A FRAMEWORK PLAN FOR COASTAL ZONE MANAGEMENT

Regional District of Comox-Strathcona

by
William M. Marsh
Alison M. Mewett

Regional District of Comox-Strathcona
350-17th Street
Courtenay, B.C.
V9N 1Y4

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Foreword

This report was prepared in response to the growing need for a rational approach to coastal zone management on the east coast of Vancouver Island. It is intended to serve planners, landowners, and communities in dealing with problems of facility siting and design in waterfront locations.

We propose a model of the coast siilar to that used for watershed; that is, a geomorphic system characterized by flows of water and sediment set into a stage of interrelated landforms. Although most approaches to coastal zone management are marine oriented, and often overwhelmingly so, our approach has a more terrestrial orientation with land use as the main target.

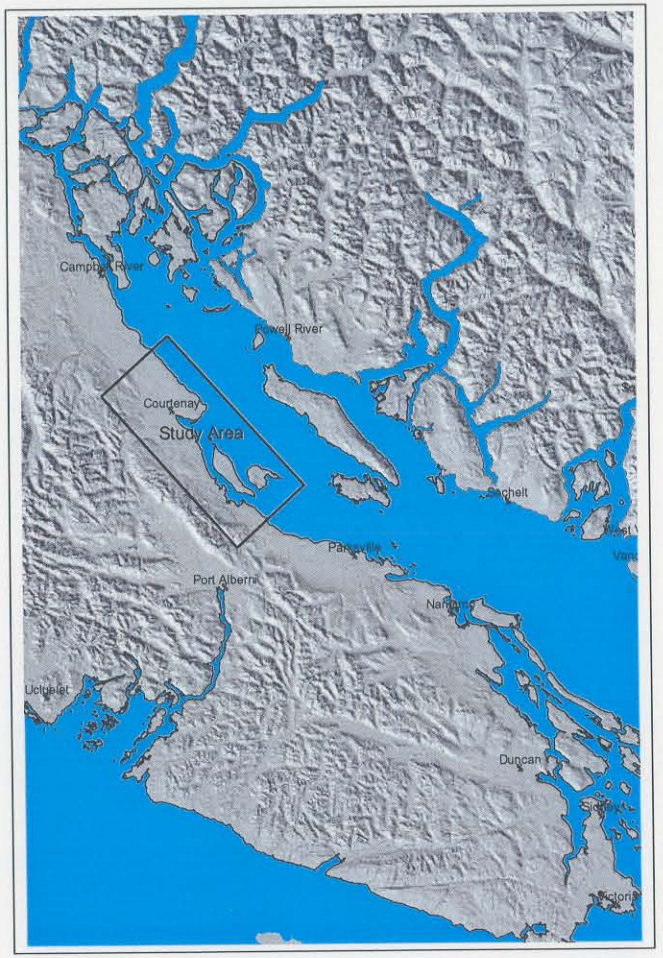
This report represents the first step in building a coastal zone plan for the Regional District of Comox-Strathcona. The next steps are discussed on page 21.

Funding assistance for this report was provided by Georgia Basin Ecosystem Initiative (GBEI).

Although specialized terminology is kept to a minimum some scientific terms are used in the text. A definition of terms is provided on page 21.

William M. Marsh is Professor of Landscape Architecture, Centre for Landscape Research, the University of British Columbia, Vancouver, B.C.

Alison M. Mewett is Supervisor of Environmental Planning and Parks, Regional District of Comox-Strathcona, Courtenay, B.C.



The Study Area *on the east coast of Vancouver Island with photographs of typical coastal scenes, notable for its absence of rocky shorelines. The vast majority of this coast is privately owned and the principal land use is residential. The photographs were all taken at low tide.*

COASTAL ZONE MANAGEMENT

Problem Statement

More than half the population of Canada and the United States lives within 100 km of a coastline. Despite our improved scientific understanding of coastal environments, property and environmental damage continues to rise as development presses into shorelands [1]. Conventional regulations such as setback restrictions have helped protect this environment, but most do not address the coastal zone as an natural system with significant differences from place to place in its make up and dynamics. Moreover, attempts to formulate more sophisticated approaches to coastal zone management have resulted in programs far too complex for planning application in the public arena.

Most planning policy pertaining to the landscape is feature oriented. It treats the terrestrial environment and its aquatic features largely as static entities by focusing almost exclusively on their distribution, form, and composition with little attention to essential processes and systems.

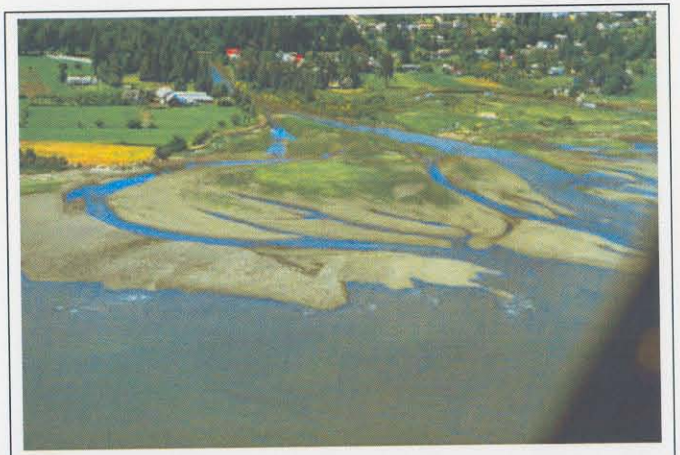
For example, in the Regional District of Comox-Strathcona (RDCS) the "Flood Protection Bylaw" requires a construction setback of 15 m (50 ft) from the ocean shoreline, unless a shoreline protection device is installed and then the setback requirement is reduced to 7.5 m (25 ft). This approach does not take into account the implications of these rules in terms of the larger dynamics of the shoreline where change is the rule rather than the exception. That is, in terms of the variability and balance of the critical systems of waves, currents, and sediment that govern the coastal environment and shape its beaches and habitats.

[2] *These shoreline protection devices have not only changed the shape and make up of the shore, but have destroyed much of its beauty and terrestrial ecology and may also have accelerated wave erosion of neighbouring properties.*

The RDCS recognizes that allowing construction too close to the shore invariably leads to at least the perceived need to install shoreline protection devices in order to stop erosion. But the RDCS also recognizes that the construction of shore protection devices commonly results in the degradation of the shoreline habitat, alteration of geomorphic functions, and loss of scenic and recreational quality [2].

[1] *Development wedged into a narrow and vulnerable section of shoreline. Land use pressure is forcing development into high risk sites that are prone to storm damage, erosion, and drainage problems.*

The shoreline is not a static interface between land and sea, but one that fluctuates in different amounts and directions over time [3]. Fluctuation may be predominantly in one direction (either seaward or landward) or it may be in alternating directions, that is, expanding and contracting, with no significant net change in either direction. And fluctuations may be large or small. Setback requirements must be sensitive to these dynamics if they are to protect natural features, related processes, and land use facilities. This study is an attempt to formulate a coastal zone management program for the eastern shore of Vancouver Island based on the configuration of the longshore sediment system, or what is commonly called longshore drift system [4]. In most places longshore drift systems are long and complex and do not lend themselves to planning and management schemes because of jurisdictional problems and definitional complexities, among other things. But those in this region are relatively small, covering only 4 to 5 km of coastline and including one or two sediment source areas and a single sediment sink. These longshore cells are small enough and operationally simple enough to serve as framing systems for coastal planning and management in much to same way local watersheds are used in some communities as the framing systems for land use and water management planning.

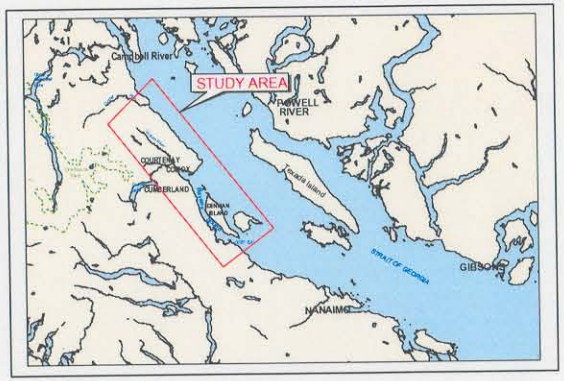


[3] *The shoreline is not a static line between land and sea but a dynamic interface that shifts seaward and landward over various time intervals.*

[4] *The heart of a longshore sediment system where winter storms move sediment along the coast and into the harbour in the background.*

Objectives

In this study we propose to illustrate how to build a system-based methodology that recognizes the processes and systems that shape the coastal zone. It contrasts with most approaches to coastal zone management planning in as much as it is not based solely on the form, composition, and ecological features of the coast. Our aim is to experiment with an approach that uses drift sectors or cells as the framework for a coastal zone management program for the 80 km section of shoreline between Deep Bay and Salmon Point.



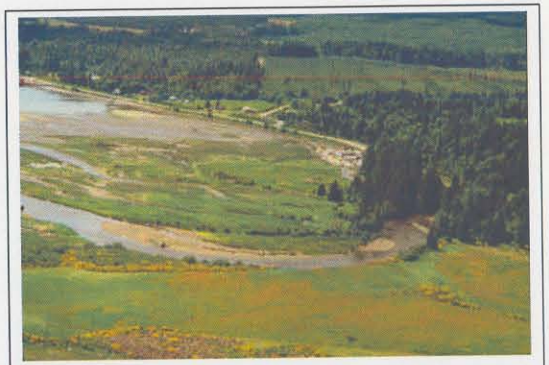
What We Are Trying to Protect

There are three principle reasons for a local government to become involved in coastal land management. These are to protect public resources, to protect the environment, and to limit liability exposure arising, for example, from law suits allowing construction on shores that subsequently are severely eroded.

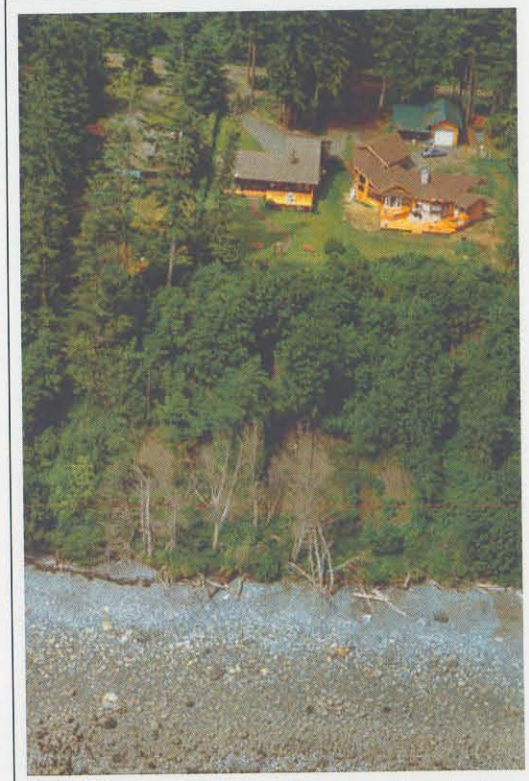
The coast provides various public resources. These include features and conditions such as historical and archaeological features, recreation resources, and scenic amenities, that are highly valued by the general public. For obvious reasons the coast was very significant to native North Americans. Abundant archaeological features such as middens and settlement sites attest to this. In modern times, the public is drawn to the coast for recreation, residential, and commercial reasons. Thus access to the coast and the protection of coastal resources is a premium in our society. At the same time the visual/scenic quality of the coastline and its features are highly valued by BC residents and tourists. British Columbia generates neartly $9 million annually from tourism, much of which is confined on coast lands and waters [5].

The coastal zone is also recognized as a highly productive biological environment. Accordingly, the public gives high priority to protecting the biological (ecosystem) function and features of the coastline [6]. We would argue that equally important is the need to protect the geomorphic function as well, principally the movement of sediment and the formation of beaches, bluffs, and sand dunes. Finally, local government is interested in protecting private property not only for the sake of the landowners but also as a measure of basic risk management. This involves preserving capital investments such as protection of houses from destruction related to erosion, flooding, or slope failure [7].

[5] *Goose Spit, the most popular public beach in the region and an RDCS park. This beach is fed with sand supplied by the longshore system shown in photograph 4. Should that system be interrupted, the beach could decline*



[6] *The delta of Tsable Creek, a diverse and productive complex of habitats which are vulnerable to pollution from both aquatic and terrestrial-based land uses.*

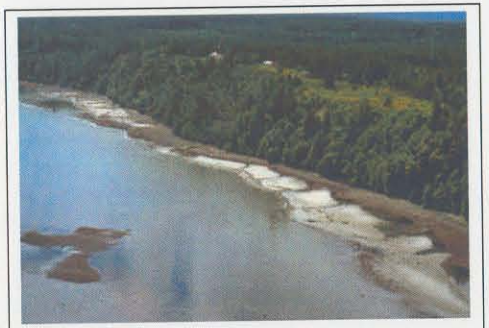


[7] *A high bluff north of Kye Bay. Such bluffs are marginally stable and thus prone to unexpected failures which can quickly consume facilities if they are located too close to the edge.*

Physiography of the Study Area

The entire study area lies within the Nanaimo Lowland, a belt of low-relief ground extending from Nanaimo to Campbell River. The Nanaimo Lowland is underlain by sedimentary rock formations (e.g., shale, sandstone, and coal) that dip eastward under the Georgia Strait. These formations are covered by an irregular mantle of unconsolidated deposits of glacial, interglacial, and marine origins. The modern coastline in the Nanaimo Lowland is cut into these deposits and exposures in bluffs and banks reveal that the dominant material is a glacial till, known as the Vashon Till, which dates from the last (Fraser) glaciation [8].

The Vashon Till is a compacted mass of clay, silt, sand, and larger particles which has a bedrock-like consistency in many places. In wave-cut exposures it often stands vertically and retreats by collapse from undercutting by storm waves. Where banks are tree-covered, this process is relatively slow but along barren banks and bluffs, it can work at rates of 20 to 50 cm per year.



[9] *Sediment sorted by particle size. Here sand and pebbles are being transported northward ahead of cobble-sized particles. Behind the shore is a stable, tree-covered bank, typical of many sediment transport zones.*

On shores with direct exposure to powerful stormwaves, ie., those exposed to storms blowing up the Georgia Strait from the southeast, several hundred meters of retreat have taken place over the past 5,000 years or so. Much of the material eroded from the Vashon Till has gone to the building of beaches, bars, spits, and related landforms. The process involves waves and currents sorting the eroded till into different particle size classes. Clays and silts are washed out and carried into deeper water; sand is transported rapidly downshore where it becomes part of distant beaches [9]. Pebbles and cobbles are also transported downshore, but much less rapidly, especially the cobbles. They go into building extensive cobble/pebble beaches found throughout the area. Finally, the very largest particles eroded from the Vashon Till, the boulders, which are too large to be moved by even the largest waves, are left behind as markers of the former shoreline. Boulder belts can be seen during low water periods along many shorelines in the study area.

Sediment is also contributed to beaches by streams discharging into Georgia Strait. These stream have cut channels into the Vashon Till, removing assorted sediment, much of which is deposited in deltas (see photograph 3). From these deltas, the sediment is redistributed by waves and currents and incorporated into beaches, but the rate varies dramatically depending on exposure to storm waves and sediment size. Large streams such as the Oyster River deliver large loads of cobbles to the ocean which form relatively resistant deltas.

[8] *An exposure of Vashon Till on a high bluff at Cape Lazo. Cobbles and boulders litter the beach after finer sediment has been washed away by wave*

Habitats of the Study Area

Terrestrial and marsh habitat are also an important consideration in coastal zone management. The eastern side of Vancouver Island is part of a major flyway, the Western flyway. Various shore types, and in particular mudflats and spits, are critical bird habitat for migrating birds. In addition terrestrial forests along bluffs and banks are critical habitat for birds such as the bald eagle and blue heron that nest and hunt along the shore. Other wildlife such as mink, raccoons, and ungulates such as deer and elk also require access to the shore. Finally, some of the most sensitive and picturesque ecosystems in British Columbia are located along the shore. These include the 'sparsely vegetated' and 'terrestrial herbaceous' ecosystems such as wind-swept bluffs and exposed bedrock which are sometimes referred to as coastal prairie habitat.

There are three basic types of habitat in the study area: sandy shore in accretion and transport zones; cobble and pebble shore in erosional and transport zones; and muddy shores in bays and estuaries (particularly in low energy areas). All three habitats are characterized by unstable (i.e., beach material that shifts with wave action) and stressful moisture and thermal conditions in the tertidal zone. As a result, the benthic communities tend to be relatively poor in species an biomass, however, there is considerable variability both within and among the three habitats. Cobble and pebble shores are generally the poorest habitat, especially in erosional zones. Common organisims of the intertidal zone include red algae, barnacles, kelp crab and anemomes. Sandy shores are also poor habitat, but in accretion zones where sand is accumulating, the backshore is attractive to moss, dune grass, flowering herbs, and shrubs. Muddy shores are by far the richest habitat in the study area in terms of biomass and productivity. Biomass here may be two times or more greater than that on sandy and stony shores. Burrowing creatures are abundant. Common benthic animals include worms, clams, oysters, cockles, and mud shrimp.

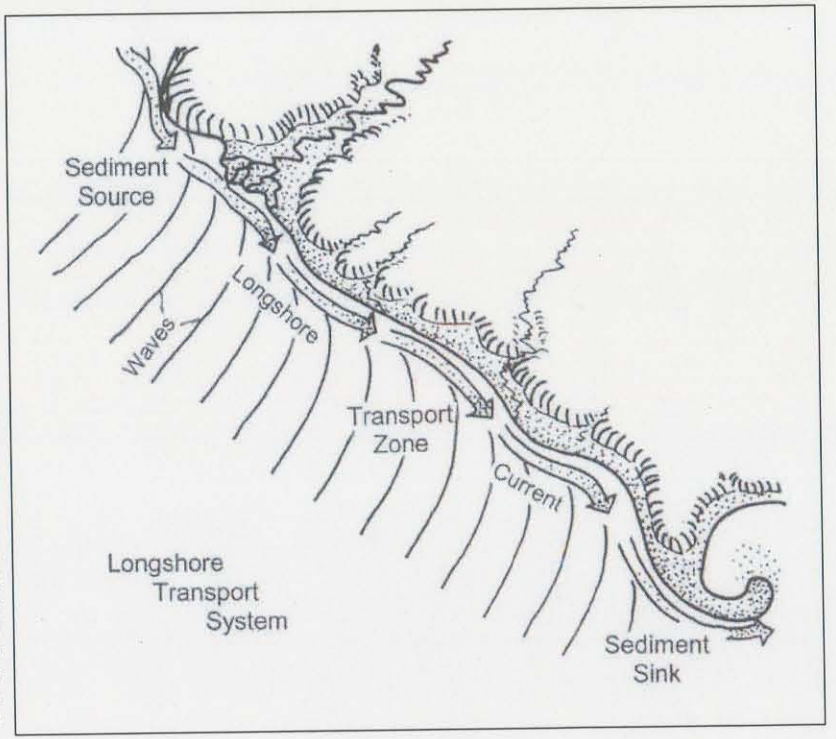
Current Approaches to Coastal Zone Management and Resultant Problems

Several different approaches to coastal zone management have already been developed by various agencies in the Georgia Strait-Puget Sound Region. Three of these approaches were reviewed for potential application in the Regional District of Comox-Strathcona: the British Columbia "Physical Shore-Zone Mapping System" as developed by the Resource Inventory Committee (RIC); the Washington State "Coastal Zone Management"; and the Capital Regional District document "CRD Coastal Management: The Marine Shorelands of the Capital Region".

The RIC system, although valuable for other purposes, is not useful in this context. The information is too detailed for making land use decisions, (eg., dozens of different shoreline types are identified that do not logically relate to different land use management policies.) Moreover, specialized training is needed to map and interpret data, neither of which is generally available within local government staff. And finally the RIC system is ecologically based, and does not address the formative geomorphic systems, the very agents by which the littoral habitats themselves are created.

The Washington State Coastal Zone Management program is an attempt to use geophysical data, such as those in the RIC system, to create management policies. It is a very lengthy document, too complex to use or readily adapt to local land use planning decisions, overly detailed for land use planning purposes, and again requires specialized training to map and implement. Moreover, it is ecologically based and does not address the longshore system.

The CRD Coastal Management document provides a very short and easily understood outline of the shoreline types within the Capital Region. Additionally, the shoreline typology is based on the geomorphic function rather than ecological conditions. However, the data set omits some key information. For example, because shore types are not mapped, the program does not take into account the exposure level of various shoreline types, and it fails to recognize streams as sediment sources.



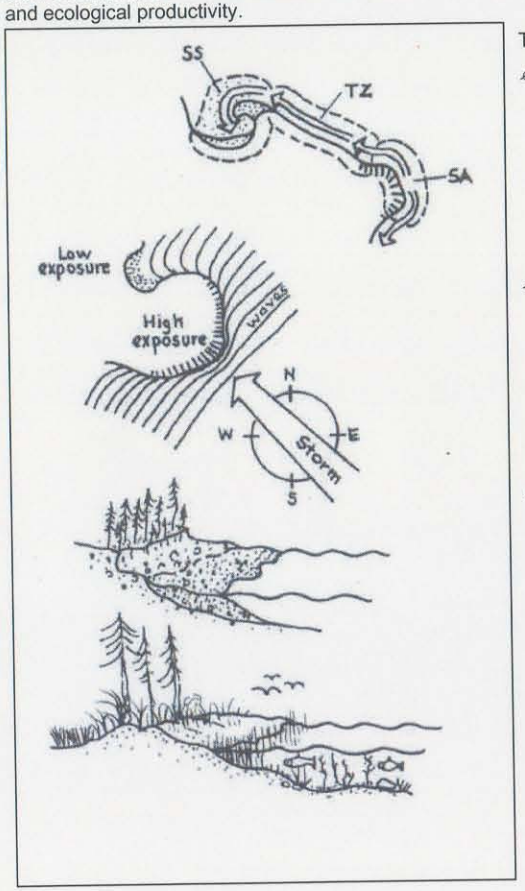
Search for Methodology

Can we approach the coastal zone in the way we approach watersheds by beginning with the defining system? In a watershed it is the drainage network – streams linked to streams carrying flows of different magnitudes. In the coastal zone it is the system of waves and currents that set up longshore or drift systems. Just as every stream reach belongs to a drainage net, every segment of a shoreline belongs to a drift system of some size. Each of these systems has three basic parts: (1) a sediment source area; (2) a transport zone; and (3) a sink.

Longshore sediment systems, or drift cells, are the primary drivers of shorelines, governing the movement of sediment, the distribution of forms and features, and the dynamics of the littoral zone. Most longshore systems are long and complex, but those in this Regional District are relatively small-scale. They are best characterized as circulation cells that operate more or less as partially-closed systems. The location and configuration of cells can be based approximately on the patterns of storm waves, the orientation of the shorelines, and the distribution of coastal landforms such as eroding bluffs, beaches, and sand spits. Valuable insight was also provided by Professor Wolf Bauer of the University of Washington, who in 1979 prepared a report on the shorelines of east Vancouver Island in which coastal trends and features are described section by section.

Mapping Methodology

The proposed system employs three main steps. The coast is first subdivided into longshore cells within which sediment source area/s, transport zone, and sediment sink are defined. Second, each cell is ranked according to its relative energy level based on exposure to winter storm waves. This is necessary to understanding the potential for shoreline change such as bank erosion and shoreline retreat in sediment source areas. Within this framework the shoreline within each cell is classified, segment by segment, according to composition morphology and ecological productivity.



The mapping layers are as follows:

- Drift Cells – defining each drift cell and within each drift cell the sediment source area/s (SA), transport zone (TZ) and sediment sink (SS) area/s.

- Exposure – determining the relative energy level of each drift cell based on the exposure to the dominant wind (in this region the weather systems that create the vast majority of sediment movement and related landforms are low pressure cells which in winter generate powerful winds from the south-east). Each drift cell is rated as a high, medium or low energy system.

- Shore type – categorizing each segment within the drift cell based on its general form and composition. This involves rating each segment based on its relative stability, that is, whether it is highly erodable (eg. sand / gravel beach or bluff) or fairly stable (eg. cobble/boulder beach or rock shoreline).

- Ecology – categorizing each segment based on its relative ecological value, that is, whether it is a highly productive or less productive area.

Finally a synthesis of each section can be determined by common typology to determine the appropriate land use management guidelines, including appropriate setbacks for proposed land uses.

Application Framework

The study area (Deep Bay to Salmon Point) is divided into three broad coastal zones based on relative exposure to south-east winter storms. These zones are a low energy zone between Deep Bay and the Courtenay River estuary; a high energy zone between Goose Spit and Kye Bay; and a medium energy zone between Little River and Salmon Point. This study reviews a typical section within each zone.

A. Low Energy Zone - Deep Bay to Fanny Bay

Description: This section of shoreline is comprised of several deep bays, a prominent headland, cobble beaches, broad tidal flats, and numerous stream deltas. Denman Island, located 1.5 to 2.5 km to the east, provides protection from the south-easterly winter storms. The sound between the Denman and Vancouver Islands (Baynes Sound) is biologically rich and has become B.C.'s principal site for oyster finishing, producing about 80 percent of the Province's oysters.

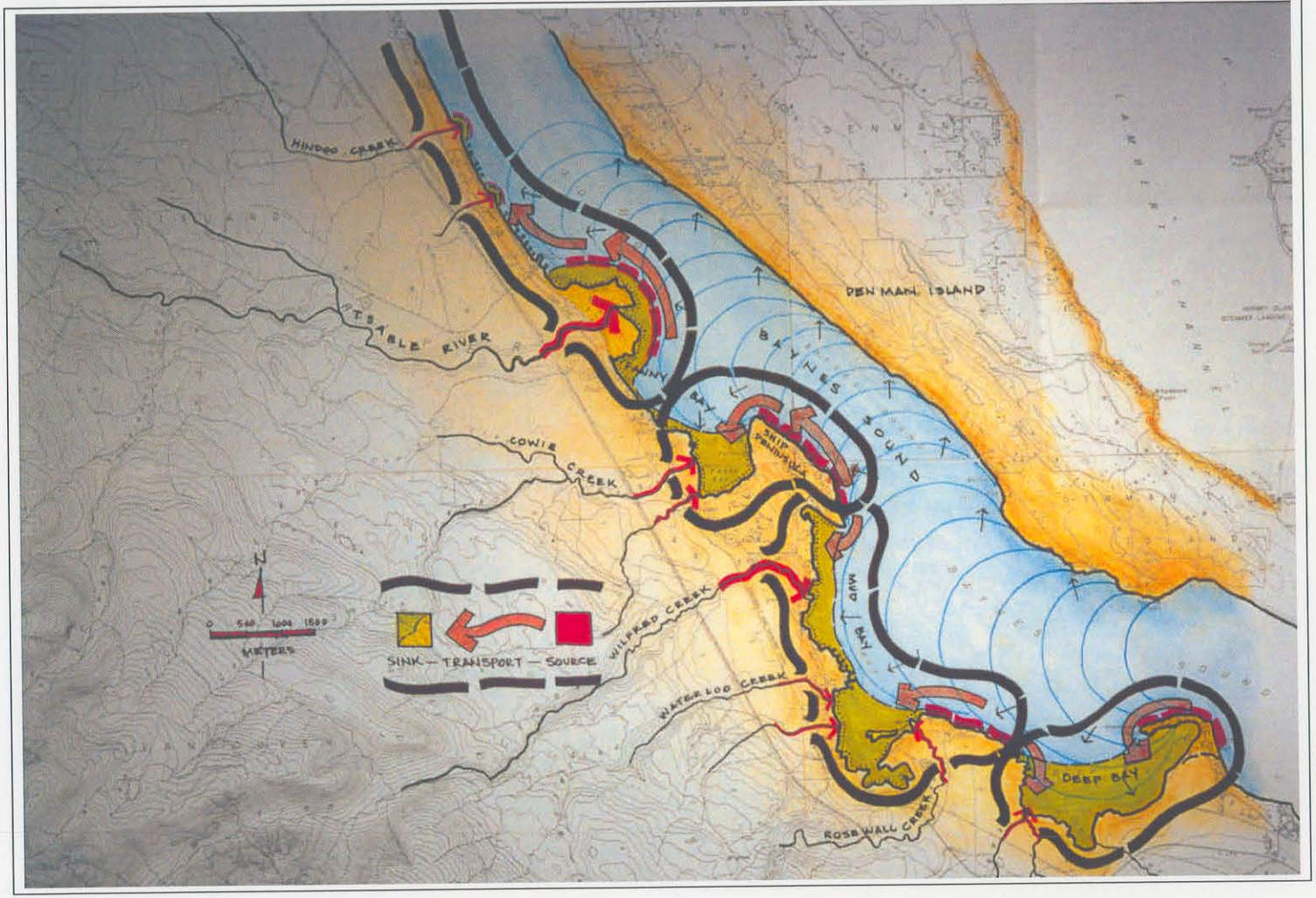
Drift Cell: This area is made up of several interconnected drift cells. The primary sediment sources are stream deltas. The longshore drift system is driven primarily by the winter winds from the south-east. Waves are refracted along the coast resulting in a predominately northward littoral drift. Waves also refract around the northern tip of Denman Island resulting in a weaker southward littoral drift. The primary sediment sinks are Deep Bay, Mud Bay and Fanny Bay.

Exposure: This is a low energy shoreline because the coast is protected by Denman Island and the resulting fetch is short in all directions. Much of the sediment delivered by the streams remains in the bays and in large subaerial deltas at the mouths of streams such as the Tsable and Trent rivers.

Shore Type: The shoreline is comprised of short to moderate reaches of cobble beaches backed by low banks. These beaches are interspersed with embayments marked by broad, marshy tidal flats [10]. There appears to be little change in the shoreline from year to year; frontage properties have been stable for decades.

Ecology: Large mud flats have formed in the bays from stream and longshore sediment accumulation resulting in highly productive aquatic habitat. Baynes Sound is also a major area for herring spawning and the streams support salmon runs.

[10] *Typical shoreline in a low energy zone. Protected from powerful stormwaves, sediment accumulates in broad tidal flats at the heads of embayments which serve as rich habitat for benthic and other organisms.*



Study Area A *lies in the lee of Denman Island where it is protected from southeasterly storms. The longshore system is characterized by several small cells and transport is weak overall with accumulations in bays and deltas.*

B. High Energy Zone - Goose Spit to Kye Bay

Description: This section of shoreline is comprised of two sections of high bluffs, stretches of cobble beaches, a large sand spit, and two sections of Class I, sandy beaches. The shoreline has maximum exposure to south-east winter storms. The two beaches are highly valued recreation areas with frequent activity more or less year around.

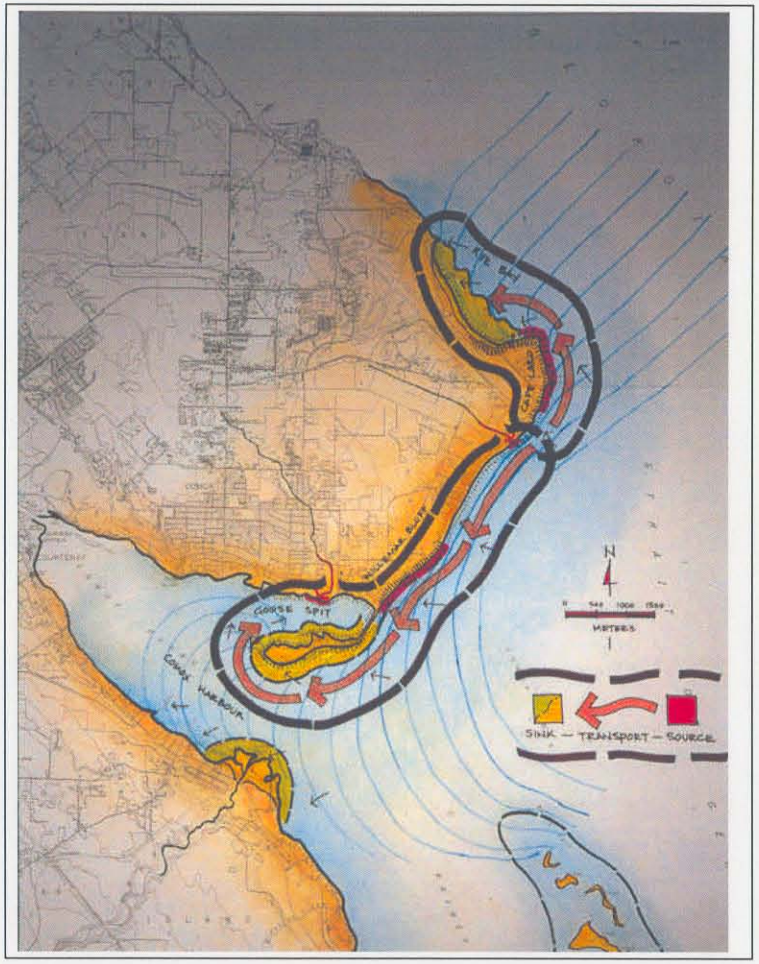
Drift Cell: This area is made of up two interconnected but largely self-contained drift cells. The primary sediment sources for both are the eroding bluffs, Willemar and Cape Lazo. Both longshore drift systems are driven by the winter storms from the south-east. The waves are refracted to the south-west and to the north-east. The south-west sink is a large sand spit (Goose Spit) at the mouth of the Comox Harbour [11]. The north-east sink is a bay (Kye Bay) immediately to the north of Cape Lazo.

Exposure: The shoreline runs perpendicular to the south-east winter winds and the fetch is considerable (more than 100 km), resulting in a high energy shoreline. The bluffs are receding (at one spot as much as 6m (20 ft) in one year) resulting in a large volume of sediment which goes into beaches at Goose Spit and Kye Bay.

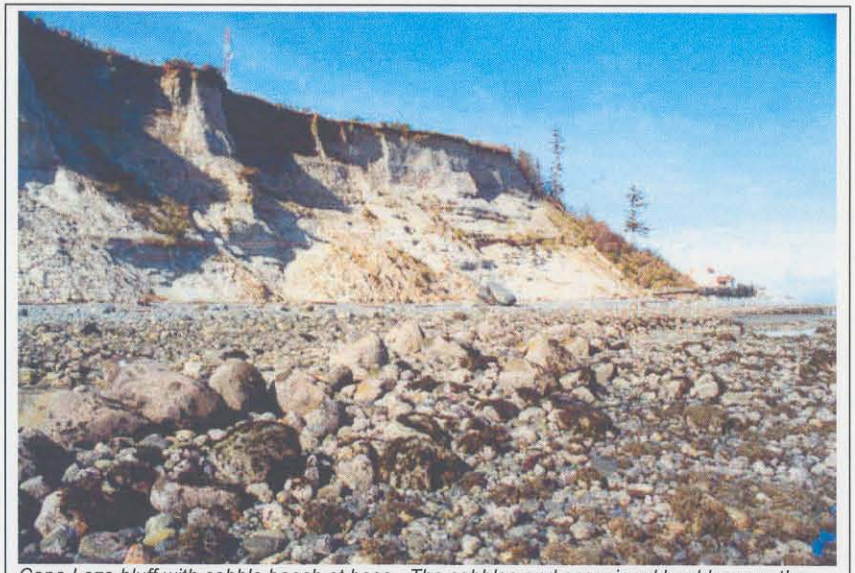
Shore Type: High bluffs comprise about one third of the shoreline. The remainder is sand beaches mixed with sand/gravel and cobble beaches all of which are backed by low banks. The result is a combination of very unstable bluffs and highly active transport beaches. In addition, wind erosion is pronounced along barren sections of the high bluffs.

Ecology: This is a relatively unproductive shoreline with little intertidal vegetation. Only one small stream discharges to the ocean in this zone, and it supports a very small salmon run.

[11] *Typical high energy shoreline. Sediment is delivered to Goose Spit (in background) from exposed sections of Willemar Bluff such as the one on the lower right.*



Study Area B *is oriented perpendicular to southeasterly storm waves. Willemar Bluff and Cape Lazo are the two main sources of sediment and Goose Spit and Kye Bay are the two main sediment sinks.*



Cape Lazo bluff with cobble beach at base. The cobbles and occasional boulders are the residue from erosion of the Vashon Till which makes up much of the bluff.

C. Medium Energy Zone - Black Creek to Salmon Point

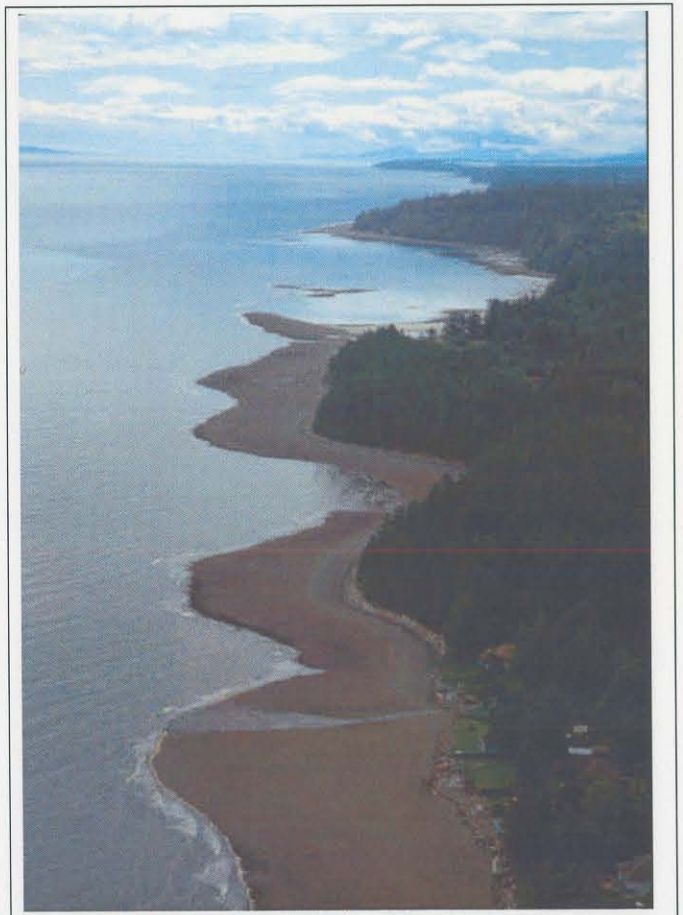
Description: This section of shoreline is oriented northwest-southeast. It has fairly uniform alignment with no deep bays or prominent headlands, though shallow bays are common. The shore is comprised of long stretches of sand, sand/gravel and cobble/boulder beaches [12].

Drift Cell: This area is made up of several sub-cells that form part of the larger longshore drift system. There are two primary sediment sources. The first is sediment from the south, mainly from Kye Bay, and the second is sediment from streams, mainly the Oyster River and Black Creek. The longshore drift system is driven by winter storm winds from the south-east. Waves are refracted into a northwest orientation along the coast resulting in a predominately northern littoral drift. The primary sinks are the windward sides of the stream deltas (which act in the same manner as a groin), small bays, and deeper water north of Salmon Point. Sediment also shifts southward in summer, though the amount is smaller than the northward transport of winter.

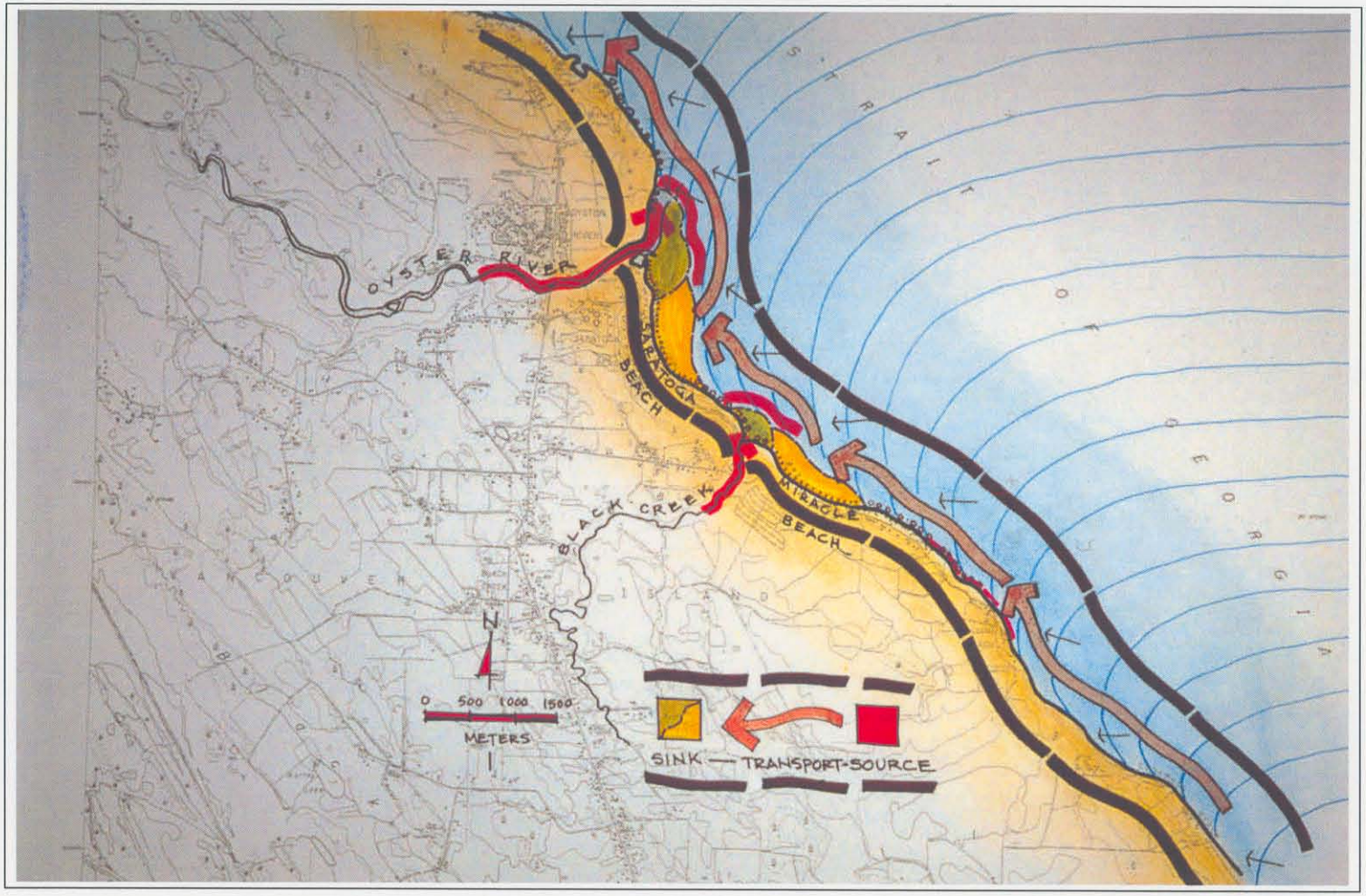
Exposure: As the shore is more or less parallel with winter storm winds, it is ranked as a medium energy. The result is a relatively stable shoreline but one in which beach width varies or wobbles somewhat over time, a common trait of transport shorelines. The magnitude and frequency of this wobble motion is not known. Based on indicators such as tipped and undercut trees, it appear that some sections at this time may also be slowly retreating.

Shore Type: The shoreline is comprised of fairly low banks and moderate-sized (10-20m) forested bluffs with cobble/boulder beaches within the transport zone and sand beaches in the sinks and near deltas.

Ecology: The deltas are highly productive aquatic and bird habitat. Both the Oyster River and Black Creek support sizeable salmon runs. The beaches are less ecologically active with roughly moderate to low productivities.



[12] *Study Area C looking southward. This is a medium energy shoreline, oriented roughly parallel to winter storm waves from the southeast. Beach composition ranges from sand to cobbles.*



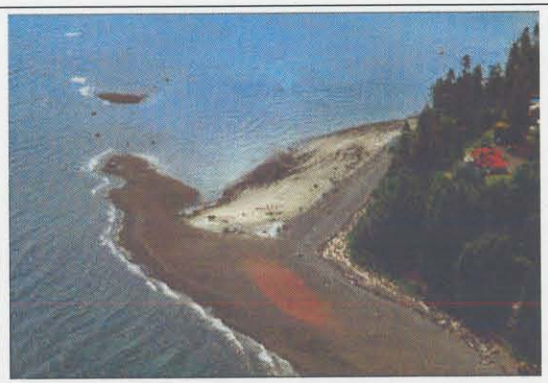
***Study Area C** is predominantly transportational with small sinks in shallow bays and 'behind' deltas. Sediment is supplied from Key Bay and stream deltas and most is driven northwestward by winter storms from the southeast.*

Proposed Management Program

The following management policy recommendations are based on selected observations from this study:

1. Appropriate setbacks will help protect property values and reduce the need or desire for shoreline protection structures. Such structures often disrupt the longshore system, especially the beach drift component, and degrade shore and backshore ecology. Appropriate setbacks will also help preserve the scenic integrity of the shore and the terrestrial coastal habitat [13];
2. Disruption of the longshore system may result in diminished supply of beach sediment and in turn decline of highly valuable foreshore recreation areas[14];
3. Terrestrial ecology of the coastal zone is closely tied to natural vegetation on the shore, backshore, and beyond. It is important for wildlife food, cover and habitat as well as bank stability against erosion [15].

[13] *Inappropriate setback. Greater setback distances would reduce landowners urge to construct shore protection devices.*



[14] *Interruption of sand transport by harbour facilities or other structures downshore can lead to the loss of beaches such as this one. Deprived of sand supplies, beaches can "dry up" altogether.*

[15] *A forested bank which is being threatened by erosion from runoff coming from the deforested strip behind it. Maintenance of vegetation in the coastal zone is critical to bank stability and habitat conservation.*

The general assumption is that high energy source areas are retreating, sinks are accreting, and transport zones are more or less stable or "wobbling" (that is, eroding and accreting at various intervals with no appreciable change over several decades). The actual rates of change for various shorelines will be documented using historical aerial photographs. These include reviewing each of the nine primary shoreline types: High Energy Zones – sediment sources, sediment transport segments, sediment sinks; Medium Energy Zones – sediment sources, sediment transport segments, sediment sinks; and Low Energy Zones – sediment sources, sediment transport segments, and sediment sinks.

Based on the above observations the following management policies are proposed as a first approximation:

EROSION (Retreating) SHORELINES

Shore Type	*Recommended Land Use Management Policy*
 Low Energy: ✍ stable shoreline ✍ sediment is introduced from streams and, to lesser degree from shoreline erosion. The sediment tends to accumulate (as illustrated by Hindoo Creek delta in photograph), with only small amounts of sediment lost to erosion ✍ longshore sediment transport is light	✍ Maintain natural vegetation to minimum 7.5m (25ft) from high water mark (HWM) ✍ Minimum construction setbacks of 15m (50ft). ✍ Protect from pollution, with minimum septic drainfield setbacks of 15m (50 ft) and no fertilizer or pesticide use in same area. ✍ Ensure septic fields are well maintained. ✍ Hardening of the shoreline should be prohibited. ✍ Groynes and similar structure are unnecessary and should be discouraged. ✍ Filling of marshes and tidal flats should be prohibited.
 Medium Energy: ✍ moderately stable shoreline ✍ sediment is introduced from streams and, to a lesser degree, from eroding shorelines. The sediment creates a delta (the Oyster River delta is shown in photograph) but the delta shifts over time and is underwater during high tide. Although large quantities of sediment may be released to the beach from the delta, the quantity delivered by large streams surpasses the quantity removed by storm waves. Hence, deltas build seaward and act as barriers to longshore transport. However, deltas are unstable, changing seasonally and with major storms. Notice that sediment is trapped behind the delta (in this case Saratoga Beach).	✍ Maintain natural vegetation to minimum of 15m (50 ft) from HWM ✍ Minimum construction setbacks of 30m (100 ft). ✍ Protect banks from water loading related to septic drainfields, irrigation, and storm drainage. ✍ Shoreline protection devices should be discouraged in favour of vegetation for banks and backshore areas. ✍ If banks need stabilization assistance, native materials (plants, rock, wood) and ecologically sensitive designs should be used. ✍ Groynes could have a serious impact on downshore beaches and should be prohibited.
 High Energy: ✍ unstable shoreline with active bluff and bank erosion. This should include potentially unstable, or metastable, banks and bluffs that are held in place by one or two factors such as a tree cover without which failure is imminent. ✍ sediment is introduced from streams and eroding shorelines. In both cases the sediment is removed from the shore very quickly; hence, the absence of prominent deltas. High energy shorelines can provide huge volumes of sediment to the longshore system. ✍ erosion and shoreline retreat rates may rise with higher ocean levels and greater storm magnitude and frequencies in the next two or three decades	✍ Maintain natural vegetation on backshore to minimum 15m (50 ft) from top of bank or 25m (80 ft) on banks/bluffs higher than 15m (50 ft). ✍ Minimum construction setbacks of 60m (200 ft). ✍ Protect banks from water loading related to septic drainfields, irrigation, and storm drainage. ✍ Shoreline protection devices should be discouraged in favour of vegetation for stabilizing banks, bluffs, and backshore areas. ✍ If banks need stabilization assistance, native materials (plants, rock, wood) and ecologicaly sensitive designs should be used. ✍ Groynes should be prohibited to quard against interrupting the supply and movement of sediment.

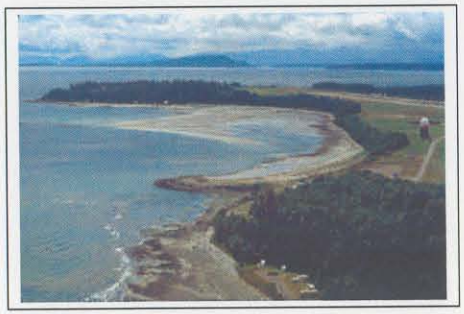
TRANSPORTATION SHORELINES

Shore Type	*Recommended Land Use Management Policy*
Low Energy: ✍ stable shoreline ✍ longshore sediment transport is light. This is evidenced, for example, by the absence of sediment buildup behind the Baynes Sound shellfish groynes shown in the photograph ✍ highly productive aquatic habitat; valuable grounds for shellfish industry	✍ Maintain natural vegetation on shore to minimum 7.5m (25 ft) from high water mark (HWM) ✍ Minimum construction setbacks of 15m (50 ft) from HWM. ✍ Protect from pollution with no fertilizer or pesticide within construction setback and ensure septic fields are well maintained. ✍ Hardening of the shoreline should be prohibited. ✍ Groynes and similar structure are unnecessary and should be discouraged.
Medium Energy: ✍ moderately stable shoreline but some 'wobble' can be expected ✍ large volumes of sediment moves along the coast ✍ sediment supply supplemented by inputs from small streams	✍ Maintain natural vegetation on backshore to minimum 15m (50 ft) from HWM. ✍ Minimum construction setbacks of 15m (50 ft) from HWM. ✍ Shoreline protection devices should be discouraged in favour of vegetation for stabilizing banks and backshore areas. ✍ If banks need stabilization native materials (plants, rock, wood) and ecologically sensitive BMPs for design should be used. ✍ Groynes could have a serious impact on downshore beaches and should be prohibited.
Shore Type	*Recommended Land Use Management Policy*
High Energy: ✍ relatively stable but considerable 'wobble' is possible ✍ large volumes of sediment moves along the coast ✍ may shoe signs of accelerated wobble and shoreline retreat with rising sea level and increased storm magnitudes and frequencies over the next two or three decades	✍ Maintain natural vegetation on shore to a minimum 15m (50 ft) from HWM ✍ Minimum construction setbacks of 30m (100 ft) from HWM. ✍ Shoreline protection devices (SPDs) should be discouraged in favour of vegetation for stabilizing banks and backshore areas. ✍ If SPDs are used native materials (plants, rock, wood) and ecologically sensitive BMPs for design should be used. ✍ Groynes would likely have a serious impact on downshore beaches and should be prohibited.

ACCRETION (ADVANCING) SHORELINES

Shore Type	*Recommended Land Use Management Policy*
Low Energy: ✍ stable backshore, but shoreline may prograde (advance) and change with sediment accumulation ✍ sediment from source areas is trapped here, as shown in the photograph of the estuary to the right of Goose Spit ✍ sensitive to contamination because pollution tends to accumulate, and due to low flushing	✍ Protect beach for high habitat values ✍ Maintain natural vegetation to minimum 7.5m (25 ft) from high water mark (HWM) ✍ Minimum construction setbacks of 15m (50 ft) from HWM ✍ Protect from contamination with no fertilizer or pesticide use within construction setback and ensure septic drainfields are well maintained. ✍ Hardening of the shoreline should be prohibited. ✍ Groynes are unnecessary and should be discouraged.

Medium Energy: ✍ moderately stable shoreline, e.g. pocket beaches and beaches 'behind' deltas ✍ sediment moved by the longshore system can be trapped here, as shown in this photograph of the Oyster River delta ✍ this type of beach is at risk if sediment supply is cut off due to construction of beach and harbour facilities	✍ Protect beach for public access and recreational use. ✍ Maintain natural vegetation to minimum 7.5m (25 ft) from HWM. ✍ Minimum construction setbacks of 15m (50 ft) from HWM. ✍ Shoreline protection devices should be discouraged in favour of vegetation for stabilizing banks and backshore areas. ✍ If banks need stabilization native materials (plants, rock, wood) and ecologically sensitive BMPs for design should be used.



High Energy: ✍ moderately stable shoreline but highly dynamic sediment system, e.g. pocket beach, bay ✍ sediment from erosion sources is temporarily trapped here, as illustrated in the photograph of Kye Bay (and in the photograph of the beach to the left of Goose Spit above) ✍ this beach type is scarce and highly valuable for recreation ✍ beaches are prone to rapid change and may include sand dunes and abundant drift wood ✍ the dunes are susceptible to damage by construction or destruction of the protective outer berm	✍ Protect beach for public access and recreational use. ✍ Maintain natural vegetation to minimum of 7.5m (25 ft) from HWM ✍ Minimum construction setbacks of 30 m (100 ft) from HWM. ✍ Shoreline protection devices should be discouraged in favour of vegetation for stabilizing banks and backshore areas. ✍ If banks need stabilization native materials (plants, rock, wood) and ecologically sensitive BMPs for design should be used.

Measuring and Evaluating Shoreline Change

The methodology proposed for determining shoreline setbacks and management policies is predicated on the fact that all shorelines are in a state of change, some very slowly, others very quickly, some 'growing' (accretion), some 'shrinking' (erosion), some 'wobbling' (alternately accreting and eroding with no appreciable net change). This necessitates coming up with quantitative data on the behavior of these different types of shorelines. Three approaches can be used to generate such data. The first examines the forms and related features of the coast and identifies which shoreline is erosional, which is depositional, and so on. This is basically the approach we used to build the framework plan presented earlier. It requires insightful interpretation but it dies not provide hard data on rates of change. The second approach relies on field (survey) measurement of the shoreline, year to year. This approach yields data, but it is expensive to acquire and not very meaningful unless the measurement period has covered 10 to 20 years. The third approach uses archival data sources such as old serial photographs and land survey records to measure change rates. Land records in this area data back 100 years or more and aerial photographs date back about 70 years for much of the coastline. A test case was set up using this method. The location selected for study was a section of shoreline located between Cape Lazo and Kye Bay, which is the eastern half of the Zone B high energy system.

The study used archival airphotos to examine the changes to the shoreline over the last 70 years or so. It looked for the rate, type, and possible causes of change including the influence of natural phenomena (such as the 1947 earthquake) and anthropogenic modifications (such as the placement of groynes).

The technique involved overlaying aerial photographs representing different decades to determine whether change could be identified and, if so, how much change took place. This technique is promising but not without problems. For example problems can arise with the airphoto scales (e.g. changes too small for detection on an airphoto can be significant on the ground), with distortion between the edge and the middle of the photograph, and with incompatibility of photos, in scale and orientation, from one year to the next.

The study was able to determine:

a) the trends of change in a section of shoreline; that is, whether the net change was negligible or significant and in what direction (erosion, wobble, accretion); and

b) the net change (e.g. from earliest airphotos (around 1930) to latest airphotos (around 2000) in round numbers, although not the detailed change in the intervening years.

However, the study also showed that in situations where the shoreline change had been relatively small (i.e., less than about 3 meters) the ability to quantify the change was difficult, if not impossible. Additionally, a change of 3.0 m (10 feet) over 70 years amounts to only about 4cm (1.7 inches)/year, which is negligible for most land use planning purposes. However, if this occurs within one or two years it is much more likely to cause serious alarm, even panic, among property owners that often results in the installation of a shoreline protection device.

The study did confirm the assumption about the typology of the shoreline, i.e. the study area is a high energy shoreline which is eroding at Cape Lazo and providing sediment for transport and accretion sections downshore. Cape Lazo itself has retreated, at an uneven rate, by approximately 100 feet during the 70 years of the study. The accretion beaches (Kye Bay) have not significantly enlarged in this time period (indicating that sediment is transferred northward toward Salmon Point) but do show shifting patterns of change. It is also worth noting that beach armouring has taken place in each of the beach types within the study area, indicating at least a perceived need for protection at some time during the 70 years. How much of this armouring subsequently contributed to the need for armouring elsewhere is difficult to tell, but is fairly likely.

Summary

This study offers an approach to building development guidelines for the coastal zone in the Regional District of Comox-Strathcona. It is based on the premise that coastal zone management aimed at land use in this part of the Georgia Basin must address the formative geomorphic systems that shape and change the coastline. Accordingly, the proposed approach uses drift cells as a framework, taking into consideration sediment source areas, transport zones, and sinks and their potential for change based on exposure to high energy winter storms. This is supplemented by data on shore type and ecology. Using these criteria, the shoreline is divided into discrete zones. Development guidelines such as setback distances are applied to each zone.

The main rationals behind this approach include: (1) the ease of data/map interpretation (i.e., the ability to build maps without sophisticated mapping technology); (2) the relative ease of translating the guidelines into RDCS Official Community Plan policies and zoning bylaws; (3) the ease with which the rationale for the guidelines can be communicated to the public as part of achieving 'buy in' and compliance; and (4) the ease of creating a plan/guideline manual.

This methodology offers at least 5 significant advantages: it is system-based, technically replicable, implementable, flexible, and target logical (i.e. not imported from somewhere else). The main disadvantage of this methodology it that it may be limited by geographic scale in terms of application to other coastal regions where the drift cells are large and multi-jurisdictional.

Next steps

Several tasks need attention before this approach can be applied throughout the Regional District. This includes completing this study and 'test driving' this study within the working environment of the Regional District. There are four steps involved in completing the study. First, a complete set of management guidelines must be prepared that are not only appropriate but also include an outline of how they can be implemented (for example, through the Development Permit process) and include a compilation of best management practices (BMPs) for shore and backshore protection, management, and use. Secondly, a cost-effective and easy method for mapping shoreline typology must be developed and applied. And finally, a manual of the final data set must be developed that can help explain the recommended guidelines to politicians and the public.

Definition of Terms

bank: a relatively low backshore slope, generally less than 15 metres high, composed on unconsolidated (non bedrock) material such as glacial till.

benthic: pertaining to habitats and organisms on the sea floor.

bluff: a high backshore slope, generally greater than 15 meters elevation, composed of unconsolidated (non bedrock) material such as glacial till.

BMPs: best management practices; recommended measures used to mitigate the impact of land use on the coastal environment.

drift cell: a discrete part of subset of a longshore sediment system consisting of a sediment source, transport zone, and sediment sink.

erosion: the dislodgement and removal of soil, sediment, or rock as a result of wave action, wind, runoff or glaciation.

exposure: the relative vulnerability of a section of a coastline to wind and waves from a particular direction.

groyne: an engineered structure built seaward from the shore for the purpose of capturing sediment.

HWM: High Water Mark. This is intended to represent the boudnary between aquatic (including shore) and terrestrial environments based principally on vegetation. The elevation of the HWM varies on different coasts depending on the form and elevation, but in general it is thought to correspond to an elevation above the mean high tide mark.

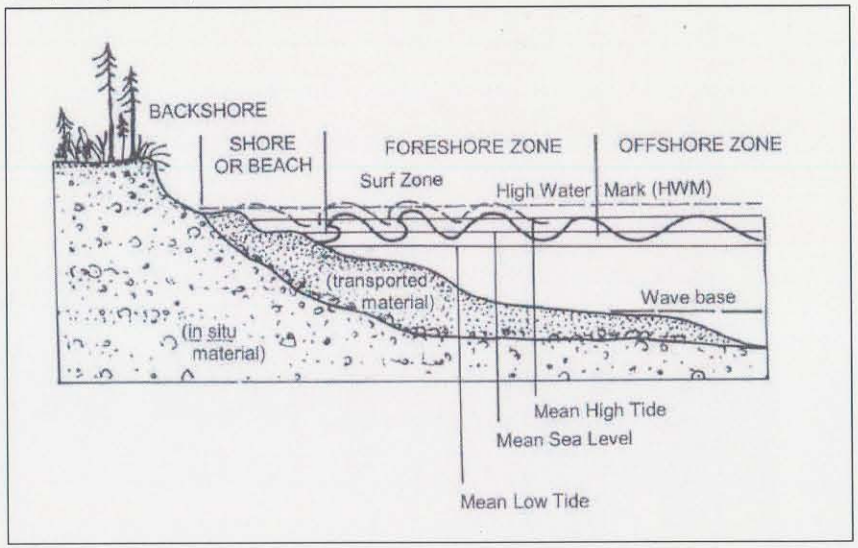
longshore sediment system: the system of sediment movement along a coast consisting of one or more sediment sources, transport zones, and sediment sinks; a longshore system may include several drift cells.

longshore transport: the process of sediment movement along a shore as a result of wave and current action; also called longshore drift.

Nanaimo lowland: the belt of low-relief land extending along the eastern side of Vancouver Island between Nanaimo and Campbell River.

setback: the distance landward of the high water mark which is restricted from development.

Vashon Till: an extensive glacial deposit in the Georgia Basin consisting of a compact mix of clay, silt, sand, cobbles, and boulders.



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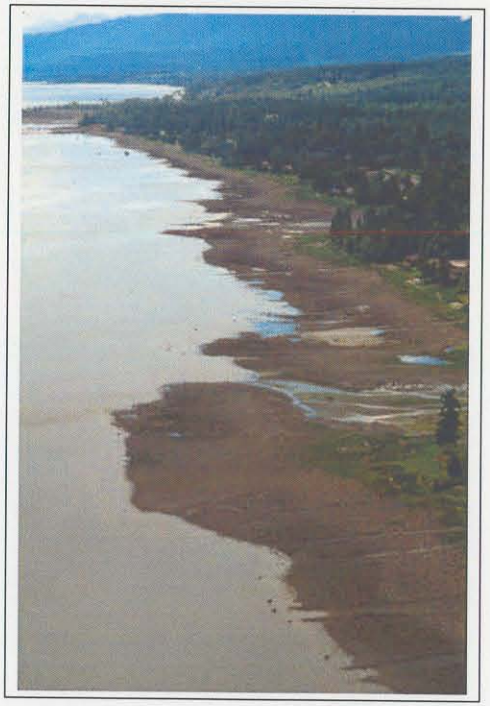
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