in Goldstream Park. They are described as turbiditic graywacke-argellite sequences that have been metamorphized to schist and slate. They are derived from sediments deposited on the ocean floor up to 300 million years ago, were mixed with volcanic depositions and metamorphized by pressure. Schists are finely crystallized rocks in thin layers or leaves. A major characteristic is their prominent bedding and cleavage. The Leech River Schists are quite flaky, poorly joined and friable. The schists are prominent along road cuts in the park.

2.3.2 The Bonanza Volcanics

Another common rock type of Goldstream Park are the Bonanza Volcanics (apparently referred to as Malahat Volcanics by some authors). These rocks are derived from massive volcanic tuffs and flows originating in the early Jurassic. They tend to be dark greens or maroons on fresh surfaces which weather to pale or whitish hues. These volcanics include a variety of rock types including argillites, cherts and feldspars.

The schists and volcanics have been pressed together, folded and metamorphized into minor mineral occurrences such as quartz and calcite veins. This has been the basis of minor gold and copper mining activities in the vicinity of Goldstream Park in the late 1800's and early 1900's.

2.4 GEOLOGIC NATURAL HISTORY THEMES

The Goldstream River upstream from the campsite lies in the Leech River Fault. This is a major east-west trending fault were two major rock types have been thrust together. The estuary and lower Goldstream River lie in the San Juan Fault.

Schists - distinctively layered rocks are commonly observed along road cuts and along the railway grade.

Schistose Sandstone - is found along the highway near its junction with the north road access to the campground.

Ribbon Chert Rock - is exposed at the base of two hydro line towers near the highway, 2.25 km north of Niagara Creek.

Amygdaloidal Basalt - rocks with gas-filled cavities are located in the highway cut near the Hall's Boathouse access road.

Intermediate Volcanic Rock - clastic (fragmented) andesite and schistose rocks are found on the northwestern flanks of Mount Finlayson adjacent to the road.

Schistose Volcanic Rock (originally andesite) - found along the campsite access road near the crossing of the hydro transmission lines.

Minor Gold Veins - in the shafts at the "Mystery Mine" south of Niagara Creek; another gold vein has been reported near the campground road bridge.

Copper Deposit - accompanied by some gold and silver at the Mount Skirt-Phair mine shafts southeast of the gravel pit.

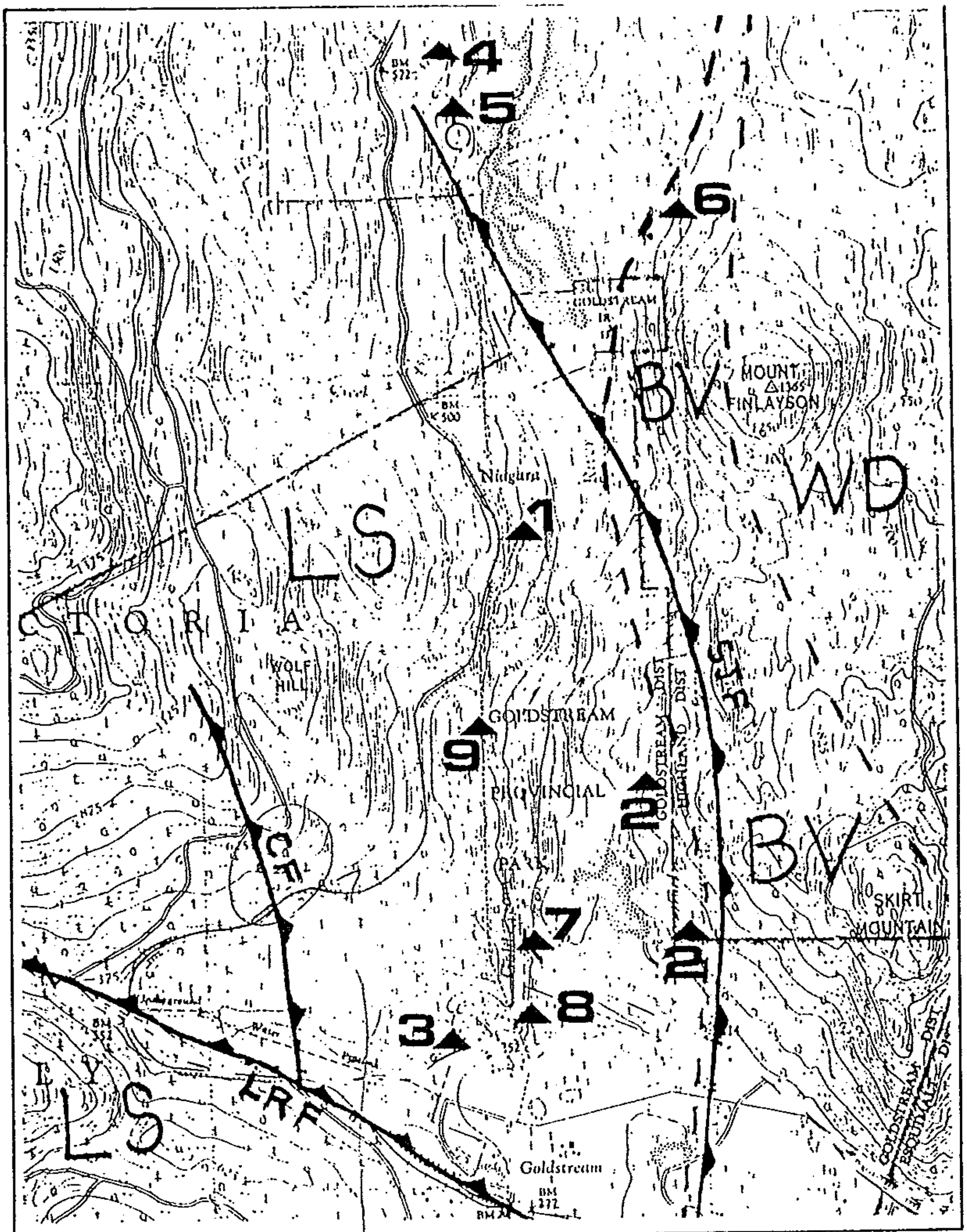


Figure 2.4 LOCATION OF GEOLOGIC FEATURES (adapted from Inselberg, 1976)

LRF = Leech River Fault; SJF = San Juan Fault; CR = Cross Fault

LS = Leech River Sedim; BV = Bonanza Volcanics; WD = Wark Diorite

1 = Mystery Mine, minor gold vein, one adit 17 meters, 1 shaft 9 meters
2 = Mount Skirt-Phair Mine, copper, some gold & silver, 2 adits, 2 shafts
3 = Minor Gold Vein, obscure mine, location estimated, near bridge?
4 = Ribbon Chert, at base of two hydro line towers
5 = Amygdaloidal, gas-filled cavities in basalt at highway cut
6 = Clastic (fragmented) andesite and schistose volcanics
7 = Deformed schistose volcanics
8 = Schistose volcanics, originally andesite
9 = Limestone suspected due to high calcium levels in water

ALL LOCATIONS ARE APPROXIMATE OR ESTIMATED

2.5 PLEISTOCENE ICE AGE

2.5.1 Introduction

Ice ages have occurred at numerous intervals throughout geologic time. However, because of the geologic evidence, we are most familiar with the recent glaciations of the Pleistocene (Ice Age) Epoch which took place over the last one to two million years and coincided with the development of modern man (see Table 2.2).

In North America, the Pleistocene Epoch was comprised of five major glaciations separated by four interglacial intervals. The glaciations are related to major climatic changes. However, the causes for climatic change are poorly understood.

A large number of authorities and sources have summarized the sequences of Pleistocene glaciations using varying terminology and theories. The following account is based primarily upon a recent description of the Pleistocene Epoch by Howes (personal communication).

2.5.2 Phases Of Glacial Advance

Each of the five main glaciations of the Pleistocene had four stages:

(1) Alpine Phase - Small valley glaciers and ice fields developed at an early stage at high elevations such as in the Vancouver Island Mountains as the climate began to cool.

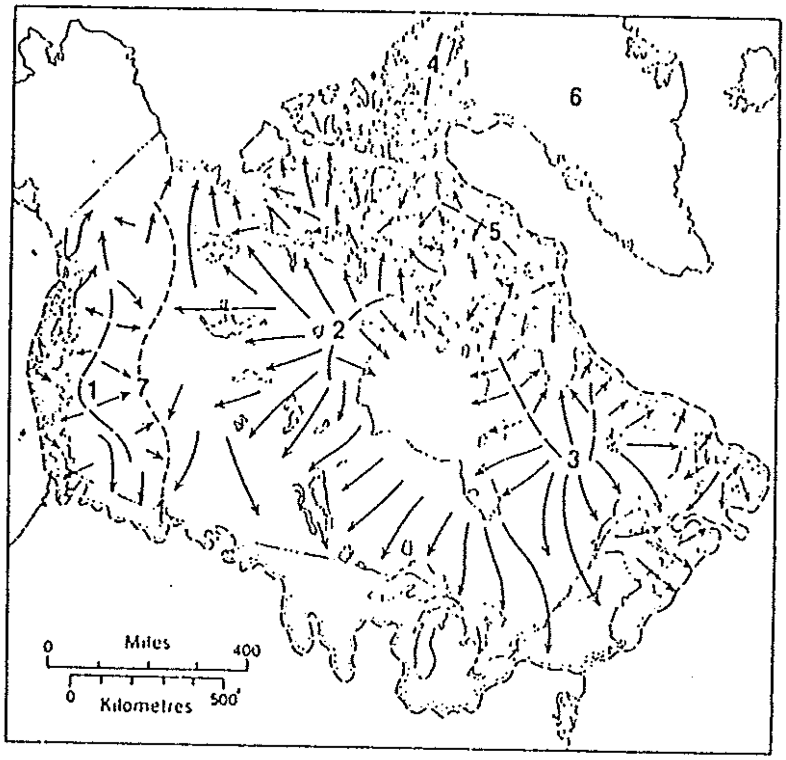
(2) Intense Alpine Phase - The high elevation glaciers grew and expanded into adjacent valleys to form trunk glaciers.

(3) Mountain-ice-sheet Phase - The glaciers flowed out of the mountain valleys and developed extensive piedmont (base of mountain) glaciers along the flanks of the mountains. During this phase, glaciers flowing eastward off Vancouver Island coalesced with valley glaciers flowing westward off the Coast Mountains. One lobe of this ice flowed north along Queen Charlotte Strait adjacent to northern Vancouver Island. Along southern Vancouver island a second lobe flowed south along the Strait of Georgia. This latter lobe split in two near southeastern Vancouver Island, one portion continuing southward into Puget Sound, another portion flowing west-northwestward along Juan de Fuca Strait.

(4) Continental Ice Sheet Phase - This phase occurred when the ice thickened to such an extent that ice flow became independent of topography. The continental ice sheet over-road most, if not all, the mountains of Vancouver Island and flowed southwesterly across southern Vancouver Island.

The earliest glaciations of the Pleistocene appeared to have been extensive and rounded even the highest hills. They formed many of the basins now occupied by lakes and contributed to the creation of fiords such as Finlayson Arm.

The successive glaciations resulted in the deposition of several layers of glacial and non-glacial materials. Many of the earlier deposits were completely covered by subsequent glaciations or eroded away during interglacial intervals. Consequently, our knowledge is limited about the earliest ice advances. Research and radio-carbon dating or organic remains have allowed for the general description of the three most recent glaciations.



Greatest extent of glaciation of North America during the last ice age. The ice spread outward from six "ice ridges" numbered as follows:

1. Cordilleran
2. Keewatin
3. Labrador
4. Queen Elizabeth Islands
5. Baffin
6. Greenland
7. The dashed line indicates the approximate juncture of Cordilleran and Keewatin ice. An unnumbered ice-centre existed in the Appalachian region.

(from Lang and Muller, 1975)

Figure 2.5 EXTENT OF THE MOST RECENT GLACIATION
(from Inselberg, 1976)

Table 2.2 QUATERNARY TIME PERIOD

PERIOD	EPOCH	GENERAL ICE AGE NAMES	LOCAL ICE AGE NAMES
QUATERNARY	RECENT	Post Glacial	Post Glacial
	PLEISTOCENE	Late Wisconsin	Fraser Glaciation
		Mid. Wisconsin	Olympia Non-glacial Interval
		Early Wisconsin	Semiahmoo Glaciation
		Sangomon Interglacial	Puyallip Interglacial
		Illinoian Glaciation	Stuck Glaciation
		Yarmouth Interglacial	
		Kansas Glaciation	
		Aftonian Interglacial	
		Nebraskan Glaciation	
TERTIARY	PLIOCENE	Pre Glacial	
	MIOCENE		
	OLIGOCENE		
	EOCENE		

2.5.3 Earlier Glaciations

The Stuck Glaciation is the local parallel to the continental Illinoian Glaciation, the third Pleistocene ice advance. The occurrence of moraine materials (till) at exposed cliffs at Muir Point and Cordova Bay is evidence of this glaciation. Little else is known about it.

Gravels, bog and marine sediments overlaying the Stuck tills indicate an interglacial interval locally referred as the Puyallup Interglacial. Plant remains in these deposits suggest that the climate was probably similar to that at present. This interglacial period occurred during the continental Sangomon Interglacial.

During Early Wisconsin Time till deposits were laid down which are associated with the locally named Semiahmoo Glaciation. This was followed by another non-glacial interval of Middle Wisconsin age between about 60,000 and 29,000 years ago, the Olympia Non-glacial Interval. During this time, glaciers were confined to the mountains and the climate was similar, or, at times, cooler than at present. Saanich Peninsula was completely free of ice and was probably partly submerged below sea level during this interglacial period.

2.5.4 Fraser Glaciation

The most recent glaciation was the Fraser Glaciation which occurred during Late Wisconsin Time and began about 29,000 years ago. Being the most recent ice advance it has left the greatest impact on the landscape and is the best understood glaciation. In fact, geologists have subdivided the Fraser Glaciation into a number of subdivisions called Stades which denote relatively minor expansions and contractions of the ice at intervals of a few thousand years each. However, these subdivisions are somewhat speculative and do not contribute greatly to a general person's appreciation of the Fraser Glaciation. As well, the literature (such as Inselberg, 1976) provides extensive description of local glacial advances such as the so-called Cowichan Tongue and its effect upon depositions in the Goldstream to Colwood areas. Howes (personal communication) discounts the importance of this and accounts for the depositions more as a general result of Fraser Glaciation ice.

During the early stages of the Fraser Glaciation the ice began to move south along the Strait of Georgia - the Mountain-ice-sheet Phase. Meltwater from this advancing ice resulted in the deposition of sands and some gravels which are now exposed at several locations such as Quadra Island, Comox, Parksville and James and Sidney islands. These depositions probably took place between about 17,000 and 28,000 years ago and are now referred to as the Quadra Sands.

These sands formed a large floodplain possibly connecting southern Vancouver Island with the mainland. This allowed animals such as the Imperial mammoth, mastodon, muskox, horse and bison to cross the Strait of Georgia and accounts for their bones being found in gravel deposits in the Victoria area.

By about 15,000 years ago most of Vancouver Island was covered by ice representing the Continental Ice Sheet Phase. At Victoria the ice was 1,500 meters thick. This sheet of ice appears to have carved out basins resulting in certain modern water bodies such as Thetis Lake. The ice deposited till which is found in deposits up to 30 meters deep in the region. Most of our soils are derived from transplanted materials such as the underlying tills or glacio-fluvial deposits associated with the Fraser Glaciation.

Deglaciation began prior to 13,000 years ago and by 10,000 years ago the glaciers had retreated to positions in the mountains similar to what they have today. The post-glacial warming trend appears to have peaked about 5,000 years ago suggesting that we are possibly in another Pleistocene interglacial period at present.

2.5.5 Post-glacial Depositions

As the Fraser Glaciation ice melted a major glacio-fluvial delta was built up over the Colwood area. There is good evidence that a major stream drained southward through Saanich Inlet and the Goldstream Valley and entered the ocean over the Colwood and Langford areas to create massive gravel deposits as evidenced by the major gravel operations there today.

As the ice was melting, the sea level rose and much of what is now Saanich, Colwood and Langford was invaded by the sea. A major lobe of ice to the north was melting and drained south through the Goldstream Valley. The deltaic gravels resulted from the meltwater stream discharging into the ocean at various locations south of the Goldstream Park area.

Marine clay depositions throughout the region also attest to this invasion of the sea. At its maximum, the sea level was as high as the current topography's 75 meter level. During this period, large melting ice blocks were left scattered at isolated locations on the Colwood Delta. Gravels and sands were deposited around the margins of the ice blocks then, when the blocks melted, kettle holes and depressions were left in the landscape. Glen, Florence and Langford lakes and Esquimalt Lagoon are legacies of this process. At later stages, the meltwater stream draining south through Goldstream Park became smaller while the surface of the delta rose in relation to the sea. Meltwater channels were then cut into the surface of the delta which now occur as distinct, sinuous channels south of Langford Lake.

2.5.6 Sea Level Adjustments

While the sea level rose because of the release of vast volumes of water from the waning continental ice sheets, the land's surface also began to rise. The great weight of the continental ice had depressed the land which rebounded shortly after the ice melted. This elevated major marine features such as the Colwood Delta. Fluvial action and water erosion were accelerated as the land was uplifted and streams such as the Goldstream River down-cut through glacio-fluvial and till deposits.

The differential rates of the sea level and the land both rising resulted in an early invasion of the sea over the land then a period between 5,000 and 9,000 years ago when the sea level was up to 11 meters lower relative to the land than at present. During the last 5,000 years the sea level has again been rising slowly relative to the land's surface as suggested by the fact that several archaeological sites in the region are now under water or in the intertidal zone.

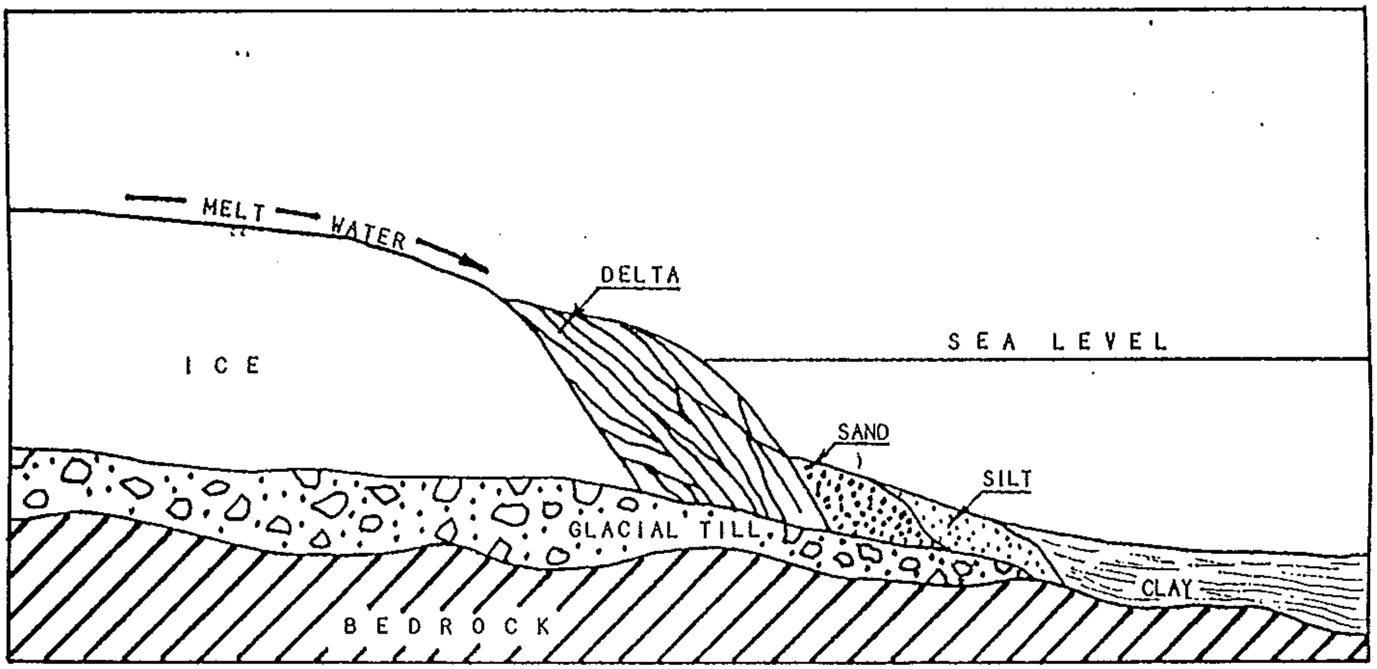
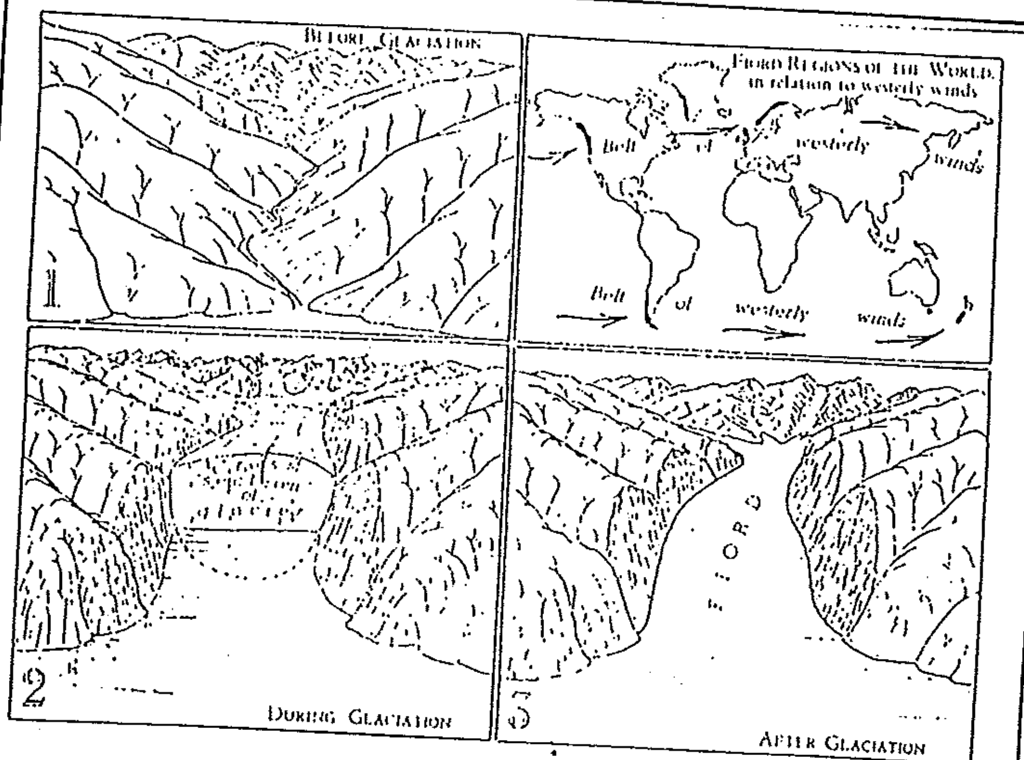


Figure 2.6 ORIGIN OF GLACIAL DEPOSITS

AS THE GLACIAL FRONT ADVANCES MATERIAL UNDERLAYING THE ICE IS ABRADED, PLUCKED AND CARRIED SHORT DISTANCES BY THE ICE. WHEN REDEPOSITED UNDER THE MOVING ICE IT IS CALLED GROUND MORAINE OR GLACIAL TILL, A HETEROGENOUS MIXTURE OF MATERIALS INCLUDING SILTS, SANDS, ANGULAR ROCKS AND BOULDERS. THE DELTA IS FORMED AS WASHED MATERIALS ARE CARRIED AND SORTED BY THE MELTING ICE WATERS INTO A LAKE OR THE OCEAN RESULTING IN STRATIFIED MATERIALS, USUALLY GRAVELS OR SANDS. SAND AND SILT DEPOSITS MAY FORM AT THE EDGE OF THE DELTA WHILE FINE TEXTURED PARTICLES, OFTEN CLAYS, SETTLE OUT OF THE LARGE WATER BODY.



Fiords occur where normal valleys, as shown in diagram 1, were deepended and straightened by erosion caused by large tongues of ice that spread from an ice cap during the last ice age, and extended as far as the coast. Sea water entered the valley after the ice melted. Fiords are most common along west coasts, where belts of westerly winds caused heavy precipitation and larger glaciers (from Lang and Muller, 1975).

Figure 2.7 FIORD FORMATION
(from Inselburg, 1976)

As the Pleistocene came to a close it is theorized that people moved into the Puget Sound and southern Vancouver Island area about 7,000 to 8,000 years ago from southern portions of the continent which had remained ice-free.

2.5.7 Pleistocene Natural History Themes

Goldstream Park and nearby areas are very rich in Pleistocene Ice Age natural history themes.

Mount Finlayson - Roche Moutonnee profile of the mountain shows evidence of major continental and piedmont ice erosion. The west slope of the mountain which is prominently visible from the estuary area shows dramatic evidence of glacial erosion.

Mount Finlayson - Eratics - Conglomerate boulders originating from locations in the Gulf Islands were deposited by ice on Mount Finlayson.

Basal Till (Moraine) - Till can be observed near the confluence of Waugh Creek and the Goldstream River. The till is distinguished by its being composed of unsorted material - silt, sand, stones and angular rocks - as opposed to materials such as sorted gravels which tend to be uniform in character.

U-Shaped Valley and Fiord - Finlayson Arm and the Goldstream Valley are probably structural in origin but ice erosion evidently steepened, deepened, broadened and rounded these depressions into classic U-shaped valleys. Saanich Inlet-Finlayson Arm represents the only fiord on the southeast side of Vancouver Island. It is 24 km long, between 0.5 and 4 km wide and has an average depth of 120 meters

Hanging Valley - Niagara Creek above Niagara Falls represents a hanging valley partially accounted for by ice erosion deepening the Goldstream Valley relative to the tributary valley of Niagara Creek.

Deltaic Deposits - Extensive gravel deposits south of Goldstream Park are evidence of a large glacio-fluvial delta where a major stream of glacial meltwater entered the ocean.

Outwash Deposits - gravel deposits in Goldstream Park which are readily observed at the gravel pit are evidence of outwash and meltwater deposits left by waning ice.

Meltwater Channels - Large meltwater channels south of Langford Lake are readily observed from the railway right-of-way. A smaller meltwater channel is suggested by the occurrence of large boulders along a small stream just up from the campsite at the south end of the Arbutus Trail.

2.6 SOILS

2.6.1 Soil Development

Soil landscapes in British Columbia are, for the most part, geologically young. It is important to appreciate that soils are an evolving feature subject to the constant actions of chemical, physical and biologic processes. Soil development varies greatly from one place to another depending upon a number of factors:

(1) Parent Materials - The geology and type of material the soil originates from; this which may vary from weathered bedrock, alluvial sediments, glacial deposits to organic matter, etc.

(2) Climate - Factors such as moisture, humidity, temperature, action of ice and evaporation have a strong influence upon soil development.

(3) Topography , Landscape Position and Gravity - Different soil forming processes take place on summits vs slopes, depressions, and level terrain.

(4) Biologic Activity - Soil fauna (worms, etc.), terrestrial wildlife and plants contribute organic matter to the soil and have physical and chemical effects.

2.6.2 Soil Classification

Similar to biologists, soil specialists use classification systems to describe, organize and group different soils. Major soil groupings include Orders, Great Groups, Subgroups and Series. These groupings are loosely analogous to the biologist's terms for Order, Family, Sub-family and Species. Modern soil surveyors often map soils grouped into Soil Associations which might be roughly considered parallel to Genera. Soil Associations identify soils of about the same age, found under similar climatic conditions and derived from similar parent materials.

In British Columbia there are nine major soil groupings or Orders. Two of these soil orders - the Podzols and Brunisols - have widespread distribution on southern Vancouver Island. Soils in and around Goldstream Park are Brunisols, although the processes which develop Podzols elsewhere have modified the Goldstream Brunisols.

The Podzols are very common throughout the wetter portions of Vancouver Island. They have developed mainly on coarse textured materials where there is an abundance of water moving through the soil. Chemical and biological transformations are intense in the upper horizons (the horizontal layers of a soil profile) because of the wet mild climate. The high amounts of water tend to wash decomposed organic matter and minerals out of the top soil layers and deposit them at varying depths. Consequently, Podzols are usually distinguished by light gray upper horizons and a contrasting, reddish brown layer below it.

2.6.3 Goldstream Park Soils

Goldstream Park is situated in a climate which is comparatively drier than other portions of Vancouver Island. Brunisolic soils are characteristic of this region where there are warm, dry summers, high moisture deficits and low total annual precipitation. Physical, chemical and biologic weathering is relatively less than for the Podzols. The Brunisols, acting somewhat like immature Podzols, have retained a brownish colour in their upper horizons. The Brunisols tend to be less acidic and have a higher base saturation than the Podzols and are therefore potentially more fertile. In Goldstream Park the coarse textured parent materials have also restricted soil development. The low levels of clay particles in the soil result in lower rates of chemical transformations.

Two subgroups of Brunisols are found in Goldstream Park: Orthic Dystric Brunisols and Duric Dystric Brunisols. Generally, both types are characterised by a thin organic layer on the surface, a pH of 5.5 or lower and a moderate to high base saturation percentage. The Duric Dystric Brunisol type suggests that a mild form of Podzolization occurs in the form of a cemented layer at 50 to 100 cm depth, the result of some leaching from the upper horizons. These "Duric" soils are found on the slopes to the west of the valley suggesting a somewhat greater amount of water and finer textures in the parent material.

2.6.4 Soil Associations

Soil maps prepared by Jungen (1985) indicate elements of nine soil associations occurring in and around Goldstream Park (see Figure 2.8).

CHEMAINUS RIVER AND GENOA BAY SOIL ASSOCIATIONS

The floodplain of the Goldstream River downstream from the Finlayson Road Bridge is mainly comprised of soils of the Chemainus River Association with smaller elements of the Genoa Bay Association. These two associations have developed on low lying, gently sloping, deep fluvial deposits which are subject to varying degrees of periodic flooding. The dominant Chemainus River Association features medium soil textures such as silty to fine sandy loams which are well to imperfectly drained. They tend to be dark yellowish brown to olive brown in colour. The smaller areas of Genoa Bay soils are found on coarse textured gravels which are rapidly drained. They tend to be light yellowish brown to pale brown in colour. Both soils are occupied by the Swordfern, Red Alder-Salmonberry, Skunk Cabbage and Common Scouring-rush plant communities described by Inselberg (1976).

QUAMICHAN AND QUALICUM SOIL ASSOCIATIONS

These two soil associations have developed on the deep, sandy gravelly fluvial and glacio-fluvial deposits along the Goldstream River and on the ice age delta extending to Langford Lake. These are rapidly drained, coarse to very coarse textured soils found on level to gently sloping terrain. They are strongly acidic and tend to be light yellowish brown in colour. An interesting feature of the Quamichan and Qualicum soils is their tendacy to have Podzol-like characteristics such as their relatively pale colour and cemented horizon at 50 to 90 cm depth. These soils are the major sites for the Douglas fir-Salal plant communities.

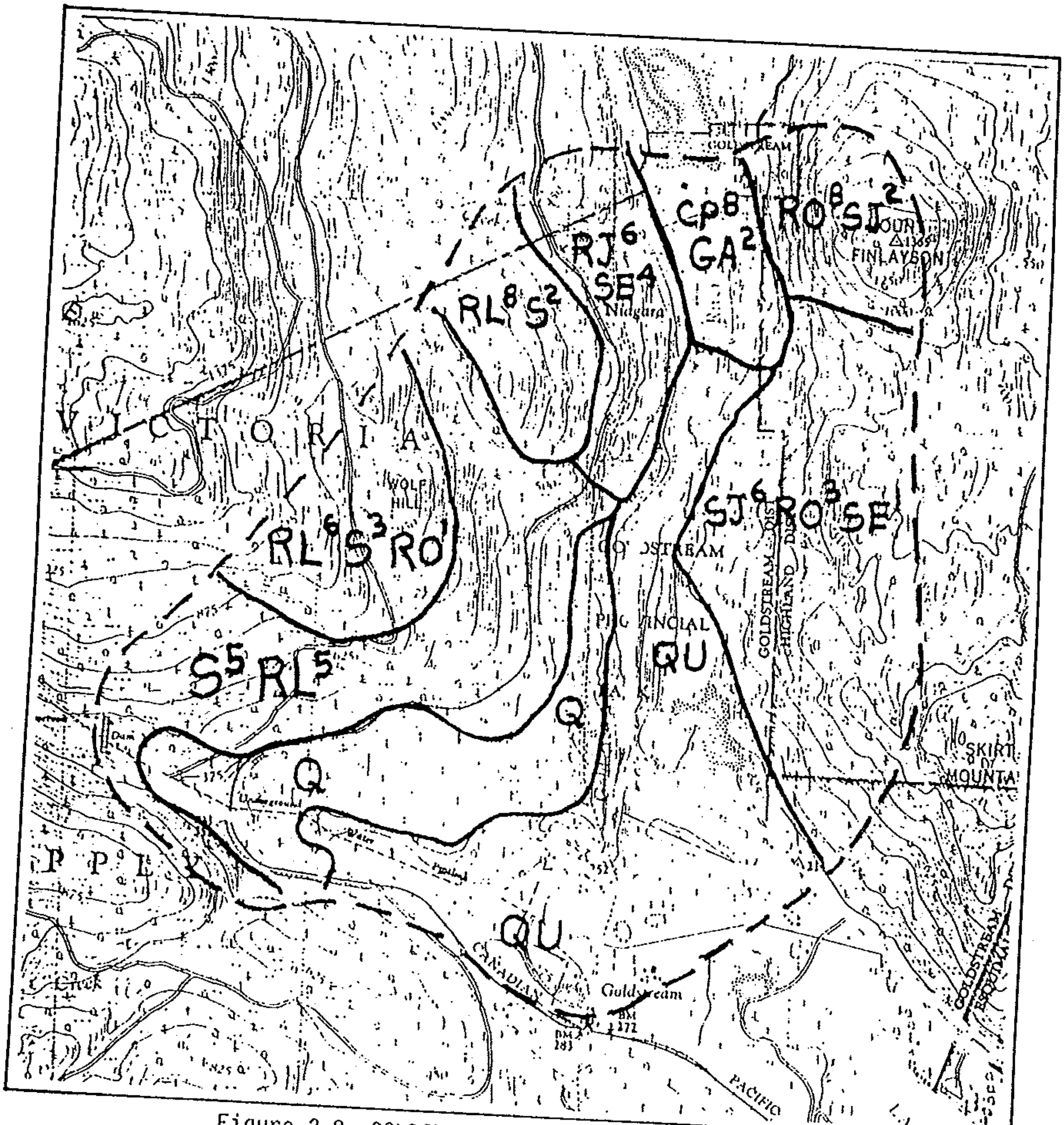


Figure 2.8 GOLDSTREAM SOIL ASSOCIATIONS

(after Jungen, 1985)

CP	Chemainus River
GA	Genoa Bay
Q	Qualicum
QU	Quamichan
S	Shawnigan
SE	Somenos
SJ	Sprucebark
RJ	Ragbark
RL	Rosewall
RO	Rock Outcrop

Numerals refer to proportions of a soil association occurring in a map unit; i.e. CP8 GA2 refers to a unit comprised of 80% CP and 20% GA soil associations.

SHAWNIGAN AND SOMENOS SOIL ASSOCIATIONS

The Shawnigan and Somenos soil have developed on the deeper, coarse textured morainal deposits found scattered throughout the hilly upland terrain mainly north and west of the Goldstream River. These soils are well drained, strongly acidic and comparatively deep. Cobbles and boulders are common and topography varies from undulating to slopes of 50%. They are dark yellowish brown to yellowish brown in colour and feature a strongly cemented layer at 70 to 110 cm depth indicating some Podzol-like characteristics. The Shawnigan and Somenos soil associations support the wetter elements of the Madrona-Douglas fir plant community and the drier elements of the Douglas fir-Salal plant community.

SPRUCEBARK, RAYBARK AND ROSEWALL SOIL ASSOCIATIONS

These three soil associations have developed on shallow, coarse textured colluvial and morainal deposits. A distinct characteristic is their shallow nature being less than one meter deep over bedrock. Topography is often irregular and slopes vary upward to 100%. These soils are stongly acid, rapidly drained and tend to be yellowish brown in colour. They are common to the mountainous terrain adjacent to Goldstream Park, especially towards the east. Plant communities supported by these shallow soils mainly include the Madrona-Douglas fir and Fescue-Dogtail communities.

2.6.5 Soil Natural History Themes

The brownish to yellowish coloured soils found throughout Goldstream Park are diagnostic of Brunisolic soils. Soil profiles are difficult to observe without significant disturbance such as digging a soil pit. Soil profiles are revealed along road and railway cuts but must be excavated to reveal the profiles which are usually covered by eroding materials falling downward over the cut.

3. CLIMATE

3.1 CLIMATIC CHANGE

The recent geologic record suggests that climates in the northern hemisphere have generally experienced a warming trend since the last glaciation about 10,000 years ago. The evidence for this is relatively clear such as the waning of the last ice age and rise in sea levels on a world-wide scale. This warming trend is also reflected in pollen studies from organic deposits. At stratified levels in bogs different types of pollen occur exhibiting general changes in vegetative cover in response to climatic changes. Studies at the nearby Rithet's Bog have demonstrated this.

However, the causes for climatic change are not clearly understood. Possible causes might be related to changes in the Earth's orbit, axis or rotation, continental or ocean floor shifts, atmospheric changes or variations in the Sun's radiation.

3.2 GLOBAL CLIMATIC CONTROLS

At the global scale, a major climatic control is the fact that lower latitude tropical areas receive more heat than they loose. This is because more incomming solar radiation is absorbed than is radiated outward by the Earth at these latitudes. The opposite holds true for middle and polar latitudes. Heat is transferred northward and southward from the equatorial regions by atmospheric and oceanic circulation. Otherwise, the tropical areas would continue to heat up the extremely high temperatures while the poles would continue to cool to a very low level. This constant re-adjustment and circulation to maintain a heat balance throughout the word accounts for almost all the phenomena of weather and climate that we observe.

World-wide atmospheric pressure systems and the Coriolis force (the deflecting force imparted upon moving bodies by the Earth's spin) set up a general pattern of global air movement. From the equator poleward there are five major circulatory systems. In the northern hemisphere these systems are in order from the Equator: the Equatorial Doldrums, Easterly Trade Winds, High Pressure Belt (Horse Latitudes), Prevailing Westerlies and Polar Easterlies. The settled parts of Canada basically lie in the flow of the Prevailing Westerlies. Consequently, most of British Columbia's weather systems are a result of moist Pacific air masses moving from the west onto the coast.

3.3 REGIONAL CLIMATE

Goldstream Park lies within a very small climatic region which is unique to Canada. This region occupies the extreme southwestern portion of Vancouver Island, the southern Strait of Georgia and a small southwestern fringe of the Fraser Delta area. Here, the climate is considered to be a Dry Summer Mediterranean (Csb) climate after Koppen. Most of the coast of British Columbia lies in a Humid Temperate Climate (Cfb). Both climates are characterised by mild winters and relatively low variation in seasonal temperatures. The Cfb climate is noted for its high total annual precipitation. The Csb climate is distinguished by less total annual precipitation, high amounts of sunshine and by an extremely dry summer period. This region represents the most northerly extension of the Csb climate in the World.

The major factors influencing the region's climate are proximity to the Pacific Ocean, significant topographic controls and the influence of various air masses and pressure systems.

Most of the air arriving along coastal British Columbia originates in northeast Asia from where it moves southeastward towards the Pacific Ocean. At first, this air is relatively cool and dry but as it moves eastward across the ocean it picks up considerable heat and moisture. This transfer of heat and moisture is greatest in the winter which contributes to coastal British Columbia's mild, wet winters. In summer, this process is less pronounced and there is a tendency for the air masses to be cooled by cold water upwelling off our coast. In addition, low pressure storms tend to be deflected northward during the summer.

Generally, three pressure systems affect the climate of southwestern British Columbia. Two of them, the Aleutian Low and Hawaiian High are the main controls of weather in winter and summer respectively. A third system, the Polar Anticyclonic Ridge, sometimes brings unusually cold air into the region for relatively short periods of time in winter.

3.4 LOCAL CLIMATIC CHARACTERISTICS

During winter, the Aleutian Low dominates the central north Pacific. This system directs moist air onto the coast against major mountain barriers such as the Olympic and Vancouver Island Mountains. The moist air is forced to rise over the windward sides of the mountains. Cooling of the rising air promotes condensation in the form of clouds and rain which results in high amounts of precipitation on the windward slopes. Conversely, relatively dry conditions prevail on the leeward slopes and on the protected lowlands around the southern Strait of Georgia such as at Victoria.

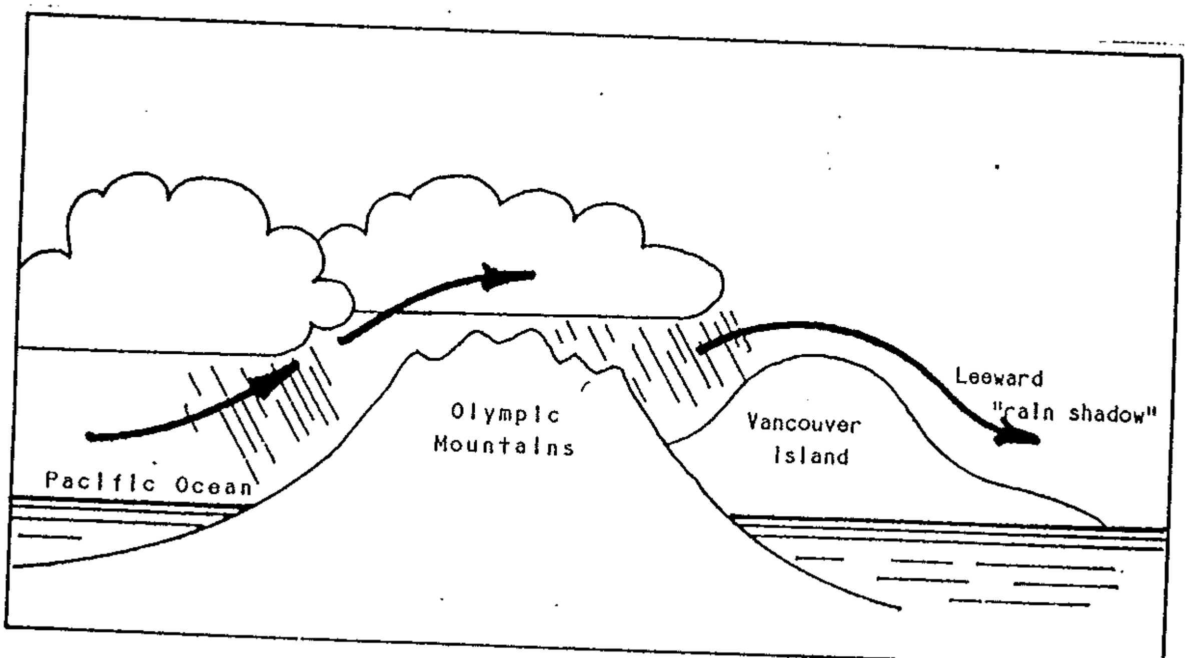


Figure 3.1 OROGRAPHIC EFFECTS OF WINTER PRECIPITIATION

The relatively mild, winter maritime air maintains comparatively high winter temperatures. Mean daily January temperatures average three to four degrees Celsius throughout the greater Victoria area while Victoria has 275 frost-free days per year, one of the highest rates in Canada. Only about five percent of total annual precipitation is in the form of snow.

Periods of persistent freezing temperatures are rare and usually of short duration. Occasionally, continental polar air spills over the Coast Mountains or through major valleys such as along the Squamish River and covers the Strait of Georgia Region. This results in comparatively cold weather and most of the snow that the region experiences. However, temperatures of less than minus ten degrees Celsius are very infrequent.

The mild winters account for a high diversity and high numbers of birds throughout the winter months. As well, numerous plants, both native species and horticultural varieties flourish in the region. In January, one can see 25 to 30 wild plants in flower throughout the greater Victoria area (Edwards, 1967).

Spring and fall in the region are mainly distinguished by a gradual transition between the wet winter and dry summer periods. Temperatures, precipitation and hours of daily sunshine progressively change each month with very little evidence of distinctive weather phenomena associated with these two seasons.

Table 3.1 CLIMATE NORMALS, VICTORIA REGION
(Environment Canada, 1982)

STATION	MEAN ANNUAL PRECIP. (mm)	MEAN ANNUAL DAYS WITH PRECIP. (mm)	MEAN DAILY JANUARY TEMP. ('C)	MEAN DAILY JULY TEMP. ('C)
Landsdowne	735.8	134	3.8	16.2
Gonzales	647.2	138	4.1	15.4
Tillicum	834.0	152	3.7	16.8
Airport	872.9	155	3.1	16.3

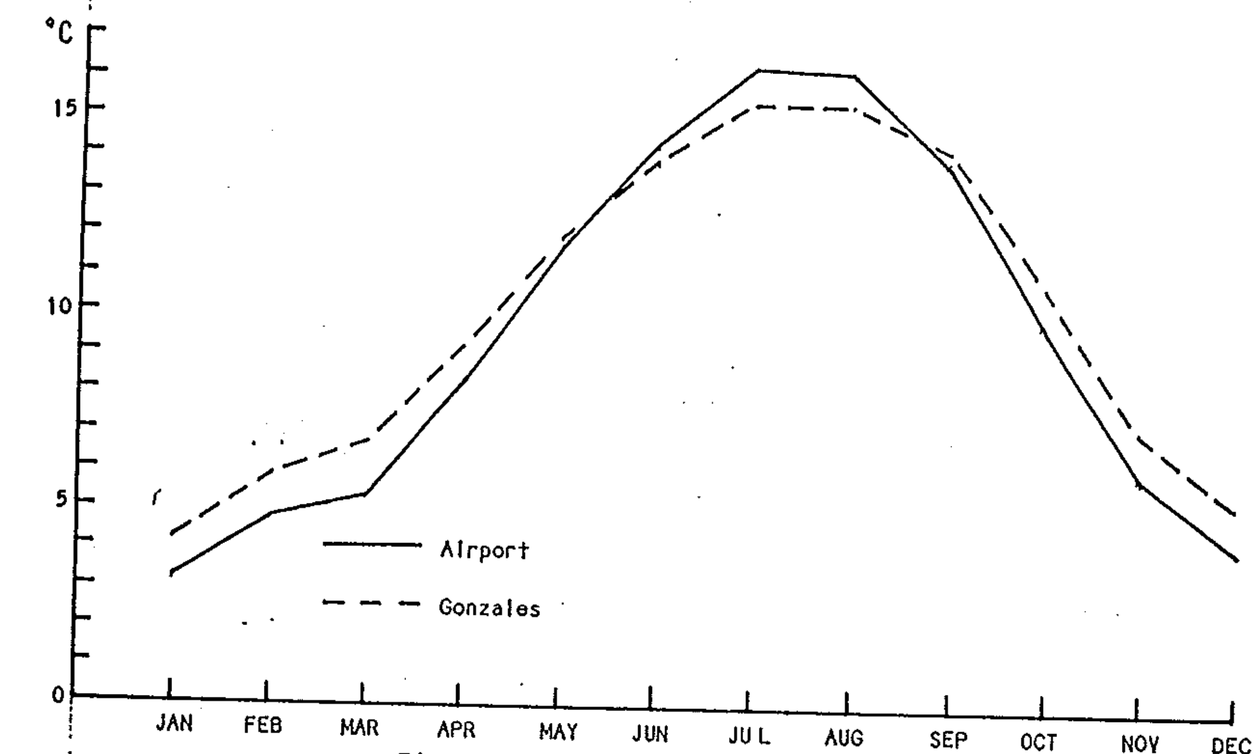


Figure 3.2 MEAN DAILY TEMPERATURE
(Environment Canada, 1982)

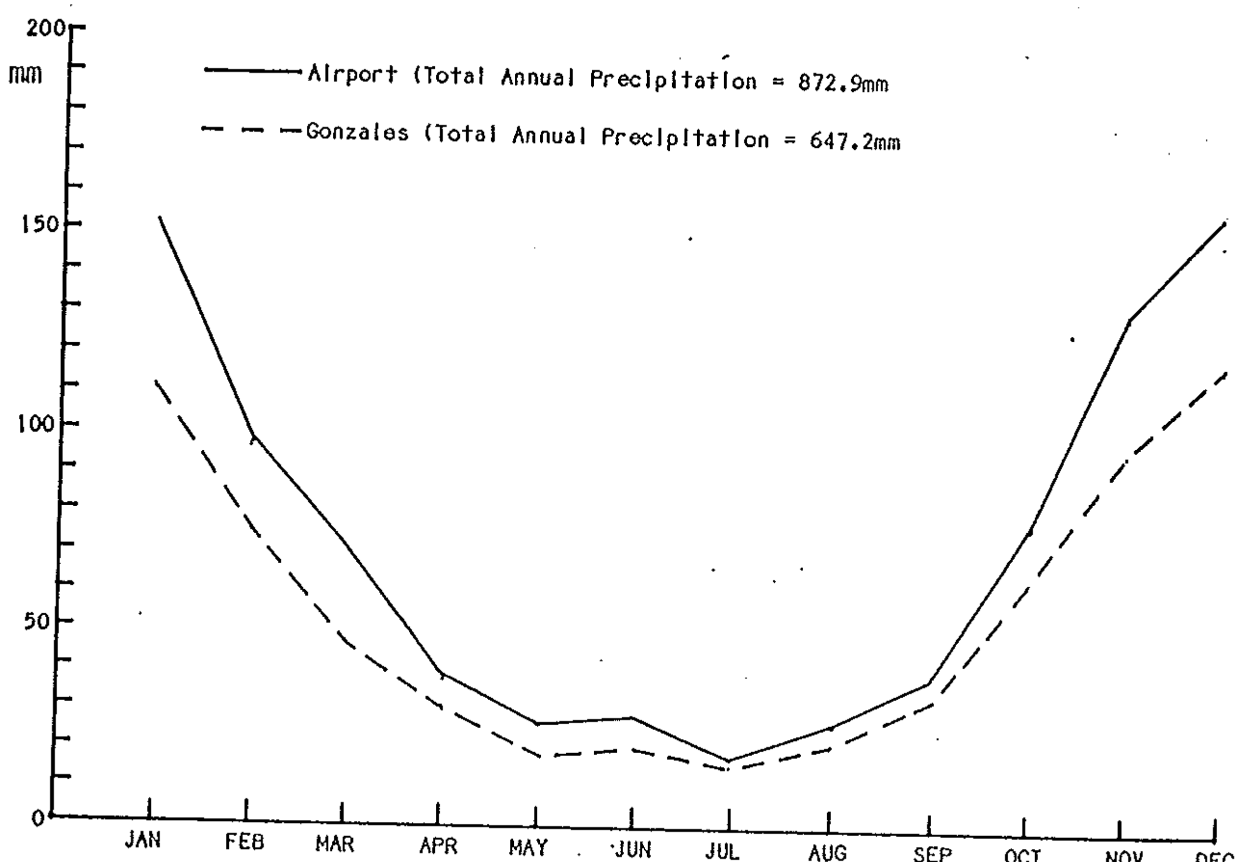


Figure 3.3 MEAN MONTHLY PRECIPITATION
(Environment Canada, 1982)

A distinct feature of the region is the almost constant presence of wind. Calm conditions prevail less than one percent of time. Several factors contribute to this. The region is exposed to the Juan de Fuca and Georgia straits and Puget Sound. This promotes diurnal land and sea breezes. As well, the waterways are flanked by major mountains which produce natural air flow channels. In winter, gale and storm force winds occasionally result from major storms moving in from the Pacific Ocean. The effects of winds are moderated in Goldstream Park. It is afforded some protection by nearby mountainous terrain and the mostly closed forest canopy limits winds on the ground.

Towards summer the Hawaiian High pressure system displaces the Aleutian Low. This results in less moist air being directed towards the coast and warm continental air may be drawn into the region from the southeast. Summer temperatures are warm but rarely hot. Mean daily temperatures of 15 to 16 degrees Celsius are common in July and August. Mean maximum daily temperatures vary between 19 and 21 degrees and extremes in excess of 30 degrees are rare.

Only about five percent of total annual precipitation occurs during July and August. May, June, July and August are all relatively dry months with mean monthly amounts of precipitation usually well below 30 mm. This represents amongst the lowest rainfall in Canada during summer months.

During most summers there is a critical moisture shortage and dangerously dry conditions are common. The occurrence of arbutus and Garry oak are indications of this seasonal moisture deficit. Competing utilization for water for domestic consumption and maintenance of salmon rearing in Goldstream River is often critical at this time of year.

The relatively dry conditions and rain shadow effect in the region results in high annual totals of sunshine. At Gonzales Hill in Victoria there are 2,207 mean hours of annual sunshine. In Canada this is second only to the southern prairies.

3.5 FLUVIAL PROCESSES AND WATER RESOURCES

3.5.1 Goldstream Watershed

The Goldstream watershed is approximately 7,000 hectares in area. It includes the tributaries Waugh, Niagara and Arbutus creeks and several lakes averaging one to two kilometers in length. Except for the minor tributaries, all the watershed is artificially controlled for domestic water use and all the larger lakes are impounded by man-made dams. Control of the water is the responsibility of the Greater Victoria Water Board.

3.5.2 Stream Erosion and Deposition

In the relatively humid climate of coastal British Columbia stream erosion is a dominant process in creating landforms. The major factors associated with water's ability to erode, transport and deposit material are:

(1) amount of precipitation,

(2) stream gradient,

(3) surface relief of the land.

Since the Pleistocene ice age, there has been considerable uplift of the land. This has greatly accelerated stream erosion. Today, all three factors - rainfall, stream gradient and surface relief - have moderate magnitude in the Goldstream drainage. Consequently, the evidence of the erosion, movement and deposition of materials is fairly evident around Goldstream Park. Most of the erosion takes place at upstream and headwater areas outside the park while much of the deposition of materials occurs along the lower reaches of the Goldstream River. Within the park, therefore, features of fluvial deposition are common.

Downstream from where the highway crosses the Goldstream River a varying pattern of stream deposition is readily observed. Within this section upstream portions feature comparatively high stream gradients and velocities. As the river approaches Finlayson Arm gradients and velocities progressively decrease. As the river slows, finer and finer particles are deposited. For instance, gravel bars are common at the Finlayson Road Bridge, coarse textured sand bars are common further downstream and silts and fine sands are deposited at the estuary. This is a general pattern. Locally, along the stream, various pools and eddies show the effect of stream velocity controlling the deposition of different sized particles.

3.5.3 Geohydraulogy of the Estuary

A major feature of Goldstream Park is the estuary at the mouth of the Goldstream River. The estuary is partly the result of fine particles settling out of the river as described above. A secondary geohydraulic factor in the development of the estuary is marine sedimentation. The relatively low gradient of the Goldstream River at its mouth has resulted in an extensive and productive estuary.

Four basic zones can be identified in the estuary:

(1) the river floodplain above the influence of the marine environment,

(2) an intermediate surgeplain featuring reversing flow of the river by tidal pressure,

(3) the marine tideplain where the dominant influence is marine water,

(4) the tidal foreshore which is found at the outer edge of the estuary.

In the course of time each zone is slowly taken over by the other as accretions from the river slowly elevate the land in a seaward direction.

A major feature of the estuary environment is the dilution of marine salinity by freshwater. This creates biologic communities and ecosystems which are partly different from both the adjacent riverine and marine environments.

The biologic productivity of the estuary is unusually high. This is a result of fine sediments and organic matter brought into the system by the river and the constant mixing of nutrients by tidal action. With rising tides nutrient rich sediments are stirred up, stagnant pools are recharged with oxygen and marine organisms are brought in followed by feeding fish. With a falling tide nutrients, decaying organic matter and living organisms are carried out to join the offshore food web. At low tide, exposed creatures attract numerous feeding birds and terrestrial animals.

Estuary environments are relatively scarce along coastal British Columbia. At the same time, they attract human development such as for industry and log handling because they are at tidewater, are flat and easy to develop. They are also favoured areas for agricultural development and are extremely important for the sustained maintenance of fin-fish industries. The fact that Goldstream Park protects the estuary therefore has especially important conservation values.

3.6 NATURAL HISTORY THEMES

3.6.1 Stream Erosion

The erosive force of water is dramatically displayed at Niagara Falls. An unusually deep depression has been carved out of the ground and bedrock by water at the base of the falls.

During rainy weather rivulets of water can be observed carrying bits of soil and organic material. The turbidity of the river also changes as its load of sediments varies because of upstream soil erosion.

Cutbanks along the river are the result of stream erosion, especially where the current is deflected towards unconsolidated materials along the edges of the river.

3.6.2 Fluvial Deposition

Materials of varying size - gravels, sands, silts, clay particles - are deposited along the Goldstream River in a progressive fashion between the Finlayson Road Bridge and the estuary.

A fluvial fan is found at the base of Niagara Creek where it joins the Goldstream River floodplain. The differential deposition of varying sized materials can be observed on the fan; coarse materials (boulders and gravels) are found nears its apex in the vicinity of the highway; finer materials (sands and silts) are found at the fan's apron in the vicinity of the Nature House.

3.6.3 Estuary Processes

Tidal action and the reversal and change in flow of the Goldstream River can be observed in the main channel downstream from the Nature House.

Fluvial and marine sediments are conspicuous along the lower Goldstream River and in the tidal channels throughout the estuary.

4.0 FLORA

4.1 BIOGEOCLIMATIC ZONE

Goldstream Park lies within the Coastal Douglas Fir Biogeoclimatic Zone. This Zone is associated with the relatively mild, dry climate in the rainshadow of the Vancouver Island and Olympic mountains. The mesic (intermediate type) climatic climax association is Douglas-fir - salal (Pseudostuga menziesii - Gaultheria shallon). Although this association is the dominant one, there is considerable variety within this zone. Arbutus and Garry oak are found throughout on drier sites. These tree species are not found elsewhere in Canada. On wetter sites western red cedar, western hemlock and bigleaf maple are common.

Two sub-zones, drier and wetter sub-zones, are recognized in the Coastal Douglas-Fir Biogeoglimatic Zone. Goldstream Park appears to lie on a transition between these two sub-zones. By definition, the drier sub-zone is characterised by 650 to 1,000 mm of mean annual precipitation while the wetter sub-zone has 1,000 to 1,500 mm precipitation. Goldstream Park probably receives slightly less than 1,000 mm based upon nearby meteorlogical records thus suggesting the drier sub-zone for the park. The occurrence of Garry oak is considered diagnostic for the drier sub-zone. However, in and around the park, Garry oak is not well developed and is mainly confined to southwesterly facing rock outcrops on the adjacent mountains.

Generally, the low elevation areas have high soil moisture and western red cedar, western hemlock, grand fir; bigleaf maple, red alder and western yew are common tree species in Goldstream Park. Here, edaphic (soil) conditions over-ride climatic factors producing vegetation patterns not normally associated with the Douglas-Fir Biogeoclimatic Zone.

Table 4.1 COASTAL DOUGLAS FIR BIOGEOCLIMATIC SUB-ZONES

SUB-ZONE	MEAN ANNUAL PRECIPITATION	PLANT ASSOCIATION
CDFa Drier Garry oak - Douglas fir Sub-zone	65-100cm	Pseudostuga menziesii Mahonia nervosa Eurhynchium oreganum
CDFb Wetter Madrona-Douglas fir Sub-zone	100-150cm	Pseudostuga menziesii Gaultheria shallon

4.2 PLANT SUCCESSION

Fire appears to be a major control of plant distribution and succession in the region. Garry oak, arbutus and Douglas-fir are shade intolerant species, they do not regenerate under shade. Therefore, agents such as fire or logging are usually required for the maintenance of these tree species. Fires on Mount Finlayson and on the slopes adjacent to the Goldstream Valley have apparently been a factor in the present occurrence of these species.

Species such as western red cedar, western hemlock and grand fir are relatively shade tolerant. Given mesic conditions and freedom from disturbance (i.e., fire) these trees will form a climax forest which may maintain itself for hundreds of years. This appears to be the case along the main valley of the Goldstream River. However, flooding adjacent to the river and windthrow create enough disturbance in certain areas to allow for a secondary successional stage of red alder and bigleaf maple at locations throughout the alluvial flats.

In summary, four broad categories of forest succession can be identified at and around Goldstream Park:

(1) Disturbed Sites - roads, railways, hydro lines, the gravel pit and around the Nature House where a history of human disturbance severely limits natural vegetative growth,

(2) Primary Succession Sites - areas were fires have maintained shade intolerant forests of Douglas fir, arbutus and Garry oak,

(3) Secondary Succession Sites - areas of successive flooding, windthrow sites and disturbed areas along roads were red alder and bigleaf maple are found,

(4) Climax Forest - the old stands of western red cedar, western hemlock and grand fir which have developed on the alluvial soils in the valley and forests of Douglas-fir and arbutus on the dry, well drained sites at higher elevation.

Except for road, hydro line and railway right-of-ways and the gravel pit the effects of man upon vegetation in Goldstream Park have been relatively limited. This has led to a fortuitous situation whereby trees close to 700 years old are found in close proximity to a large urban centre like Victoria.

4.3 PLANT COMMUNITIES

Certain local conditions combine to provide a broad range of habitats and plant associations in the Goldstream Park area. These factors include fire history, plant succession and soil conditions. Soil moisture appears to be the major factor in determining the reletively large number of diverse plant communities around the park.

Inselberg (1976) provides the best overall description of plant communities around Goldstream Park. He identifies 20 plant communities. A summary description of the plant communities grouped under 14 headings follows. More detailed descriptions taken from Inselberg are found in the Appendices along with a map of plant community units.

4.3.1 Moss-Lichen-Grass Rock Outcrop Community

This community is found on the higher slopes of Mount Finlayson in very dry situations. The moss-lichen aspect is confined to bare rock surfaces while the grass aspect is found on shallow soils in crevices between rocks.

The main vegetative cover is comprised of lichens and mosses with minimal shrub or tree cover. Common species include grey fringed-cap moss, Wallace's selaginella, juniper haircap moss, broom moss and several species of lichens of the Cladonia genus. Tree cover is incidental in this community featuring only scattered Garry oak, arbutus or Douglas-fir. Shrubs are also scattered in distribution with mainly Oregon grape (mahonia) occurring accompanied by occasional ocean-spray, snowberry and broom. Several wildflowers are found. These include common camus, great camus, Menzie's larkspur, nodding onion, chocolate lily and western buttercup. Numerous grass species occur, most of which are introduced.

4.3.2 Fescue-Dogtail Upper South Slope Grass Community

This community is confined to the summit of Mount Finlayson on dry, thin soils overlaying bedrock, mainly the Sprucebark Soil Association. It supports most of the herbs found in the Moss-Lichen-Grass Rock Outcrop Community. Native grasses include species of oatgrass, fescue and blue wild-rye.

4.3.3 Madrona - Douglas-fir Community (two)

The Madrona - Douglas-fir Communities have widespread distribution on rocky, dry sites above the valley floor in the park and throughout adjacent upland areas on Shawnigan, Somenos, Sprucebark and Rosewall Soil Associations. There are two sub-divisions identified: (1) a small area on the north and east summit area of Mount Finlayson which contains manzanita, and, (2) more extensive units without manzaniti.

These communities feature relatively open, attractive forests of arbutus, Douglas-fir and Garry oak. Common shrubs include kinnikinnick, manzanita (on the summit of Mount Finlayson), Oregon grape, snowberry and wild rose. Flowers and plants in the herb layer include great camus, common camus, broad-leaved shootingstar, Menzie's larspur, Montia species and several grasses.

4.3.4 Douglas-fir - Salal Mesic Community

The Douglas-fir - Salal Mesic community is the mesic association for the Coastal Douglas-fir Biogeoclimatic Zone. It is found on well drained glacial outwash materials mainly on the Qualicum and Quamichan Soil Associations. Forest cover is commonly comprised of open stands of Douglas-fir. Ocean spray is a good indicator of this association. Other shrubs include Oregon grape, red huckleberry, common and trailing snowberry, baldhip rose and twinfower. There is some swordfern in the understory while two interesting low growing flowers, Indian pipe and candystick are found in this community/

4.3.5 Douglas-fir - Salal Wet Community

This community represents a wetter phase of the Douglas-fir - salal association. It is found on the lower slopes often adjacent to the communities occupying the valley bottoms. This community is developed on well drained glacio-fluvial deposits common to the Quamichan and Qualicum Soil Associations.

Although Douglas-fir is a major forest constituent, it is often accompanied by western red cedar and grand fir in this wet portion of the association. The forest canopy is less open and the shrub layer more developed than in the mesic association. Western yew, western flowering dogwood and bigleaf maple are often found mixed with the Douglas-fir. Trailing vanilla-leaf, blackberry, red huckleberry and baldhip rose are common shrubs. An attractive ground cover of swordfern, bracken or vanilla-leaf is common. Wildflowers include western trillium, broad-leaved starflower and three-leaved foamflower. The wetter conditions are indicated by the presence of mosses such as Eurhynchium oreganum and Mnium species.

4.3.6 Swordfern Communities (two)

The Swordfern Community has two variants. One occupies moist to wet alluvial sites adjacent to the Goldstream River in the vicinity of, and downstream from, the Finlayson Road Bridge. Another, the Swordfern Fragmentary Association, is found on seepage sites along tributary "routes" to the river. These sites are amongst the most productive from a commercial forestry point of view. The seepage sites have significantly less species diversity than than the alluvial sites.

Tree cover is mainly western red cedar and grand fir with deciduous species such as red alder and bigleaf maple on disturbed sites. Douglas-fir is highly productive in this community as a pioneer species but it presently has only scattered occurrence on these sites in the park. A major characteristic of the Swordfern Community is the lush swordfern growth. Lady fern is also common. Shrubs are fairly well developed and include salmonberry, red huckleberry and thimbleberry. A diagnostic feature of this community is the absence of Oregon grape. Flowers and herbs include western trillium, pathfinder, vanilla-leaf, bleeding heart, large-leaved aven, three-leaved foamflower and broad-leaved starflower. Similar to the wet Douglas-fir - Salal Community, mosses such as Eurhynchium oreganum are common.

4.3.7 Grand Fir - Western Red Cedar Alluvial Fan Community

This community is found on the gently sloping, coarse textured alluvium and is restricted in distribution in the park to portions of the fan of Niagara Creek east of the highway. It is developed on the Genoa Bay Soil Association. This community is not frequently flooded compared to other alluvial communities and the herb and shrub layers are therefore well developed. The lack of flooding also promotes conifer regeneration instead of deciduous trees.

Grand fir and western red cedar are the main tree species. However, other species such as bigleaf maple, Douglas-fir, western flowering dogwood also occur. Common snowberry and Indian plum are the most common shrubs along with salmonberry, trailing blackberry and beaked hazelnut. Swordfern and cleavers make up most of the ground cover which features frequent exposures of bare gravels and rocks.

4.3.8 Broadleaf Maple - Grand Fir Alluvial Fan Community

This community is situated on the frequently flooded, wet, coarse textured alluvium on the Niagara Creek fan and Genoa Bay Soil Association. A few large conifers occur but vegetative cover is primarily dominated by a secondary succession of bigleaf maple and red alder. Shrub, herb and ground cover is similar to that of the Grand Fir - Western Red Cedar Community.

The maples growing on the alluvial soils in the park are often draped in Neckera douglasii, an epiphytic moss. This is a major visual characteristic of Goldstream Park.

4.3.9 Black Cottonwood Lower Alluvial Fan Community

This is a highly disturbed community which experiences frequent floods and water erosion. It is restricted to a small area at the apron of the Niagara Creek fan adjacent to the Goldstream River. Here, the soils are finer textured and drainage is somewhat impaired by a high water table.

Grand fir, western red cedar, black cottonwood, red alder and bigleaf maple are all found on this site. The understory species composition is similar to that of the Grand Fir - Western Red Cedar Community. However, the understory is comparatively sparsely occupied by plants because of the frequent innudations of water.

4.3.10 Common Scouring-rush Alluvial Bottomland Community

This community is found on small scattered sites along the lower Goldstream River on wet to very wet alluvial flood plain. Tree cover includes western red cedar, grand fir, western yew, bigleaf maple and red alder. Indian plum, salmonberry, stink current, thimbleberry and red elderberry are found in the shrub layer while the herb layer has common scouring-rush, swordfern, lady fern, skunk cabbage, tall fringecup and three-leaved foamflower.

The small extent of this community and the limited distribution of common scouring-rush in the park makes the community vulnerable to impact and loss by human activity.

4.3.11 Skunk Cabbage Community

This community is found on alluvial bottomland sites near the mouth of the Goldstream River. These soils are poorly drained, contain high amounts of organic matter and are black muck in appearance. The association of skunk cabbage, lady fern and red alder together is a good indicator for this community in the park.

Bigleaf maple and red alder are the common tree species found in association with western red cedar and grand fir. Thimbleberry, salmonberry and red huckleberry are the most common shrubs. Indian hellibore and false lily-of-the-valley are found in the herb layer.

4.3.12 Sedge Depressional Area Community

Very small sites of this community are found in bedrock depressions where black muck soils have accumulated in areas where standing water may exist for periods of six to eight months of the year. The largest unit identified on Inselberg's map is near the start of the Arbutus Loop Trail.

Red alder, willow species and Pacific crab apple are the only woody plants associated with this community. Shrubs and herbs include hardhack, broad-fruited bur-reed, grass, sedge and water-cress species, a horsetail and marsh speedwell.

4.3.13 Red Alder - Salmonberry River Area Community

This community is found in a narrow band along the edges of the Goldstream River. It is subject to repeated flooding and varying moisture conditions. Vegetation is an early successional community with the frequent occurrence of red alder. A large diversity of habitats are found in this community depending upon proximity to the river and degree of flooding. Common herbs and flowers include swordfern, lady-fern, coltsfoot, western trillium, creeping buttercup, large-leaved aven and false lily-of-the-valley.

4.4 SALTMARSH COMMUNITIES

The estuary of the Goldstream River supports salt marsh vegetation, the Glasswort - Pacific Silver Cinquefoil Community. Biologically, this is an extremely productive are because it receives very high levels of energy, nutrients and minerals. Section 3.5.3 summarized how tidal action and stream sedimentation contributed to the input and mixing of nutrients and minerals. Sunlight contributes high levels of energy to the estuary while the marine influence contributes waters rich in salts and minerals. This rich environment is inhabited by a wide variety and large numbers of primary producing organisms which in turn attract and support organisms higher up on the food chain.

Salt marsh plants are mostly terrestrial flowering plants which have adapted to the conditions imposed by varying levels of exposure to salt water. Such plants are called halophytes (salt loving plants) and grow in the intertidal area at elevations between the lowest and highest tides.

Within the Salt Marsh Community there is a great variety of plants most of which do not occur elsewhere in the park. The plants are distributed in distinct zones depending mainly upon the relative their relative exposure to the marine environment. Levels of salinity probably play a role in this zonation but the frequency and duration of submergence under water appears to be the main factor in determining the zonation and distribution of the salt marsh plants. Plants in the lowest zones are exposed to super-saturated soils and covered by water every day for extended periods of time. Plants such as glassworts are able to tolerate these extreme conditions best and find their greatest occurrence at these lower elevations. At the higher elevations, plants may be submerged for only short intervals during the day or only a few times a year. Here, rushes and grasses occur where the freshwater influence is greatest. Intermediate areas are occupied by saltgrass.

The following sequence outlines the general zonation of plants in the estuary.

lowest elevation; greatest and most frequent subtidal submergence	glasswort	greatest tolerance to saturated soils and interruption of photo synthesis; greatest supply of available nutrients
mid-elevation; medium amount of tidal submergence	glasswort & saltgrass	
highest elevation; infrequent tidal submergence	sedges, rushes & grasses	close to "normal" root conditions for uptake of nutrients

Inselberg (1976) identifies two major zones in the salt marsh community of Goldstream Park: the lower elevation Glasswort Sub-community and the higher elevation Pacific Silver Cinquefoil Sub-community.

The Glasswort Sub-community receives the greatest marine and tidal influence. The diagnostic species is woody glasswort (Salicornia virginica). Other major plants include seashore saltgrass, Canadian sand-spurry, gumweed and fox-tail barley.

The higher sub-community is dominated by Pacific cinquefoil, creeping bentgrass, asters, Arctic rush, common orache and sea milkwort.

4.5 OTHER COMMUNITIES

The islet vegetation at the mouth of the Goldstream River has not been mapped or described well in the literature. These islet areas are in a wet habitat subject to frequent flooding, erosion and brackish conditions. This area is visually similar to the salt marsh community in that it has no tree or shrub cover. Two general sub-units are defined. A lower lying area is characterised by by seashore saltgrass, a rush (Carex lyngbyei?), tufted hairgrass, Puget Sound gumweed, Pacific silver cinquefoil and broad-leaved dock. A higher area contains tufted hairgrass, purple aster, Pacific silver cinquefoil and yarrow.

4.6 BIOLOGIC PRODUCTIVITY

There is a strong correlation between the various plant communities and biologic productivity. This productivity is expressed in terms of numbers of species, rate of organic recycling, total organic mass and compexity of biologic inter-relationships.

Generally, the higher and mid-elevation areas have experienced a net erosion of nutrients and minerals. Energy input from the sun is high but nutrient levels in the soils are low. These areas include the Moss-Lichen-Grass, Fescue - Dogtail and Madrona - Douglas-fir communities. Primary succession following fire is slow, growth rates are comparatively low and sensitivity to human disturbance can be high. For instance, the relatively thin soils are more subject to erosion and the slow growing ground vegetation responds poorly to trampling.

At lower elevations there tends to be a net accumulation of minerals, nutrients and moisture. Examples of some of the temperate World's most productive forest sites are found in association with the Swordfern Community. Species diversity is greater on the moist, bottomland communities. Plants requiring the greatest nutrient levels such as bigleaf maple, red alder, western red cedar and skunk cabbage are confined to the moist, nutrient rich alluvial sites. Amongst the richest biologic areas are the salt marsh communities where there is a high concentration of plants, invertebrates and terrestrial animals.

4.7 PLANT SPECIES

Preliminary lists of plant species known or expected to occur in and adjacent to the park are found in the Appendices. These lists indicate that 47 non-vascular and 243 vascular plant species occur in the vicinity of Goldstream Park. The lists likely represent minimum numbers of plants as no definitive list of plants appears to have been made for the park. For reference and comparison a table of the numbers of families, genera and species for Saanich Peninsula is also presented in the Appendices.

5.0 FAUNA

5.1 FRESHWATER FAUNA

The Goldstream River is home to at least ten species of fish and an unknown number of aquatic invertebrates. The largest invertebrate is the crayfish found in the lower reaches of the river. Although it eats dead plants and animals, crayfish also prey upon young fish and small organisms. Snails, leeches, water striders, mayflies, caddes flies and insect larvae are also commonly seen in the river.

The most noticeable fish are the three species of salmon which migrate up the river every fall. Chum salmon are by far the most numerous anadromous (sea run) species accompanied by small runs of coho and chinook salmon. Three other anadromous species use the Goldstream River: Pacific lamprey, coastal cutthroat trout and steelhead trout. Other fishes inhabiting the river include brown bullhead (introduced), threespine stickleback and prickly sculpin. Rainbow trout are suspected to occur while small numbers of sunfish (pumpkinseed) apparently enter the river during high water levels from Langford Lake. Dolly Varden char and brown trout used to be found in the river but none have been seen for several years.

5.1.1 Pacific Lamprey

Like the native salmon, Pacific lamprey live most of their lives at sea. They are considered a predator and are parasitic on fin fish by attaching themselves to their victim and feeding upon blood and tissues by a sucking action. The lampreys enter the Goldstream River to spawn in the early summer. The adults, which are 30 to 90 cm long, lay eggs in sandy gravels at the head of riffles. Like salmon, they die shortly after spawning. The larvae may spend several seasons in the river bottom before they emerge as adults and return to the ocean.

5.1.2 Prickly Sculpin

The prickly sculpin is a small fish, usually less than 15 cm long, which lives both in the river proper as well as in brackish water in the upper estuary. It feeds on a variety of small insects, larvae, eggs and mollusks and in turn is eaten by birds, trout and garter snakes. The prickly sculpin spawns in late spring through early summer under boulders. The yellow to orange egg mass is guarded by the male.

5.1.3 Threespine Stickleback

The threespine stickleback is a very small fish, usually less than six cm long, with relatively large dorsal and pelvic spines. They are found both in the river and in adjacent marine waters. Sticklebacks feed on small organisms usually along the bottom of the river. They are a fairly numerous fish and are important as a food source for larger fish and aquatic birds. They breed throughout the summer months. The males construct nests from plant debris in the bottom mud into which the female deposits the eggs. The male fertilizes the eggs and cares for the nest and young fish which hatch in a few days or a week.

5.1.4 Anadromous Trout

The Goldstream River has small runs of coastal cutthroat trout and steelhead trout. These two species from the Salmo genus are close cousins to the Atlantic salmon. Unlike Pacific salmon, the adults of the Salmo genus usually return to the ocean and may return to spawn a second time.

Steelhead are identical to rainbow trout except that they go to sea as adults. The trout mainly return to the river in winter months and spawn in the spring, although their spawning time is not as regular as the local salmon species. The young fry may remain in the river for as long as the spring of their third year. Like coho, the steelhead fry are highly dependent upon adequate water levels in summer for their survival. Adult steelhead return to spawn after two or three years in the ocean.

The coastal cutthroat trout is distinguished by two reddish slashes along the lower jaw. Similar to steelhead, coastal cutthroat trout may or may not be anadromous. They usually spawn in the river in late winter or spring months. Young cutthroat remain in the river for highly variable lengths of time. The anadromous cutthroat do not travel extensively in the ocean like steelhead. They tend to linger near their "home" stream and probably spend most of their lives in and near the estuary.

5.2 PACIFIC SALMON

The salmonids which include trout, char and salmon species, are extensively distributed in the world, especially in the temperate climates. They evolved from a common ancestor about 25 million years ago. There are three main genera today:

(1) Salmo - the trouts and Atlantic salmon,

(2) Salvenlinus - the chars and laketrouts,

(3) Onchorhynchus - the Pacific salmon, the only ones which die as a result of a rapid aging process accompanying the single time that they reproduce.

Migration is an important aspect in the biology of salmonids. There are diurnal migrations for feeding; extensive ocean-going migrations, usually seasonal, for some species; and reproductive migrations such as the river runs. The anadromous (going to sea) migrations were possibly induced by the ice ages.

There are five species of Pacific salmon: chum, coho, chinook, pink and sockeye. Only the chum, coho and chinook return to the Goldstream River.

Five general phases in the life of the Pacific salmon are recognized: egg, fry, smolt, juvenile and adult.

5.2.1 Egg Phase

The salmon eggs are laid in gravel beds in early winter and by the end of December most will have formed into the "eye" stage. By early spring the eggs have developed into the alevin stage when they remain in the gravel and live off the attached egg sac. Factors such as disease, predation, insufficient oxygen, siltation, freezing and waste buildup take a heavy toll of eggs. Normally only 10% of the salmon survive this phase.

5.2.2 Fry Phase

The fry phase begins when the egg sac has been fully absorbed and the small fish emerge from the gravel bed. This usually happens in late spring or early summer. At this time, food becomes critical for coho and chinook who remain in the river for up to a year. The young fry spend their time alternatively hiding and resting and station keeping on the lookout for insects, larvae and drift. Chum fry migrate down to the estuary immediately upon emergence from the gravel. It is assumed that some kind of imprinting takes places upon the nervous system at this time in order for the salmon to have a reference point for returning to the same stream as adults.

The maintenance of adequate streamside vegetation is important to the success of the salmon. Plant roots protect the stream edge from erosion. Moreover, overhanging branches help maintain cool water temperatures for the fry and provide an important source of insect food for the coho, chinook and steelhead fry.

5.2.3 Smolt Phase

Of the three Goldstream salmon species only the coho have a distinct smolt phase. This phase takes place for about two to three weeks in the estuary as the young fish adjust to saline conditions. Major metabolic changes take place in the gills and kidneys.

5.2.4 Juvenile Phase

This phase corresponds to the salmon's life in the ocean. Its length varies between two or three years to seven years depending upon species, genetic stock, sex and individual differences. During the early portions of this phase the salmon feed on smaller organisms along the shores of Saanich Inlet and grow rapidly in preparation for the journey into the open ocean. When the salmon enter the open ocean they tend to follow the major ocean currents flowing northward off the coast of British Columbia. Their migrations are extensive and they may travel thousands of kilometers, generally in a counter-clockwise route around the north Pacific Ocean. Individual fish may travel 10 to 16 kilometers a day. As the fish grow, larger prey is taken. Crustaceans, squid, herring and needlefish become the main foods for coho and chinook.

The salmon appear to be guided in a number of ways during their ocean travels. Temperature differences, salinity, currents, star positions, electro-magnetic cues and polarized light may all play a role in ocean navigation. However, as the older juveniles approach their home stream for spawning the olfactory sense (smell) appears to become a critical navigational aid. The salmon are sensitive to solution dilutions in the order of parts per billion. This is a major reason for discouraging human activity or disturbance in the river during spawning. Smells from dogs or humans treading in the river might disorient the fish.

5.2.5 Adult Phase

As the juveniles approach the estuary they are subjected to massive physiological changes when they enter the adult phase. These changes include:

- reduced or no feeding,
- stimulation of reproductive functions,
- thickening of skin and absorption of scales (possibly for nutrient required in the upstream journey),
- kidney and gill adjustments to the freshwater environment,
- major body colour changes which seem to trigger courtship behavior.

Spawning entails the female preparing redds (nest depressions in gravel) and depositing several hundred eggs in each until two to eight thousand eggs in total are laid. The eggs are quickly fertilized by the male and both adults die a short time after spawning.

Table 5.1 SUMMARY OF SALMON PHYSICAL CHARACTERISTICS

PHASE	CHUM	COHO	CHINOOK
FRY (fresh-water)	3-4cm dorsal green; faint parr marks; sides silver	2-4cm dorsal brown; black edge on fin; lower fins orange; distinct parr marks	7-7cm dorsal fin w. white tip; very prominent parr marks
SMOLT	N/A	10-15cm; dorsal brown or green; dorsal fin with white tip; parr marks faint or absent	no distinct smolt stage
JUVENILE (at sea)	metallic blue dorsal surface; black speck-ling; slender caudal peduncle	metalic blue dorsal surface; numerous black dorsal spots	green-blue to black dorsal surface; numerous black dorsal spots
	140-186 pyloric caeca; 8-26 gill rakers on 1st gill arch; teeth conical	45-85 pyloric caeca; 19-25 gill rakers on 1st gill arch; teeth needle-like	140-185 pyloric caeca; 18-30 gill rakers on 1st gill arch; teeth conical
ADULT (spawning)	3-8 kg 2,500 eggs	3-7 kg 3,500 eggs	4-30kg 5,000 eggs
MALE ADULT	no body spots; vert. pattern on sides of purple, black & yellow; prominent teeth	dark body; wine red sides protruding upper jaw	black shading to grey sides; body and caudal fins spotted
FEMALE ADULT	no body spots; dark lateral line stripe	like male but but lighter colour and no protruding jaw	same as male

5.3 CHUM SALMON

Chum are by far the most numerous salmon in Goldstream Park. Several thousand of them, sometimes more than 30,000, return for spawning in a given year. The chum return to the river in four separate cycles at four-year intervals. Most chum are harvested commercially by nets as they concentrate in in-shore waters on their return to the home streams. Because of their low fat content that are favoured by Indians for smoking.

Chum salmon spawn in close to 900 medium-sized streams along coastal British Columbia. They tend to favour shallow, gently flowing streams and are most often found spawning in the lower reaches of their home rivers. Such is the case in the Goldstream River where most chum spawn in the lower two kilometers of the stream. Coarse gravel is used for the spawning beds.

The mature adults begin to enter Goldstream River in October and keep arriving for about nine weeks. Different races appear to arrive at different intervals and utilize different sections of the river. For instance, the first group which tend to be smaller in size (about three kilograms) spawn early in the lower section of the river. Larger stock (five to eight kilograms) appear in November and head for the section of the river near the highway.

The spawning adults do not tend to pair up as much as other salmon species and individual males are very aggressive while in the river. Males, with their large teeth and hooked jaws often cause serious wounds to each other as they compete for opportunities to mate with females. The nickname "dog" salmon is based upon this aggressiveness.

The females seek out suitable gravel streambeds for spawning. They use furious tail and body motions to prepare a shallow depression, the redd, which is about 14 cm long, 9 cm wide and 6 cm deep. This action also clears the gravel of silt and debris which could stick to the eggs and interfere with gaseous exchanges for the developing embryos. While preparing the redd the female can often be observed testing it for depth and size with her body. When the redd is ready she deposits several hundred small pink eggs in it.

In the meantime several males compete with each other for opportunities to fertilize the eggs. When successful, the male moves beside the female and with a violent quiver releases the "milt" (sperm) which fertilizes the eggs.

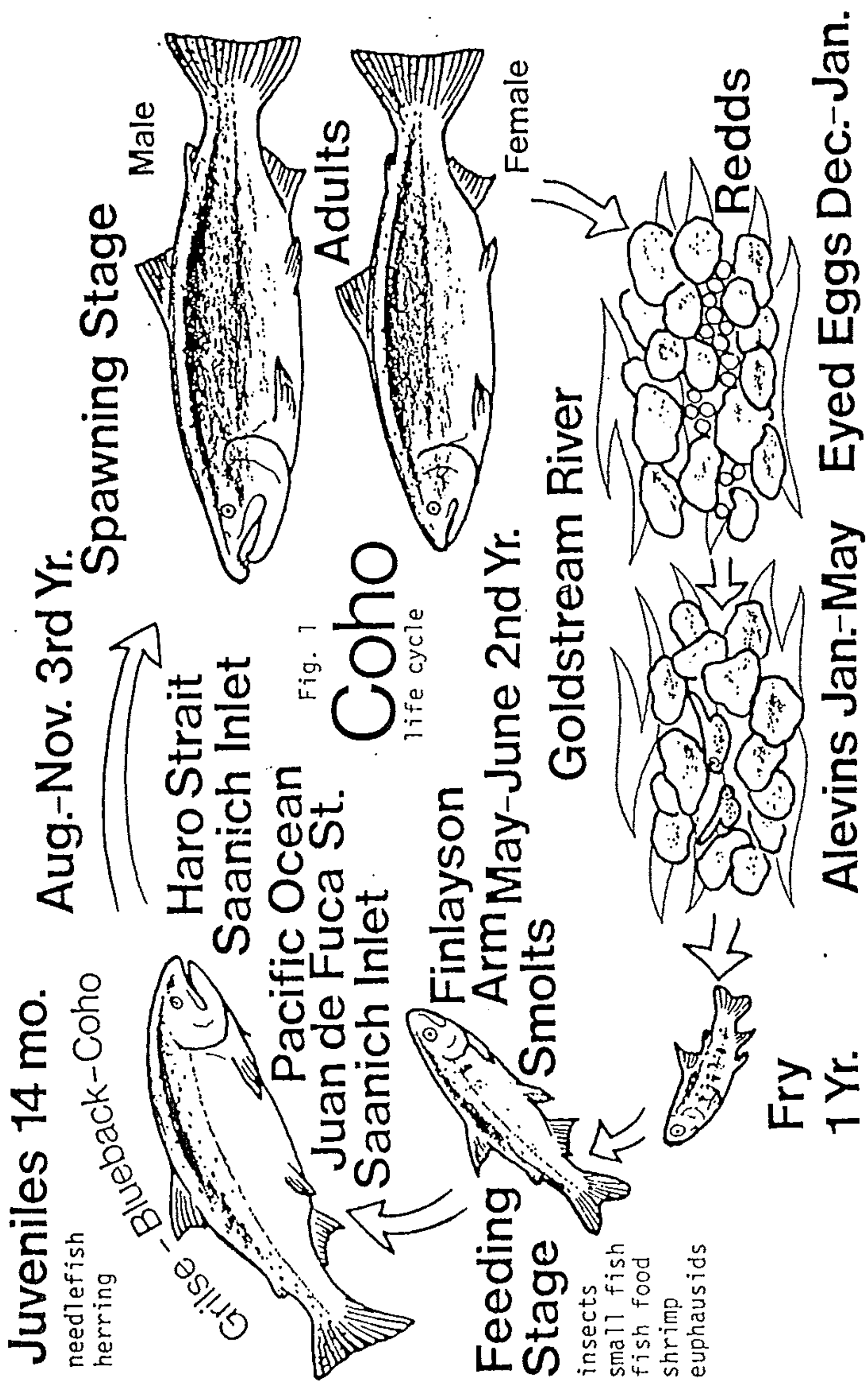


Figure 5.2 COHO SALMON LIFE CYCLE

The female then moves upstream and with tail and body actions covers the redd with gravel. For up to several days the female will repeat this process until she has deposited 2,500 or more eggs in the same general location. The adults hover over the redds for a few days in an effort to protect them but very shortly they weaken and the current takes them downstream while they die. Their decomposing bodies litter the shoreline and bottom of pools along the lower river and estuary. Individual adults live in the river for only about seven to ten days.

The eggs become alevins in early spring. The fry emerge from the gravel in May or June and head immediately into the estuary where they feed primarily upon plankton for several months. They continue to eat plankton as they move into the marine waters of Saanich Inlet in late summer.

As juveniles, the chum salmon travel throughout the north Pacific for two or three years possibly getting up to 4,000 kilometers away from the Goldstream River. They continue to eat plankton and relatively small organisms throughout their life at sea. During their last year at sea in May or June the maturing process begins as they return to the home river. At this time they average about 3.5 kilograms in size although a few individuals may weigh as much as 15 kilograms.

5.4 COHO SALMON

Modest numbers of coho salmon, usually less than a few hundred, spawn in Goldstream River each year. They return to over 750 streams and rivers along Coastal British Columbia. Coho arrive at Goldstream in three separate cycles at three year intervals.

Coho are taken both by commercial and sport fishermen. Commercial harvest involves both net and trolling gear. They are a highly prized sport fish, especially when taken on light trolling gear. Mature adults average 2.5 to 5.5 kilograms.

Compared to chum salmon, coho tend to favour somewhat faster flowing water for spawning sites. In Goldstream River they tend to spawn in the upper four kilometers of the river within the park. Coho might be observed laying eggs at the edges of pools where stream slow is fairly swift. However, coho are shy and seek out secluded areas to spawn.

The male and female cohos pair up in the estuary and lower portions of the river about November. Males outnumber females and un-mated individuals die before they spawn. However, these "extra" males move upstream and often attempt to raid other male territories, sometime successfully. Normally, the coho are three years old when they return to the river. However, a few two year old males ("jacks") may mature early and are part of the river run. The relative number of jacks often provides an indication of the size of the run to be expected in the following year.

The female makes long redds about twice the length of her body and several centimeters deep in the gravel. She lays 3,500 to 5,000 small reddish eggs over the course of several days similar to the behavior of the chum salmon. Unlike the chum however, the male accompanies the female over the redd while the eggs are being laid and then fertilizes them. The parents defend the spawning ground for about ten days before they quickly weaken and die within two weeks of spawning.

The eggs become eyed about the New Year and form into alevins in early spring. Shortly after, the fry emerge from the gravel. The coho enter a critical phase in their life at this point. Most fry remain in the river for about a year and stream conditions and food must be optimal for the young fish to survive. The ability of Goldstream River to provide favourable coho fry rearing habitat appears to be the factor limiting the population. Sufficient cool water in the summer months is the major factor. Many of the enhancement projects on the river over the last few years are designed to meet the needs of the coho fry. Throughout the summer, young coho fry can be readily observed in the Goldstream River accompanied by steelhead and chinook fry. During this period they feed largely upon insects.

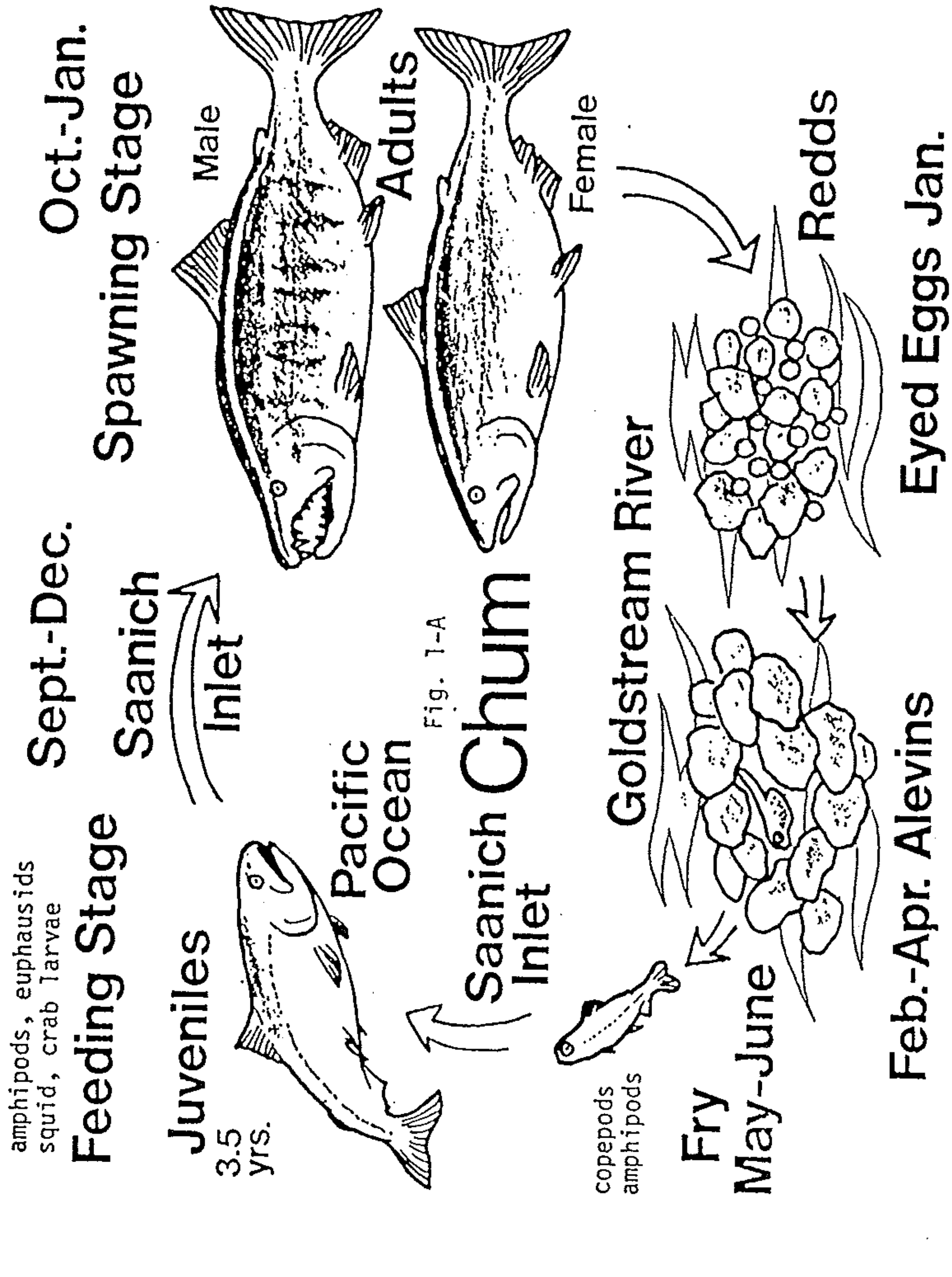


Figure 5.1 CHUM SALMON LIFE CYCLE

Depending upon the success of feeding and rearing during their first summer the fry begin to move into the estuary as smolts, usually the following spring. The smolts move gradually along the marine shoreline feeding voraciously on the abundant shrimp and ephausids of Finlayson Arm and Saanich Inlet as they develop into juveniles. Some may linger in the Strait of Georgia but eventually most juvenile fish move into the open Pacific moving north in summer months and south in winter months.

During late summer of their second year at sea the Goldstream coho concentrate in Haro Strait before beginning their return to the river.

5.5 CHINOOK SALMON

Chinook (spring, king, tyee) salmon mainly spawn in the larger river systems such as the Fraser and Skeena Rivers. Their presence in small streams is minimal and the Goldstream River has only a very small run never exceeding 100 adults in any year. They are the largest Pacific salmon. Adults at Goldstream average three to six kilograms but individuals elsewhere often exceed 15 kg. Commercial harvest of chinook is by net or trolling. Sport fishermen angle for chinook in both fresh and saltwater. They are prized for their relatively large size.

At Goldstream River the chinooks mainly spawn in fast flowing, upper sections of the river. Their lifestyle is comparatively unstructured. For instance, fry may stay in the river for only two months or for up to a year. Juveniles may stay in local waters or make extensive ocean journeys. They also mature at different ages. Most Goldstream chinooks are three or four years when they spawn but certain races, especially northern ones, may spawn when they are five, six or even seven years old.

If water levels are high enough, returning chinooks start to enter the Goldstream River as early as October. They linger in the freshwater longer than other species and it may be a month before they spawn after entering the river.

Pairing of male and female chinook takes place at the spawning ground. The female creates a redd about 24 cm long, 19 cm wide and 8 cm deep. They favour relatively coarse gravels in swift flowing water. The male and female shed sperm and eggs simultaneously into the redd. Secondary males often attend the spawning pair in an attempt to mate with the female. Following egg release the female moves upstream to cover the redd. She usually makes several redds and may deposit more than 5,000 relatively large eggs. Subsequent redds may be fertilized by different individual males. Like all Pacific salmon adults die shortly after spawning.

5.6 SALMON RECYCLING

Each winter several tonnes of salmon flesh are cycled into the relatively small confines of the lower Goldstream River. The salmon bodies feed large numbers of animals, are host to bacteria, fungi and small organisms and result in large quantities of nitrates, phosphates and nutrients being released into the river and deposited downstream in the estuary. These nutrients in turn feed organisms and plankton which become important food sources for the young salmon, especially chum, when they enter the marine waters. Dippers, crows, gulls, ravens, raccoons, mink, otter and eagles all take advantage of the salmon flesh. Other species are more directly predacious upon the salmon. Cutthroat trout and other fish eat salmon eggs and fry while kingfishers and herons hunt for young fish.

5.7 SALMON NUMBERS

The various salmon species feature differing patterns in their cyclic returns to the Goldstream River. The chum return on a very regular basis at four-year intervals. The stocks of separate chum cycles return on a four year basis with very little genetic mixing between each group. Each cycle is arbitrarily designated as "A", "B", "C" or "D". Adult chum returns are summarized in the following table.

Table 5.2 ADULT CHUM RETURNS (1000's)

YEAR	CYCLE A	CYCLE B	CYCLE C	CYCLE D
1940's	10-50	10-20	5-50	20-50
1950's	5-50	2-5	2-50	5-10
1960			2-5	
1961				5-10
1962	5-10			
1963		2-5		
1964			5.5	
1965				10-20
1966	5-10			
1967		5-10		
1968			5-10	
1969				8
1970	5-10			
1971		2-5		
1972			2-5	
1973				1-2
1974	5-10			
1975		1-2		
1976			4.5	
1977				4-6
1978	30-40			
1979		5.6		
1980			*	
1981				*
1982	*			
1983		*		
1984			*	
1985				*
1986	*			
1987		*		
1988			30+	

* get updated figures

A similar cycle exists for coho salmon but on a three-year cyclical basis. There are genetic barriers between each cycle although the jack coho help mix genes between cycles.

Table 5.3 ADULT COHO RETURNS (1000's)

YEAR	CYCLE A	CYCLE B	CYCLE C
1940's	75+-3500	400-750	1500?
1950's	75-1500	200-1500	75-1500
1960			400
1961	400		
1962		75	
1963			400
1964	3500		
1965		75	
1966			750
1967	400		
1968		500-1000	
1969			150
1970	1000-2000		
1971		1000-2000	
1972			100-300
1973	110-300		
1974		300-500	
1975			346
1976	107		
1977		103	
1978			172
1979	91		
1980		*	
1981			*
1982	*		
1983		*	
1984			*
1985	*		
1986		*	
1987			*
1988	201		

* get updated figures

Returns of chinook salmon have never been large and never appear to have exceeded 100 in any year.

Both the chum and coho numbers in Goldstream River have experienced significant declines over the years. Reliable records go back to the 1930's and 1940's when 1,500 to 3,500 coho and 10,000 to 50,000 chum were common annual returns. Coho have experienced the greatest declines and currently there are only a few hundred returns per year. Chum numbers were down through the 1950's through 1970's but numbers seem to be approaching historic levels in recent years.

The salmon declines are attributed to a number of causes:

(1) decline of juveniles in the ocean from sport fishing and commercial harvesting and from declines in prey food, namely herring,

(2) pollution of Goldstream River - suspected septic tank seepage contributes to algae growth and decline of insect populations which is the main food source for coho fry,

(3) Goldstream River water limitations - diversion of natural flows for domestic water consumption and increased evaporation from the watershed from man-made lakes limit water volumes and contribute to increased water temperatures during critical summer months for fry rearing,

(4) induced stream siltation - past road construction and logging activities are believed to have contributed to the incidence of "flash" floods which increase stream siltation (especially harmful to eggs) and erosion of rearing and spawning habitat.

5.8 SALMON ENHANCEMENT

Since the early 1970's the Amalgamated Conservation Society has coordinated volunteer efforts to improve and enhance salmon production in the Goldstream Rivere, specially for coho. This society represents several associations and public schools which liaise closely with the Ministry of Environment, Department of Fisheries and Oceans and Greater Victoria Water Board.

The major enhancement projects have included:

- salvage operations such as removing stranded coho fry from shallow pools,
- artificial feeding of coho fry in spring and summer to increase their size and chances for survival,
- installation of incubation boxes to raise coho fry from eggs in a controlled manner to increase production,
- construction of small rock dams at the foot of pools to increase their depth and area and to reduce stream velocity,
- removal of fine textured deposits such as silts from the stream bottom,
- relocation of the stream bed to its former channel to improve chum spawning habitat,
- gabions installed on exposed river banks to protect against erosion,
- construction of a small spawning channel for coho.

5.9 INVERTEBRATE FAUNA

Because of its great variety of habitats Goldstream Park has a diversity of invertebrate fauna. Information is poorly documented about invertebrates in the park and most information is in the form of preliminary species lists which are duplicated in the appendices.

5.10 AMPHIBIANS

The damp habitats of Goldstream Park provide for a moderate abundance of amphibians. The main species occurring in the park are Western Red-backed Salamander, Pacific Tree-toad and Red-legged Frog. Species of minor abundance or only possibly occurrence include the Pacific Coast Newt, Long-toed Salamander, Northwestern Salamander, Red Salamander, Clouded Salamander and Northwestern Toad.

5.10.1 Western Red-backed Salamander

Ovaska (1987) has writen a PhD thesis on the Western Red-backed Salamander and used Goldstream Park for the main field work. This salamander is common to alluvial bottomland habitats. It is most active in the fall and spring months. Cold temperatures in winter and drought conditions in the summer appear to drive the salamander into underground retreats at these times of year. In the park, the primary mating season is the the fall. The female carries the fertilized eggs through the winter. The eggs are laid in the spring and the females tend and protect the egg clutches for up to several months. The hatchlings appear in the fall.

5.10.2 Pacific Treefrog (Pacific Tree-toad)

The Pacific Treefrog is distinguished by its small size, variable and changeable colour and prominent adhesive toe-pads. It is very well adapted to climbing and spends much of its time foraging in trees and bushes for insect foods. They breed in shallow ponds. Part of the mating ritual involves unusually load calls by the male throughout the spring. Pacific Treefrogs are common throughout Goldstream Park.

5.10.3 Red-legged Frog

The Red-legged Frog inhabits the moist bottomland areas of the park. It is distinguished by bright red colouring along the legs and lower belly, especially with the older adults. Mating takes place in water in the late winter or early spring. The male's mating call is very feeble.

5.11 REPTILES

5.11.1 Garter Snakes

All three of British Columbia's garter snakes are well established in Goldstream Park. This is probably related to the good supply of amphibian and intertidal organisms and small fish prey. The estuary and adjacent shrubby areas are thought to be very important habitats for the snakes - the estuary for feeding areas and basking sites, the shrub areas for over-wintering. The major distinguishing characteristics of the three snakes are summarized as follows:

Common Garter Snake - large head; pointed snout; body tending to be long and slender; body ground colour black to dark brown with three yellowish to green stripes running the length of body; found throughout the park, (estuary, lowland forests, uplands).

Northwestern Garter Snake - small head; blunt snout; usually red dorsal stripes and/or red ventral surfaces; body tends to be stout; rarely enters water and is probably confined to the higher, drier ground in the park.

Western Terrestrial Garter Snake - large head; prominent yellow to orange, often wavy mid-dorsal stripe along back; yellow lateral lines along body; often enters water (fresh or marine); probably rarely leaves estuary area.

5.11.2 Northern Alligator Lizard

The Northern Alligator Lizard is the only other reptile found in the park. This is a small slender lizard growing up to ten cm in length. It favours dry conditions and is mainly confined to the arbutus and dry Douglas-fir forests of the park.

5.11 BIRDS

Approximately 155 bird species are known for or expected to occur in Goldstream Park. This represents about one-half of the 323 birds listed on the Victoria Natural History Society Check List (1984).

The estuary area is the best location to see the greatest numbers of birds. A variety of grebes, waterfowl and shorebirds are very common. This is a good location to also view larger raptors which often ride air currents around Mount Finlayson. Common birds of prey include Bald Eagle, Turkey Vulture, Red-tailed Hawk, Osprey, Merlin and Peregrine Falcon. Great Blue Herons are frequent visitors to the lower river and estuary area. A distinctive bird which is not commonly seen elsewhere in the region is the American Dipper. This bird is readily seen during the salmon runs when it forages for salmon eggs in the stream in its characteristic underwater manner.

The salmon runs attract high numbers of scavengers. Chief among these are the Northwestern Crow and the Glaucous-winged, Herring and Mew gulls.

5.13 MAMMALS

Approximately 21 mammals likely occur at Goldstream Park. Raccoons are probably the most often seen mammals, being almost a nuisance for campers. The Little Brown Myotis is commonly seen flying over the estuary area in search of insects in the evenings. Occasionally, mink are observed, especially during the salmon runs. Coast Deer, Canadian River Otters, Red Squirrels and introduced Eastern Cottontails are also fairly conspicuous. The Wandering Shrew and White-footed Mouse are common in the park but not frequently seen.

Several mammals probably visit the park on a regular basis but are rarely observed or recorded. These include: Western Big-eared Bat, Big Brown Bat, Hoary Bat, California Myotis, Long-eared Myotis, Townsend Vole (in estuary), Muskrat, Norway Rat and Marten.

Large carnivores, the Wolf, Cougar and American Black Bear also likely visit the park on rare occasions.

5.14 MARINE LIFE

Although Goldstream Park lies at the edge of marine waters, marine life is not a focus for park visitors. The estuary and muddy shoreline discourage access to the marine shore. Also, there is little documentation about the park's potential marine biology themes.

6. CULTURAL RESOURCES

6.1 ORIGINAL PEOPLES

About 8,000 years ago, following the retreat of the last ice advances, it is assumed that Indian people moved into the Puget Sound and Strait of Georgia regions from the south. Eventually, this new area flourished with diverse natural resources. The mild climate, lush vegetation, extremely rich marine life and salmon runs provided for the establishment of a very intricate culture.

Two main Indian linguistic groups comprise the Native peoples of Vancouver Island: the Salishan which occupy southeast Vancouver Island, the south coast and southern Interior in British Columbia, and the Wakashan, which occupy the remainder of Vancouver Island and the mid-coast of British Columbia. There are three linguistic sub-groups on Vancouver Island: the Coast Salish to the southeast and two sub-groups of the Wakashan elsewhere, the Nootka along the west coast of the Island and the Kwakiutl on the north and northeast portions of the Island.

The Coast Salish included ten or more language groups around the Strait of Georgia. One language group, the Lkongeneng or Straits Salish occupy what are today Saanich Peninsula, Victoria, Sooke and Boundary Bay. The Straits Salish are very closely related to their neighbors, the Halkomelem to the north which include the Cowichan, Musqueam and Stalo tribes. Locally, the Straits Salish are comprised of three tribes, the Sooke, Songish and Saanich. In turn, the Saanich Indians are comprised of three local groups, the Tsaykum of north Saanich, the Tsa-aout of east Saanich and the Tsartlip of west Saanich. Traditionally, the Goldstream Park area lies within the territory of the Tsartlip.

There is no evidence of permanent settlement by Indians in Goldstream Park. However, the valley's salmon and forests have been important resources for the Tsartlip Indians.

6.2 COAST SALISH LIFE

(Summarized mainly from Barnett, 1938 and Shuttles, 1960)

The Coast Salish live in a highly productive region. Some authorities suggest that the Pacific Northwest featured the greatest concentration of people in North America before European influences. Natural resources for food, shelter, transportation, and clothes were diverse and abundant. Salmon, halibut, cod, herring, clams, mussels, sea urchins, sea mammals and seaweeds were readily available marine resources. Western red cedar was a highly important item for providing material for shelter, clothing, baskets and canoes.. The land provided an abundance of spring bulbs, herbaceous plants, fruits and berries as well as numerous animals such as elk, deer and a variety of upland and water birds.

6.2.1 Food Gathering and Natural Resources

All members of the community were involved in the gathering and preparation of food. During spring, summer and fall, the Indians travelled extensively to gather foods. Certain items were more plentiful in one place than another or more abundant in one season than another. Temporary encampments were common during these periods. Permanent villages were mainly inhabited in the winter which was a highly important period for spiritual pursuits.

The abundance of food resources resulted in the development of a highly sophisticated culture accompanied by a relatively primitive technology almost entirely dependent upon hunting, fishing and gathering. The abundance of fish precluded the development of complicated fishing gear or techniques. Often, a weir was all that was required to harvest salmon. Traps, harpoons and gaffs were used depending upon local traditions and environmental situation. Herring were captured by rake-like objects. The most hazardous hunting was the pursuit of sea mammals with harpoons from canoes. Most mammals were caught in nets or traps, sometimes with the aid of dogs. Mountain goat appear to have been the only animals actively sought out by hunting parties.

Food was prepared by smoking, spit roasting, earth oven baking and stone boiling in wooden vessels. Utensils were usually made from maple or alder while containers were fashioned from cedar. Light clothing was made from cedar bark and rushes while fur robes and woven blankets were used in the winter. Wool, made mainly from dogs, was a highly prized item for clothing which was usually only available to those who could afford it.

Settlements were normally along the ocean shore. Permanent buildings were mainly cedar plank houses and lodges with a single sloping roof. The high side of the buildings faced the water. Totem poles and carved house supports were common with many coastal Indians but these do not appear to have been made by the Saanich. Summer shelters were a lean-to or a four-post frame covered with mats, bark or planks. Canoe building was a highly specialized craft often associated with spiritual qualities. A supernatural assistant, usually the spirit of the woodpecker, was required in the construction of canoes.

The Tsartlip had well established fishing privileges at Boundary Bay which they shared with the Lumni Indians of Washington State. The Tsartlip spent part of the summer at Boundary Bay while the fall months were spent at Goldstream River during the salmon runs. Their permanent villages were along the shoreline of Finlayson Arm and Saanich Inlet. They normally maintain a smoke house on the Indian reserve adjacent to Goldstream Park.

6.2.2 Social Life

The family nucleus centred around the building and owning of houses. The man was the head of the household often in partnership with his sons and/or brothers. The head of household could not afford to abuse the dependence of the members upon him. At the same time, the members could not afford to risk the disfavour of the head of household. Stories of tyrants and bullies are rare and are told with disapproval.

Unlike the Nootka and Kwakiutl, the Coast Salish head men were not considered chiefs in the normal sense. Community leaders were considered more as "gentlemen" or "smart men". However, these individuals tended to hold privlages over hunting and fishing areas and gear which were shared with other members of the community. Claming beds were free to all while root plots were held by a family. Weapons, canoes and wool blankets had very high values and were individually owned.

Social classes were maintained with a relatively wide gap in privlages and wealth between the highest and lowest classes. A slave system was in effect and the slaves were considered totally subservient but were not tortured or physcally abused. "Lazy" people were the most despised types of individuals.

Marriages were mainly contracted between social equals and usually took place between villages to establish or maintain alliances. Marriages were accompanied by significant exchanges of gifts and expensive goods.

There was considerable emphasis upon the accumulkation and sharing of wealth which was associated with supernatural power and spritual beliefs. The Potlatch was an important means of redistributing the wealth amongst the community. Successful people gained considereable prestige and power with the giving of gifts and wealth to others.

Rituals and spiritual beliefs were very important aspects in the lives of the Coast Salish. All critical periods of life such as puberty and family deaths were accompanied by rituals. At puberty there was a rigorous course of training and purification to prepare individuals for a major supernatural experience. This period, especially for men, was an extremely important life phase when individuals sought supernatural sanction and encouragement for their activities and chosen life pursuits. A spirit helper was considered particularly essential to become a hunter, fisherman or canoe maker. This spirit quest often involved a long, arduous isolation in the wilderness and distinguished the Coast Salish from the Nootka and Kwakiutl Indians.

6.3 THE CONTACT PERIOD

The Strait of Juan de Fuca was discovered about 400 yearsa ago. Sir Francis Drake may have been the first European to see the strait in 1579 but the Spaniard, Apostolos Valerianos (Juan de Fuca) claimed to be the first to discover and name the strait in 1592. Close to 200 years passed before the coast of British Colunbia was explored further.

In the 1750's Vitus Bering and other Russians explored north coastal British Columbia and began to exploit the sea otters. About the same time Spanish explorers such as Quadra, Perez and Hezeta entered the area to maintain Spain's claimed sovereignty to the west coast. However, following Cook's visit to Nootka Sound in 1778, the Spanish ceded the coast to Britain. In the early 1790's George Vancouver carried out the first detailed exploration of the Strait of Georgia region and Vancouver Island in conjunction with the Spanish explorers Galiano and Valdes.

The early 1800's ushered in the exploration and development of a fur trade in the province's Interior following Simon Fraser's descent of the Fraser River in 1808. In 1838, James Douglas surveyed southern Vancouver Island in anticipation of establishing a new west coast headquarters for the Hudson Bay Company because the post at Fort Vancouver (Oregon) was obviously going to fall under American control. In 1843 Fort Victoria was establoished by Douglas, the first permanent European settlement on Vancouver Island.

Exploitation of the sea otters had resulted in considerable contact between the Nootka and Europeans as early as the mid-1700's. However, until the establishment of Fort Victoria, the Indians of southern Vancouver Island had few European contacts.

During the early periods of contact the west coast Indians flourished. This was a result of fur trade wealth and the acquisition of European items, especially metal implements, tools and weapons. The Coast Salish began to trade furs with the Europeans in the 1840's. At this time there were frequent marriages between the Salish women and Hudson Bay men. Almost immediately alcohol became a major problem for the Indian people. The Indians prized ecstatic experience which seemed very readily attainable from alcohol.

The Indian people had no natural immunities to numerous European diseases, esapecially smallpox. In 1862 there was a smallpox outbreak at Victoria and the whites evicted the Indians who were forced to return to the native villages and spread the disease even more. During this and subsequent outbreaks perhaps as many as one-third of all Indians in the province died from these diseases. By 1882, only 30,000 Indians were left in all of British Columbia.

At the same ime there were local "incidents" between the whites and Indians which were not handled well by the local authorities at Fort Victoria. The tendancy was for the white administration to mete out "justice" to whole groups or communities of Indians rather than dealing with the few individuals who apparently caused the original "problems".

The Hudson Bay Company policy was that Indians had no claim to any of the land of Vancouver Island except that which was either cultivated by them or had houses on it before 1846. All other land was regarded as "waste" and was therefore available for colinization. Douglas made eleven treaties with Indians in the Fort Victoria area using this policy. The Indians of the region surrendered their lands for very low compensation and were left with a few small reservations, the freedom to hunt on unoccupied lands and to continue to fish as before. To this day the Tsartlip excercise their right to harvest salmon out of the Goldstream River. The Indians probably thought they were surrendering certain rights to use of the land, not title to it.

6.4 EARLY DEVELOPMENT OF THE REGION

Fort Victoria was originally established to administer the fur trade. However, the Interior gold rush of 1858 resulted in Victoria becoming a boom town. It became a major trans-shipment point for the miners and their goods on the way to the Fraser River gold fields. Very shortly there were 30,000 inhabitants at Fort Victoria.

In 1860 the stockade surrounding Fort Victoria was removed and the original buildings were replaced during the "boom". In 1862 the City of Victoria was incorporated and in 1868 it was made capital of British Columbia.

During this same period (the 1860's) devastation of the sea otter populations resulted in the decline of that fur trade only to be replaced by an active fur sealing industry of which Victoria became the fleet headquarters. The great forest wealth was also beginning to be exploited and coastal shipping became a major activity at Victoria. In the meantime the Interior gold rush faded.

6.5 HISTORY OF GOLDSTREAM PARK AREA

As early as 1880 the Goldstream Park area was recognized for its recreational and leisure values and natural features. The Colonist of July 30, 1880 carried an announcement regarding the opening of a resort at the river:

> "Pure Goldstream water supplied free of charge. This water smooths wrinkles of the old, gives health to the sick, beauty to the young, and wisdom to all."

In 1899 the Colonist reported on a series of Sunday evening concerts at Goldstream with 1,000 people in attendance and a round-trip tram fare of 25 cents.

The Goldstream River appeared to be a favoured leisure destination by Victoria area residents for many years but it wasn't until 1958 that the present provincial park was established.

Before creation of Goldstream Park the area had four cultural historic themes in addition to its Native Indian significance:

(1) mining,

(2) construction of the Esquimalt & Nanaimo Railway,

(3) construction of the Malahat Road,

(4) water resource development.

6.6 MINING AT GOLDSTREAM

The Goldstream River was apparently named by Peter J. Leech in 1858 after he discovered traces of "colour" (gold) on its banks. It wasn't for another few years however before anything was made of this discovery. A party of four prospectors sent out by James Douglas apparently re-discovered gold in the river in 1863. At this time, Victoria was full of adventurers and miners attracted from around the world in the wake of the Interior gold rushes. News of the Goldstream gold resulted in an instant gold rush on an October day in the pouring rain. Within a few days 300 men were at work on the river.

While placer mining at Goldstream, Robert Miller discovered some quartz veins which held some promise for hard rock mining. His friend, George Clarke staked much of the area. The prospects of lode gold further fueled the speculation and excitement at Goldstream. Within weeks there were 22 quartz claims in operation. Early assays indicated that the gold content of the ore was very high but within a few months it became clear that real prospects of successful gold mining at Goldstream were very poor.

About this time an expedition of men found gold at Leech River and the miners at Goldstream went off on another rush. The Leech River gold rush was over within a year when the early promise of a rich property faded like Goldstream's.

In 1897 the Colonist reported on another mining prospect in the Goldstream area. This was mainly a copper prospect accompanied by some gold and silver on the west side of Mount Skirt. The property was referred to as the Phair Mine because James Phair appeared to be the main partner behinbd the enterprise. Apparently, some tunneling was done in 1899. However, by the early 1900's this prospect also faded.

Today, the legacy of this early mining activity is associated with two sites. Figure 2.4 shows the approximate locations of two old mines. Site 1 on the map refers to the "Mystery Mine" along the Gold Mine Trail about 600 meters south of Niagara Creek. This mine is probably associated with the early gold rush of 1863. Site 2 on the map identifies the Mount Skirt-Phair mine of circa 1899. Site 3 on the map is described as an obscure mine or minor gold vein whose history is unknown.

6.7 THE E&N RAILWAY

The Esquimalt and Nanaimo Railway has special historic significance because its construction was one of the conditions for British Columbia's entry into confederation with Canada in 1871. Construction of the E&N Railway link between Victoria and Nanaimo was a protracted process which was not completed until 1886. It produced major squabbles between the Provincial and Federal governments which included threats by British Columbia to pull out of confederation.

On July 17th, 1873 Marcus Smith drove the first stake in the initial survey for the E&N at Esquimalt. However, the Federal government was reluctant to build the line and construction wasn't started in earnest until 1884. The following notes summarize this period of controversy:

1874 - British Columbia threatens to withdraw from Confederation over the issue of the railway,

Nov. 14th, 1874 - Earl Carnarvon of Great Britain acting as an arbitrater orders the construction of the island portion of the transcontinental railway,

1875 - the Senate turns down the railway proposal,

1876 - Lord Dufferin initiates an investigation regarding the railway,

1879 - the Federal Government announces its intention to complete the transcontinental railway but it soon becomes evident that the Vancouver Island section is to be left out,

1881 - Amor De Cosmos travels to Britain to petition the British Government about the Vancouver Island railway,

1883 - the Federal Government grants a subsidy of $750,000 and two million acres of land to build the Island railway.

Robert Dunsmuir had a strong interest in the construction of the Island railway. He wanted rail access to Victoria and its harbour for his coal mines in Nanaimo. In 1884 Dunsmuir headed a partnership in the railway enterprise and commissioned Joseph Hunter, a former C.P.R. engineer, to survey and construct the railway. The first spike was driven at Esquimalt on May 7th 1884 - the last spike was driven on August 13th, 1886 near Shawnigan Lake by Sir John A. Macdonald. Following the first regular train service between Victoria and Nanaimo on September 24th of that year the railway became a great success and almost all ship transport between Victoria and Nanaimo disappeared. The Federal Goverent continued to hold up the subsidies for ten years because it though there were too many curves along the rail line. In 1905, the Esquimalt and Nanaimo Railway was purchased from Dunsmuir by the C.P.R.

The western border of Goldstream Park is essentialkly defined by the E&N Railway line. In this area, the railway grade is close to 4% as it rises to gain elevation on the approach to the Malahat summit. This explains the wide sweeping curve of the rail line around the Goldstream Valley west of the campsite. Distinctive features of the line are the high trestle bridges and a tunnel in the vicinity of the park. The bridge at Niagara Creek is particularly impressive. It is about 130 meters long and 80 meters high. The Colonist of May 19th, 1885 reported that 250 Chinese and 100 whites were working on this section of the railway.

6.8 THE MALAHAT ROAD

Malahat is an Indian word thought to refer to the abundance of fish in Saanich Inlet (Mala = bait, kut = plenty). It is also reported to be the name of a tribe.

The first road connecting the Victoria and Cowichan areas was completed in 1884. It followed a route from the vicinity of Goldstream River, west to Sooke Lake then north along Shawnigan Lake to Cowichan Bay. This was a relatively long route which took two or three days to travel. It was also a poor trail and most freight north from Victoria went by sea. Generally, it was felt that a road over the Malahat Summit was impossible.

Major J.F.L MacFarlane is credited with initiating the construction of the Malahat Road. He had retired from military service in India and lived at a farm at Mill Bay. It became a Provincial election issue and the candidate suppporting construction of the road named Hayward won.

Between 1908 and 1912 the Malahat Road was constructed. The present highway generally follows this route. The Colonist of October 7th, 1927 reported that the road cost $297,249 and entailed 18 bridges and 123 culverts. During this period of construction there was some horse logging along the east side of the Goldstream Valley.

6.9 HYDRO-ELECTRIC GENERATION

Between 1898 and 1957 a small hydro-electric generation plant operated at Japan Gultch on the Goldstream River just west of the park boundary. The generating station was initiated following the purchase of the Goldstream watershed from the E&N Railway by the Esquimalt Water and Power Company in 1885. In 1897 the Water and Power Company made an agreement to supply power to the B.C. Electric and Railway Company for electrical needs in the Victoria area. This supplanted a steam plant which was curently operating in Victoria.

In 1896 the Goldstream Power House was built. It was reported to be the first "high head" (high pressure) hydro plant on the Pacific Coast. The plant was subsequently enlarged in 1903 and 1905. The Esquimalt Water and Power Company went bankrupt in 1925 and Victoria City acquired the Goldstream watershed.

Eventually, the Goldstream watershed became more important as a source of domestic water rather than for power generation. The generating plant was closed in 1957 and was dismantled within six months. Meanwhile, in 1949, the Greater Victoria Water Board assumed authority over the selling and distribution of water in the watershed. The Board also logs the watershed which has an Annual Allowable Cut (a sustainable volume of timber harvesting) of 50,000 cubic meters per year. In 1950 the Water Board considered logging what is now the Goldstream Park area. However, in 1955 an agreement was made whereby 275 hectares of the lower Goldstream Valley was turned over to the Provincial Government for park purposes.

6.10 GOLDSTREAM PARK DEVELOPMENT

Goldstream Park was established as a Class A Provincial Park on June 26th, 1958. The initial park comprised the 275 hectares turned over to the Province by the Greater Victoria Water Board. Between 1970 and 1972 the Water Board and City of Victoria made a further 55 hectares available for park additions while three hectares were deleted in 1969 for a hydro line right-of-way. The park presently has an area of 327 hectares.

The Freeman King Nature House is a major park facility. The building was constructed in 1947 and operatred for many years as a clubhouse for the Victoria Fish and Game Protection Society. The adjacent estuary area was used extensively for trap shooting. In 1972 the building was purchased by the Province but was leased back to the Fish and Game Association until 1975 when it was renovated and established as the nature house.

Table 6.1 CHRONOLGY OF CULTURAL THEMES

6000 BC +/-	original Indian peoples enter region following retreat of Pleistocene ice
1579	Apostolos Valerianos discovers the Strait of Juan de Fuca
1740's	Russians begin to exploit sea otters along West Coast
1778	Cook visits Nootka Sound
1790's	Vancouver, Galiano and Valdes explore and chart Strait of Georgia and Vancouver Island
1838	James Douglas surveys southern Vancouver Island
1843	James Douglas establishes Fort Victoria
1858-60	Interior goldrush stimulates growth of Fort Victoria
1862	Smallpox outbreak at Victoria; City of Victoria incorporated
1863	Goldstream gold rush
1868	Victoria made capital of British Columbia
1871	Confederation of British Columbia with Canada
1886	Completion of the E&N Railway
1898	Construction of the Goldstream hydro-electric generation plant
1899	Phair mine activity at Mount Skirt
1912	Completion of Malahat Road
1958	June 26, Goldstream Park established
1970-72	additional areas added to park
1972	acquisition of Victoria Fish and Game Protective Association Clubhouse
1975	opening of Freeman King Nature House

BIBLIOGRAPHY

Alexander, Steacy. 1980. A Bibliography of Natural History References and Some Naturalist's Hiking and Exploring Guides for British Columbia. (Annotated), Extension & Information Branch, Ministry of Lands, Parks & Housing, Victoria, B.C.

Anon. 1979? Report on Research on Ecology of Snakes and Frogs in Provincial Parks. Unpublished notes in Freeman King Nature House files.

Anon. (undated) The Coast Salish of British Columbia. Unpublished notes in Freeman King Nature House files.

Armstrong, J.E. et al. 1965. Late Pleistocene Stratigraphy and Chronology in Southwestern British Columbia and Northwestern Washington. Geological Society of America Bulletin, Vol. 76: pp. 324-327.

Bandoni, R.J. & A.F. Szczawinski. 1976. Guide to Common Mushrooms of British Columbia. Handbook No. 24, B.C. Prov. Museum, Victoria, B.C.

Banfield, A.W.F. 1974. Mammals of Canada. Univ. of Toronto Press., Toronto, Ont.

Barnett, H.G. 1938. The Coast Salish of Canada. American Anthropologist, Photocopied notes in Freeman King Nature House files.

Baurer, Wolf. (undated) Physiographic Anatomy of the Estuary Complex. Photocopied notes in Freeman King Nature House Files.

Baurer, Wolf. (1978?) Case for the Low Gradient Estuaries. Photocopied notes in Freeman King Nature House Files.

Bell, M.A.M. & R.J. Kallman. 1975. The Cowichan-Chemainus River Estuary Status of Environmental Knowledge to 1975. Special Estuary Series No. 4, Environment Canada, Ottawa, Ont.

Borror, D.J. & R.E. White. 1970. A Field Guide to the Insects. Houghton Mifflin Co., Boston, Mass.

Capes, K.H. 1964. Contributions to the Prehistory of Vancouver Island. Idaho State Iniv., Pocatello Museum, Occ. Papers No. 15, Pocatello, Idaho. (Not seen but numerous quotes and notes from this source in Freeman King Nature House files.

Cowie, A.J. 1948. Early History of the Esquimalt and Nanaimo Railway. Public Archives of B.C., Victoria, B.C.

Campbell, R.W. et al. 1979. A Bibliography of B.C. Ornithology, Vol. 1. Prov. Museum Heritage Record No. 7., Victoria, B.C.

Canada Dept. of Agriculture. 1972. Glossary of Terms in Soil Science. Research Branch, Can. Dept. Agric., Publication 1495, Ottawa, Ont.

Carefoot, T. Pacific Seashores: A Guide to Intertidal Ecology. J.J. Douglas, Vancouver, B.C.

Carl. G.C. 1963. Guide to the Marine Life of British Columbia. Handbook No. 21., B.C. Prov. Museum, Victoria, B.C.

Carl, G.C., W.A. Clemens & C.C. Lindsey. 1959. The Freshwater Fishes of British Colubia. Handbook No. 5., B.C. Prov. Museum, Victoria, B.C.

Chapman, J.D. 1952. The Climate of British Columbia. Paper presented to Fifth B.C. Natural Resources Conference, U.B.C., Vancouver, B.C.

Conway, G.R.G. 1915. Water Powers of Canada - Province of British Columbia. Dominion Water Power Branch, Dept. of Interior, Ottawa, Ont.

Cowan, I.M. & C.J. Guiguet. 1960. The Mammals of British Columbia. Handbook No. 11, B.C. Prov. Museum, Victoria, B.C.

Day, J.H., L. Farstad & D.G. Laird. 1959. Soil Survey of Southeast Vancouver Island and the Gulf Islands, British Columbia. Report No. 6 of the Soil Survey of Canada, Dept. of Agriculture, Vancouver, B.C.

Dept. of Transport. 1960. The Climate of Canada. Meteorlogical Branch, Toronto, Ont.

Dyckman, C. & S. Garrod. 1977. Small Stream and Salmonid: A Handbook for Water Quality Studies. United Nations Educational, Scientific & Cultural Organisation, Paris, France

Edwards, R.Y. 1967. Naturalist's Guide to the Victoria Region. B.C. Nature Council and Victoria Natural History Society, Revised Edition, 1975 by David Sterling, Victoria, B.C.

Eis, S. & E.T. Oswald. 1975. The Highland Landscape. Canada Forestry Service, Dept. of Environment, Victoria, B.C.

Environment Canada. 1982. Canadian Climate Normals, Temperature and Precipitation, 1951-1980. Canadian Climate Program, Atmospheric Environment Service, Ottawa, Ont.

Green, D.M. & R.W. Campbell. 1984. The Amphibians of British Columbia. Handbook No. 45, Royal B.C. Museum, Victoria, B.C.

Gregory, P.T. & R.W. Campbell. 1984. The Reptiles of British Columbia. Handbook No. 45, Royal B.C. Museum, Victoria, B.C.

Griffith, R.P. 1977. An Investigation of the Effects of Stream Velocity and other Environmental Variables on the Utilization of Cover by Overwintering Juvenile Coho Salmon (Onchorhynchus kisutch). B.Sc. Thesis, Dept. of Biology, Univ. of Victoria, Victoria, B.C.

Groot, C. 1981. Modification on a Theme - A Perspective on Migratory Behavior of Pacific Salmon. From Proceedings of "Salmon and Trout Migratory Symposium", Dept. of Fisheries & Oceans, Nanaimo, B.C.

Harrison, S. (undated) Geology of Saanich. Reprint of Part A of a Museum Bulletin on the Flora of Saanich Peninsula. Photocopy in Freeman King Nature House files.

Hart, J.L. 1973. Pacific Fishes of Canada. Fisheries Research Board of Canada, Ottawa, Ont.

Hazelwood, W.G. 1976. Fisheries Enhancement of Goldstream Park. Photocopied report in Freeman King Nature House files.

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

Historic Parks & Sites Division. 1976. Human History - Goldstream Park. Park History Program, Unpublished notes in Freeman King Nature House files.

Holland, S.S. 1964. Landforms of British Columbia - A Physiographic Outline. B.C. Dept. of Mines & Petroleum Resources, Bull. No. 48, Victoria, B.C.

Howes, D. 1989. Personal Communication. (Vancouver Island Guidebook, 1st draft in preparation). B.C. Ministry of Environment, Victoria, B.C.

Howes, D.E. & H.W. Nasmith. 1983. Field Trip Guidebook - Trip II - Quaternary Geology of Vancouver Island. University of Victoria, Victoria, B.C.

Inselberg, A.E. 1976. Biophysical Resource Analysis Report: Goldstream Park. Interpretation & Assessment Section, B.C. Parks Branch, Report No. 50, Victoria, B.C.

Jungen, J.R. 1985. Soils of Southern Vancouver Island. MOE Technical Report 17, Surveys & Resources Mapping Br., Ministry of Environment, Victoria, B.C.

Krajina, V.J. 1964. Ecology of Western North America, Vol. 1. Dept. of Botany, Univ. of Brit. Col., Vancouver, B.C.

McLusky, D.S. 1971. Ecology of Estuaries. Richard Clay Ltd., Great Britain.

Meade, S. 1974. Notes on the Goldrush of 1863 (Goldstream). Unpublished notes in Freeman King Nature House files.

Meade, S. 1976. Spiders of Goldstream and the Victoria Area. Unpublished notes in Freeman King Nature House files.

Meidinger, D. 1987. Recommended Vernacular Names for Common Plants of British Columbia. B.C. Ministry of Forests, Victoria, B.C.

Muller, J.E. (1975?) Victoria Map Area, British Columbia (92-B). Geologic Survey of Canada, Paper 75-1, Part A.

Muller, J.E. & J.A. Jeletzky. 1970. Geology of the Upper Cretaceous Nanaimo Group, Vancouver Island and Gulf Islands, British Columbia. Geologic Survey of Canada, Dept. of Energy, Mines & Resources, Ottawa, Ont.

Munn, W.D. 1976. Natural History Objectives, First Approximation. (Draft), Parks Branch, Dept. of Recreation & Conservation, Victoria, B.C.

Ovaska, K.E. 1987. Social Behavior of the Western Red-Backed Salamander, Plethodon vehiculum. PhD Thesis, Dept. of Biology, Univ. Victoria, Victoria, B.C.

Parks & Outdoor Recreation Division. 1973-76. Flora and Fauna Reports. Misc. reports filed in Jan., 1973, Apr., 1974, Apr., 1975, Jan., 1976 regarding natural features in Goldstream Park; B.C. Parks Branch, Victoria, B.C.

Parks & Outdoor Recreation Division. 1979. Vancouver Island Regional Interpretation and Information Plan, Vol. 1. Interp. & Info. Div., Program Development Section, Ministry of Recreation & Conservation, Victoria, B.C.

Parks & Outdoor Recreation Division. 1980. Goldstream Park: A Guide to the Teachers' Resource Kit. Ministry of Lands, Parks & Housing, Victoria, B.C.

Parks & Outdoor Recreation Division. 1986. Goldstream Park Master Plan. South Coast Region, Ministry of Lands, Parks & Housing, North Vancouver, B.C.

Plasterer, H.P. (undated) Fort Victoria, From Fur trading Post to Capital City of British Columbia, Canada. Colonist Printers Ltd., Victoria, B.C.

Roemer, H.L. 1972. Forest Vegetation and Environments on the Saanich Peninsula, Vancouver Island. PhD Thesis, University of Victoria, Victoria, B.C.

Scagel, R.F. 1971. Guide to the Common Seaweeds of British Colubia. Handbook No. 27, B.C. Prov. Museum, Victoria, B.C.

Scofield, W.B. 1969. Some Mosses of British Columbia. Handbook No. 28, B.C. Prov. Museum, Victoria, B.C.

Shuttles, Wayne. 1960. Variations in Habitat and Culture on the Northwest Coast. Paper presented at 34th International Congress of Americanists, Vienna, Austria.

Spriggs, W.M. 1985. The History of the Greater Victoria Water Board. Unpublished notes in Freeman King Nature House files.

Sterling, D. 1965. Birding on Vancouver Island. Canadian Audubon, 1973 Revised Monograph.

Sterling, D. 1974. Notes on the Birdlife of the Royal Roads Military College Area. Parks Branch, Dept. of Recreation & Conservation, Victoria, B.C.

Szczawinski, A.F. & A.S. Harrison. 1972. Flora of the Saanich Peninsula. B.C. Prov. Museum, Ocass. Paper No. 16, Victoria, B.C.

Taylor, T.M.C. 1963. The Ferns and Fern-allies of British Columbia. Handbook No. 12, B.C. Prov. Museum, Victoria, B.C.

Trewartha, G.T. 1954. An Introduction To Climate. McGraw-Hill Book Co., New York, N.Y.

Valentine, K.W.G. et al. 1978. The Soil Landscapes of British Columbia. Resource Analysis Branch, Ministry of Environment, Victoria, B.C.

Victoria Natural History Society. 1984. Checklist of Victoria Birds. Victoria, B.C.

Waddell, Jane. 1987. Hiking Trails I, Victoria and Vicinity. Outdoor Club of Victoria, Trails Information Society, Victoria, B.C.

Way, D.S. 1973. Terrain Analysis. Hutchinson & Ross Ltd., Stroudsburg, Pennsylvania.