The **Stewardship** Series

Coastal Shore Stewardship:

A Guide for Planners, Builders and Developers

on Canada's Pacific Coast

Canada

Province of British Columbia

Lanarc Consultants Ltd.

Spectacular 1.37 Acre Private Oceanfront Point Of Land, Foreshore Lease Plus Dock - Protected Moorage! Sunny (South, Southwest, Exposures - Sunsets Forever!) Warm Ocean Swimming, Low Bank Sculptured Sandstone Foreshore! Easy Care, Totally Irreplaceable, Totally Beautiful!

(This is a real estate advertisement derived from an MLS listing describing a coastal property on Salt Spring Island, Spring 2002)

It is a beautiful picture – and yet the image created in this real estate advertisement is a distant mirage for most of us. It also conveys nothing of the responsibility that goes along with living on the shore. And you will notice that we have left out the price!

The shore, which is where the land and sea meet, is:

- changing constantly;
- crucial to the survival of sea life and many land creatures;
- highly attractive for industrial, residential and recreational development.

If we're to successfully balance the competing interests for this limited resource then we must understand:

- the dynamics that shape the coastal shore;
- the sensitivities of our particular part of the coastal shore;
- the rules that govern development; and
- the best methods for protecting the coastal shore.

This guide is one of a series. It is written for all those who have an interest in the coastal shores of British Columbia.

Good development will:

- save money, time and investment;
- manage risks properly;
- protect natural resources, such as fisheries; and
- ensure the survival of the natural environment for the future.

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Whether you are a homeowner, a developer, a businessperson, a senior government manager or a local government planner, we hope you find this document useful. We all must work together to ensure that coastal resources are cared for, protected, and wisely used.

Whenever a coastal system is damaged or degraded, even temporarily, its repair, recovery and restoration is a cost to everyone. Whatever is lost through our negligence or ignorance is difficult to regain. Whenever something is lost, we narrow the social and economic options for us and for future generations.

The alluring advertisement at the top of the page promises "Totally Irreplaceable, Totally Beautiful!" It's totally true.

About the Chapters

Shores and people – whether you live, work or play along the coast, this chapter highlights some of the reasons why you should contribute to Coastal Stewardship.

Shores are shaped and reshaped every day by the effects of wind and waves, and the movement of sediment. Find out more about these processes, and how they influence the habitat and complex biological systems that are supported by different physical shore types.

Some shores are better able to absorb the impact of development than others. This chapter describes five basic shore types and highlights some of the development sensitivities of each.

The shorezone is complex—physically and biologically the jurisdictional rules can be equally complex. Local governments can have land use bylaws that govern use of the shores and, at the same time, provincial and federal agencies have legislation, policies and guidelines that also apply to these areas. This chapter identifies some of the legislation affecting shores and describes the roles of key shore management agencies.

This chapter provides "hands on", environmentally responsible information for those who plan to work or live near the coastal marine environment, and applies to both commercial and private endeavours.

Coastal living is an important part of the British Columbia lifestyle. This chapter identifies some of the excellent resources that already exist to help us live sustainably while reducing our impact on shores.

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A Stewardship Context

Fisheries and Oceans Canada

Shores are "Living Systems"

This guide often refers to coastal shores as living systems. The planning and development of coastal areas requires a careful understanding of how these systems work. Shores usually change very gradually, but occasionally these changes are dramatic and seemingly unpredictable. We may not be able to forecast the timing or severity of storms or beach erosion but we have a good idea of what can be done to reduce the impacts on people, plants and wildlife. That is what this guide is all about.

Shores have structure, function and process. They are constantly moving, changing and evolving in response to the influence of such external natural forces as winds and tides. The form and dynamics of the physical shore create the conditions for the presence and survival of B.C.'s coastal plant and animal communities. If these biological resources are to be sustained and the integrity of our coastal ecosystems maintained, we must be careful how we use our shores. A cautious approach to development of our coastline recognizes that "when an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." *(Taken from the Wingspread Consensus statement on the Precautionary Principle 1998)*

Note:

Text written *like this* identifies federal or provincial legislation.
Information written *like this* is available on the Internet - refer to the Website Address Insert included in this document for details.

Why a Coastal Shore Stewardship Guide for Planners, Builders and Developers?

Our coastline is home to many people, marine based industries and sensitive marine organisms. The first two interests demand greater access to these areas, yet the latter requires greater protection. The competition and conflict in these areas is increasing under the strain of greater commercial and industrial demands for access to foreshores, more and larger waterfront homes and exponential increases in recreational use of these areas. In order to address the needs of each of these interests, yet protect the basic functions and values that created these treasured areas in the first place, we must adopt an ecosystem-based approach to planning and management of these coastal shores.

This guide provides the basis for such an approach and is intended for use by anyone who regulates, designs, develops, builds, uses, lives, plays on or just loves the coastal shore. It is based on the principle that to properly manage and steward these crucial areas, we must first understand them better. Knowledge of coastal shore structure and function, and how the physical, biological and social elements of these dynamic transition zones are linked, is the basis of this document. Better stewardship demands better appreciation of this interconnectedness. While it will be obvious to most of us that developments in or on the foreshore will have environmental consequences, it may not be as obvious that they can also have economic consequences. It may also not be apparent that what we do in the backshore or upland will affect the coastline, often at great environmental, economic and social cost.

This is the most recent in a series of stewardship guides for planners and developers to focus on different ecosystem types. Coastal shores were chosen as the focus because of their extremely high value, sensitivity and the increasing conflict and competition for use of these areas. This document was also developed in response to demands for ready access to information on integrated planning approaches and best management practices for activities commonly undertaken in these areas

There is no static demarcation indicating a "shoreLINE" behind which certain things can be done, and beyond which they can't. Shores and their various components — backshores, foreshores, and nearshore marine areas — are interdependent dynamic systems, and are under considerable stress. The ecological complexity and value of these areas cannot be overstated. Neither can the natural ecosystem services these areas provide, such as temperature modification, waste assimilation, renewable and consumptive natural resource production. These areas can only continue to provide these basic ecological functions and values if we manage them sustainably.

The stewardship of coastal shores requires that we learn about the structure and function of shore systems and how their physical and biological elements are linked. We need to understand that what we do on shore can permanently affect the coastline. This guide covers marine shores; there are other resources for wise stewardship of lake and river shores.

Canadian Wildlife Service

Estuarine marshes have tidal drainage channels that at low tide continue to hold water a few inches deep, providing food and shelter for fish fry and smolts as they gradually acclimate from freshwater to saltwater. Estuarine marshes are vital habitat for over-wintering waterbirds.

Naturally formed barriers lessen the tremendous energy of storm force waves, protecting the habitat, resources and property behind them.

Fisheries and Oceans Canada

Why Should We Care About Shores?

Shores carry huge environmental, intrinsic and aesthetic values, but are under constant threat.

All of us are responsible for our shores, regardless of ownership and jurisdiction. Whether you are an individual landowner, developer, recreational boater, community planner, or politician, a share of the responsibility for protecting coastal systems is yours.

There are many reasons to care for our coastal shores.

Coastal Shore Values

Services and Resources: Fish, shellfish and marine plants supply us with food, medicinal ingredients and other useful commodities. Marine commercial and recreational activities support coastal economies through shipping and tourism. Healthy shore systems help moderate the effects of storms and cleanse and assimilate waste products. The sea sustains our lives.

Recreation: Fishing is one of the most popular recreational activities in British Columbia. Add in sea kayaking, surfing, sailing, swimming, playing on the beach, hiking, biking and bird watching and it becomes apparent how important coastal shores are to our recreational enjoyment. Who doesn't love going to the beach? Tourism, which is based substantially on our coastal recreation opportunities, is the second largest industry in the province.

However, recreation and tourism are focused on small bays, inlets and protected sandy beaches, a small percentage of the coast. By damaging or degrading these resources, we diminish our own opportunities for enjoying the coastal zone, and we limit the potential for future generations to do the same.

Property Values: Real estate prices are one way to reflect the value we place on shores. Whether for residential, commercial or industrial uses, the finite coast commands a premium. To protect this value, we must recognize that our actions can affect adjacent properties and even that of distant neighbours.

Aesthetic Values: Natural coastal landscapes have enormous aesthetic value. The public demands access to these areas through waterfront parks and walkways. The international film industry seeks out the unspoiled beauty of the B.C. coast. Our coastal economy recognizes this value through real estate prices, taxes and tourism - for example, the property or the hotel room with a sea view usually costs more.

Cultural Identity: Many coastal residents recognize their connection to coastal shores. Songs are written and stories are told about salmon, keeping time with the rising and falling tide, and west coast storms. The art of Emily Carr, E. J. Hughes or *Roy Henry Vickers* shows how this coastal heritage is valued by the people of British Columbia. Orca, eagles, bear and salmon symbolize the important aesthetic and spiritual connection to the coastal environment that is shared by First Nation and non-aboriginal peoples alike.

Oak Bay Marine Group

Our recreational use of the coast is focused primarily on protected bays and beaches. These areas are particularly sensitive to careless use or overuse.

Roy Henry Vickers

PINK SALMON, by Roy Henry Vickers is a representation of the salmon life cycle as it occurs in the creeks and rivers of the West Coast of British Columbia

Threats to our Coastal Shores

More People: The Georgia Basin has three times more people than 40 years ago – that number will double again in less than 20 years. More people means more demand for access to the coast, more pollution, more stress on wildlife habitat.

Public Health and Safety: Our activities which affect coastal shore processes and resources in turn affect public health and safety. These include beach or shellfish closures caused by elevated fecal coliforms, or health advisories related to chemical contaminants, or damage caused by erosion from severe winter storms.

Community Economics: The prosperity of coastal communities is tied directly to coastal processes and resources. An 80 percent decline in wild salmon catches since the peak season in 1987 has directly affected the economies and the social fabric of many coastal communities. Beach closures, poor water quality, and damaged shore protection structures contribute to higher costs and lower productivity for coastal communities.

Urban Shorelines: When natural shores are hardened with bulkheads, riprap, lockblock or other means, sediment movement changes along the shores and habitat is damaged or lost. Beaches can disappear, as can wildlife, plants and fish.

Cost: Ignorance of coastal processes can be expensive. Landowners spend thousands of dollars to install shore protection measures, only to find that they are "blown out" a few years later. Or worse, improper shore structures may trigger greater erosion, and thus a vicious cycle of competition between landowners and coastal forces. One has finite money and resources; the other a limitless supply of energy and time. When we choose to develop on the shore, we also are choosing a certain level of risk, and our insurance premiums reflect that. Nature always bats last.

Climate Change: Over the next century, climate change is expected to have a significant impact on B.C.'s coasts. We can expect winter storms to be more intense, with bigger waves and increased storm surges. These changes will lead inevitably to greater risk of flooding and erosion.

Ozone thinning has dramatic effects on all species with low tolerance to UV radiation. Higher UV radiation and increased temperatures affect photosynthesis and ultimately the aquatic food web. Global warming will melt the ice caps--changing sea level and salinity, along with atmospheric circulation patterns--thereby changing our climate. Warmer, drier winters and low precipitation in the fall could be disastrous for Pacific salmon, which need moderately high flows in the fall in local streams to spawn and sufficient cold water flow in winter to sustain incubating eggs.

The population of the Georgia Basin has risen steadily over the past 40 years, and is expected to double by 2023.

Maurice Jassak

image provided by seevancouverbc.com

Damage to poorly located waterfront property by natural processes can be extensive and expensive.

Mike Tarbotton

Revetments, like this lockblock wall, invariably fail by causing accelerated erosion at the base of the slope and/or behind the wall.

Mike Tarbotton

Examples of Why We Should Care

Biodiversity and Species at Risk

B.C. has the highest diversity of native wildlife in Canada, with about 5,250 species of plants, 1,138 species of vertebrates, an estimated 60,000 invertebrate species and 10,000 fungi species. It is a major migratory route and rearing area for many salmon and birds. The continued health of shores and nearshore habitat is a necessity in sustaining the biological diversity of the province.

But many of our species are at risk of serious decline or extinction.

- Three populations of resident and offshore Orca whales- threatened; causes unknown, but concerns expressed over high contaminant levels in tissues and conflicts with boats and vessel traffic.
- Right Whale - endangered; causes include collisions with ships, entanglement in fishing gear, habitat degradation, noise, climate change and pollution.
- Sea Otter - threatened; historically extirpated by fur hunting; abundance and range increasing through re-introductions.
- Marbled Murrelet - threatened; loss of nesting habitat in old growth forest, breeding populations widely dispersed.
- Ancient Murrelet - a species of concern; limited to a few large colonies, threatened by introduced predators (raccoons) and potential oil spills.
- Great Blue Heron -considered "vulnerable" in BC. Georgia Basin population has declined 3-5% per year since the 1960s. Colony-sites are extremely vulnerable to human and natural factors. Many incidences of colony abandonment due to human disturbance, land development activities or Bald Eagle disturbance and predation have been documented. Loss and degradation of foraging habitats in coastal areas are also a significant threat to herons.

The B.C. Species and Ecosystems at Risk website, located under the Ministry of Land, Water and Air Protection, provides more information and many links to other sources for details about species at risk in B.C.

A federal Species At Risk Act (SARA) has been in the making for almost 10 years and was passed in December 2002. For more information about SARA, check the Government of Canada's Legislative Summaries or Environment Canada's site.

Animal Wellness Magazine

Right Whale

Jane Watson

Sea Otter

Illustration Alexe Lohvinen

Marbled Murrelet

Canadian Wildlife Service

Great Blue Heron

Shellfish Closures

Shellfish closures are good indicators of the bacteriological health of the marine environment. Pollution from urban runoff, sewage discharge, agricultural drainage and other sources can easily contaminate shellfish areas.

The coast of British Columbia yields an abundance of filter-feeding bivalve molluscs such as clams, mussels and oysters. In 1998 alone, the harvest of wild and cultured bivalves was worth over $40 million to the B.C. economy. The opportunity to harvest continues to be lost in many areas of the coast, largely because of increasing fecal and chemical contamination. These closures, which have doubled in the last 25 years, are caused largely by E. coli or dangerous levels of toxins.

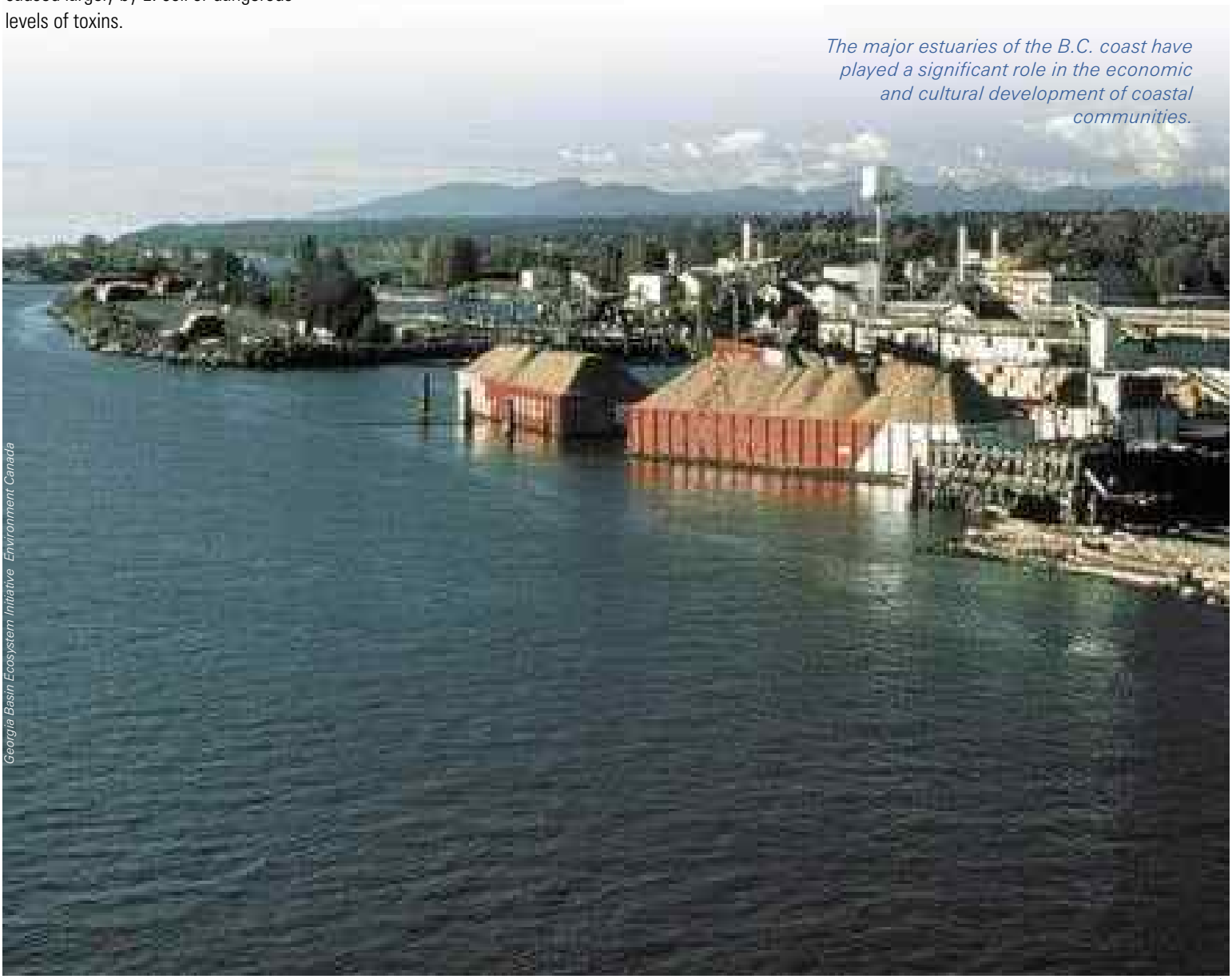
Alexe Lohvinen

Loss of Coastal Wetlands

Coastal wetlands and estuaries are among the richest biological areas in the world, supporting a wide range of marine and coastal fish, wildlife and plants. Additionally, wetlands can filter urban, industrial, and agricultural runoff and buffer adjacent land uses. They also can store and convey floodwaters, buffer storm impacts to foreshore structures and infrastructure, cycle carbon and provide the base of the marine aquatic foodweb. The value of the natural services, biological productivity and infrastructure investments attributable to the B.C. coastal wetlands would be in the billions of dollars annually.

Some estimates suggest that we have already lost more than 18 percent of our coastal wetlands. In some of our biggest estuaries the numbers are much worse: 54 percent lost in the Nanaimo Estuary, 53 percent lost in the Cowichan Estuary, 93 percent lost in Burrard Inlet. In the Fraser River Estuary, one of the most developed but most biologically important areas of the coast, 82 percent of the historic salt marsh habitat has been lost.

The major estuaries of the B.C. coast have played a significant role in the economic and cultural development of coastal communities.



Georgia Basin Ecosystem Initiative Environment Canada

Coastal Shore Systems

The Work of Physical Forces

Many physical forces shape the coast we see today. Some of these forces, such as continental drift, glaciation, climate and changes in sea level act over billions of years and cannot be observed directly. Others, such as wind, waves, and tides, can be seen at work whenever we visit the beach.

In geological terms, our coasts are transient. 15,000 years ago the Fraser River Delta did not exist; most of British Columbia was covered by ice almost to the peaks of the highest mountains, and sea levels were more than 100 m lower than today.

This section offers some basic information about the most important physical processes that shape the coast, including waves, currents, tides, and sediment movements.

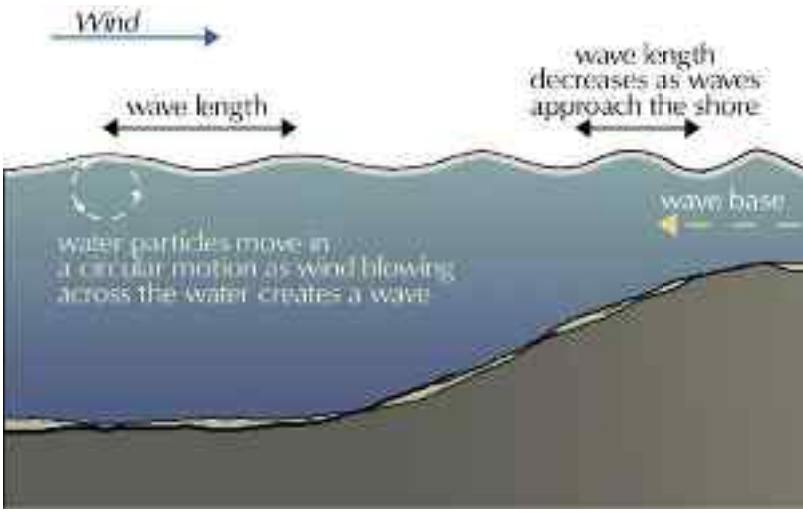
Coastal Processes

Three natural processes shape the physical characteristics of shores.

- *Waves* – Wind waves are the primary force in the coastal zone, creating most of the erosion, sediment transport and deposition that form beaches, sand spits, and other coastal shore features.
- *Sediment Movements* – Sediment, where it is available on the coastal shore, is constantly moving with the waves and currents towards, away from, and along the coast.
- *Water Levels* – Water levels on the coast vary according to the twice-daily tides, surges caused by storms, and, over longer periods of time, changes in western North American sea levels, due to climate change or other global events.

The people who live on Savary Island are acutely aware of the relationship between coastal processes and their own health, safety and economic well being. Formed only 10,000 years ago, Savary Island is an unconsolidated sand deposit that has been gradually decreasing in size as a result of coastal erosion.

Harriet Rueggeberg



Waves

Waves are the primary energy source that shapes coastal shores. The force exerted by waves is a function of the wave size, which in turn is a product of the velocity of the wind, the distance over which the wind blows (fetch) and the length of time the wind blows (duration). For this reason wave size, and therefore wave energy, varies widely along the B.C. coast, from sheltered environments such as Sidney Spit Provincial Park in the Strait of Georgia, to the exposed Pacific coast of Long Beach/Pacific Rim National Park or the west coast of Haida Gwaii. In spite of these differences, the physical processes that shape the shore are actually quite similar.

Andre Lemieux

Tsunamis

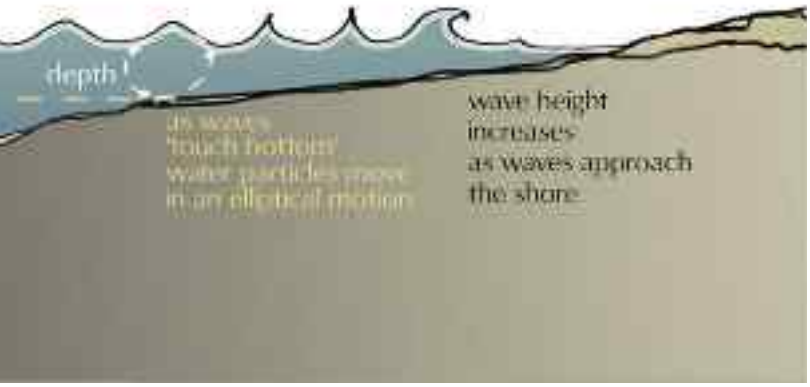
Tsunami is a Japanese word for "giant wave." Tsunamis are waves generated either by underwater earthquakes or landslides.

The largest tsunami to hit the British Columbia coast was the result of an earthquake centred about 100 km east of Anchorage, Alaska on March 27, 1964. The resulting tsunami took about four hours to reach the west coast of B.C. While in the deep ocean, this wave probably never exceeded 1 m in height, but as it reached shallow water it shoaled. At Port Alberni at the head of Alberni Inlet, the wave reached a height of 7 m and caused $10 million damage.

The 1975 Kitimat landslide resulted in an initial fall in sea level of 4.6 m followed by a rise of 7.6 m in a matter of minutes.

Wave Base Depth

The point where the wave first touches bottom is called the "wave base depth". If there is sediment available in this area then the waves chum up the sediment making it available for currents to move the sediment along the coast. Wave base depth increases with wave height (roughly 1 to 2 times wave height) and since wave height varies with different wave events, such as storms, the area where sediment is moving also varies.

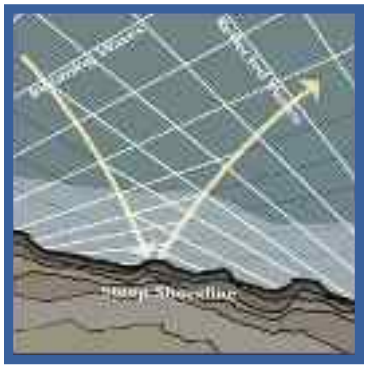


Three other important physical processes result from waves entering shallow water:

Refraction — is the bending of waves as they approach the shore. As waves enter shallow water and touch bottom, wave velocity decreases. If a wave approaches the shore at an angle, it refracts or bends as the inner end of the wave slows down sooner than the outer end. For this reason, waves usually hit a beach almost parallel to the shoreline even though they may have approached the coast at a sharp angle.

The result of refraction is that wave energy becomes concentrated at headlands and the seaward side of islands, and is diffused in embayments and the leeward side of islands. The net result is erosion where the energy is concentrated and sediment deposition where energy is diffused. For example, at Sidney Island, the predominant wind and wave directions are from the south and southeast. The large spits and intertidal lagoons that have developed on the north side of Sidney Island protect important habitats from the powerful energy of wind and waves.

Reflection — is the echoing of waves off a solid object. When a wave hits a steeply sloping bank, cliff or seawall, the wave energy is reflected back rather than being dissipated on the shore. Reflected waves can be as high as the incoming wave itself. The two waves interact and combine with each other, producing even larger waves. The bigger waves then create strong bottom currents close to the shore, creating increased seabed erosion close to these reflecting "structures." It is for this reason that seawalls often fail and fall over as the seabed in front is eroded away.



Diffraction — is the diffusion or spreading of waves in the lee of an island or headland. Although offshore islands or headlands may protect a stretch of coast from direct wave energy, the waves will penetrate into the "shadow zone" behind a barrier.

Water Levels

A tidal "wave" is a bulge in the ocean level caused by lunar and solar gravitational forces. There are two high tides and two low tides each lunar day (24hr 50min.). This cycle means hydrographers can predict tidal water levels many years into the future. They even estimated the tides (accurate to the minute) during Captain Vancouver's voyage to these coasts in 1792. This tidal rhythm affected the way that coastal areas were used long before Captain Vancouver's visit and is recorded in the following Tlingit (Tsimshian) legend:

Txamsem took his raven blanket and flew over the ocean with the firebrand in his hands. He arrived at the mainland and came to another house which belonged to a very old woman, who held the tide-line in her hand. At that time the tide was always high, and did not turn for several days, until the new moon came, and all the people were anxious for clams and other sea food.

Giant entered and found the old woman holding the tide-line in her hand. He sat down and said, "Oh, I have had all of the clams I need!" The old woman said "How is that possible? How can that be? What are you talking about, Giant?" "Yes, I have had clams enough."

The old woman said, "No this is not true." Giant pushed her out so that she fell back, and he threw dust into her eyes. Then she let the tide-line go, so that the tide ran out very low, and all of the clams and shellfish were on the beach.

Mike Tarbotton

So Giant carried up as much as he could. The tide was still low where he re-entered. The old woman said, "Giant, come and heal my eyes! I am blind from the dust." Giant said, "Will you promise to slacken the tide-line twice a day?" She agreed, and Giant cured her eyes. Therefore the tide turns twice every day, going up and down. (From Boas, 1916)

Tidal Facts

- The vertical distance between high and low tide in the open ocean is small, typically about 10 cm. However, as the tidal wave approaches the coast, it is reflected and amplified in the inlets and channels. In the Strait of Georgia, the tidal range increases as you move from Victoria (range 3.3 m) to Vancouver (range 5.1 m) and beyond to Toba Inlet (5.5 m).

Fisheries and Oceans Canada

- Tide height is measured from datum, which Canadian hydrographers define as the lowest normal tide.
- On a monthly cycle, the highest and lowest tides occur during full and new moons (spring tides)
- The lowest and highest tides of the year occur in December and June.
- In the winter, low tides occur mostly at night. In summer, low tides occur mostly during daylight hours. This is important to know for planning shoreline construction activities.
- In B.C., some of the most dramatic storm impacts occur during a combination of winter high tides and storm surges. Big waves can cause far more problems when they hit shore on an extreme high tide as compared to a low tide.
- Tides have a significant influence on the physical characteristics of coastal shores, moving heavy logs and debris, and sorting sediments throughout the tidal range.

Storm Surges

Storm surges occur when the wind and pressure generated by a storm act on a large body of shallow, coastal water. Surges can move rapidly with the storm system, and can be extremely destructive. In our local waters, storm surges are important factors in coastal flooding and shoreline erosion. When combined with spring tides and storm waves, they can have a major impact on our coast. Maximum storm surges in the Strait of Georgia are about 1 m high.

Serious storm surges occur in B.C. roughly every decade or two, but their effect can be dramatic. It is important to account for this 1 m sea level rise from storm surges when designing shore structures.

Rising Water Levels

There is some indication that climate change is causing sea levels to slowly rise. Over the long term, this will cause increased shore erosion as the coast continually adjusts to the new water levels.

Sediment Transport

Determining the sediment mass balance (the amount of sediment being added or taken from a beach) is a challenging technical problem. It is a function of both the availability of sediment as well as the force of energy to transport it. Currents and waves can move vast amounts of sediment along the coast. Interruptions to the system, such as cutting off a sediment source, can have profound effects. For example, the damming of many rivers on the western U.S. coast, which are primary sources of sediment, has caused the gradual loss of beaches along the coast. Similarly, very large storm events can cause the loss of an entire beach, as happened in Carmel, California in December 2002.

Joy Hillier

Longshore Drift

Two forces combine to create a movement of sediment parallel to the coast. The first is that most waves approach the shore at an angle, and although refraction bends the waves into a more direct approach, it can not bend them enough to make them break completely perpendicular to the beach. The second is a longshore current of water that moves parallel to the shoreline in the direction of wave movement. As sediment is churned up by the waves entering the shallow water, the longshore current transports it downshore where it settles, before being churned up and transported again. Longshore drift cells typically include a sediment source, a transport zone and a sediment deposition zone. These cells repeat along the coast, sometimes with smaller cells nesting into larger cells, and can be identified in a variety of ways:

- Interpretation of existing features. Typical sediment sources are rivers and eroding bluffs, and typical sediment deposition sites are protected bays and spits. The direction of a spit is an accurate determination of the net sediment movement. Interpreting erosion sources and deposition features may require specialized knowledge of coastal processes and a combination of map interpretation and field observations.
- Survey measurements. This process is the only way to obtain quantifiable information about the rates of erosion or accretion. Detailed surveys of a variety of locations are available through the *Geological Survey of Canada.*
- Review of archival aerial photos. Where available, archival aerial photos can help to identify changes in coastal morphology, nearshore elevation and other products of ongoing coastal sediment transport processes.

Cross Shore Transport

Another type of current on the coast is a cross shore current. Although longshore transport is more influential over the long term, cross shore transport is a more immediate process. Cross shore transport is usually the result of the winter/summer storm cycle wherein sediment is removed seaward during the winter and then slowly replaced over the summer.

What Direction is Sediment Moving?

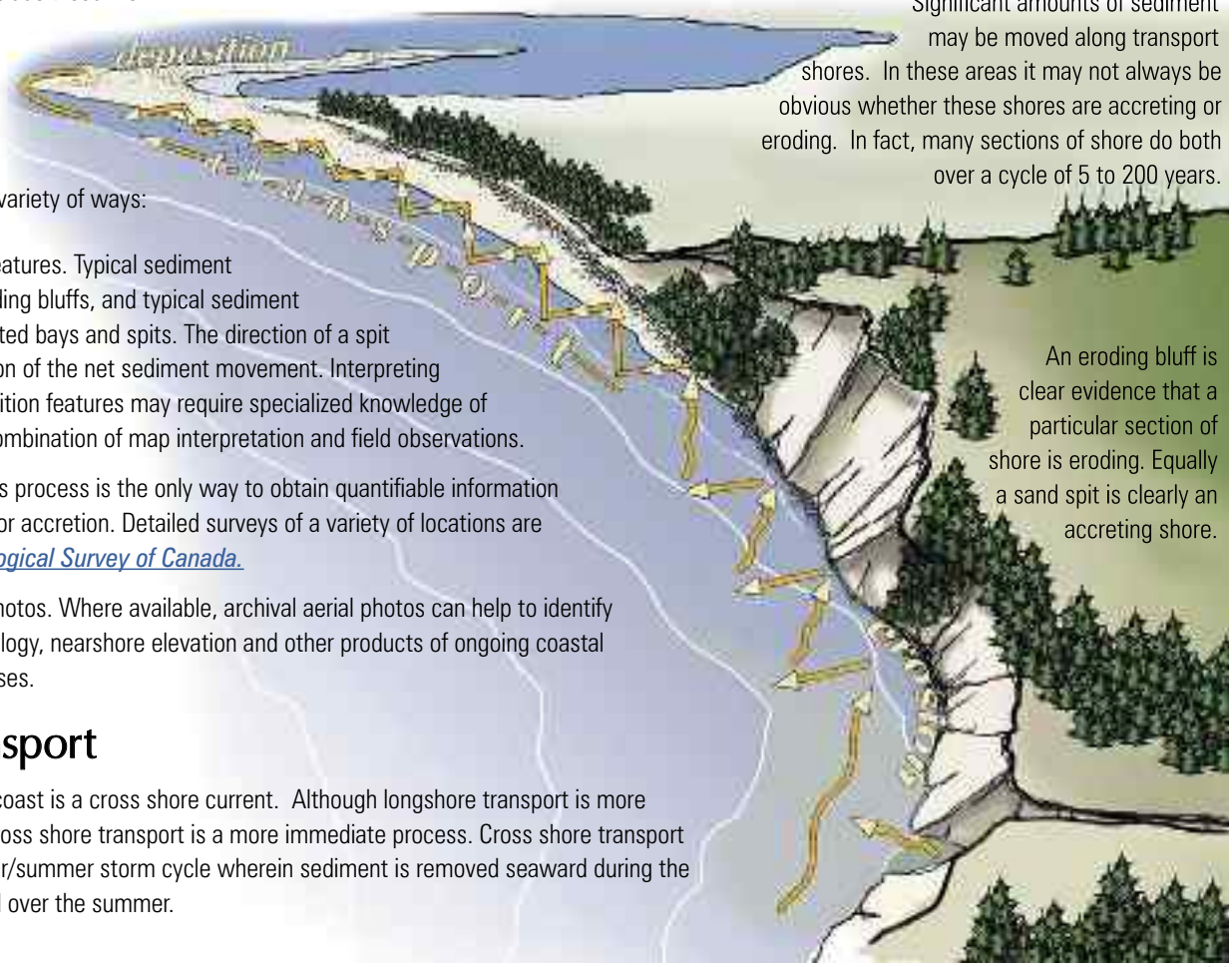
On most shorelines, wave and current direction change with the seasons and with storms. For this reason the same sediment may be transported past one point in the shore several times during the course of a year. However, the direction of net sediment transport (the balance of sediment moved one way versus another) is determined by the predominant wind direction. For example, in the Strait of Georgia the predominant winds (i.e. the ones with the most energy to move sediment) are the winter winds and storms from the south and south-east.

How Much Sediment is Moving?

The amount of sediment being moved is determined by its availability, the size of the material (for example, sand is more readily moved than gravel) and the size, or energy, of the waves and currents that reach the shore.

Erosion, Transport or Deposition?

Understanding sediment transport is essential for good coastal planning and stewardship. Ecologically wise decisions depend on information about the net direction of sediment movement, how much sediment is available, and whether the shoreline is accreting (building seaward), eroding (retreating landward), or more or less static. It is important to realize that even though an accreting shoreline, such as a sand spit, has a net gain of sediment it is also constantly losing sediment and will shift somewhat over time.



Significant amounts of sediment may be moved along transport shores. In these areas it may not always be obvious whether these shores are accreting or eroding. In fact, many sections of shore do both over a cycle of 5 to 200 years.

An eroding bluff is clear evidence that a particular section of shore is eroding. Equally a sand spit is clearly an accreting shore.

Energy and Sediment Dynamics

This table describes nine shore types based on the relative amount of energy they receive, which is based on the exposure to the dominant wind, and whether or not they are an eroding, transport, or accreting shoreline within their longshore drift cell. Although a high energy system in the Strait of Georgia is not comparable to a high energy system on the West Coast nevertheless they share many similarities. The table is adapted from the *Framework Plan for Coastal Zone Management* prepared for the Regional District of Comox-Strathcona.

Eroding Shores

Signs of an eroding shore include the presence of steep banks or bluffs; lack of vegetation (trees and shrubs are unable to get established) or tipped trees with exposed roots. The absence of a delta at a river mouth indicates the sediment is being "eroded" or removed at roughly the same rate that it is being delivered. A shore is most likely to erode where the underlying material is fine such as sand and gravel. An eroding shore may be on a steady landward march or may be more or less static for long periods of time, followed by a period of erosion.

Mike Tarbotton

High Energy

High energy shores are those that are exposed to the full force of predominant winds (i.e. those winds that dictate the direction of longshore transport) with a considerable fetch. In the Strait of Georgia a high energy shoreline is one that is perpendicular to and exposed to the predominant winter winds and storms from the south-east. The west coast of Vancouver Island and Haida Gwaii have high energy shorelines exposed to the western winter storms.

The volume of sediment movement along these shores can be very high, and they tend to have large beaches. Wind erosion can be considerable and as a result there may be a well established dune backshore on these shorelines, perched sand dunes on top of cliffs, and/or trees that are stunted or have a windswept profile.

Mike Tarbotton

In a high energy system, an eroding shoreline is very unstable and is characterized by the following:

- Provides huge volumes of sediment to the longshore system and the sediment is removed from the shore very quickly.
- May have sections of exposed soil where vegetation has been unable to become established.
- Vegetation is lost as roots are exposed and undercutting removes soil.
- Severe storms can cause dramatic erosion.

As a result, development in a high energy erosion shore should be avoided or located well back from the shore, existing native vegetation should be maintained to minimize the speed of erosion, and shore protection devices should be avoided as they are likely to quickly fail.

Medium Energy

Medium energy shores are those that are at an angle to, or parallel to, the predominant winds, where the force of the waves is reduced, or where the fetch is shorter. These shores may also be exposed to predominant summer winds. Although these do not have as much energy as the winter winds they may provide some balance to net sediment transport.

The volume of sediment movement along these shores can still be considerable but is less than a high energy shoreline.

Mike Tarbotton

In a medium energy system, an eroding shoreline is moderately stable. Sediment is introduced from streams and rivers and to a lesser degree from eroding shorelines. In general a medium energy eroding shore typically:

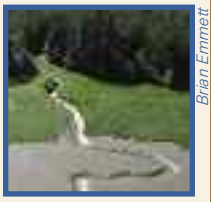
- Provides moderate amounts of sediment to the longshore system.
- Has pronounced river deltas but may be under water during high tide and is constantly shifting.
- Is mostly vegetated, which is effective in slowing the rate of erosion.

As a result, development should be located far enough back to accommodate natural erosion. Existing native vegetation should be maintained to ensure ongoing stability of slopes, and shoreline protection devices should be discouraged.

Low Energy

Low energy shores are those that are protected from the predominant winds; for example, shores that are in deep bays or inlets, or are protected by islands or headlands. These shores tend to be fairly stable as they are not subject to the erosive forces of wind-generated waves.

The volume of sediment movement along these shores is fairly low. Where sediment is available, these shores tend to accumulate sediment. Because they are sheltered, they tend to have high biological productivity and are also more susceptible to pollutants.



Brian Emmett

In a low energy system an eroding shore is stable with sediment introduced primarily from streams and rivers. In general a low energy eroding shore is characterized by the following:

- Provides little sediment to the longshore system.
- Shows signs of stability such as vegetated deltas.
- Has well established vegetation at the backshore.

As a result, development in a low energy erosion shore should be located far enough from the shore to protect against septic pollution, and existing native vegetation should be maintained to minimize any erosion.

Transport Shores

Transport shores occur between areas of erosion and sediment deposition. These sections of the coast are relatively stable, although they may alternately show signs of erosion and deposition over time. Large quantities of sediment may be moving past these shores so any blocking of this sediment movement can have significant impact on downshore shorelines many kilometres away.

Regional District of Comox Strathcona

In a high energy system, a transport shoreline is relatively stable although considerable "wobble," from periods of erosion and then deposition, may take place over time. In general. a high energy transport beach is characterized by the following:

- Huge volumes of sediment move past the shore.
- Shore structures that interfere with sediment movement will have significant impacts, including severe scouring and deposition, and the loss of downshore beaches.
- Severe storms may exaggerate the cyclical erosion and deposition of transport shores.

As a result, development in a high energy transport beach should be located far enough back from the shore to accommodate the natural shore "wobble." Existing vegetation should be maintained to prevent the shore switching to an unstable condition, and groynes should be prohibited.

In a medium energy system a transport shoreline is moderately stable but some "wobble," from periods of erosion and then deposition, may take place over time. In general a medium energy transport beach is characterized by the following:

- Large volumes of sediment move along the shore.
- Activities, shore protection devices or groynes that interfere with the movement of sediment will have significant impacts on the shore

As a result development in a medium energy transport beach should be located far enough back from the shore to accommodate the natural shore "wobble." Existing vegetation should be maintained to prevent shoreline instability and groynes should be prohibited.

In a low energy system, a transport shoreline is quite stable although localized erosion or deposition is possible. In general, a low energy transport beach is characterized by the following:

- Low volumes of sediment move along the shore.
- Tends to be highly productive aquatic habitat.

As a result, development in a low energy transport beach should be located far enough back from the shore to protect against contamination from septic fields and runoff, and existing vegetation should be maintained to protect the shore from localized erosion.

Depositional Shores

These shores are usually caused by the deposition of sediment as a result of decreased wave energy, increased sediment supply, and/or decreased water depth. They are characterized by low relief with features such as sand beaches, deltas, spits, sand dunes and beach ridges and are located typically in embayments and in the lee of islands or headlands. A large, steady supply of sediment is needed to create and maintain these features and an interruption to either can result in their loss. Depositional shores are prone to rapid changes in shape and volume.

Regional District of Comox Strathcona

In a high energy system, a depositional shore is moderately stable but very dynamic. These beaches are highly valued recreation areas but scarce. In general, a high energy depositional shore is characterized by the following:

- Huge volumes of sediment accumulate in the form of spits and beaches.
- Beaches may include sand dunes in the backshore, which are an integral part of the shoreline and are highly susceptible to damage.

The scarcity, fragility and value of these shorelines means they should be protected for public access and recreation. Development should be located far enough back from the shore so that backshore dunes and beach ridges are kept intact.

In a medium energy system a depositional shore is moderately stable and dynamic. These shores are also highly prized and scarce. In general, a medium energy depositional shore is characterized by the following:

- Large volumes of sediment accumulate in the form of pocket beaches.
- Its beaches may include beach ridges in the backshore, which are an integral part of the shoreline.

The scarcity and value of these shorelines mean they should be protected for public access and recreation. Development should be located far enough back from the shore that backshore beach ridges are kept intact.

In a low energy system, a depositional shore has a stable backshore but the shoreline advances as sediment accumulates. They include estuaries and provide highly valuable habitat. In general, a low energy depositional shore is characterized by the following:

- Sediment is trapped with little sediment loss to longshore drift.
- Often forms features such as estuaries, mud flats and tidal marshes.
- Highly productive aquatic habitats.
- Very sensitive to contamination that accumulates in fine sediments.

As a result, a low energy depositional shore should be protected for its high habitat values. Development should be avoided and the shore should be protected from contamination from septic fields and runoff.

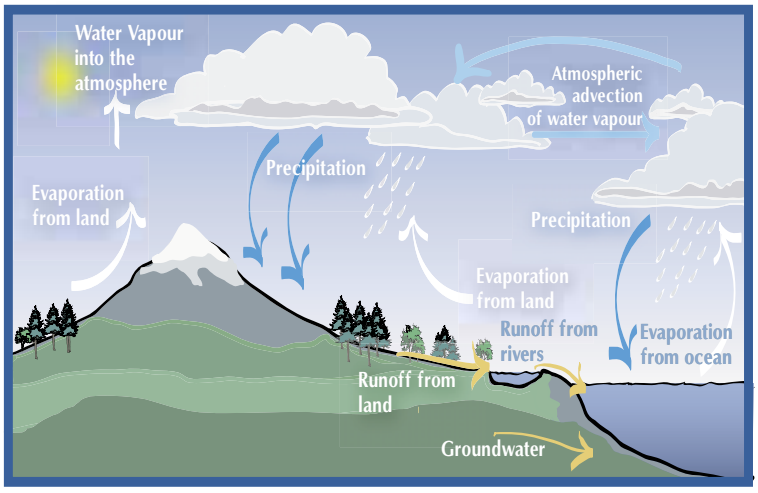
Water Quality

The waters of the deep Pacific Ocean control the water quality of much of B.C.'s northern and central coasts, including the west coast of Vancouver Island. The flushing of tides, winds, and ocean currents means that the rate of exchange of seawater on our exposed coasts is generally much higher than the exchange that occurs in our "inland sea."

Charlie Gibbs

Within the Strait of Georgia, the conditions are more varied. The water in the middle and upper Strait has limited exchange with the waters of the offshore Pacific. Within this "inland sea," pollution from the land and air can accumulate and have a significant impact on water quality. Smaller inlets, coves and bays within the Strait are even more likely to be affected by nutrients and toxins added by human activity.

In the natural process, energy from the sun evaporates water mainly from the sea into the atmosphere. Winds carry the water over the seas and land. If the atmosphere cools, the water returns as precipitation. Where the water falls on land, it travels downhill over the surface or as groundwater, and eventually reaches the sea. Over eons, the water travelling over or through land picks up soluble materials from minerals and biota on land and carries them to the sea.



Pollution from the Air

Rain or snow picks up toxics emitted into the air by human activity. Large quantities of pollutants in the atmosphere may change concentrations in these pollutants in coastal seawater.

Leaded gasoline, which was phased out in the late 1970s, is the major source of lead in the deeper water sediments of the Strait of Georgia. Most of this lead was deposited by atmospheric transport.

Pollution from the Land

In settled areas, chemicals and nutrients added by human activity also end up in the ocean:

- A pipeline leak in central British Columbia, for example, can deliver toxics into the Strait of Georgia through rivers and airborne pollution.
- An abandoned mine in Howe Sound pollutes a nearby stream -- but the stream flows to the ocean and the toxic materials accumulate in the nearshore sediment.
- Sediment runs off from sites disturbed by forestry, agriculture, road building, and land development. Sediment carried by rain into streams is eventually carried downstream. It adds minerals, organic material and sediment-borne pollutants to the seawater, which can change the chemistry of nearshore waters. The direct sediment discharges from riverine sources also shape and determine the function of coastal estuaries. In Haida Gwaii, up to 70 percent of sediment comes from stream channel erosion related to human activities.
- Chemicals and fertilizers from farming, if not applied correctly, can runoff farmland and end up in the sea.
- Poorly maintained septic systems can contribute nutrients, fecal coliforms and toxins to the nearshore environment.
- Stormwater runoff from urban areas, streets and highways can carry heavy metals and toxics that have significant impacts on water quality. The increase in impermeable surfaces such as driveways and roads makes it harder for the stormwater to infiltrate and be cleaned before it reaches our streams and rivers.

Pollution in the Water

- Oil spills, though infrequent, can have devastating local effects on specific coastal areas. The impact of spills can be particularly harmful for wildlife, and may linger for many years.
- Ocean dumping can lower water quality.
- Water based industries such as aquaculture and marine log storage can be a source of chronic pollution.

For more detailed information about pollutant sources and their control, refer to Chapter Five, entitled "Working with the Coastal Shore", pages 50 through 77 of this guide.

What Happens?

In larger estuaries, where freshwater input from rivers and streams is large compared with the natural exchange of seawater, significant pollution can occur. Small bays with restricted flushing are most sensitive to the effects of pollution from runoff and land uses.

Fisheries and Oceans Canada

Changes in water quality can affect nearshore biotic communities in a variety of ways:

- An increase or decrease in nutrient concentration will alter growth of aquatic plant communities and plankton.
- An increase in suspended sediments can shade out seagrasses. Lost seagrass can modify the transport of sediment along a shore and affect adjoining areas.

  Sediment runoff from upland development to nearshore areas can dislodge or bury attached organisms, smother vegetation, reduce light penetration and photosynthesis, eliminate food sources for filter feeding organisms or make it difficult for visual feeders to "see" their prey.
- In poorly flushed areas, excess nutrients can cause rapid algal growth which uses up most of the available oxygen in the water, causing distress to fish and other animals. The effects of nutrient excess can be seen in enclosed bays with storm discharge input. An example is Victoria Harbour, where the water occasionally turns bright green with plankton blooms as days lengthen in spring.
- Pollution, oil slicks and toxic blooms can affect our use and enjoyment of beaches and coastal areas.
- Toxic bacteria, viruses and protozoa can make fish and shellfish unfit for human consumption.
- High concentrations of toxic chemicals can reduce the ability of fish and shellfish to reproduce and maintain the natural species composition of the local ecosystem.

How Much is a Lot?

Because of the massive volumes of water involved in the ocean, water quality in coastal areas is slow to change. The Strait of Georgia alone contains about 1,000 km^3 of water. Despite this, comparatively small amounts of pollution from sewage or stormwater runoff can create localized problems for shellfish, waterfowl and other biota as well as people.

Our oceans form the largest ecosystems on earth but their capacity to assimilate waste is finite. Dilution is not the solution to pollution. Source control is clearly the best approach.

What Should We Expect in the Future?

The most severe changes in water quality will be in populated areas. The Georgia Basin, which is already home to 74 percent of British Columbia's population, is expected to reach 4 million people in less than 20 years.

As our population grows, the need to protect water quality means that we must:

- Address the impacts of urban sewage.
- Manage storm water runoff and non-point source pollution better.
- Control nutrient inputs into poorly flushed areas.
- Control waterborne and industrial sources of pollution.

Without extreme care, the Georgia Basin can expect an increase in water quality problems. As the population increases, the ability of the Basin to absorb and treat our wastes will be tested. This guide outlines planning and coastal development "best practices" that can help to reduce the pollution issues associated with increasing coastal settlement.

Scott Nickerson Environment Canada

Killer whales - Sentinels of Marine Ecosystem Contamination

Killer whales are long lived and occupy a position at the top of marine food chains. They are therefore vulnerable to accumulating high concentrations of contaminants that are persistent, bioaccumulative and toxic (PBT compounds). Compounds of particular concern include the banned polychlorinated biphenyls (PCBs) and many organochlorine pesticides, as well as new chemicals with similar properties. These contaminants have been associated with immune system disorders, skeletal malformations, reproductive tract lesions, tumours, and altered endocrine function in marine mammals.

BC's killer whales are among the most chemically contaminated marine mammals in the world. These animals and their prey use large areas for habitat, so they are considered "integrators" of contaminant information in the environment – their bodies help monitor marine ecosystem health. Their levels of contamination also represent a combination of local and global sources of contaminants, since many PBT compounds move through the environment by atmospheric transport.

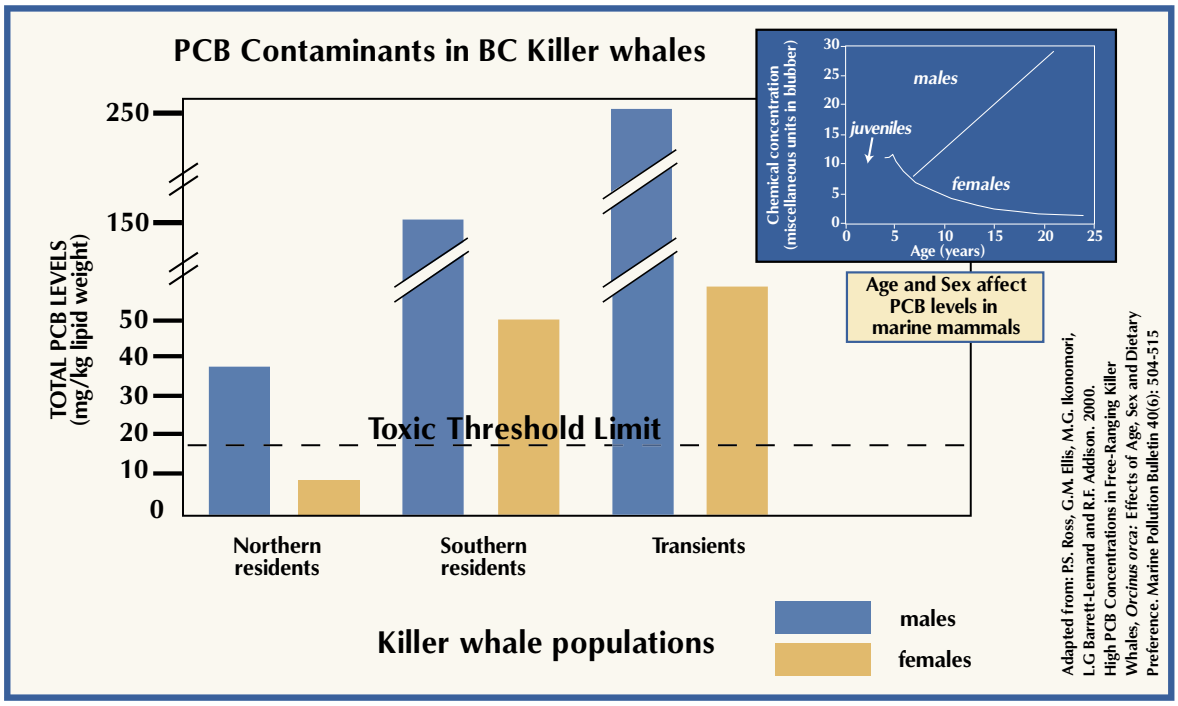
Studies have shown that dietary preference, sex and age of Killer whales affect the level of contaminants in their tissues (see graph). Resident populations eat primarily salmon, while transient populations feed almost exclusively on seals, sea lions and porpoises. These latter prey are at a higher trophic level and as such, accumulate contaminants more than fish.

Also, as males grow older, they become increasingly contaminated with a complex mixture of these fat soluble chemicals. Females, on the other hand, transfer a large portion of their contaminants to their offspring via nursing. Their young can therefore be exposed to high concentrations of harmful substances, at a time when they are most sensitive.

Graeme Ellis

Killer whales require an abundance of clean and healthy prey- primarily salmon or smaller marine mammals, many of which feed on salmon. In British Columbia, however, the persistence of banned contaminants, leakage from old contaminated sites, continued use of new or unregulated compounds, and atmospheric deposition of contaminants from distant sources all contribute to the contamination of the marine food chain.

Protecting salmon and salmon habitat represents a critical part of protecting resident killer whale populations. This requires citizen-based as well as local, regional and international efforts to reduce the release of harmful chemicals into aquatic environments, both freshwater and marine. Direct inputs as well as indirect runoff and deposition must be addressed in order for such efforts to be effective.



Aquatic Nuisance Species in British Columbia

Non-indigenous, non-native, exotic, or alien species are being transported regularly in aquatic environments around the world. Sometimes they become a nuisance in their new-found "host" environments by growing in explosive proportions or by transporting diseases for which there are few or no resistance factors. Non-indigenous species may aggressively compete with indigenous species for habitat, food, or simply prey on them or spread disease. Either way, they can cause serious biological and economic damage.

Aquatic nuisance species are of concern in British Columbia, not only because of the extent of the province's marine coastline, but also because of the large network of freshwater lakes and rivers which support commercially important species and recreational activities.

There are numerous pathways by which non-indigenous species can be introduced into BC coastal systems. These include ballast water, the pet and aquarium trade, live seafood, aquaculture, and transportation of pleasure boats from infested areas such as the Great Lakes.

There is limited documentation of the status of non-indigenous nuisance populations in the province. European Green Crab (Carcinus maenas), Zebra Mussels (Dreissena polymorpha), Eurasian Water Milfoil (Myriophyllum spicatum), Purple Loosestrife (Lythrum salicaria), Common Carp (Cyprinus carpio), Spartina (Spartina alterniflora), and Atlantic Salmon (Salmo salar) are among the nuisance species that have been observed in BC. There are many others that have the potential to reach BC waters including Chinese Mitten Crab (Eriocheir sinensis) and New Zealand Mudsnail (Potamopyrgus antipodarum).

Although some species have not arrived in large numbers, the potential for harm should be understood. It is important to learn about species like these that may threaten existing native plant and animal populations in BC.

Learning to recognize such species is aided through pictures and descriptions and is an significant step to controlling their spread. If you suspect a species to be non-indigenous, collect it in a plastic bag and freeze it, recording all information on the habitat you found it in and contact your nearest Fisheries and Oceans or Ministry of Water, Land and Air Protection office for further information. Biology departments of universities should also be able to help with identification.

It is important to not transport live species from one coastal area or waterway to another. Remove any aquatic weeds or animals from your boat, recreational gear and drain the water from your boat before moving to a new area. Be aware of laws that regulate the transport of non-indigenous species. Remember that it is usually impossible to eradicate an established non-indigenous species. Preventing their introduction is the key.

Zebra mussels, an invader from Europe, arrived on the West Coast after infesting the Great Lakes. The prolific, tightly growing colonies are a detriment to marine life as they cement themselves to living creatures, weighing them down so that they can no longer move. They also colonize man-made objects such as water intakes, completely clogging up the pipes.

The European Green Crab is an efficient predator. It feeds on clams and oysters as well as juvenile crabs and other shellfish. It poses a menace to the aquaculture industry and native wildlife by competing for limited food supplies.

Spartina alterniflora, Smooth Cord Grass, is native to the Atlantic Coast, colonizing tidal marshes. It is considered non-native and invasive on the Pacific Coast .

The Connection between Physical Processes, Habitat and Species

British Columbia's coast supports a great variety of marine plants, invertebrates ,fish, migratory birds and marine mammals. It is one of the richest and most diverse temperate environments in the world.

This is no accident. British Columbia's coastal habitats - ranging from lush kelp forests to mudflats and salt marshes in quiet bays - provide the physical diversity that supports abundant biological communities.

These biological communities are created and influenced by combinations of physical, chemical and biological factors. The major physical factors, which include slope gradients, substrate size, wave exposure, salinity, temperature and tidal elevation, are illustrated on the following page.

Biological interactions, such as predation and competition for food and space, also influence the composition and distribution of nearshore plants and animals. For example:

- The lower limit of mussels in the intertidal zone is usually controlled by sea star predation, while the upper limit of barnacles is determined by their tolerance to heat and exposure.
- Rooted vegetation (eelgrass and marshplants) helps to stabilize sand and mud substrates and provides cover and attachment surfaces for a diverse fish and invertebrate community.
- Sea Otters, which are a threatened species, can have drastic effects on sea star populations by competing for sea urchins, a food source favoured by both.

Plants and animals can also influence the physical characteristics of a shore environment. For example:

- Large fringing kelp beds on exposed coasts dampen the influence of wave energy.
- Worms and other organisms in mudflats process large amounts of substrate, altering sediment chemistry and organic content. These organisms can also secrete mucus-like material, which helps bind and stabilize finer substrates, making them less susceptible to erosion.
- The root systems of dune grass species serve to bind and stabilize backshore areas against the erosive power of both wind and waves.

Will Megill

D. Kent

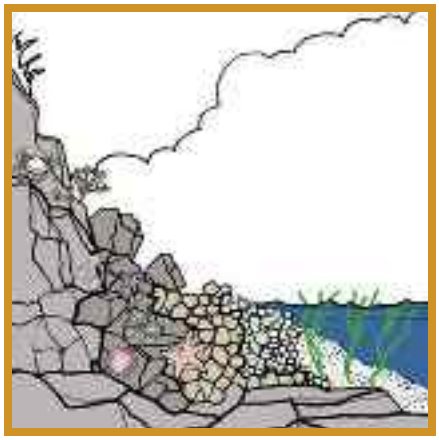
Charlie Gibbs

The British Columbia coast is home to the world's largest octopus, the biggest barnacle, the heaviest starfish and one of the largest coastal concentrations of killer whales.

Major Physical Factors

Foreshore slope, substrate size, wave exposure, salinity and tidal elevation can influence the composition of biological communities throughout the intertidal and nearshore zone, in measurable ways.

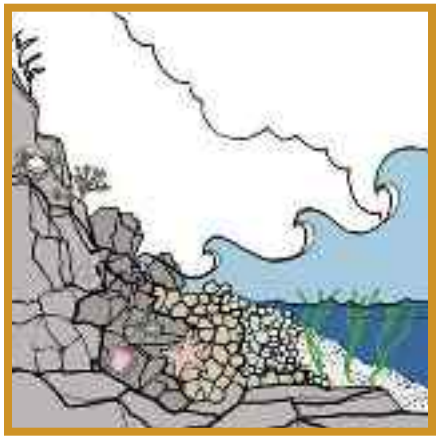
On the British Columbia coast, the effects of these physical factors are apparent. The larger rivers and abundant winter rainfall generate considerable salinity gradients in many nearshore areas. In the Strait of Georgia, low energy sediment shores (gravel, sand, mud) are common while rock and mixed rock and sediment shores dominate the outer coasts. Island archipelagos, fjords and inland seas such as the Strait of Georgia provide a wide range of wave exposures.



Substrate

Bedrock and large rocks support the growth of attached algae and invertebrates. Sand and finer substrates do not provide suitable attachment habitats for these types of organisms. Worms, bivalves and other invertebrates dominate habitats of mud and sand. Rooted plants and single celled plants grow as a mat on the surface of this sandy substrate. This environment provides habitat for many sessile and some mobile invertebrates as well as a carbon source to fuel the nearshore aquatic food web.

Wave Exposure



The characteristics of different shore types also influence biological communities above the high tide line. On exposed shorelines, such as Long Beach on the west coast of Vancouver Island, a fringe of stunted trees and shrubs grows immediately above the driftwood logs, marking the upper limit of storm waves. This fringe of vegetation is adapted to high winds and salt spray and shelters larger trees located further inland. In contrast, in protected coastal fjords, the coastal forest grows right to the high water mark.

On exposed shores, plants and animals usually attach themselves firmly to bedrock or boulders, or adapt to survive in rapidly shifting, smaller substrates (cobbles, pebbles and sand). On more sheltered shores, smaller cobbles and pebbles are not often moved and smaller organisms are not dislocated by wave action. The plants and animals that attach to these smaller substrates can thrive.

Salinity and Temperature

Plants and animals growing in river estuaries adapt to low and rapidly changing salinity levels. For example, the giant kelp does not grow in the Strait of Georgia because it cannot tolerate the summertime combination of low salinity and warmer waters.

Estuarine marsh and shrub distribution is related directly to salinity levels and patterns of seasonal flooding. This coastal fringe vegetation provides unique habitat for many birds and mammals, stabilizes the soil, and helps prevent movement of sediment-bound contaminants into the marine environment. Dunes and dune grasses function in a similar manner on exposed beaches.

The fate of Pacific salmon depends on brackish estuaries, since the fish must make the transition in them from freshwater to saltwater and back again, in order to reproduce.

Tidal Elevation

The range of tides influences the vertical distribution of plants and animals in the intertidal and shallow subtidal zones. Upper limits of many species are often determined by tolerance to air or wave exposure. Lower limits are highly influenced by competition and predation between plants and animals inhabiting these areas.

The diversity and survival of British Columbia's coastal species depend on the continued, healthy ecological function of coastal habitats and the nearshore processes that create and sustain them:

- Estuaries are key feeding habitats for black and grizzly bears as well as for eagles and migrating birds.
- Coastal bays and estuaries are important overwintering areas for ducks, geese and swans.
- Beaches, estuaries and mudflats are vital feeding areas for shorebirds during spring and fall migrations and over the winter.
- Each spring, herring spawn on nearshore marine plants such as kelp and eelgrass. The adhesive eggs sticking to the plants are washed with well-oxygenated water as the plants move back and forth with wave action and tides. This abundant source of protein attracts thousands of migrating birds.

Impacts to These Connections

Coastal managers often say "No people, no problem." Human activities can alter the connections between species and habitat, disrupting ecological function. This can happen very quickly - overnight in some cases - or take a long time.

- A new seawall built above a sandy beach increases wave action that erodes the existing beach. This affects the beach spawning habitat of sandlance or smelt, which in turn are food sources for many larger fish, including salmon.
- Walking a dog or jogging on a beach can disturb birds from their normal routines. This can be most harmful during spring migration when waterbirds need to build up fat reserves for the long journey north. Birds that are constantly disturbed may abandon an important feeding area and move to less productive habitat. This could affect their long term survival.
- Installing a retaining wall or groyne perpendicular to the shore can disrupt longshore sediment movement, which affect shoreline and habitat characteristics several kilometres away.
- Clearing backshore for new coastal developments can remove marine riparian vegetation - grasses, sedges, shrubs and trees found at or near HHW. This can eliminate: food sources (insects) for juvenile salmon; temperature regulation for intertidal species; absorption of wave energy; and provision of foreshore diversity and structure that provides microhabitats for many species. Removing upland vegetation also destroys perching habitat for birds such as kingfishers and eagles.
- Clearing backshore can also de-stabilize upland sediments, causing erosion. Adding sediment to nearshore areas by erosion can change the elevation and seaward profile of the area, making it more subject to wave erosion. Erosion can also necessitate dredging and more disruptive activities to maintain navigation channels.

Cumulative Impacts

A cumulative impact occurs when one change to the environment is added to other past, present and foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The shorelines in the populated regions of B.C. are subject to an ever-increasing number of small-scale developments and human-induced changes. The clearing of a single waterfront property may have little effect on surface rainwater runoff from a coastal bluff to the sea. A groyne may disrupt a very small amount of longshore sediment movement. A seawall hardens and straightens only a small portion of the shore.

But, over time, these small insignificant impacts, when combined with each other and those of other shoreline users, can become a large impact. Couple this with the fact that we tend to repeat these insults all along the coast and the scale of the problem becomes apparent. The cumulative impacts are synergistic and become very significant.

Changes to coastal systems caused by human activity stress natural systems. While some changes may not be significant, and coastal systems, being complex, are somewhat resilient, the consequences of other stressors can be catastrophic . The cumulative effect of too many stressors such as our coasts are experiencing today may simply be too great for the natural systems to adapt or respond to. Chronic chemical pollution from stormwater runoff, for example, or continuous erosion from backshore clearing and grubbing or slope failures can easily overstress natural systems and cause a chain reaction of unintended consequences.

It is important to understand that cumulative effects are not inevitable. Ten properly sited and designed docks may have less impact than a single, poorly designed one. We can minimize cumulative impacts when we better understand the physical and biological processes described in the previous pages. Siting a structure or adopting best design standards and management practices are intended to mitigate the impacts these structures can have on such things as longshore drift, erosion or shading.

Because the number of people living and working along the shore is increasing so rapidly, ***we need to get it right.***

Marine Sensitive Areas

The concept of marine sensitive areas is a way of focusing action on the most important, unique, sensitive or representative marine areas for protection from impacts. These areas are sensitive because of the nature of the processes that occur in them and/or the unique or fragile habitats and species that they support. Typical areas are shown in the accompanying photographs.

Some marine sensitive areas are found in national or provincial parks or wildlife areas, but their particular marine features have received little attention - until recently. The governments of B.C. and Canada along with non-governmental organizations are taking a variety of steps to protect marine sensitive areas. For example, the governments of B.C. and Canada are developing a joint strategy for establishing a network of Marine Protected Areas throughout B.C. (see page 42 in "Planning and Approvals"). The federal government also recently passed the *National Marine Conservation Areas Act*, and several sites are being considered by Parks Canada for designation as NMCAs.

Critical habitat may be highly vulnerable to human disturbance.

Mo Morrogh

Shoreline areas with a high rate of (active) sediment transport are vulnerable to interruption of sediment transport mechanisms.

Regional District of Comox Strathcona

Areas where water does not circulate well or where exchange is limited are particularly susceptible to changes in freshwater and chemical inputs, and to activities that alter circulation patterns.

Fisheries and Oceans Canada

Areas of fine sediments and shallow depth that are close to freshwater input are vulnerable to chemical contamination.

Regional District of Comox Strathcona

Habitats formed by the long-term interaction of complex physical processes are slow to recover from disturbance or disruption of any of these processes.

Regional District of Comox Strathcona

Salmon get a helping hand

It took eight truckloads of gravel to save the salmon spawning grounds of a river in northwest B.C. The river had been dammed 50 years ago when a pulp mill was built on its banks. Gradually the dam eliminated the supply of fresh gravel and sediment from upslope and upstream areas to the spawning and rearing grounds downstream. In due course most of the spawning habitat disappeared and the few fish that returned to the river were actually competing for spawning areas, laying their eggs on top of each other's.

A Coho would arrive first, dig a redd, and lay her eggs. Then a Chinook would appear a few weeks later, dig up that redd, and deposit her eggs, leaving the Coho eggs to float up and get eaten by the trout.

So two years ago the local residents decided to give Nature a helping hand. They trucked in and deposited over 70 cu m of clean gravel into the river, below the dam. Almost as soon as they put it in, they saw the Steelhead beginning to spawn. Within two weeks, the heavy spring rains and high flows had sorted and redistributed the gravel, creating new spawning areas all along the lower river and into the estuary.

It will be some years before the residents will know if the technique worked, since salmon don't return to their spawning streams for two to six years. But early indications are that the gravel deposit was a simple way to restore spawning habitat lost because of the dam, which was built long before more stringent controls were in place.

Harriet Rueggeberg

Different Shores-Different Concerns

Shore Types

We have described the physical forces that shape shores and the biological communities that inhabit them. We learned that in order to protect our shores, we need to understand the impressive power of tides, wind and waves, and the delicate balance of plants and animals that live under the influence of these systems.

It is also important to know that there are different types of shores, and that each shore type has a different ability to accommodate disturbance. Some are stable and robust; others are fragile and easily destroyed. This section describes the physical and biological attributes of these different shore types. For each shore type we describe development sensitivities and offer a checklist that will provide guidance for local and regional land planning decisions.

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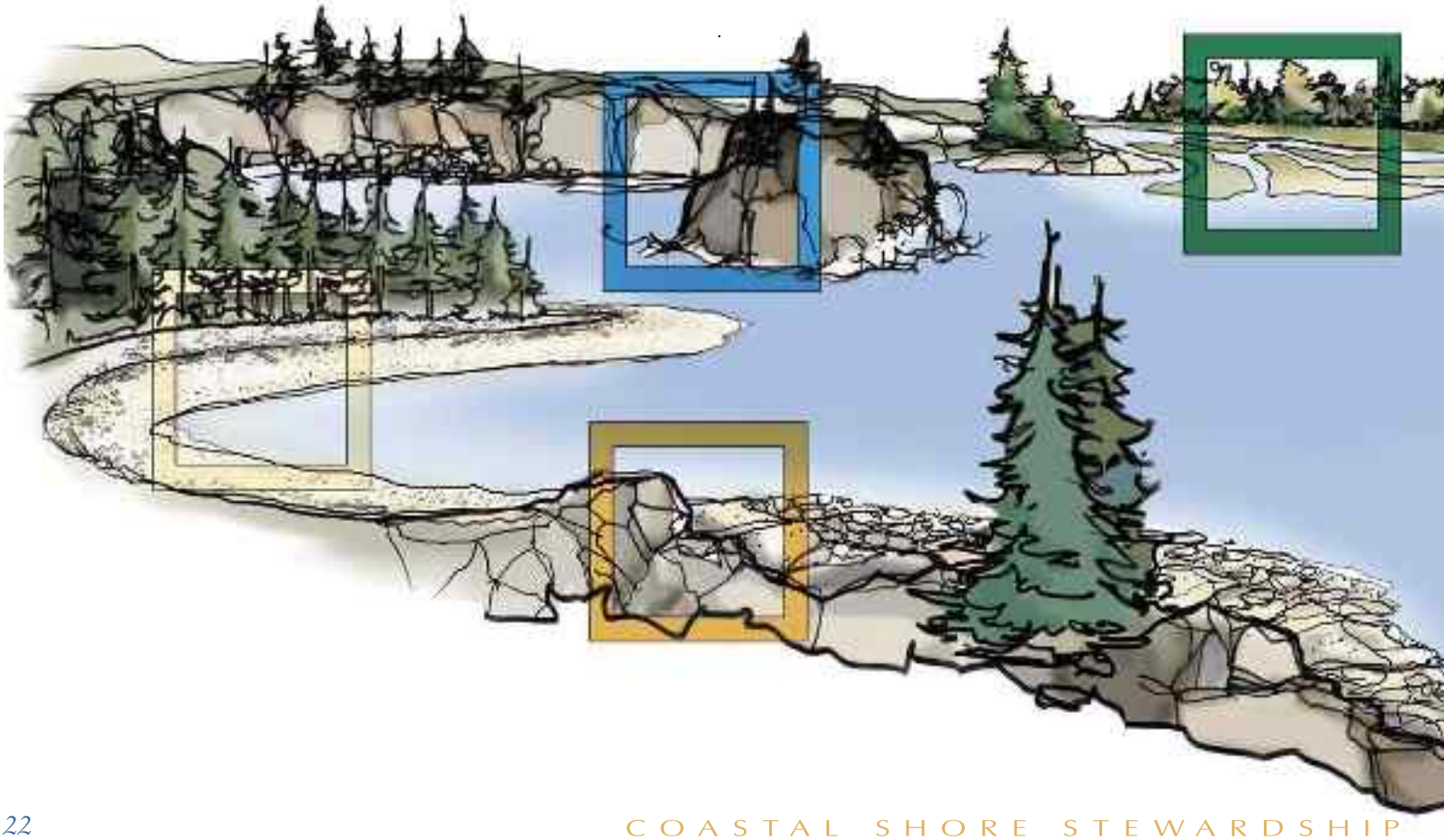


Shore Classification

A great deal of effort has gone into classifying shores into shore types. Such classification systems help to support coastal planning and management efforts. For example, most of British Columbia's shores have been classified to determine their sensitivity to oil spills while some, notably estuaries, have been classified and colour coded with respect to their fish habitat values. These classification systems also contain management prescriptions that outline where and under what circumstances development activities may be acceptable.

Federal and provincial management agencies have developed fairly detailed shorezone classification systems. For the purpose of this document, these systems have been simplified to five shore types. Knowledge of these five shore types will help in making environmentally sound decisions on the use of B.C.'s coast.

Care has been taken to ensure that this simplified classification can be matched back to the federal/provincial classification systems so that local planners can correlate their plans with existing coastal mapping, and so that coastal communities will be able to build on existing resources available through federal and provincial coastal programs.

Five icons are used throughout this chapter to identify these five shore types.

Archipelago Marine Research Ltd.

Rocky Shores *are usually very stable and cover much of the B.C. coast. They are quite resistant to change and provide habitat for a variety of intertidal organisms.*

Regional District of Comox Strathcona

Rock and Large Sediment (Boulder/ Cobble) Shores *occur where cobble or heavy gravel sediment is available from eroding rock benches or cliffs. If the sediment includes some finer material, a dense cover of stable shore vegetation will grow.*

Pacific Geological Survey

Sediment (Sand and Gravel) Shores *are formed where a great deal of smaller particle sediment is available from sources such as sandstone bluffs. Often these shores are very sensitive to disturbance and can change very quickly.*

Regional District of Comox Strathcona

Rivers and streams that carry upland sources of fine sediment can form estuary deltas in a relatively short period of time. ***Estuaries and Mud Flats*** *are very sensitive to change.*

Fisheries and Oceans Canada

The Stanley Park Seawalk is an example of an ***Altered Shore****, which is common in urbanized areas of the Georgia Basin.*

Rocky Shores

A rocky shore typically consists of a solid rock bench across the intertidal zone, that may or may not extend up to the high tide line. Thin gravel and boulder veneer deposits are often found on these benches, but usually cover less than 10 percent of the intertidal area. This type of shore can also be a near vertical rock cliff that may extend above and below the intertidal zone. Sand, gravel and cobble sediment deposits often form small beaches near the high tide line. Rocky shores are resistant to erosion and do not provide a significant supply of unconsolidated sediment to the coast.

Main Physical Features

The main physical characteristic of rocky shores is the limited amount of sediment. These shores generally resist erosion, although sandstone shores may still be subject to erosion. Rocky shores have a more noticeable movement of sediment on to and off beaches than movement along the shoreline. These shores:

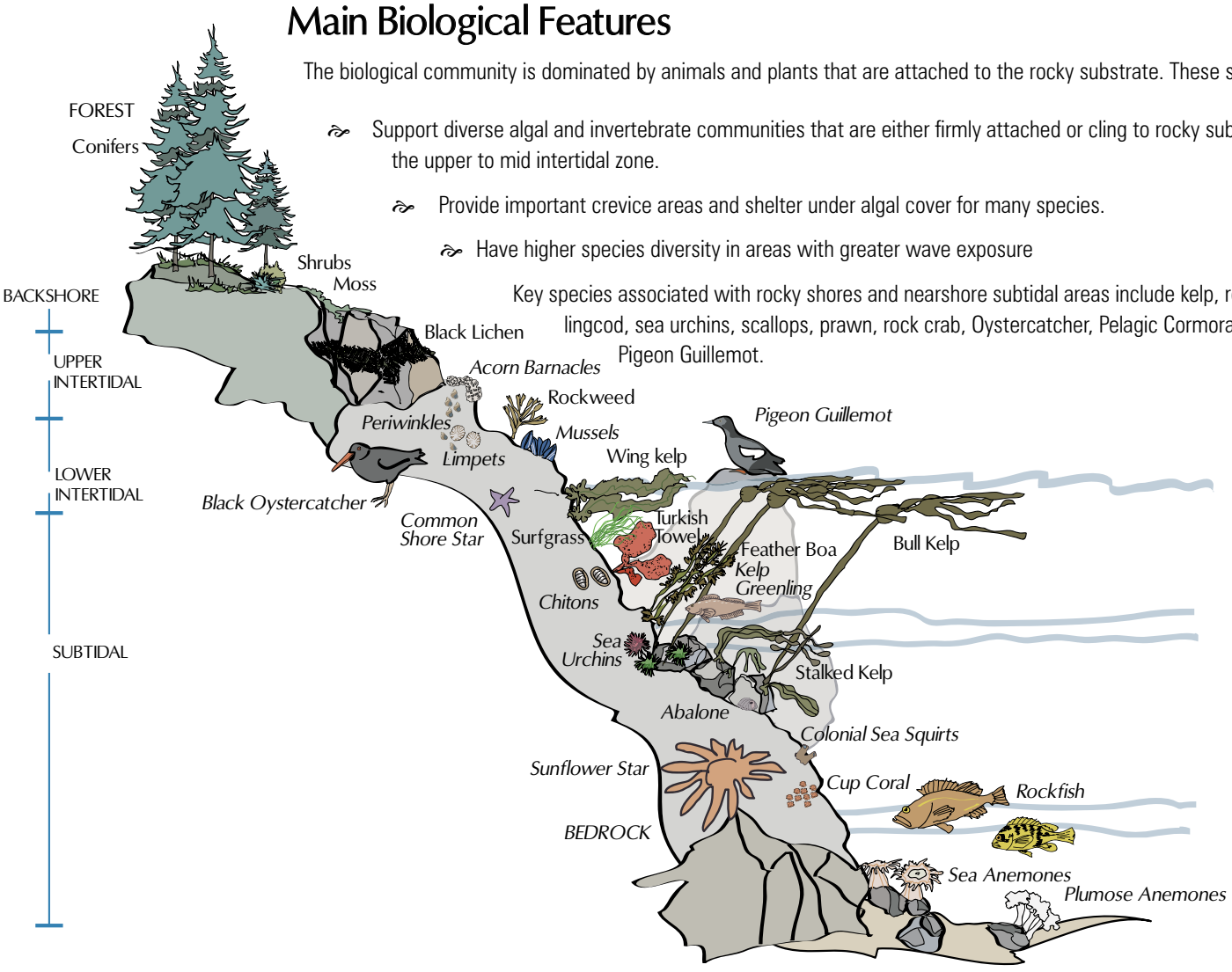
- Have very limited sediment supply.
- Are very stable over human time scales (i.e., 100s of years). Geological processes (1000s or millions of years) usually determine their foreshore shape.
- Have low sediment transport rates along the shore, ranging from 0 to 500 cubic metres/year.

Main Biological Features

The biological community is dominated by animals and plants that are attached to the rocky substrate. These shores:

- Support diverse algal and invertebrate communities that are either firmly attached or cling to rocky substrate in the upper to mid intertidal zone.
- Provide important crevice areas and shelter under algal cover for many species.
- Have higher species diversity in areas with greater wave exposure

Key species associated with rocky shores and nearshore subtidal areas include kelp, rockfish, lingcod, sea urchins, scallops, prawn, rock crab, Oystercatcher, Pelagic Cormorant and Pigeon Guillemot.



Adapted from a sketch by Archipelago Marine Research Ltd.

Lanarc Consultants Ltd.

The "Malaspina Galleries" on Gabriola Island are sandstone cliffs that have eroded over time to create a series of hollows and caves. Because of the deep water adjacent to these cliffs almost no sediment remains.

Mike Tarbotton

Much of B.C.'s coast is characterized by rock ramps or platforms with little sediment.

Mike Tarbotton

This is primarily a rocky shore that has a shallow slope and a thin veneer of sediment.

Development Sensitivites

Rocky shores are very stable and are not formed by large amounts of sediment. They are generally considered good areas for upland development. Care is warranted though because intertidal and shallow, subtidal biotic communities on rocky substrates can be diverse and very susceptible to certain types of disturbance.

- Rocky shore communities are relatively insensitive to changes in sediment process, particularly in more exposed areas where sediment is quickly dispersed by wind and wave action.
- Intertidal communities are particularly sensitive to impacts that scrape and abrade the rocky surfaces including trampling in intensely used areas.
- Microhabitats, created in the spaces between rocks, different sized rocks and the understorey of larger kelps, are important in rocky shores. Microhabitats contribute to species diversity and provide shelter for both predators and prey species important in the ecosystem.
- Structure-forming species such as kelp are important components of rocky intertidal communities. Harvesting of these species can lead to undesirable changes in community structure and reductions in abundance of these important physical habitat features.
- Intertidal and subtidal algae found in these areas are sensitive to the shading effect of pile docks or floating structures.
- Biological recruitment to rocky areas that have been disturbed by development activities can be quite rapid (two to three years).
- Even bedrock cliffs can be subject to faults, so structures should be set back far enough from the crest of the slope to ensure geotechnical stability.

Rock and Large Sediment (Boulder/Cobble) Shores

Rock and large sediment shores are usually found on rocky coasts where loose sediments overlay 10 to 40 percent of the intertidal shore area. These sediments usually form thin layers of cobbles or heavy gravel. The main source of these sediment deposits is wave erosion of the adjacent rock bench or cliffs.

Coastal cliffs or bluffs formed of unconsolidated materials can be a major source of sediment on rock and sediment shores. Large sediments such as boulders or cobbles do not usually move along the shore but form what is called a "lag deposit" on top of the solid bedrock.

Main Physical Features

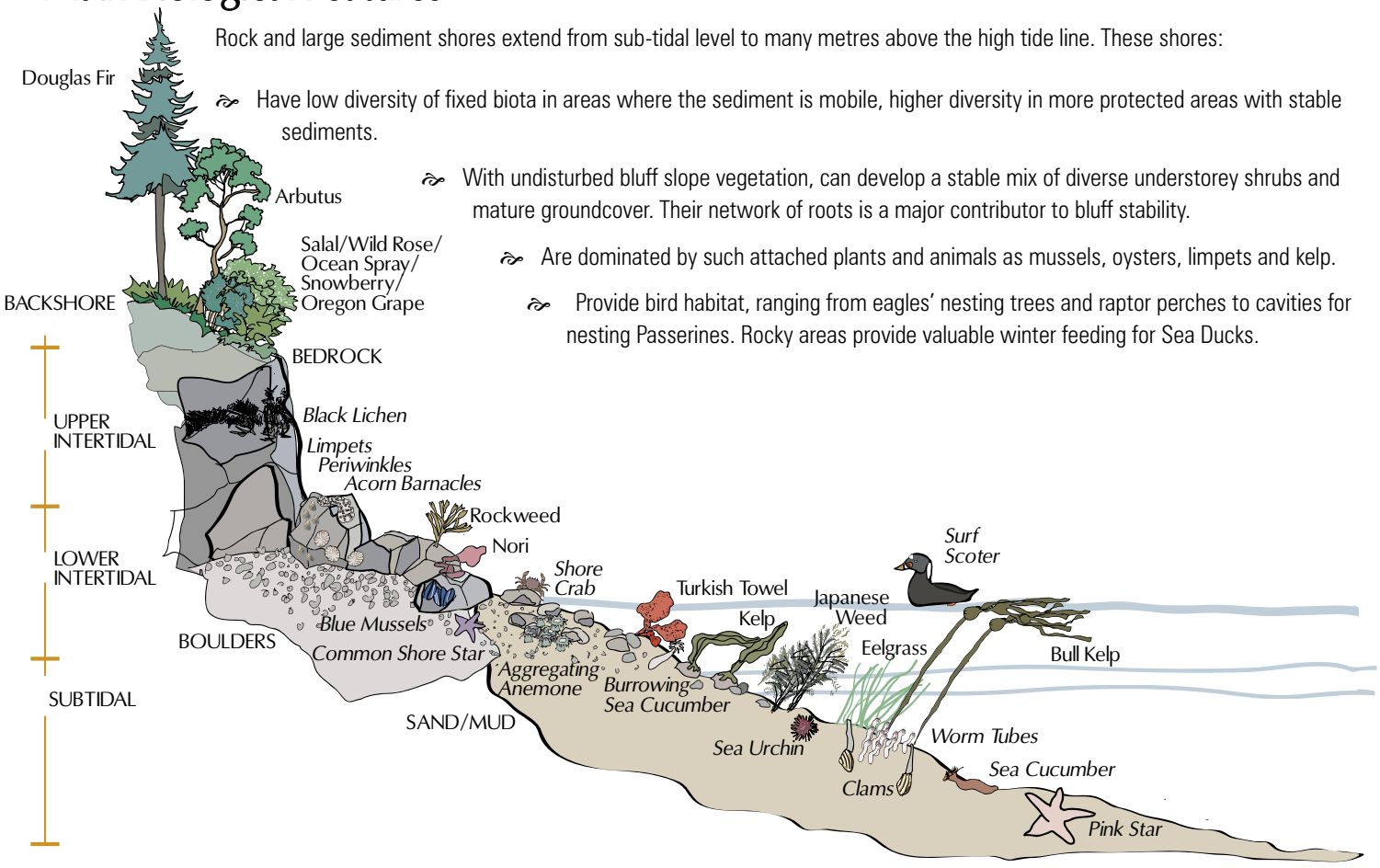
For rock and large sediment shores, onshore/offshore and longshore sediment transport are both important transport processes. This shore type actually reflects a variety of different conditions. Generally these shores:

- Are moderately resistant to erosion.
- Have a limited sediment supply except where there are upland bluffs.
- Are usually stable over human time scales (e.g. 100s of years).
- Have their foreshore shape determined by geological processes (1,000s or millions of years).
- Have sediment transport rates along the shore that are usually small, ranging from 100 to 2500 cubic metres/year.
- Have characteristic features such as rock terrace or cobble/boulder beaches with driftwood accumulations in the high intertidal and backshore.

Main Biological Features

Rock and large sediment shores extend from sub-tidal level to many metres above the high tide line. These shores:

- Have low diversity of fixed biota in areas where the sediment is mobile, higher diversity in more protected areas with stable sediments.
- With undisturbed bluff slope vegetation, can develop a stable mix of diverse understorey shrubs and mature groundcover. Their network of roots is a major contributor to bluff stability.
- Are dominated by such attached plants and animals as mussels, oysters, limpets and kelp.
- Provide bird habitat, ranging from eagles' nesting trees and raptor perches to cavities for nesting Passerines. Rocky areas provide valuable winter feeding for Sea Ducks.



Adapted from a sketch by Archipelago Marine Research Ltd.

Lanarc Consultants Ltd.

This rocky shore has a small amount of loose sediment overtop. The sediment supports the growth of vegetation and provides a broad range of habitat.

Mike Tarbotton

Mature vegetation growing close to the water's edge is characteristic of this shore type.

Brian Emmett

The larger shore sediments on this type of shore tend to resist movement.

Development Sensitivities

Rocky backshore areas are quite stable and are generally considered good areas for building upland development. Stability and erosion is always a concern on coastal bluffs even if the underlying area is bedrock. Assessment of stability should focus on areas with sediment.

Abrasion, shading and loss of habitat features such as crevice space and structure-forming plants and invertebrates are major concerns in rocky areas. Impacts to sediment processes that produce and sustain sensitive habitats such as eelgrass beds are also major concerns in intertidal and shallow subtidal sediments. Conservation of riparian (waterside) vegetation is important on coastal bluffs.

- If sediments move during storms, annual or seasonal algae such as Enteromorpha (sea lettuce) and mobile invertebrate species living on the surface will dominate.
- If sediments are stable (more protected or deeper areas), perennial algae such as Fucus (bladderwrack) and attached invertebrates will dominate.
- These shores, and the associated biotic community, have a long recovery time following oil spills, particularly when oil is trapped on the bedrock below layers of boulder and cobbles.

Sediment (Sand and Gravel) Shores

Sand and gravel shores are found on both steeply sloped shores, and coastal plains that have a significant supply of loose sand, gravel or small cobbles. These materials erode easily and are readily transported by wave and current action. Coastal cliffs (bluffs) are often a major source of beach sediment. Features such as spits and coastal lagoons can be created when the sediment associated with longshore drift accumulates. Finer sediments, including gravel and sand, are often moved down the coast by wave action and accumulate as pocket beaches in sheltered bays between headlands, or as gravel beaches near high water in small indentations along the coast.

Sand and gravel shores are highly sensitive to human interference and interruption of longshore transport processes. Breakwaters, groynes and modifications to the onshore/offshore movement of sediment transport can have serious effects. Coastal plain shores are also susceptible to flooding during high tides, surges and storm waves.

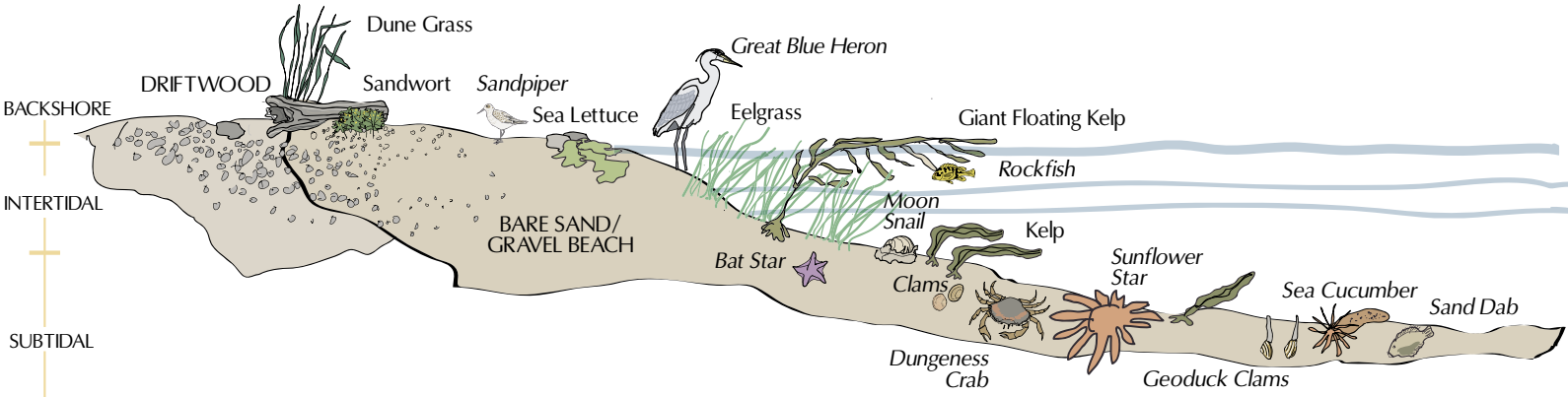
Main Physical Features

Sediment shores occur where there is a supply of steadily eroding small particle size sediment from coastal bluffs or rivers. These shores are very dynamic and their features can change quickly with large storms. Low-lying sandy shores may be prone to backshore flooding. Generally these shores:

- Have easily eroded sediment.
- Have a large supply of loose sediment.
- Are very dynamic on a human time scale.
- Have foreshore shape determined by wave and tide action.
- May have very large sediment transport rates along the shore depending on wave exposure. Sediment transport rates range from 1,000 to 1,000,000 cubic metres/year. Think of 40,000 truckloads of sediment rolling past these shores each year!
- Have rates of longshore sediment transport that are usually larger than onshore/offshore transport.

Main Biological Features

- The intertidal and nearshore biological communities of sand and gravel shores are dominated by burrowing invertebrates such as worms and clams that live in the sediment, and attract large concentrations of birds such as Scoters and Goldeneye.
- Large mobile invertebrates, such as sea stars, may also be present. These animals can move quickly in response to shifting sediments.
- Eelgrass, a rooted perennial plant, often grows in meadows in sand/mud substrates in protected areas. Disruption to sand and gravel shores can have a devastating impact on eelgrass beds.
- Backshore vegetation (dune grasses, salt adapted plants and shrubs) forms a distinct habitat zone and is important in stabilizing the upland sediments and preventing erosion.



Adapted from a sketch by Archipelago Marine Research Ltd.

Mike Tarbotton

Sand and gravel shores are constantly changing as winds and waves move sediment along the shore.

Mike Tarbotton

A detailed analysis of physical shore systems is required to determine if a sediment shore is likely to erode or accrete. Refer to pages 8-13 for more information about sediment dynamics.

Mike Tarbotton

A single winter storm can pull large amounts of sediment from the higher shore areas into an intertidal area. This process is reversed gradually over the summer as the sediment is built up again as longshore currents carry sediment from nearby beaches and estuaries.

Development Sensitivities

Building is a risky activity on sand and gravel shores and can be costly to your pocketbook and the environment. Because sand and gravel shores are very dynamic, they are also sensitive to human activity, particularly activities that disrupt sediment processes. These could include seawalls, groynes, wharves or docks, or upland development that is located poorly. Species such as eelgrass, and their associated biological communities, require fine substrates and are therefore sensitive to changes in sediment processes that result in erosion, accretion or changes in sediment size.

Marine birds and fish may also be affected by changes in invertebrate community composition, as infaunal organisms are important food sources for them. It is difficult and often impossible to compensate for losses or alteration of these types of habitats.

Sand and gravel shores provide many opportunities for coastal tourism and recreation. Recreational beaches occur infrequently since they are created only where there is a constant local supply of eroding sand and rocky headlands that trap sediment. Development pressure is generally greatest near these beaches and the possibility of damage can be acute.

- Many shorebirds rely on the seasonal sediment dynamics of beaches for foraging. Shoreline protection structures such as revetments and seawalls can affect these seasonal processes.
- It is important not to remove vegetation. It helps protect against erosion of backshore areas.
- Boat wakes can contribute significantly to erosion in protected areas.
- Intertidal and subtidal eelgrass beds, which often are found in these areas, are rooted in the fine sediment and are particularly sensitive to disturbances that may uproot them (propeller wash, dredging). They are also sensitive to changes to the sediment processes that either erode substrate and dislodge the plants or deposit lots of sediments that smother the plants. It is difficult to compensate for losses to eelgrass habitat, as recruitment processes are not well understood and ideal growth conditions are hard to reproduce.
- Along the north coast where gravel beaches provide the only passable route for vehicles, it is especially important to be aware of the potential for environmental damage. Driving on beaches crushes the flora and fauna that live on and immediately under the surface, and can destroy spat eggs or species such as surf smelt that use the beaches for spawning.

Estuaries and Mud Flats

Estuaries are formed where a river enters the ocean. Rich nutrients and fine sediments carried by the rivers, the variety of habitat created by the formation of deltas, and the mixing of fresh and salt water make estuaries highly productive. They are important nursery habitats for many kinds of fish and invertebrates.

Estuaries come in many forms. They include large flat deltas such as the Fraser River Estuary, and steep river mouths such as those found at the head of many coastal fjords. The form of the estuary depends on a number of factors: the river's flow and volume, the topography and water depths near the river mouth, and the type, size and availability of sediment in the catchment area. Typically, large rivers with a relatively flat mouth, such as the Fraser, form extensive deltas made up of fine sand and silt sediments. Steep rivers may also form small deltas if there is an upland source of erodible material. In these situations, the sediment on the delta is usually much coarser gravel and cobbles.

Main Physical Features:

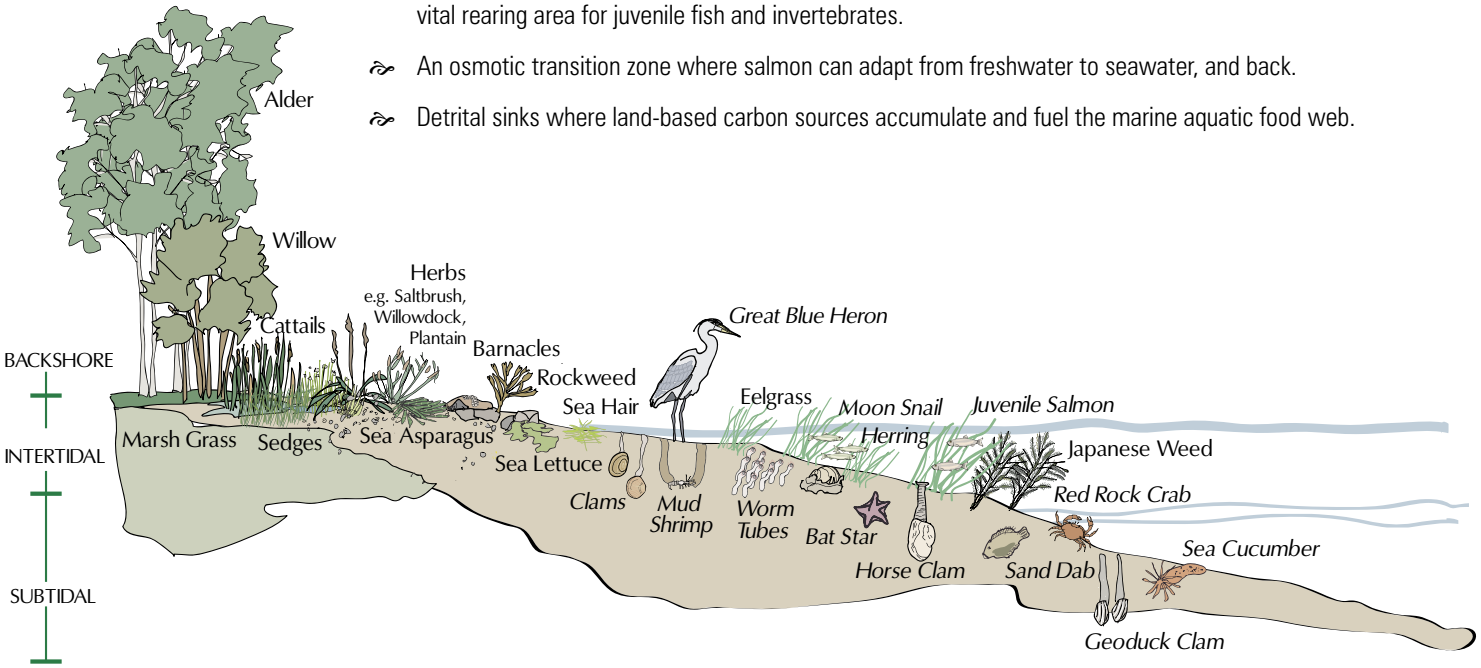
Estuaries are formed by complex and dynamic physical processes. In general, estuaries:

- Have a physical form determined primarily by river flow, river sediment supply, tides, wind and longshore sediment transport
- Are very dynamic - they can change rapidly, often over periods of less than a year, and often as a result of major storms or flooding.
- Are formed by complex physical processes and are extremely sensitive to disturbance if these processes are disrupted

Main Biological Features

Many estuaries are characterized by highly productive and brackish salt marshes, and other distinct vegetation communities (estuarine swamps and meadows) that adapt to seasonal flooding and salty soils. Their intertidal and subtidal biological communities can survive with rapid changes in temperature and salinity. Estuaries provide important rearing and feeding areas for many fish species including juvenile salmon as well as waterfowl. They are also vital habitats for several mammals including deer and Black and Grizzly bear. Estuaries contain:

- A variety of biological communities that can survive rapid changes in water temperature and salinity.
- Salt marshes and other brackish vegetation that provide cover, detritus and produce invertebrates used as food sources by fish and waterfowl.
- Important staging and overwintering habitat areas for waterfowl and shorebirds; feeding area for Great Blue Heron; vital rearing area for juvenile fish and invertebrates.
- An osmotic transition zone where salmon can adapt from freshwater to seawater, and back.
- Detrital sinks where land-based carbon sources accumulate and fuel the marine aquatic food web.



Adapted from a sketch by Archipelago Marine Research Ltd.

Fisheries and Oceans Canada

Estuaries provide habitat for a wide variety of wildlife. Deeper portions are frequently major shipping centres and home to a variety of industries and commercial interests.

Regional District of Comox Strathcona

Sediment dynamics in estuaries can be dramatic. The delivery of sediment downstream can change the shape of the shore in a very short period of time.

Lanarc Consultants Ltd.

The upland parts of many coastal estuaries along the B.C. coast provide productive agricultural lands.

Development Sensitivities

Estuaries and associated vegetation features (eelgrass, marsh plants) are extremely sensitive to anything that disrupts the complex physical and chemical processes by which they are formed (changes in freshwater flow, sediment input, and longshore processes). Once disturbed, recovery is very slow and where habitats do re-establish, they are often different than the original habitat and will not support the same species.

- Estuaries are particularly sensitive to metal and organic contaminants that bind to fine sediments and are often transported to estuaries by rivers. This is because fine sediments tend to be deposited in these areas. Storm drains and sewer outfalls can be significant sources of sediment- bound contaminants in urban areas.
- These areas are often crucial to the life cycles of many birds and mammals (eagle, bear, and waterfowl), particularly in British Columbia where so many species depend on migratory salmon.
- Intertidal and subtidal eelgrass beds, which often are found in these areas, are rooted in the sediment and are particularly sensitive to disturbances that may uproot them (propeller wash, dredging) or changes to the transport of sediment. It is difficult to compensate for losses to eelgrass habitat as recruitment processes and ideal growth conditions are not well known.
- Maintenance of coastal riparian vegetation is important in order to maintain the integrity of carbon cycling and sediment flow to upper intertidal marsh areas.
- Estuarine areas with restricted tidal circulation, such as tidal lagoons, can be particularly susceptible to changes in freshwater or chemical (nutrient) inputs and to physical disturbances that affect water circulation patterns.
- Estuarine marsh vegetation provides carbon and physical habit for invertebrates that nourish juvenile salmon.

Changes in elevation, caused by dredging or filling, will alter physical habitat features and substrate quality, which encourages establishment of nuisance invasive species such as purple loosestrife or cordgrass.

Altered Shores

These are shores that have been modified by human activity. Only a small percentage of British Columbia's shores has been modified, but that percentage tends to be in some of the most productive coastal habitats. People tend to settle in the same areas that are most favourable to marine life - sheltered bays, estuaries, gently sloping shorelines, and so on. Hence, the impact of human activity is significantly greater in some B.C. coastal ecosystems, such as the Georgia Basin, than simple percentages would indicate.

Furthermore, the degree of modification is particularly high in areas such as sheltered bays and estuaries where communities, harbours and ports tend to be located. Altered shores are the only shores that are increasing over human time scales.

Main Physical Features

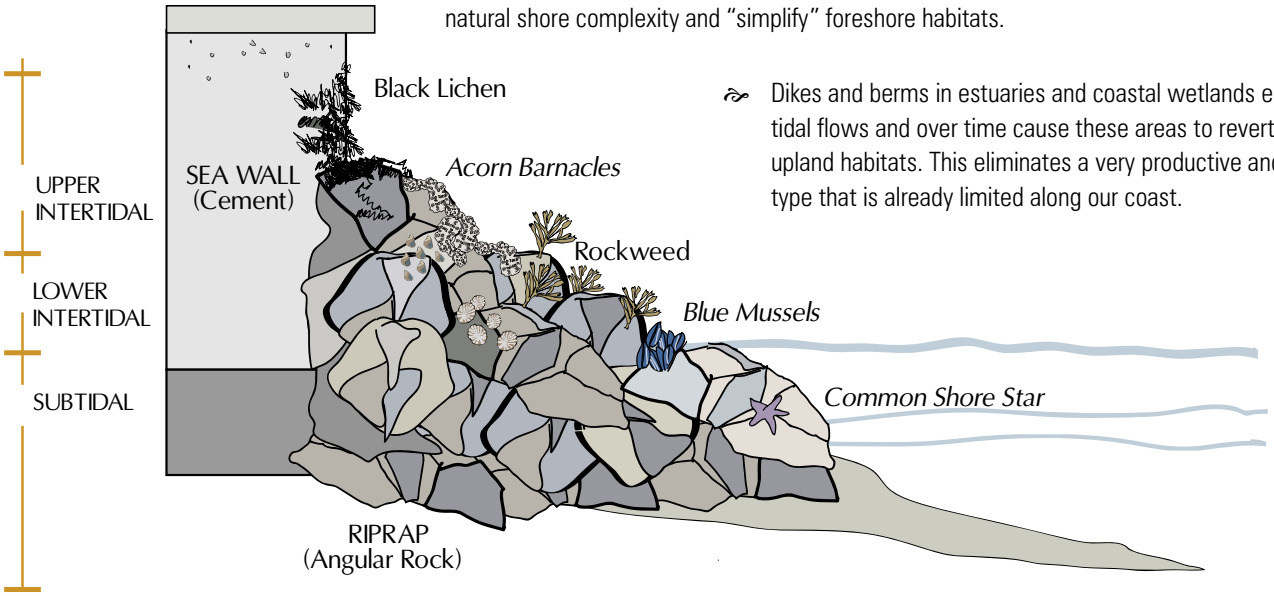
Generally, these human-made shores:

- Are built of imported large rock (riprap), concrete, steel or wooden piles.
- Tend to be straight, hard and impermeable.
- Alter local water action and sediment transport patterns either deliberately (as part of their design and function) or inadvertently.
- Usually involve foreshore filling, which buries underlying natural substrates and biological communities.
- Often require maintenance dredging (e.g. deep-water ports), which constantly impacts benthic (bottom dwelling) communities and sediment patterns.

Main Biological Features

Altered shores are typically less diverse biologically than natural shores - for example:

- Structures with smooth surfaces, such as steel piles or concrete seawalls, have a lower surface area than natural shorelines, and often are poorly colonized by algae and invertebrates.
- Riprap embankments provide more surface area, but habitat spaces tend to be of uniform size. Even though algae and invertebrates colonize these crevices, diversity is limited.
- Pile structures such as piers and docks can provide cover for fish and nesting habitat for birds such as the Purple Martin, but can also shade out underlying marine plants.
- Dikes and seawalls accelerate local erosion at the toe of the slope, prevent the accretion of sediment and the establishment of low bench marshes that provide food for fish.
- Vertical structures such as bulkheads and retaining walls remove riparian vegetation, eliminate natural shore complexity and "simplify" foreshore habitats.
- Dikes and berms in estuaries and coastal wetlands eliminate natural tidal flows and over time cause these areas to revert to backshore or upland habitats. This eliminates a very productive and diverse habitat type that is already limited along our coast.



Adapted from a sketch by Archipelago Marine Research Ltd.

Canadian Wildlife Service

In many populated parts of the coast, shores have been altered dramatically. The installation of shore protection works often begins a costly chain reaction, as homes have often been built too close to the shore.

Fisheries and Oceans Canada

Shore protection works can affect the way that wave energy is dissipated and can alter sediment movements, creating areas of intense scouring and deposition.

Mike Tarbotton

Low-lying coastal areas can be subject to dramatic changes during severe storms. Waves and storm surges can combine to flood low-lying areas.

Development Impacts

Rather than being sensitive to development, altered shores are the recipients of development impacts. These can include:

- Straightening and hardening of the shore zone, reducing the amount and diversity of substrates available for organisms to colonize or find shelter.
- Burying benthic habitat under fill or structures.
- Removing natural seawater flows to shore areas and/or filling in intertidal and inshore areas, eliminating habitats such as salt marshes and mudflats.
- Removing shoreline vegetation, causing bank destabilization and a decline in habitat quality and quantity.
- Altering how and where sediment is deposited along the shore, changing long-established patterns of erosion and beach formation.
- Creating localized changes in wave energy, reflection and resonance, which can cause shore erosion or make shores unusable.
- Shading marine plants, thereby making habitat less productive.
- Introducing pollutants through outfalls, during construction or operational activities, or by the choice of building material, such as creosoted pilings.
- Poor drainage practices on upland properties, which can lead to erosion, slumping and failure of shore bluffs and banks.
- The interception and redirection of freshwater flows and sediment, precluding the establishment of deltas and brackish estuarine habitats for wildlife.
- Altering the shoreline, its substrate or salinity can encourage the establishment of nuisance or non-native species, which can grow quickly and eliminate native species.

The cumulative effects of altered shores in populated areas have reduced biodiversity and ecosystem health.

Coastal Planning and Approvals

Mike Tarbotton

Who Does What

The previous chapters describe how activities on land and shore influence coastal shore conditions. We must make decisions from a sound understanding of the biophysical forces and processes that shape and sustain coastal shores.

This chapter is about making those decisions. It will tell you "who does what" in the coastal environment. It begins with a brief summary of where jurisdiction lies and then describes roles and responsibilities for federal, provincial and local governments and First Nations governments, focusing on planning and approvals. Finally, it summarizes the roles that non-governmental organizations, landowners and shore users play in coastal decision-making.

The following table provides a quick guide for navigating through this range of responsibilities.

Acronyms listed on next page

Canada:	
Environment Canada	***(EC)***
Canadian Environmental Assessment Agency	***(CEAA)***
Fisheries and Oceans Canada	***(DFO)***
British Columbia:	
Ministry of Agriculture, Food and Fisheries	***(MAFF)***
Ministry of Community, Aboriginal and Women's Services	***(MCAWS)***
Ministry of Energy and Mines	***(MEM)***
Ministry of Sustainable Resource Management	***(MSRM)***
Ministry of Water, Land and Air Protection	***(MWLAP)***

Note:

Text written *like this* identifies federal or provincial legislation. Information written *like this* is available on the Internet - refer to the Website Address Insert included in this document for details.

Roles in Coastal Planning and Approvals

	Planning Role	Approvals Role	Legislation
Federal Government	Facilitate coastal zone planning under Canada's Ocean Strategy	Protect fish and aquatic habitat; marine mammals; migratory bird habitat Regulate to maintain navigable waters Regulate disposal of materials to deep ocean Assess environmental impacts of federal projects Designate protected areas	*Oceans Act: DFO* *Fisheries Act (Canada): DFO* *Migratory Birds Convention Act: EC* *Canada Wildlife Act: EC* *Navigable Waters Protection Act: DFO* *Canadian Environmental Assessment Act: CEAA* *Canadian Environmental Protection Act: EC* *Species at Risk Act: EC*
Provincial Government	Deliver coastal zone planning to address land and resource uses	Allocate, license and regulate the use of Crown foreshore and aquatic lands Approve and regulate discharges to coastal waters Approve and regulate aquaculture operations Regulate mineral, oil and gas development Designate protected areas	*Land Act: MSRM* *Waste Management Act: MWLAP* *Fisheries Act (B.C.): MAFF* *Fish Protection Act: MRSM and MWLAP* *Wildlife Act: MWLAP* *Petroleum and Natural Gas Act: MEM* *Environmental Assessment Act: MSRM* *Local Government Act: MCAWS* *Community Charter (as of December 2002): MCAWS* *Mines Act: MEM* *Mineral Tenure Act: MEM* *Park Act: MWLAP* *Ecological Reserve Act: MWLAP*
Local Governments, Municipalities, Regional Districts, the Islands Trust	Prepare and implement regional and community plans Zone lands for specific uses Plan and provide such local services and facilities as roads, parks, water, sewer and drainage	Approve and regulate residential, recreational, commercial and industrial development along coastal shores	*Powers derived from: Local Government Act* *Community Charter (December 2002- for municipalities only)* *Regional Growth Strategies* *Official Community Plans* *Zoning* *Subdivision* *Watercourse protection* *Tree protection, landscaping* *Drainage, stormwater management* *Sediment and erosion control*
First Nations	Exercise aboriginal rights to traditional lands and waters along coast. Conduct or collaborate with federal/provincial/local governments on coastal inventory and planning.		
Landowners	Call for and participate in local inventory and planning programs	Respect regulations Protect, restore and enhance coastal habitat on properties Demonstrate stewardship practices Adopt best management practices for all activities or works on private waterfront properties "Eyes and ears" for coastal stewardship	
Non-governmental Organizations	Advocate for plans where needed Participate in inventory and planning programs Acquire key coastal habitat	Advocate for improved regulations Inform and educate Manage local restoration/enhancement projects "Eyes and ears" for coastal stewardship	

Jurisdiction along the Coast

Jurisdiction over coastal areas in B.C. is split among federal, provincial and local governments, depending on the location along the coast and the relationship to the shore. It is important to note that while the following points refer to ownership and jurisdiction, all B.C.'s coast is subject to aboriginal claims based on traditional use by First Nations.

Offshore waters

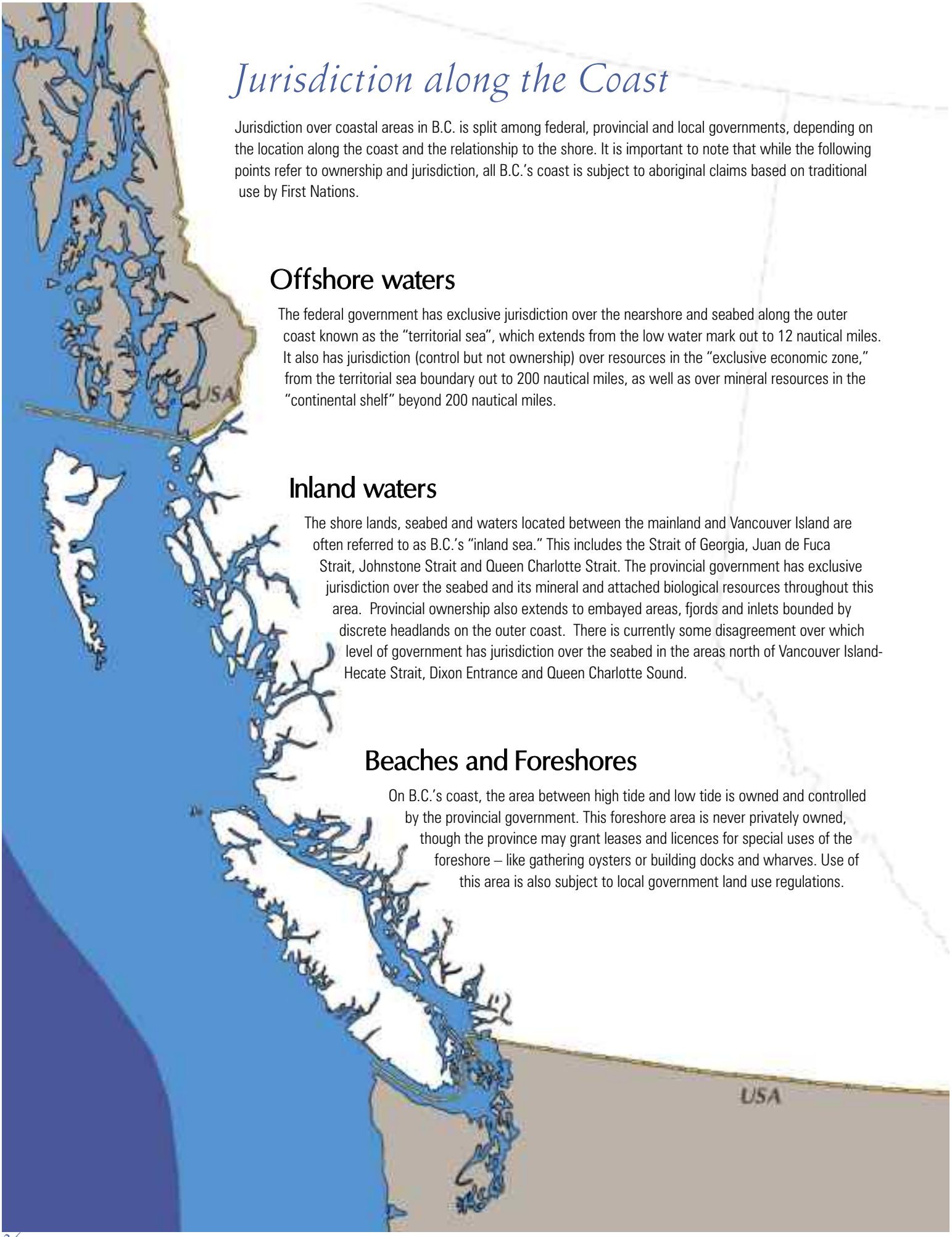
The federal government has exclusive jurisdiction over the nearshore and seabed along the outer coast known as the "territorial sea", which extends from the low water mark out to 12 nautical miles. It also has jurisdiction (control but not ownership) over resources in the "exclusive economic zone," from the territorial sea boundary out to 200 nautical miles, as well as over mineral resources in the "continental shelf" beyond 200 nautical miles.

Inland waters

The shore lands, seabed and waters located between the mainland and Vancouver Island are often referred to as B.C.'s "inland sea." This includes the Strait of Georgia, Juan de Fuca Strait, Johnstone Strait and Queen Charlotte Strait. The provincial government has exclusive jurisdiction over the seabed and its mineral and attached biological resources throughout this area. Provincial ownership also extends to embayed areas, fjords and inlets bounded by discrete headlands on the outer coast. There is currently some disagreement over which level of government has jurisdiction over the seabed in the areas north of Vancouver Island-Hecate Strait, Dixon Entrance and Queen Charlotte Sound.

Beaches and Foreshores

On B.C.'s coast, the area between high tide and low tide is owned and controlled by the provincial government. This foreshore area is never privately owned, though the province may grant leases and licences for special uses of the foreshore – like gathering oysters or building docks and wharves. Use of this area is also subject to local government land use regulations.



Fisheries and Oceans Canada

Prince Rupert Harbour, Rushbrook

Lanarc Consultants Ltd.

Nanaimo waterfront and uplands areas

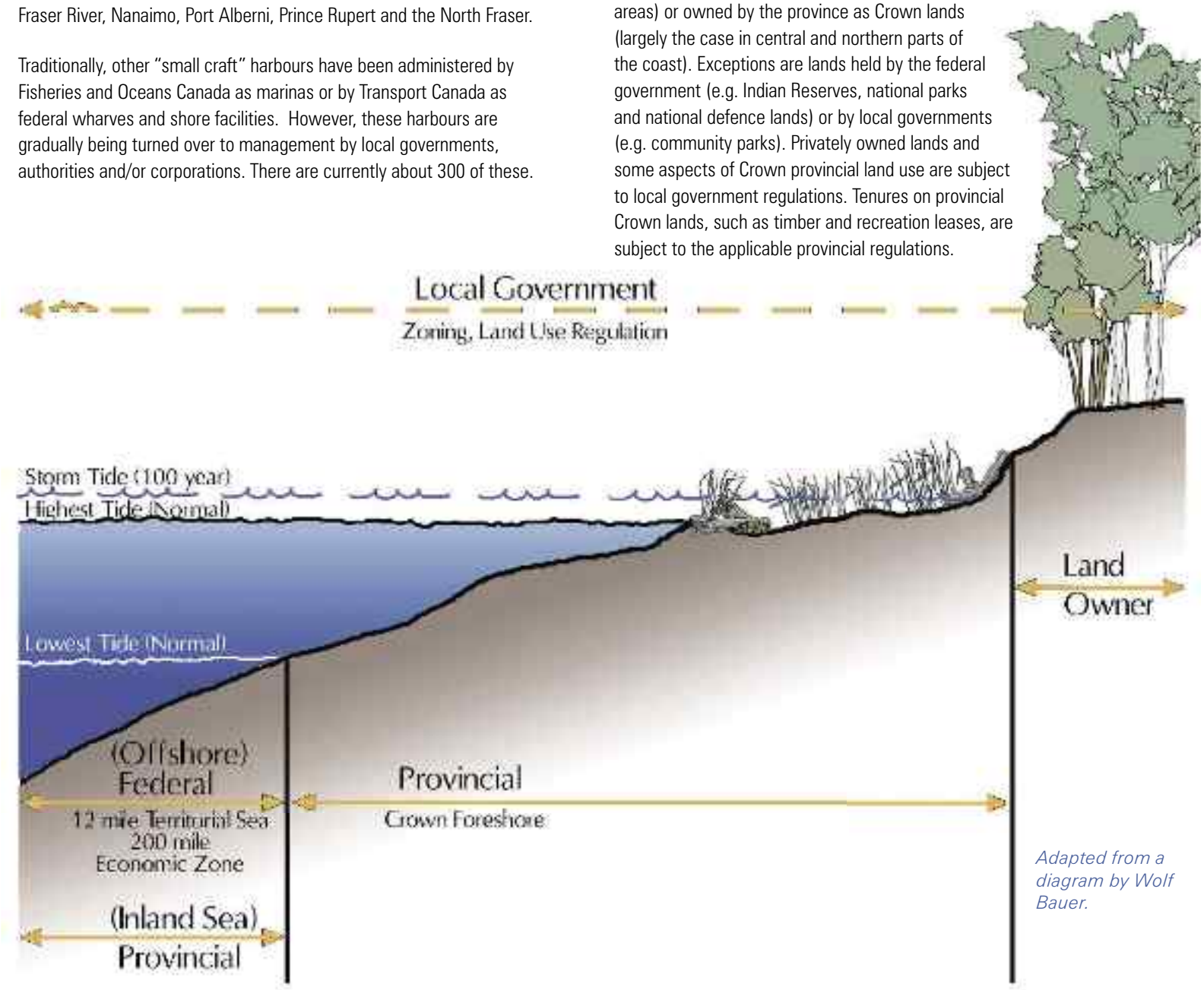
Ports and Harbours

In British Columbia, independent port corporations have management authority over seven major harbours: the Ports of Vancouver, Victoria, Fraser River, Nanaimo, Port Alberni, Prince Rupert and the North Fraser.

Traditionally, other "small craft" harbours have been administered by Fisheries and Oceans Canada as marinas or by Transport Canada as federal wharves and shore facilities. However, these harbours are gradually being turned over to management by local governments, authorities and/or corporations. There are currently about 300 of these.

Upland areas

The coastal upland is either owned privately (most prevalent in southern areas) or owned by the province as Crown lands (largely the case in central and northern parts of the coast). Exceptions are lands held by the federal government (e.g. Indian Reserves, national parks and national defence lands) or by local governments (e.g. community parks). Privately owned lands and some aspects of Crown provincial land use are subject to local government regulations. Tenures on provincial Crown lands, such as timber and recreation leases, are subject to the applicable provincial regulations.



Adapted from a diagram by Wolf Bauer.

Canadian Wildlife Service

Federal Roles

Planning - Canada's Oceans Act

Traditionally, the federal government's role in coastal planning was to manage fisheries, protect fish habitat and oversee transportation safety. This mandate has changed under the *Oceans Act.*

The *Oceans Act* is aimed at optimizing the economic potential of Canada's oceans while maintaining the sustainability of marine and coastal ecosystems. The Act calls on Fisheries and Oceans Canada (DFO) to develop and implement a comprehensive strategy for Canada that will:

- Balance economic, social, cultural, environmental and economic values to ensure sustainable development;
- Manage the increasingly complex and diverse use of the oceans through the development and adoption of integrated management approaches; and
- Engage communities and stakeholders in making decisions that affect them.

The primary means of implementing this strategy is through collaboration with provincial and local governments, First Nations and coastal communities in developing Coastal Integrated Management Plans.

National Marine Conservation Areas Act

This new legislation allows the establishment of National Marine Conservation Areas to protect and conserve marine areas for the benefit, education and enjoyment of everyone. It is administered by Parks Canada, under the Minister of Canadian Heritage.

Fisheries

The *Fisheries Act*, first enacted in 1868, is one of the strongest federal laws to protect Canada's freshwater and marine ecosystems. The Act, administered by DFO and Environment Canada, regulates the harvesting and management of fisheries and the discharge of pollutants into fish bearing waters. It also prohibits the "harmful alteration, disruption or destruction of fish habitat" (a HADD) unless authorized under Section 35 (2) of the Act.

Authorizations issued by DFO require the project result in "no net loss of habitat productive capacity" as required under the National Policy for the Management of Fish Habitat.

Marine Pollution

Complementing the *Fisheries Act*, the *Canadian Environmental Protection Act* (CEPA), enacted in 1999, enables the federal government to set national standards and regulate toxic substances, establish national guidelines (standards) for water quality, and regulate the disposal of materials to ocean environments. Environment Canada administers this act.

Navigation and Marine Transport

The *Navigable Waters Protection Act* (NWPA) is one of the oldest pieces of federal legislation. When it became law in 1882, it was intended to protect marine navigation routes by controlling the logging industry and the location of bridges and dams on navigable waters. Although its application has evolved over the years, its primary purpose is still to protect the public right of navigation. Today the Act is applied to many types of projects in all navigable waterways and coastal areas across Canada. The Canadian Coast Guard, a division of DFO, is responsible for administering its application.

The *Canada Shipping Act* regulates boating and shipping standards and activity. Transport Canada administers it.

Migratory Birds and Wildlife

The Canadian Wildlife Service of Environment Canada conserves and manages populations of migratory birds under The *Migratory Birds Convention Act*. The act protects migratory birds and their eggs and nests from destruction or harassment, governs the taking, capturing or use of migratory birds, and allows establishment of Migratory Bird Sanctuaries. Under the *Canada Wildlife Act*, the Canadian Wildlife Service may establish National Wildlife Areas on land or sea, to protect nationally significant habitat areas.

Environmental Assessment (EA) Review

An environmental assessment and review makes sure the environmental effects of a proposed project are identified, assessed and mitigated early in project planning. This is to prevent the project from harming the environment.

Both Canada and B.C. can require environmental assessments (EAs) of proposed projects. The Canada-B.C. Accord on Environmental Assessment Cooperation promotes cooperative environmental assessment when both federal and provincial EA requirements apply to the same project.

Projects that receive federal funding, occur on federal lands, or are subject to specific federal approvals fall under the *Canadian Environmental Assessment Act* (CEAA) and its regulations. The Act establishes a number of EA tracks, depending on the nature of the project and the likely environmental effects. All projects are screened initially. Larger projects that may have greater environmental impact may require a more detailed EA.

If an EA is required, the proponents are encouraged to review the legislation and relevant regulations that can apply to their project or contact relevant federal departments early in the planning phase. A discussion with such agencies, especially at the local level, assists in identifying potential environmental impacts and necessary mitigation measures. The earlier that environmental considerations are taken into account in project planning, location and design the more likely the project will succeed and have less impact on the environment. An important consideration with regard to CEAA is the cumulative effects assessment that is required; proponents must assess the contribution their project has towards a cumulative effects in the area. This effectively extends the assessment beyond the specific site.

For more information on the Act and its regulations, refer to the publication *Environmental Assessment: Making a Difference* available on *Environment Canada's website*. There are also several helpful guides availble through the *Canadian Environmental Assessment Agency*:

- *The Citizen's Guide: Canadian Environmental Assessment Process :* A guide to determining whether a project is likely to cause significant adverse environmental effects, you can access this guide *on their website*.
- *A cumulative effects assessment—practitioners' guide:* you can access this guide *on their website*.
- *Guide for the preparation of a comprehensive study:* you can access this guide *on their website*.

The Community Mapping Network

(CMN) comprises organizations that collect and map natural resource information. Its steering committee includes representatives from provincial and federal agencies, local governments, provincial environmental organizations and community groups. The CMN integrates data from many sources and makes them accessible through its mapping system. Information is mapped on fish and wildlife distributions, streams and wetlands, eagles and herons, rare and endangered species and possible restoration sites. The intent is to provide inventories and maps for community planning, storm water management, emergency response, habitat restoration and enhancement, watershed planning, coastal planning, development referrals, impact assessment, research, education and awareness. All maps and information are available from the ***Community Mapping Network website****.*

Provincial Roles

Trevor Morris

Coastal Zone Planning

For many years, coastal planning in British Columbia took place primarily in response to specific issues in specific areas — typically harbours and estuaries. During the 1970s and '80s, management plans were developed for the estuaries of the Fraser River, Cowichan River, Squamish River, Ladysmith Harbour, Sooke Harbour and Comox-Puntledge River. More recently, management plans have been developed for the Port of Stewart, Prince Rupert Harbour, Tofino Harbour and several other areas.

However, since the early 1990s there has been consensus on the need to strengthen and improve long range planning in the coastal zone. Such planning allows levels of government to collaborate in the allocation and management of resources to meet national, provincial and local interests.

The province's initial emphasis was on strategic level plans (1:100,000 to 1: 250,000) for large regions and sub-regions (e.g. Vancouver Island Land Use Plan). These plans rarely define where various uses would best occur, but offer broad direction for resource use planning and management.

More recently, provincial attention has shifted towards landscape or local scale plans (1:20,000 to 1:50,000) that provide clearer direction on resource allocation. For coastal regions, these plans suggest where applicants are likely to have success in applying for tenured uses such as aquaculture, log handling, float homes, tourism, and other types of foreshore and nearshore uses. Local-scale plans have been completed for Barkley Sound, North Island Straits and Nootka Sound. Plans are under way for Kyuquot and Quatsino Sounds, and the Malaspina Inlet Complex on the Sunshine Coast.

Smaller scale planning (e.g. 1:20,000 scale or more detailed) addresses specific issues, such as the *Baynes Sound Shellfish Aquaculture Action Plan* and log handling in Nanaimo Estuary. The results can include area designation maps, specific management measures and such operational action plans as compliance and enforcement strategies.

The *Ministry of Sustainable Resource Management* (MSRM) is the main agency responsible for the delivery of provincial coastal zone plans, through its regional offices and its *Coast and Marine Planning Office* (CMPO). The CMPO also designs planning processes, so there is a consistent planning approach between regions, and coordinates provincial coastal policy.

Coastal Inventories and Data Resources

The ***Coastal Resource Information System (CRIS)*** is managed by Decision Support Services of the MSRM. This system is designed to streamline the collection and dissemination of marine habitat and fishery resource information for coastal B.C. The system provides a central, accessible source of spatially geo-referenced information on marine habitat and fish resources. Although the individual databases and GIS layers may reside on different computers in a range of agency data warehouses, the CRIS Atlas provides all the information at one location. There is work underway to integrate and build a relational database for all databases within the CRIS. The CRIS system provides an online data entry system.

Decision Support Services has also developed the British Columbia Marine Ecological Classification system and the British Columbia Biophysical Shorezone Mapping System, which identify marine sensitive areas and shore zone mapping standards. It has mapped most of the coast for its biophysical capability to support shellfish and finfish aquaculture. For more information, check the *Decision Support Service's website*.

The ***Sensitive Ecosystem Inventory*** is a joint endeavour of Environment Canada and the B.C. ministries of Sustainable Resource Management and Water, Land and Air Protection. It identifies and maps remnants of rare and ecologically fragile terrestrial ecosystems in parts of the province that are experiencing heavy growth. Its goal is to encourage land-use decisions that support the survival of these ecosystems. The inventory is available in hardcopy (1:20,000)and electronic (ArchInfo) formats, and is accompanied by a manual that suggests measures that could be taken to preserve these fragile resources. A Sensitive Ecosystem Inventory has been completed for East Vancouver Island and the Gulf Islands, and inventories are underway for the Sunshine Coast and the Central Okanagan region. Visit the *Sensitive Ecosystem Inventories website*.

The ***Resources Information and Standards Committee (RISC)*** sets provincial standards for natural and cultural resources inventories, including collection, storage, analysis, interpretation and reporting of inventory data. Committee members represent provincial, federal, aboriginal and private sector agencies and other resource interests. RISC has established standards and published manuals for both physical and biological shore zone mapping. It also has a *website database* of coastal resource inventories.

Land and Foreshore Tenure

As the "landlord" of B.C.'s public (or Crown) lands, the provincial government can issue tenure or sell public lands. Crown lands include intertidal areas and inner coastal waters and seabeds. The right to occupy these areas requires some form of tenure - typically a lease or license of occupation. These are issued for a variety of uses including aquaculture, mariculture (shellfish), log storage, private and public moorage, wharves and marinas, and recreational uses. Land and Water B.C. Inc. (formerly B.C. Assets and Lands Corp.) is the agency responsible for allocating Crown land tenures, and reports to the *Minister of Sustainable Resource Management*.

Activities proposed on Crown shores and seabeds require an assessment of environmental impacts. These assessments are usually managed through an internal referral process administered by LWBC though large projects may be passed to the B.C. Environmental Assessment Office. For more information, visit the *Land and Water B.C. website*.

Waste Management

The provincial *Waste Management Act* controls emission and discharge of pollutants from land into the marine environment. This includes liquid waste (including stormwater) and hazardous waste, as well as contaminated sites. The Act is administered by the Ministry of Water, Land and Air Protection.

Fish and Wildlife

The B.C. *Fisheries Act* (to be distinguished from the federal *Fisheries Act*) controls activities associated with commercial fisheries and aquaculture operations. Its primary concern is the licensing of fish processing plants, fish buying establishments, fishers selling their own catch, wild oyster and marine plant harvesting and aquaculture operations.

The *Wildlife Act* regulates the management and protection of wildlife on land and sea. The *Fish Protection Act* provides for the regulation and management of anything affecting shellfish, resident finfish and marine plants. It authorizes water managers to consider impacts on fish and fish habitat before approving water licenses. The *Ministry of Water, Land and Air Protection* administers both acts.

Oil, Gas and Minerals

The *Mines Act* enables the regulation and management of extracting non-metallic (e.g., sand and gravel) and metallic minerals in the inland sea. The *Petroleum and Natural Gas Act* oversees the regulation and management of oil and gas exploration and development in the inland sea. The *Ministry of Energy and Mines* administers both acts.

Environmental Assessment

The provincial *Environmental Assessment Act* requires projects of certain types and sizes to have formal environmental assessment. Such projects include, but are not limited to:

- Aquaculture/food processing
- Offshore oil and gas development (exploration and production)
- Offshore mining operations (exploration and production)
- Large destination resorts and such associated facilities as marinas and golf courses
- Highways, railroads, transmission lines and pipelines
- Larger ports and ferry terminals
- Local government solid and liquid waste management projects
- Dams and reservoirs, dikes, diversion projects, groundwater extraction, and shore modification

Generally, residential building projects are not subject to this process because they usually are regulated solely by local governments. Their impacts are usually below provincial assessment thresholds.

Environmental assessment reviews are managed and coordinated by the Environmental Assessment Office. Details of the process are outlined in the *Guide to the British Columbia Environmental Assessment Process (January 2001).* This guide is available *on their website*.

Marine Protected Areas

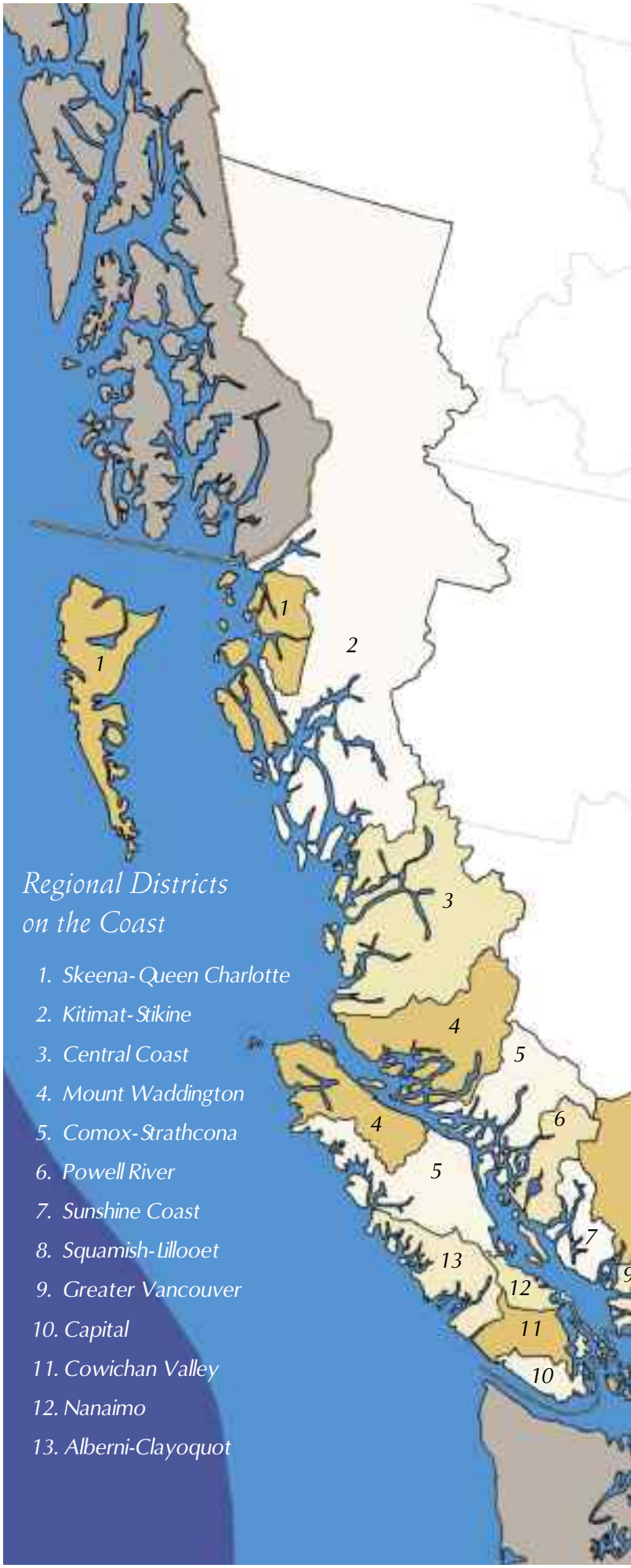
A number of federal and provincial agencies have responsibilities related to the creation of protected areas in coastal waters. For example, Fisheries and Oceans Canada is the lead federal agency responsible for coordinating the development of a system of marine protected areas, and can establish protected areas under the ***Oceans Act****. Fisheries and Oceans works closely with Parks Canada and Environment Canada, who have their own responsibilities for marine protection under the* ***National Marine Conservation Areas Act****, and the* ***Canada Wildlife Act****/* ***Migratory Birds Convention Act****, respectively. The overall objective of these programs is to further conservation and protection of living marine resources and their habitats.*

Canadian Wildlife Service

A Marine Protected Areas Strategy for Canada's Pacific Coast is being developed jointly by the governments of Canada and British Columbia. This strategy is intended to lead to a network of marine protected areas along the Pacific coast, using new and existing federal and provincial statutes. Under this Strategy, objectives for MPAs include:

- *Contribute to the protection of marine biodiversity, fish and their habitats, and cultural heritage resources;*
- *Provide opportunities for recreation and tourism;*
- *Provide scientific research opportunities and support the sharing of traditional knowledge; and*
- *Increase education and awareness efforts.*

The Endeavour Hydrothermal Vents Area recently became Canada's first Marine Protected Area to be declared under the ***Oceans Act****. Several other marine protected area initiatives are currently underway , including designation of Race Rocks and Bowie Seamount Area as Marine Protected Areas (by Fisheries and Oceans Canada), designation of the Scott Islands as a Marine Wildlife Area for seabird foraging protection (Environment Canada), and designation of the waters around Gwaii Haanas National Park Reserve as a national marine conservation area (Parks Canada).*



Local Government Roles

Regional, Community and Islands Trust Planning

Municipalities, Regional Districts and the Islands Trust (collectively referred to as local governments) are responsible for planning land use and development within their respective boundaries. Their powers are defined under BC's *Local Government Act* and as of December 2003, under the *Community Charter* for municipalities. As such, local governments can have a tremendous influence on land based activities that affect coastal shores and nearshore areas.

These planning and regulatory powers also extend to areas covered by water. The *Local Government Act* defines land to include "the surface of water," and states that municipal boundaries can include "the whole or part of adjoining foreshore and any area below low water mark." This implies that the power to plan, zone and permit land uses covers freshwater bodies and marine foreshore and nearshore areas. Many local governments extend zoning into nearshore areas.

Islands Trust Area

1. *North Pender*
2. *South Pender*
3. *Salt Spring*
4. *Saturna*
5. *Mayne*
6. *Galiano*
7. *Thetis*
8. *Gabriola*
9. *Howe Sound*
10. *Executive*
11. *Lasqueti*
12. *Hornby*
13. *Denman*

Land use planning at the local level comes in two basic forms: Regional Growth Strategies and Official Community Plans.

A *Regional Growth Strategy (RGS)* is prepared by a regional district, which comprises municipalities and unincorporated electoral areas. An RGS promotes development that is socially, economically and environmentally healthy and that makes efficient use of public services, land and other resources. An RGS looks ahead at least 20 years to address population growth with reference to land use, economic development, transportation, environmental protection and other regional programs aimed at meeting the needs of people.

Any bylaws passed by a regional district board with an RGS must conform to the direction of the RGS. Similarly, Official Community Plans established by member municipalities of that regional district must be consistent with its RGS.

Like an RGS, an *Official Community Plan (OCP)* is a statement of objectives and policies to guide decisions on planning and land use management within a municipality or electoral (or unincorporated) area. It can identify land use designations, policies and guidelines related to development opportunities and requirements, transportation networks and environmental protection. It also establishes a basis for local government regulations and servicing programs. An OCP addresses a smaller area than a RGS and usually in more detail.

Supporting Coastal Stewardship in Local Planning

Regional Growth Strategies and Official Community Plans are effective tools in providing community direction for coastal stewardship. Especially in settled parts of the coast, these plans can play a significant role in establishing a framework for coastal stewardship by:

- Calling for coordination of policies, regulations and approvals among all levels of governments.
- Establishing land use designations and policies based on an understanding of the biophysical processes of coastal ecosystems.

The next page indicates some of the policies that could be included to support coastal stewardship at the local level.

Coastal Stewardship Policies in Regional Growth Strategies and Community Plans

Stakeholder Involvement

A stakeholder review is useful, either as a part of the main community plan process or as an adjunct to the planning process. It identifies issues that affect planning and management of coastal areas in the community or region.

A list of coastal stakeholders may include coastal landowner groups, industries, recreational users and conservation organizations. Institutional stakeholders may include port corporations, harbour authorities and regional offices of Fisheries and Oceans Canada, Environment Canada, Land and Water B.C. and the Ministry of Water, Land and Air Protection (MWLAP).

Setting goals

An Official Community Plan or Regional Growth Strategy may contain a variety of goals specific to coastal stewardship - such as:

- Developing tactics to protect, restore and enhance natural coastal systems
- Providing opportunities for public recreational use and enjoyment of coastal areas.
- Planning for marine oriented industrial and commercial development.
- Planning an integrated coastal strategy with other levels of government.

Partnership policies

Local governments can use intergovernmental agreements and partnerships with non-governmental organizations to help achieve community goals for coastal areas - for example:

- Coordinate inventory and shore mapping with the provincial Coastal Management and Planning Office, the Conservation Data Centre, etc.
- Develop awareness of best management practices, and run workshops for agencies, developers, waterfront landowners, NGOs and staff.
- Establish a Coastal Zone Technical Committee.

Environmentally Sensitive Areas

It is desirable to regulate development or avoid it in areas where coastal shores are physically or biologically sensitive or subject to natural hazards. This can be done through an OCP or RGS by:

- Identifying Environmentally Sensitive Areas (ESAs) and hazard areas,
- Working to acquire these areas for parks and greenways along coasts,
- Designating development permit areas for the protection of ESAs that establish conditions for development,
- Fostering community awareness of coastal stewardship, encouraging and supporting volunteer actions.

Development policies

Encourage development in appropriate areas by:

- Designating shore areas that are most suitable for development (see examples of coastal classification systems on the next page),
- Specifying best management practices to be used in these areas,
- Encouraging desired forms of development.

Recreation policies

Recognize recreational resources as community assets by setting policies that:

- Provide continuity of public access through the development of interconnected greenways
- Provide access for water-based sports and recreation on the shores that can best support these amenities
- Ensure that recreational uses and the structures that support them (such as a docks) do not adversely impact coastal processes

Water quality policies

Policies and guidelines that reinforce ways to manage liquid waste and stormwater can reflect coastal concerns. Suggested strategies:

- Identify areas with high septic system failure rates. Inform landowners about proper maintenance of on-site sewage disposal and stormwater systems. Promote testing to ensure that systems are properly installed and well maintained.
- Promote demand management strategies to reduce the impact of industrial and commercial sewage
- Reduce the impact of non-point source (NPS) pollution by increasing public awareness
- Work with such high-risk businesses as car washes and gas stations to develop site-specific NPS plans, work with municipal engineering and public works to develop local strategies to minimize the impacts of NPS.

Marine resource policies

Many municipal and regional district boundaries extend over coastal areas covered by water. Official community plans can include strategies that protect such nearshore marine resources as shellfish concentrations, eelgrass beds, etc:

- Collaborate with, or ask senior agencies to conduct mapping and inventory of nearshore resources and locate rare or sensitive species and habitat,
- Protect shellfish and other sensitive marine resources from impacts of upland land uses,
- Develop programs to periodically check the health and quality of nearshore resources.

Hazard management policies

Official community plans should include strategies that minimize risk. A common approach is to insist on development permits in all hazardous areas. These permits must respond to such unstable and hazardous conditions as:

- Ongoing shore erosion
- Occasional flooding from storm surges and tsunamis
- Seasonal flooding; some of these areas may have been identified as part of provincial flood risk mapping.
- Areas of steep slope or where soil seepage conditions create potential for slides.

The avoidance and management of risks is important not just during the construction phase of a project, but over its entire life, including operation and maintenance. The cost of maintaining and reinforcing structures built on eroding land far outweighs the cost of proper site location, or the loss of prime development land. Proper assessment of risk – including anticipation of unforeseen circumstances – prevents costly repairs or lawsuits.

Classifying Shores

A useful tool in planning at the local government level is to classify shores from a habitat sensitivity perspective. Federal and provincial agencies have been doing this for some time in collaboration with harbour authorities and regional districts as part of estuary management plans. A few local governments have developed shore classification systems for this purpose, too.

Fraser River Estuary Management Program — FREMP, a joint endeavour of federal, provincial and local governments and harbour authorities on the Fraser River, was created in response to enormous development pressure on this threatened estuarine system. Under FREMP, the shores in the estuary have been evaluated for their ecological significance and designated into three "zones":

- A ***Red zone*** has highly productive habitat and any development must avoid impacts on the environment. The only exceptions are for projects vital to public health and safety.
- A ***Yellow zone*** has moderately productive habitat and permits development provided there is no net loss in habitat productivity. This requires a focused, intensive environmental impact assessment with full mitigation of impacts. Where impacts cannot be fully mitigated, compensatory habitats must be constructed prior to disturbance or destruction of the affected habitats.
- A ***Green zone*** is often an already disturbed area that provides marginal habitat or irrecoverable shore process functions. Development may occur, provided that reasonable efforts are made to mitigate environmental impacts.

This system provides guidance as to where development interest and initiative should be directed. For more information on *FREMP,* check out its website.

Prince Rupert Harbour Foreshore Management Plan — Prince Rupert Port Corporation and the Skeena/Queen Charlotte Regional District have endorsed a harbour plan that focuses on protection of fish habitat while ensuring water access for economic activities in the harbour. The basis of the management plan is a foreshore habitat classification system similar to that used for FREMP, with the same colour coded zoning and assessment of habitat values. The classification system inventoried intertidal vegetation, physical shoreline type, wave exposure regimes and valued habitat features to develop foreshore classification maps. Other evaluation criteria for classifying shorelines include degree of modification, restoration potential and presence of compensatory habitat.

Regional District of Comox-Strathcona — This Regional District on mid-Vancouver Island is taking a different approach to shore classification. Its purpose is to protect the coastal environment, but also to protect public resources (historical, recreational and scenic) and limit risk and liability from construction on unstable shores. The approach is based on physical forces as well as biological characteristics. It identifies shore "cells", initially by their sedimentation characteristics (eroding, transport, or accreting), and then by their relative energy level (high, medium, low) based on exposure to winter storm waves. The shore within each "cell" is then classified in segments, according to shore type (boulder/cobble, sand/gravel, mud, etc.) and relative biological productivity (high, low). Land use management policies are proposed for each major type of shore. The Regional District is still refining and testing this classification scheme for its usefulness as a management tool. For more information, contact the *RDCS Planning Department* on-line or call them at (250) 334-6000.

The Harbours Ecological Inventory and Rating (HEIR) project is an initiative to inventory and evaluate the ecological value of the backshore, intertidal and subtidal portions of Victoria and Esquimalt harbours and their connected waterways. Developed by the Victoria and Esquimalt Harbours Environmental Action Program (VEHEAP), the HEIR is a web-based information and mapping tool that provides materials to assist land and water use decisions, avoid further habitat degradation, and improve the restoration and enhancement of harbour ecosystems. Mapping layers, database information and ecological value ratings are accessible from the VEHEAP web site using the interactive ARC IMS mapping software *at their website*.

Zoning

Zoning bylaws are used to regulate types, location and density of development by "zoning" lands for particular land uses. Zoning can extend over water to include intertidal and nearshore areas.

Zones specify such land use characteristics as minimum parcel or lot sizes, the dimensions and location of buildings, and setbacks or distances between structures and property lines. Zoning can even regulate the extent and location of impervious surfaces such as driveways, parking lots and tennis courts.

Local governments use zoning bylaws to help direct different kinds of development (residential, commercial, industrial) to suitable areas and away from unsuitable ones. Zoning bylaws can help protect shore areas by restricting inappropriate land uses and practices. Zoning can also establish building setbacks along or around sensitive coastal features. Zoning designations along waterfronts can respect unique physical and biological aspects of the adjacent shore systems and the potential impact of development on these systems.

A local government can also meet shore stewardship goals through rezoning. The rezoning process offers a local government the opportunity to demand measures that would benefit the community. This could include dedication of a shore greenway, protection of sensitive features and processes or provision or restoration of shore amenities.

Other zoning-related tools can also be used to protect shore areas:

- **Density bonus zoning** allows for higher density when certain measures are taken – such as the protection of an environmentally sensitive site, preservation of a shore "leave" strip or providing public access. For example, a 20 percent density bonus would allow up to 12 units per hectare from a base zoning of 10 units/ha, in exchange for one or more of these community benefits.
- **Comprehensive development (CD) zoning** involves the creation of a unique land use arrangement for a specific site. For example, a development proposal for a marina facility could include a mix of commercial, light industrial and multi-residential development along with areas of public use and conservation. This approach is used most often in larger developments.

Development Permit Areas

An OCP can designate Development Permit Areas (DPA) that have special land use and development conditions. Land within a DPA cannot be subdivided, altered or built on without first obtaining a development permit that contains requirements established for that DPA. Under the *Local Government Act*, DPAs can be designated for three purposes:

- To protect the natural environment, its ecosystems and biological diversity;
- To protect a development from hazardous conditions; and
- To establish objectives for the form and character of intensive residential development and of commercial, industrial or multi-family residential development.

Several local governments have designated DPAs for coastal protection:

- **Nanoose Bay**, in the Regional District of Nanaimo (RDN), has designated a 'leave' strip extending 15 m inland from the natural boundary (or high water mark) of the shore as a DPA under its official community plan. "Leave" strips are intended to remain in an undisturbed state, and activities are regulated to protect habitat, prevent flooding and control erosion. Check the *RDN website* for a copy of Nanoose Bay's OCP.
- **The City of Nanaimo** takes a similar strategy in its OCP by designating under its DPA a 15 m "leave" strip along its shores for watercourse protection (DPA #23). In addition, it defines particularly steep, erodible shore areas as DPAs for natural hazard management. The content of the OCP and DPA #23 are available on the *city's website*.
- **The District of North Cowichan** is revising its OCP in which "Shoreline Protection Areas" are being considered for DPA designation. These would extend 30 m inland from the natural boundary of marine shores. Development within that 30 m DPA would be restricted generally to uses that require shore access.
- **The OCP for Rural Comox Valley,** in the Regional District of Comox-Strathcona, designates most of its shore along the Strait of Georgia as a DPA for "aquatic environmentally sensitive areas." No structures other than "shoreline protection devices" are permitted within 15 metres of the natural boundary. A portion of the shore with steep, erodible banks is also designated a DPA for hazardous conditions. The DPA specifies special protective, construction and planting requirements. The OCP and DPA can be viewed on the *RDCS website*.

Subdivision

Subdivision approval is another tool that can be used to protect shorelines. Site plans must show lot layout, road and utility layout and development standards. Subdivision applications must also address the conservation of environmentally sensitive areas, avoidance or mitigation of hazardous conditions and provision of public access. Other subdivision tools can be used to protect shore areas:

- Up to 5 percent of land proposed for subdivision can be required as a **park** at the time of subdivision. This power can be used for public acquisition of coastal areas or for access to the coast.
- Subdivision can also incorporate a **conservation covenant.** This could preserve a portion of the property for its ecologically valuable features, set up a buffer zone adjacent to sensitive coastal areas, or require specific land use practices that protect coastal habitats or vegetation. The landowner retains the right to use the land in a manner consistent with the purposes of the covenant. The organization holding the covenant - which may be a local government or a registered conservation organization, or both - becomes responsible for ensuring the terms of the covenant are followed.

Other Bylaw-making Powers to Protect Shore Areas

Landscaping	Set requirements and standards that "preserve, protect, restore and enhance the natural environment." These could be used to protect existing native shore vegetation to limit erosion, maintain vegetated corridors to support habitat, and require replanting adjacent to shore areas after construction.
Tree cutting/protection	(Municipalities only) protect significant or heritage trees by requiring permits for cutting. Regional governments can determine what trees must be preserved to prevent erosion.
Watercourse protection	Pass bylaws that prohibit polluting or impeding the flow of a watercourse. In shore areas, this could be used to protect and maintain clean freshwater inputs.
Sediment and erosion control	Require development projects to plan and undertake erosion and sediment control measures within the construction program. This could include: scheduling and designing earth moving to minimize erosion; retaining vegetation; replanting disturbed soil; diverting runoff from exposed soils.
Drainage and stormwater	Require landowners to manage the disposal of surface runoff and stormwater. The bylaw could also establish the maximum percentage of the area of land that can be covered by impermeable material. This could be an important consideration where runoff is often contaminated, or in bluff environments, where runoff can increase erosion.
Plan assessment	Require assessments of project plans as part of a rezoning or permit application. This examines the potential environmental, social and economic effects of the project and its projected benefit to the community.
Building permits	Require buildings and structures to comply with the B.C. Building Code. Approval of building permits can also be used to ensure compliance with local bylaws and see that the site is safe for development relative to hazards posed by coastal erosion, and the effects of construction on the stability of the coast.
Security	Require a security deposit to ensure that construction meets design specifications and/or permit conditions regarding restoration, landscaping, etc. Because of the greater risk of development on coastal shores, local governments should consider security deposits that address construction hazards posed by tides, wind, storms, etc.; spills (which can be widely dispersed by runoff and waves); and impacts to adjacent properties where shore development may disrupt longshore drift patterns, or cause slope failure or vegetation blowdown.

*In May 2003, the Province introduced legislation (Bill 48) to protect farming and aquaculture from local government bylaws that could limit their operations. The legislation proposes to amend the **Local Government Act** to ensure provincial approval is required on any bylaws affecting aquaculture development or operations in ways that may violate the **Farm Practices Protection Act**. The latter Act would also be amended to clarify that Crown lands and foreshore areas suitable for aquaculture can be designated as "farming areas" and therefore, subject to protection under the Act. This proposed legislation could significantly restrict local governments' ability to regulate aquaculture operations under zoning or other bylaws.*

First Nations

Over 50 First Nations have traditional ties and enjoy aboriginal rights with respect to land and resources on the B.C. coast. Many are represented in treaty negotiations with the province and Canada.

Treaty Making

The treaty-making process is overseen by the B.C. Treaty Commission, an independent, neutral body responsible for facilitating treaty negotiations among the governments of Canada, B.C. and First Nations. A First Nation does not have to prove aboriginal rights - these are already recognized and protected by the Canadian Constitution. The main goal of the treaty process is to provide certainty of jurisdiction over B.C.'s land and resources. For more information, check the *B.C. Treaty Commission website*.

Through the B.C. Treaty process, as well as through partnerships with government agencies, the roles of First Nations are evolving into those of an "order" of governance with respect to traditional shore resource and areas. Governance will vary, according to the settlement that is reached within each treaty negotiation, as will the relationship developed with senior government agencies and adjacent local governments.

Reserve Lands

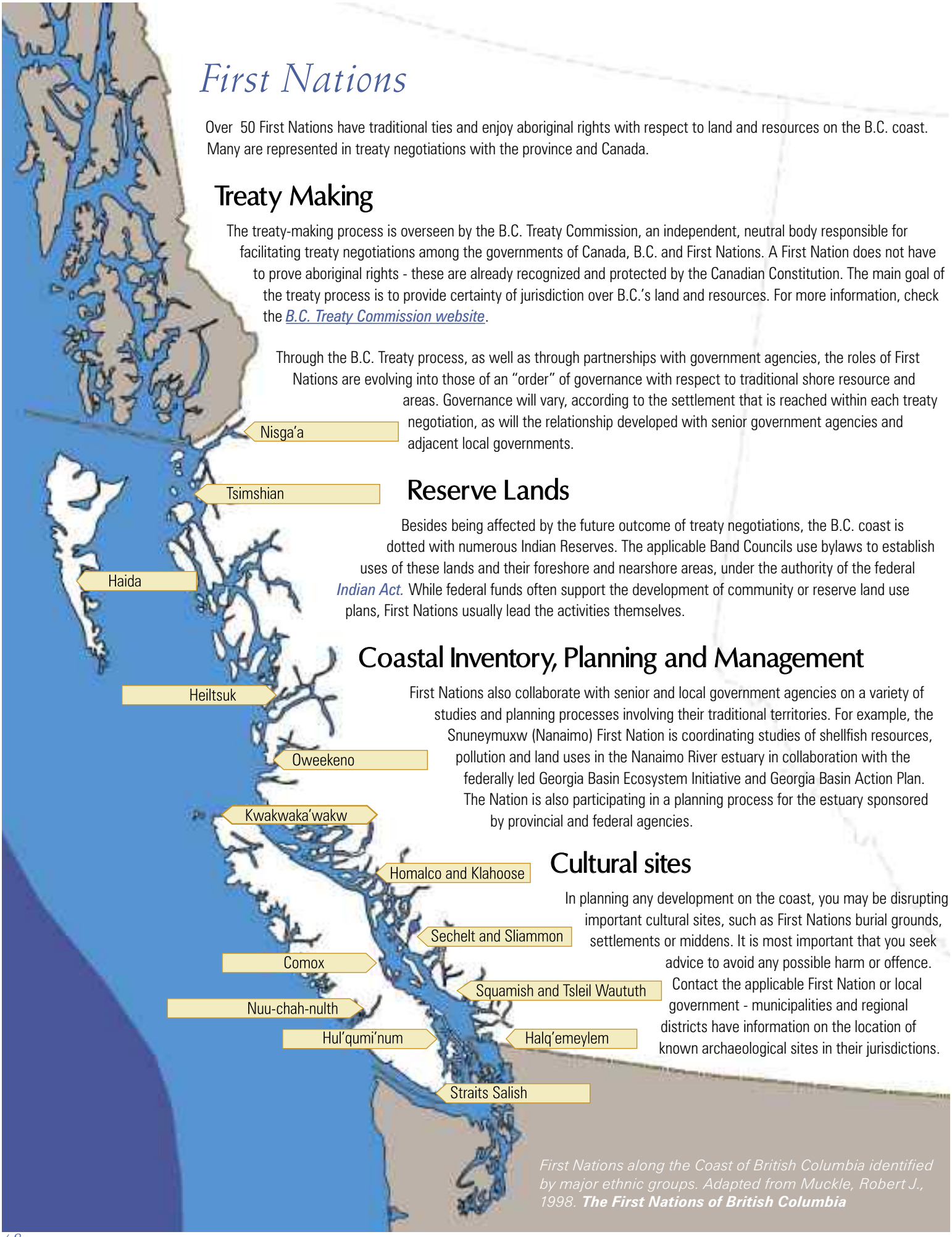
Besides being affected by the future outcome of treaty negotiations, the B.C. coast is dotted with numerous Indian Reserves. The applicable Band Councils use bylaws to establish uses of these lands and their foreshore and nearshore areas, under the authority of the federal *Indian Act.* While federal funds often support the development of community or reserve land use plans, First Nations usually lead the activities themselves.

Coastal Inventory, Planning and Management

First Nations also collaborate with senior and local government agencies on a variety of studies and planning processes involving their traditional territories. For example, the Snuneymuxw (Nanaimo) First Nation is coordinating studies of shellfish resources, pollution and land uses in the Nanaimo River estuary in collaboration with the federally led Georgia Basin Ecosystem Initiative and Georgia Basin Action Plan. The Nation is also participating in a planning process for the estuary sponsored by provincial and federal agencies.

Cultural sites

In planning any development on the coast, you may be disrupting important cultural sites, such as First Nations burial grounds, settlements or middens. It is most important that you seek advice to avoid any possible harm or offence. Contact the applicable First Nation or local government - municipalities and regional districts have information on the location of known archaeological sites in their jurisdictions.



First Nations along the Coast of British Columbia identified by major ethnic groups. Adapted from Muckle, Robert J., 1998. ***The First Nations of British Columbia***

Non-governmental Organizations

There are many non-governmental organizations (NGOs) that are working to protect, preserve and enhance coastal environments. Some of these NGOs are profiled in Chapter 6. Their roles are many and varied, but can be summarized under the following headings.

- **Education** — Many NGOs conduct public information and education sessions about stewardship as part of their mandate. They provide an increasingly important role in supporting the public outreach of government agencies.
- **Habitat identification/inventory** — More stewardship groups are taking training and becoming volunteer "citizen scientists". Quality of data and the consistency of collection methods and data management and sharing have arisen as issues. These issues are gradually being addressed through such programs as the Community Mapping Network and other collaborative efforts with local and senior governments.
- **Restoration and enhancement** — Local stewardship groups carry out site-specific restoration or enhancement projects within their communities. Conservancy organizations may forge management agreements with landowners or manage restoration or enhancement projects on the properties that they acquire.
- **Land conservation covenants** — Many NGOs, typically "land trusts", hold and manage conservation covenants under the provincial *Land Titles Act*. Land trusts are private, non-profit organizations that protect areas for environmental, scientific, historical, cultural, scenic, or compatible recreational values. A conservation covenant is a voluntary, written agreement between a landowner and another party (such as the land trust) in which the owner promises to protect the land.
- **Participation/advocacy** — Many NGOs participate in local, regional and provincial programs to represent stewardship-related interests. They may join standing or ad hoc committees, or act as experts or participants in review processes. NGOs also play an important advocacy role, encouraging or lobbying government and corporations to take measures that support the stewardship of coastal resources.

Georgia Strait Alliance

Volunteer clean up events help keep coastal areas free of debris and pollutants.

Landowners

Shorefront landowners have direct contact with the shore, and a vital role and responsibility in stewarding these areas.

Rights and Responsibilities

Waterfront landowners hold some basic "riparian" rights, which include:

- A right to unimpeded access to the shore from the property. This limits the province's ability to approve the use of fronting foreshore and nearshore areas without written authorization from the shore owner.
- At the same time, the public has the right to access the foreshore, which is public property. Property owners cannot impede public routes to the beach.
- A right to apply to the Crown to claim and acquire accretions as a natural expansion of their property. Accretion is the slow, natural deposit of sediment to a piece of shore, which enlarges the land area abutting the adjacent waterfront property. This right is tempered by consideration of the public right to access to the foreshore.
- The right to install protective works within the property in order to minimize erosion and related destruction of the property.

The exercise of these rights is subject to applicable federal, provincial or local government laws. For example, any works to protect property from coastal erosion are subject to local government regulations, provincial authorization if they extend below the high water mark, and federal authorization if they adversely affect fish habitat - which is usually the case.

For example, a landowner wants to remove several trees that are lying on the beach in front of her house in order to provide clear access to the beach. But the trees have become a habitat structure that has recruited sand and gravel and created a beach where surf smelt spawn. DFO would have to authorize the removal of these trees. Failure to obtain an authorization can result in criminal prosecution and a hefty fine.

Pat Boyle

Stewardship Role

Landowners obviously have a significant responsibility to care for their coastal properties – to protect their own interest and investment, and to ensure that the larger coastal environment is not affected adversely by their actions.

Landowners can also promote stewardship among their neighbours and other users of the shore. Living by the water, landowners can observe and report unusual events or hazardous activities. By word and example, they can help to educate other shore users on "better ways" of treating the coastal environment.

Working with the Coastal Shore

Alexe Lohvinen

As you set out to change or adapt shores near you, think forward — anticipate the outcomes and consequences of what you do.

- Your actions may change how the shore works.
- These changes could harm the living components of the shore.
- These changes could affect you, your neighbours and your community. They could be costly to fix and they could lead to the irretrievable loss of land, beaches or fishing areas. Changes done without approval could also subject you to serious financial penalties.

The results can be drastic — and unexpected.

Although the following section provides advice about factors to keep in mind when you are planning or working near coastal shores, there are really just three simple rules:

Don't Disrupt, Don't Harden, Don't Pollute

Note:

Text written *like this* identifies federal or provincial legislation. Information written *like this* is available on the Internet - refer to the Website Address Insert included in this document for details.

Fisheries and Oceans Canada

Don't Disrupt!

Disruption of the shore is often the result of poor planning and project design. For example, you might build an unnecessarily large dock that shades out the aquatic plants, build too close to the shore, replace native vegetation with lawn, or construct a groyne that robs downdrift beaches of the sediment they need. These actions could alter both the shore processes and the nearshore biological communities that are a product of their physical environment.

Harriet Rueggeberg

Don't Harden!

By straightening and armouring our shores, we eliminate local foreshore habitat. On another scale, the straightening and hardening of shores alters the erosion, transport and deposition patterns along the coast, leading to bigger physical and biological changes over a much larger stretch of shore. Hardening the shore has led to the loss of much of our most productive coastal habitat.

Fisheries and Oceans Canada

Don't Pollute!

Everything we dump into our water ends up in the ocean. In a whole ocean of water, small amounts might seem trivial, but they tend to accumulate in bottom-dwelling organisms and sediments where they concentrate and become toxic. This is a problem especially in enclosed areas. Some of what is released into the water isn't normally considered a pollutant. For example, we use nitrates and fertilizers to boost plant growth, but when they are introduced to the sea, they can cause algal blooms, particularly in areas with limited circulation or tidal exchange. These algal blooms rob the water of oxygen, which can suffocate and kill local marine life.

Working With the Shore

With these ideas in mind, coastal activities can proceed in suitable locations and in a responsible manner, with a smaller and less harmful footprint on the shore environment. The following pages cover 4 categories of coastal activities:

Land Development: How to conserve shore resources in residential, commercial and road development, while promoting and managing sound shore use in appropriate locations.

Marine Facilities: How to incorporate design and construction practices that reduce or eliminate the impact of groynes, breakwaters, seawalls, piers, jetties, docks and dikes.

Marine Discharges: How to find out about reducing the impact from upland runoff, sewage outfalls, industrial discharges and ocean disposal

Coastal Industries and Commercial Activities: How to find information that can assist in reducing effects of dredging, log storage and aquaculture on shore systems

Land Development

Sound development in the coastal environment requires that environmental sensitivities and natural hazards are taken into consideration in the design stage. Get advice early on in the project from an expert in coastal processes.

The cost of not considering shore processes and structures can be high and too frequently becomes the taxpayers' burden. It is less costly to account for and protect these ecological values up front than to repair, restore or compensate for them after the damage is done.

How can the shore be used without damaging its biological integrity?

There are different ways to meet your objectives. Each has consequences to the shore, to the community and to your project. The best alternative is the one that enables the development to proceed with the least impact. Here are some questions to ask:

- How can the building be located on the lot to minimize interference with shore processes and the threat of shore forces?
- What are the natural attributes that drew you to the site in the first place? How do these enhance the value and appreciation of the property? How can the project be designed to enhance and retain these features?
- How can the natural features of the site be used to protect the property and to avoid costly and disruptive shore protection structures?
- How can the shore be reached without destabilizing the slope—or does it even have to be accessed from this site?

It just may turn out that the impacts will be significant and can't be adequately mitigated and so you have to reconsider or even cancel the project. These questions need to be asked, and answered, before you make any significant investment.

Four Common Planning and Design Mistakes

Impacts to the shore commonly result from four planning and design mistakes:

- Buildings and facilities are put too close to the shore and fall victim to dynamic shore processes. They then require expensive protective structures that further disrupt natural shore environments.
- Poor stormwater drainage initiates or accelerates natural erosive forces.
- Natural vegetation is destroyed, particularly in the all-important buffer along the shore. This destabilizes sediments, making them more prone to erosion and it eliminates wildlife habitat.
- Inadequate on-site sewage treatment and disposal results in pollution, and may lead to slumping and failure of coastal bluffs and the properties on them.

Too often, we build too close to the water. Waves will erode front yards. High tides and winter runoff will flood basements. Having built in the wrong place, we then try to protect property with rock revetments, timber piles, concrete blocks or other retaining structures that are expensive and usually not very effective.

Alternatively, to maximize the ocean view, we build too close to the top of a bluff, and cut down the trees that stabilize the slope but obstruct the view. We also direct drainage from rooftops and driveways away from the house. This runoff runs down the slope, forming erosion gullies or saturating the soils in the bluff, destabilizing them.

These buildings have been located too close the bluff. The ongoing processes of coastal erosion will lead to expensive damage. Adjust your site plan and building design to take coastal processes into account.

Regional District of Comox Strathcona

Coastal Stewardship and the Development Process

Protection of shore systems also requires that you conform to the environmental provisions and specifications of contract documents. You also need a contingency plan to deal with unforeseen circumstances.

Several tools are available to enable this. While these are usually part of large development projects such as marinas, industrial facilities and mixed or multi-residential developments, their use on smaller developments is also recommended.

Environmental supervision of construction *is undertaken on behalf of the developer or construction contractor by someone with special training in identifying environmental concerns The Environmental Supervisor will provide advice and direction on environmental protection measures, and orient crew members and workers to site sensitivities and procedures. The supervisor should have the mandate and experience to avoid environmental impacts and stop work on sites when required to mitigate apparent impacts.*

Environmental monitoring *is the collection of technical data to measure compliance with construction standards and practices specified for the project. The Environmental Supervisor typically does the monitoring.*

Security deposits *are a fairly standard form of assurance that construction practices comply with design specifications. Security deposits need to reflect the cost of performing restoration on the site to return habitat to pre-construction levels. Because of the risks associated with building on coastal shores, local governments should consider security deposits that address:*

- *Construction hazards posed by tides, winds and storms.*
- *Spills on site, which can have impacts far beyond the construction site through dispersal by runoff and waves.*
- *Impacts to adjacent properties where shore development disrupts longshore drift patterns, exacerbates vegetation blowdown, and disturbs marine flora and fauna.*

Substantial performance *is the formal point in the construction process when the site is accepted as ready for use. Substantial performance means that deficiencies in the contractor's work are identified, but the use of the site can begin. The process of achieving substantial performance can help ensure that environmental protection measures have been followed.*

Guarantee and maintenance *should be part of the contract; for example, include environmental protection clauses in the guarantee specification to be sure that pre- construction habitat conditions are restored.*

Residential

Residential development can have significant impacts on coastal systems. The scale of the impacts may not necessarily correspond to the size and density of the housing.

As Chapter 3 describes, some shores are more suitable for development than others. Sediment shores, estuaries and marshes change rapidly as their loose sediments respond to the natural variability in wave action and water level. Estuaries and marshes are particularly sensitive to pollution from runoff and septic tanks. Residential development should avoid these areas because of their high ecological value, sensitivity to development and risk associated with building in areas with unstable sediments.

Coastal bluffs that consist of unconsolidated sand, silt or clay sediments of recent geological origin are eroded easily by wave action at their base or destabilized by water saturation. This makes them extremely sensitive to uncontrolled upland drainage, compression from weight-bearing structures and loss of vegetation—all common occurrences with residential development.

Pocket beaches are sand and gravel beaches constrained by rocky headlands on a basically rocky coastline. In many cases, the land behind the beach is low relief and marshy. Due to the dynamic nature of sediment movement on these shores, the high water mark can change its position from year to year. Again, residential development in these areas is at risk if built too close to the shore.

Considerations – Things to Find Out

A legal survey: You need to know the accurate location of your property boundaries, including the high water mark (or legal "natural boundary"). The ocean frontage may have changed since the site was subdivided. If you have no legal survey, you will need to hire a registered B.C. Land Surveyor.

Professional assistance: Seek professional advice in assessing the coastal features and processes associated with your property. Consultants with expertise in coastal environments may be able to suggest options that deliver the project more effectively and at reduced costs.

You must conduct all necessary regulatory assessments and obtain all appropriate approvals: These may include cultural or archeological assessments if there has been First Nations activity on your land, or cumulative environmental impact assessments if the project triggers CEAA (the *Canadian Environmental Assessment Act*.) Qualified professional experts should be aware of all the applicable regulatory requirements and guidelines that would apply to your project and should understand how to meet them.

Physical character and processes: What shore type is it? (Refer to pages 22 to 33 for a discussion of shore types and their sensitivity to development.) How high are winter storms and storm surges? Is the shore eroding or accreting? What direction and intensity are the prevailing winds? What longshore drift cell is this property in? The age of the vegetation may indicate the relative stability of the shore.

Biological character and communities on the shore: Inventory vegetation types and identify environmentally sensitive areas (ESAs) or features that need protection. Then assess the environmental implications of your project and determine appropriate mitigation measures or compensatory works that will be required. Check with your local government for ESAs and assessment requirements before investing in site design and layouts. Remember: Under federal law you are required to ensure that your project will not result in the harmful alteration, disruption or destruction of fish habitat.

Building requirements: A building permit will be needed in almost all instances; a development permit may also be required for environmental protection or hazard management. There may also be special requirements in the form of ***covenants*** that have been placed on your property. Ask your realtor about covenants on title and contact your local government to find out about building or development permit requirements.

Setbacks: A vegetated buffer between your development and the shore is vital to protecting and stabilizing shore edges and reducing risks of erosion. This will minimize impacts of development on the shore and the impacts of marine processes on the development. A minimum vegetated buffer of 15-30 m back from HHW is generally recommended for private waterfront property in developed areas. Wider setbacks are generally required for developments on bluffs and cliffs. Check with your local planning office for setback requirements.

Fisheries and Oceans Canada

Slope stability: Check with your local government to see if your property has been identified as an area subject to slope instability. Additional slope protection measures, such as larger setbacks, may be required in these cases. An assessment by a geotechnical consultant is helpful, and may be required by your local government.

Potential for flooding: Low-lying coastal areas may experience flooding when high winter tides coincide with a severe storm surge. The Province has completed flood risk mapping for some of B.C.'s coastal areas. There may be floodproofing requirements for habitable rooms to be built at a certain height. For unmapped areas, consult local governments and long-term residents.

Storm drainage: Do not direct drainage or runoff from rooftops or other hard surfaces over the edge of a bluff or shore bank; this only creates or accelerates slope erosion. Try to direct drainage into permeable ground that slopes away from a bluff or steep bank. Consider the volume of storm drainage being put into the ground above a bluff; will it saturate the soil and weaken the slope? You may need to consult a hydrologist or geotechnical expert.

Septic systems: Septic systems and their drainage need to be large enough to handle the anticipated level of use and must be maintained regularly. There must be no direct drainage on to the foreshore. Weakening of bluffs and steep banks by over-saturation must be avoided. You may need to consult a hydrologist or geotechnical expert.

Views and sight lines: Placing dwellings back from the shore edge can increase sight lines over vegetation or through treetops. Vegetation should be retained on slopes where it is most needed. Letting trees and shrubs frame your view can be more attractive, and stable, than a view cleared of all vegetation.

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions that may apply to your site or activities.

Protection from construction activities: Before construction, mark the boundary of the construction area and temporarily fence off setbacks, sensitive features, and trees to be retained (including the root system) to avoid their disturbance during site preparation and construction. Install sediment control measures to avoid erosion and offsite silting. Be careful with toxic materials (such as fuel, paint, adhesives, etc.) and have a hazardous spill kit and spill response plan in place.

If you are building a dock - refer to the section on docks, page 65.

For More Information

- The planning or development services department of the applicable local government is usually the first stop. Staff there can provide information, or guide you to the appropriate agencies/sources for information on:
  - Legal surveys
  - Physical and biological shore features and environmentally sensitive areas
  - Development and building permits
  - Property covenants
  - Setback requirements
  - Flooding and other hazardous conditions
  - Construction timing restrictions
  - Best management practices and requirements for site design and preparation, storm drainage, septic systems and erosion control
- *"On the Living Edge: Your Handbook for Waterfront Living"* provides useful information on how to build on the coast and maintain shore properties in ways that are in harmony with the environment. Copies can be obtained from the *Living by Water Project by visiting their website.*
- *"Guides for Coastal Property Owners"* published by the Washington State Dept. of Ecology give a wealth of information on living on coastal bluffs. They can be downloaded from *their website.*
- *"Septic System Maintenance - Pure & Simple"* is an easy-to-read guide to septic system management. See "Stewardship Resources" (page 83) for details .

Dream home turns nightmare

The happy couple was so excited with their new sea-front property. They planned to build their dream home high on the bluff and cut down the trees that were blocking their magnificent view of the Coastal Mountains. And for easy access they built a 72-step stairway to the beach below, clearing away most of the small shrubs and plants in its way.

They planted a lovely garden, as a frame for their house. They put in a septic tank, dug a trench for the water pipes and put in weeping tiles to collect and redirect stormwater from their foundation.

But after a few years their dream became a nightmare. The remaining trees were no longer windfirm and the wind had knocked them down. The lawn was a desert in summer and a mudhole in winter - piping the stormwater had robbed the soil of natural drainage. Those carefully built steps were being undercut by winter storm wave erosion and had lost their foundations.

They consulted a geologist, who told them the bluff is in danger of falling into the sea. They must decide to either move back the house or relocate it to another site.

With better planning and knowledge of the coastal environment, experiences like this can be avoided.

Washington Department of Ecology

Another example of a bluff erosion nightmare.

Commercial

Many commercial and industrial operations along the waterfront are marine-related, but some are there only because of historic land use patterns or zoning. These operations use valuable waterfront space and can affect the coastal shore unnecessarily.

What Can Happen

Commercial and industrial development along the coast can harm the environment by:

- Straightening and hardening the shore zone
- Altering or eliminating backshore and inter-tidal habitat
- Depriving the community of shore resources and access to the sea
- Creating pollution
- Infilling intertidal/subtidal areas which displaces biological resources that occupy these areas.

Maintenance dredging or basin deepening for activities such as log sorts, log dumps, marinas or ferry terminals constantly modifies the bottom and disrupts or destroys benthic communities, increases suspended sediment concentrations in the water column and can liberate sediment associated pollutants

If the operation depends on water, then proper location and design is essential to avoid and/or mitigate the potential impacts. However, local governments should discourage any commercial and industrial development that does not have to be on the waterfront. This will prevent the impacts in the first place and permit sensitive shore zones to continue to support the natural and human systems for which they are best suited.

Considerations – Things to Find Out

Legal survey: You need to know the accurate location of your property boundaries, including the high water mark (or legal "natural boundary"). The ocean frontage may have changed since the site was subdivided. If you have no legal survey, you will need to hire a registered B.C. Land Surveyor.

Professional assistance: Seek professional advice in assessing the coastal features and processes associated with your property. Consultants with expertise in coastal environments may be able to suggest options that deliver the project more effectively and at reduced costs.

You must conduct all necessary regulatory assessments and obtain all appropriate approvals: These may include cultural or archeological assessments if there has been First Nations activity on your land, or cumulative environmental impact assessments if the project triggers CEAA (the *Canadian Environmental Assessment Act*.) Qualified professional experts should be aware of all the applicable regulatory requirements and guidelines that would apply to your project and should understand how to meet them.

Physical character and processes: What shore type is it? (Refer to pages 22 to 33 for a discussion of shore types and their sensitivity to development.) How high are winter storms and storm surges? Is the shore eroding or accreting? What direction and intensity are the prevailing winds? What longshore drift cell is this property in? The age of the vegetation may indicate the relative stability of the shore.

Biological character and communities on the shore: Inventory biota (including vegetation) and identify environmentally sensitive areas (ESAs) or features that need protection. Then assess the environmental implications of your project and determine appropriate mitigation measures or compensatory works that will be required. Check with your local government for identified ESAs and/or assessment requirements before investing in site design and layouts. Remember: Under federal law you are required to ensure that your project will not result in the harmful alteration, disruption or destruction of fish habitat.

Building requirements: A building permit will be needed in almost all instances; a development permit may also be required for environmental protection or hazard management. There may also be special requirements in the form of ***covenants*** that have been placed on your property. Ask your realtor about covenants on title and contact your local government to find out about building or development permit requirements.

Setbacks: A vegetated buffer between your development and the shore is vital to protecting and stabilizing shore edges and reducing risks of erosion. This will minimize impacts of development on the shore and the impacts of marine processes on the development. A minimum vegetated buffer of 15-30 m back from HHW is generally recommended for private waterfront property in developed areas. Wider setbacks will be required in more remote and undeveloped crown foreshore areas. Wider setbacks are generally required for developments on bluffs and cliffs. Check with your local planning office for setback requirements.

Slope stability: Check with your local government to see if your property has been identified as an area subject to slope instability. Additional slope protection measures, such as larger setbacks, may be required in these cases. An assessment by a geotechnical consultant is helpful, and may be required by your local government.

Potential for flooding: Low-lying coastal areas may experience flooding when high winter tides coincide with a severe storm surge. The province has completed flood risk mapping for some of B.C.'s coastal areas. There may be floodproofing requirements for habitable rooms to be built at a certain height. For unmapped areas, consult local governments and long-term residents.

Storm drainage: Do not direct drainage or runoff from rooftops or other hard surfaces over the edge of a bluff or shore bank; this only creates or accelerates slope erosion. Try to direct drainage into permeable ground that slopes away from a bluff or steep bank. Consider the volume of storm drainage being put into the ground above a bluff; will it saturate the soil and weaken the slope? You may need to consult a hydrologist or geotechnical expert.

Septic systems: Septic systems and their drainage need to be large enough to handle the anticipated level of use and must be maintained regularly. There must be no direct drainage on to the foreshore. Weakening of bluffs and steep banks by over-saturation must be avoided. You may need to consult a hydrologist or geotechnical expert.

Views and sight lines: Placing buildings back from the shore edge can increase sight lines over vegetation or through treetops. Vegetation should be retained on slopes where it is most needed. Letting trees and shrubs frame your view can be more attractive, and stable, than a view cleared of all vegetation.

Land use designation: Some municipalities and regional districts protect waterfront lands in their Official Community Plans or Zoning Bylaws for marine-dependent uses. The area may also be designated a "development permit area" with firm rules covering commercial or multi-family design, natural hazard management or environmental protection. Check with your local government.

Harbour, port or estuary management plan: Designated areas in many harbours and estuaries encourage or discourage development, based on their relative sensitivity to environmental impacts. Contact the Port Authority or local government.

Navigation issues: The protection of navigable waters influences many forms of coastal development, and applies to water bodies of all types. Contact *the Coast Guard of Fisheries and Oceans Canada.*

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (ie: surf smelt or sandlance spawning, herring spawn, oyster spat etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions that may apply to your site or activities.

Protection from construction activities: Before construction, mark the boundary and temporarily fence off setbacks, sensitive features, and trees to be retained (including the root system). This protects vegetation during site preparation and construction. Install sediment control measures to avoid erosion and offsite silting. Train construction staff in the appropriate handling of toxic materials (fuel, paint, adhesives etc.) to ensure they are not accidentally spilled or intentionally disposed of on the shore or in the water, and have a hazardous spill response plan and equipment in place. The careful use of equipment near the shore is key to assuring low impact. Consult your local government about hiring a professional to develop appropriate avoidance and mitigation measures and monitor construction activities.

For More Information

- The **planning or development services department** of the applicable local government is usually the first stop. Staff there can provide information, or guide you to the appropriate agencies/sources for information on:
  - Legal surveys
  - Environmentally sensitive areas
  - Development and building permits
  - Property covenants
  - Setback requirements
  - Flooding and other hazardous conditions
  - Construction timing restrictions
  - Best management practices and requirements for site preparation, storm drainage, septic system installation and management and erosion control

Harriet Rueggeberg

Surface runoff is captured in a marshy depression and dissipates slowly into the ground.

Roads

The construction of roads along the coast can harm shore systems. Sloppy road building – inadequate bed preparation or inattention to drainage and high tide or storm surge water levels – can lead to severe washouts and impacts on adjacent shore areas, and destruction of the road itself. These problems are usually expensive to fix.

Coastal areas that are reached by road can be further impacted by road widening and upgrading activities. Road building cuts and fills on coastal shores usually remove riparian vegetation, eliminate backshore habitats (dunes, berms etc.), expose soils and alter runoff patterns. This can cause sedimentation of the foreshore, create a permanent impervious footprint across the backshore and become a source of chronic pollution, all of which can have a severe effect on the adjacent shore area.

Environmental damage from road use, a new road or an upgrade can include:

- Hardening of the shore zone
- Vegetation removal and bank destabilization
- Changes to drainage and coastal hydrology
- Filling in of small coastal drainages, marine wetlands, foreshores and estuaries
- Pollution from gas and oil, other hydrocarbons, salts and heavy metals in shore zone areas

In particular, building roads along the tops of eroding coastal bluffs can lead to expensive and, too often, unsuccessful coastal protection and erosion control works.

Considerations – Things to Find Out

Location: Are there alternative routes away from the shore that have fewer environmental impacts?.

Professional assistance: Seek professional advice in assessing the coastal features and processes associated with your project. Consultants with expertise in coastal environments may be able to suggest options that deliver the project more effectively and at reduced costs.

You must conduct all necessary regulatory assessments and obtain all appropriate approvals: These may include cultural or archeological assessments if there has been First Nations activity on your land, or cumulative environmental impacty assessments if the project triggers CEAA (the *Canadian Environmental Assessment Act*.) Qualified professional experts should be aware of all the applicable regulatory requirements and guidelines that would apply to your project and should understand how to meet them.

Physical character and processes: What shore type is it? (Refer to pages 22 to 33 for a discussion of shore types and their sensitivity to development.) How high are winter storms and storm surges? Is the shore eroding or accreting? What direction and intensity are the prevailing winds? What longshore drift cell is this property in? The age of the vegetation may indicate the relative stability of the shore.

Biological character and communities on the shore: Inventory biota (including vegetation) and identify environmentally sensitive areas (ESAs) or features that need protection. Then assess the environmental implications of your project and determine appropriate mitigation measures or compensatory works that will be required. Check with your local government for identified ESAs and/or assessment requirements before investing in site design and layouts. Remember: Under federal law you are required to ensure that your project will not result in the harmful alteration, disruption or destruction of fish habitat.

Setbacks: A vegetated buffer between the road and the shore is vital to protecting and stabilizing shore edges and reducing risks of erosion. This will minimize impacts on the shore and the impacts of marine processes on the road. Check with your local planning office for setback requirements.

Slope stability: Check with your local government to see if your property has been identified as an area subject to slope instability. Additional slope protection measures, such as larger setbacks, may be required in these cases. An assessment by a geotechnical consultant is helpful, and may be required by your local government.

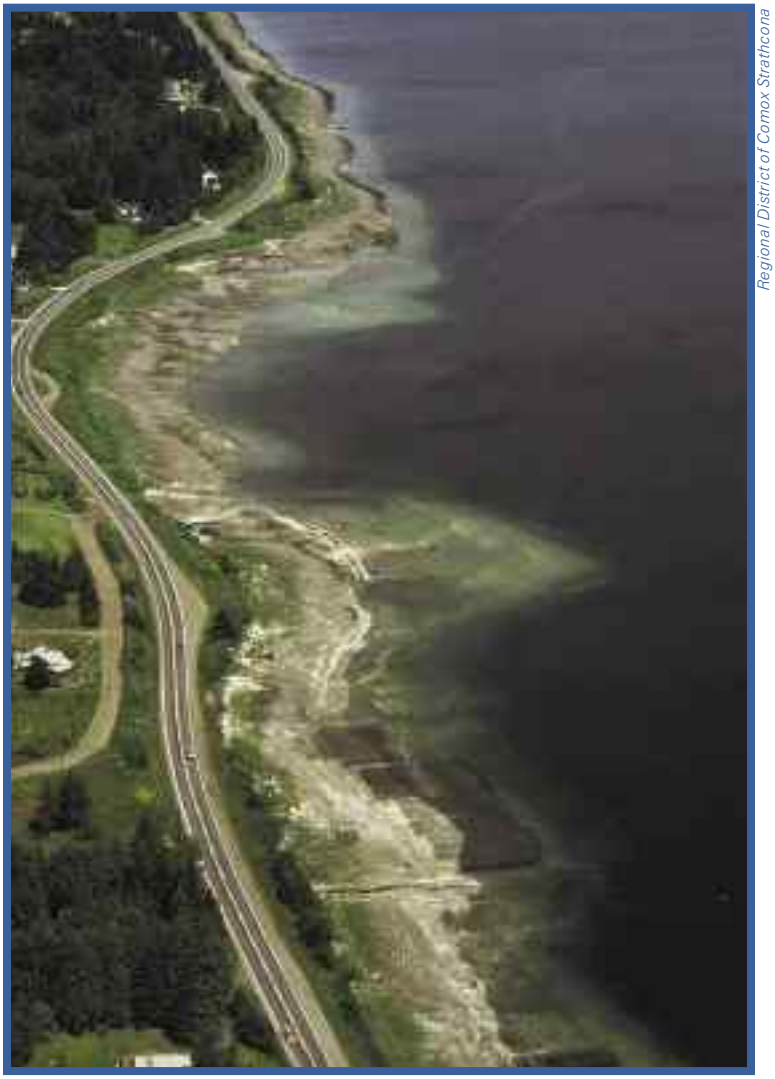
Potential for flooding: Low-lying coastal areas may experience flooding when high winter tides coincide with a severe storm surge. The province has completed flood risk mapping for some of B.C.'s coastal areas. There may be floodproofing requirements for habitable rooms to be built at a certain height. For unmapped areas, consult local governments and long-term residents.

Storm drainage: Road and parking designs must address runoff from road surfaces to prevent erosion and manage pollutants from reaching sensitive coastal ecosystems. Do not direct drainage or runoff from hard surfaces over the edge of a bluff or shore bank; this only creates or accelerates slope erosion. Try to direct drainage into permeable ground that slopes away from a bluff or steep bank. You may need to consult a hydrologist or geotechnical expert.

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions that may apply to your site or activities.

Protection from construction activities: Before construction, mark the boundary and temporarily fence off setbacks, sensitive features, and trees to be retained (including the root system) to avoid their disturbance during site preparation and construction. Install sediment control measures to avoid

erosion and offsite silting. Train construction staff in the appropriate handling of toxic materials (fuel, paint, adhesives etc.) to ensure they are not accidentally spilled or intentionally disposed of on the shore or in the water, and have a hazardous spill response plan and equipment in place. The careful use of equipment near the shore is key to assuring low impact. Consult your local government about hiring a professional to develop appropriate avoidance and mitigation measures and monitor construction activities.



Regional District of Comox Strathcona

Historic settlement patterns frequently include roads adjacent to eroding shore areas. Expensive shore protection measures are often required where roads have been widened to meet modern safety standards, or to accommodate more traffic.

A Helping Highway

The Gingolx Nation north of Prince Rupert badly needed a road to link their communities of Greenville and Kincolith, to get children to school and the sick to hospital. But the only route was right on the coast and threatened to disrupt important grizzly bear and salmon habitat. The coast was covered with sedge grass, which provides the grizzly's first food after hibernation and is a hiding place for salmon fry during high tide. The sedge would disappear during road construction

So the contractors harvested mats of sedge from other areas and transplanted 1,700 sq m of sedge to provide a buffer between the road and the ocean. It provided local employment and compensated for habitat losses associated with construction of the road.

Restoring Delkatla

While ideal coastal stewardship means no harm is done to the environment, the next best approach is to repair damage that was done in less thoughtful days.

That's the approach the people of Masset on Haida Gwaii (the Queen Charlotte Islands) took after they realized that a causeway that supported the only road into town was starving their Delkatla Wildlife Sanctuary of life-giving tidal waters.

They watched with alarm as bird numbers fell and freshwater vegetation crept deeper into vital migratory and wintering feeding areas.

The residents raised over $1 million and a few years ago re-engineered the causeway so the water in Delkatla now rises and falls twice a day. Delkatla is a tidal wetland again and once more a crucial link in the chain of life.

For more information, contact: Delkatla Wildlife Sanctuary (250)626-5015

Marine Facilities

Marine structures and facilities, such as wharves, docks, breakwaters, bridges and outfalls, are common human-made features of developed shores. In the past, these structures were designed and built primarily to withstand the physical and biological forces of the marine environment. Few builders considered their effect on the environment.

But now, anyone designing or building marine structures must respect environmental criteria. Designers must take into account bottom-dwelling ("benthic") communities, effects on nearshore vegetation, currents, wave patterns and shading effects.

General Considerations

Marine structures can be grouped into three types:

- Those that are based on ***fill*** of some type and are faced with slabs or revetments (e.g., groynes, breakwaters);
- Those that are supported or anchored by ***piles*** or posts (e.g., piers, wharves); and
- Those that are attached to shore and ***float*** over the water (e.g. floating dock).

As a general rule, a fill-based structure has a greater impact on the near- and foreshore environment because its footprint— the area of shore that is covered and destroyed — is considerably greater than a pile-based or floating structure. Its effect on shore currents, sedimentation patterns and wave actions also tends to be greater.

- Whenever possible, use pile-based or floating structures rather than fill-based structures.
- When planning any kind of marine structure, consider the following design parameters:
  - **Size/footprint** – the smaller the structure, the less damage to the bottom (for fill-based projects) and less shading (for pile-based floating structures) will occur.
  - **Materials** – reduce or eliminate the use of materials that leach toxics into seawater (such as copper, arsenate, zinc and chromate from treated wood).
  - **Location** – avoid or span areas of high biological productivity, such as marshes, eelgrass or kelp beds; avoid any changes to the currents or the way the sediment moves as these are either sensitive habitats or they are critical habitat forming processes.
  - **Roughness** – the greater the surface roughness of the structure, the greater chance that it will provide micro-habitats for attaching aquatic organisms. Where possible, try to replicate natural substrate type and quality with the design and fabrication of the structure.

Groynes and Breakwaters

Groynes are intended to reduce or eliminate site-specific erosion. They trap sediment moving along the shore. They are built perpendicular to the shore, creating a new beach on the updrift side (the side from which most of the sediment comes) and reducing deposition on the downdrift side. This creates a series of small beaches between groynes oriented roughly at right angles to the prevailing wave direction. Groynes are typically constructed of timber panels supported by piles, rock or concrete blocks. Multiple groynes (known as a groyne field) are built to protect a length of shore. Vancouver uses groynes successfully in English Bay to stabilize artificial beaches made of imported sand.


Mike Tarbotton

Breakwaters are designed to protect a shore area, harbour or anchorage from waves. Breakwaters can be floating or bottom-founded. Floating breakwaters, used in mild wave conditions, provide only partial wave protection because wave energy can pass below the float. Bottom founded breakwaters can be designed for any wave condition, but water depths over 15 to 20 m and waves bigger than 10 m make this type of structure too expensive.


Mike Tarbotton

Floating breakwaters such as this one in the Fraser river can be designed to reduce the erosive energy of wakes.

Breakwaters are usually connected to shore. However, offshore breakwaters sometimes form part of a harbour protection system.

The key factors to consider in breakwater design are wave height, length, direction and the effects of the structure on wave refraction and erosion.

What Can Happen

The major long-term impacts come from changes caused when we modify local wave and water circulation patterns and alienate marine habitat by using fill.

- Erosion transfer: These structures partially or completely cut off the supply of downdrift sediment. They can end up transferring an erosion problem to an adjacent, downdrift stretch of coast. Recent studies have shown that groyne fields are often ineffective and can cause serious coastal erosion elsewhere. Consequently, groynes have been out of favour in the coastal engineering community for the last 20 years. However, there are places where groynes can be effective as long as the designer has detailed studies of prevailing coastal processes.

- Burial of benthic habitat: The bottom area covered by groynes or breakwaters is alienated permanently. Groynes and breakwaters can also affect adjacent benthic habitats by changing sediment deposition patterns.
- Wave energy alteration: Breakwaters increase wave energy, causing localized shore erosion. They can also make a harbour or shore area unsuitable for boat use or moorage at certain times.
- Reduction in flushing: Breakwaters may reduce flushing of the marine waters they enclose, which may heat the water, concentrate the pollutants and add to the accumulation of sediment.
- Biophysical change: The reduced exposure to waves and surf behind a breakwater alters the physical environment and can encourage colonization by biota that could not otherwise occupy these areas. This may be good or bad, depending on your view. For example, eelgrass has colonized new areas of Roberts Bank in the Fraser River Delta in response to causeway construction. However, the mudflat and its associated biological community were displaced.
- Construction impacts: Construction of these structures can bury productive habitat, dislocate mobile species, cause turbidity and contaminate coastal waters.

Considerations – Things to Find Out

Need: Shore structures like these are often built without considering their consequences. Are there alternative ways of solving the problem? Consult a physical shorezone expert for options.

Impact assessment: Determine the type of shore being affected .(Refer to pages 22 to 33 for a discussion of shore types and their sensitivity to development.) Review long-term sedimentary processes in the area. Identify biological resources and habitats that need to be avoided or protected.

Regulatory requirements: See Chapter 3 of the DFO guide for Shoreline Structures Environmental Design (For More Information) for guidance on project review processes and requirements under the federal *Fisheries Act* and other regulations.

Provincial lease or licence: The province has jurisdiction over foreshore and inland waters (refer to Chapter 4, Coastal Planning and Approvals). You must get a lease, licence or permit to use these areas from Land and Water British Columbia Inc.

Local government requirements: Some local governments require a development permit to build within shore areas. Check with the municipal or regional district development services department.

Port, harbour or estuary management plan: Many ports, harbours and estuaries in developed areas have specific plans in place. These plans often identify areas where shore structures won't incur significant environmental impacts. Check with the applicable port authority or local government.

Impacts on navigation: Contact Navigable Waters Protection Division (Coast Guard) of Fisheries and Oceans Canada (DFO) for requirements under the *Navigable Waters Protection Act.*

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions that may apply to your site or activities.

Professional assistance: As can be seen from this list, many approvals can be required to build these structures, due in large part to the number of things these structures can affect. For this reason it is wise to hire a qualified professional to assist in assessing the coastal resources and processes, developing site plans that achieve your objectives while minimizing impacts to the shore, and finding options that deliver the project more effectively and at reduced cost. You must conduct all necessary regulatory assessments and obtain all appropriate approvals: These may include cultural or archeological assessments if there has been First Nations activity on your land or cumulative environmental impact assessments if the project triggers CEAA (the *Canadian Environmental Assessment Act*.) Qualified professional experts should be aware of all the applicable regulatory requirements and guidelines that would apply to your project and should understand how to meet them.

For More Information

- *"Shoreline Structures Environmental Design: A Guide for Structures along Estuaries and Large Rivers"* (M.A. Adams, 2002) This report by Fisheries and Oceans Canada covers project review procedures and design criteria for a variety of shore structures. It also provides detail on shore vegetation and its restoration.
- *DFO Fact Sheet: Marine Guide to Preventing Shoreline Erosion.* Outlines fish habitat issues associated with foreshore erosion control structures, impact assessment requirements, BMPs and local DFO contacts for additional information or advice. This fact sheet is available at *DFO's website*.

Seawalls and Revetments

Revetments are hard, smooth surfaces that are built to protect a bank or bluff from erosion by wave action and currents. Seawalls are free-standing structures made typically of concrete or rock. They usually create land by infilling behind the wall. They are commonly used to create public walkways along the shore.

Seawalls and revetments are built to facilitate various water-related activities and to protect upland property and structures from flooding, erosion and damage. Often the protected land originally was part of the shore process zone.

What Can Happen

Seawalls and revetments can alter shore processes significantly:

- Hardening and straightening of shores: Probably the most dramatic effects occurs when hardened, straight surfaces replace what were undulating, vegetated shores. This reduces the amount and diversity of substrates available for organisms to colonize, removes places of shade or protection from predators and removes shore vegetation that provides wildlife habitat and protection from erosion.
- Disruption of longshore drift: By changing the configuration of the shore, these structures alter how and where sediment is deposited.
- Wave energy alteration: Seawalls and revetments can increase wave energy, wave reflection and resonance, which can speed up shore erosion at the toe of the structure itself. This can also make the shore area inaccessible by small boats at certain times, particularly when high winds and high tides coincide.
- Burial or alienation of habitat: A seawall or revetment isolates the foreshore from the nearshore and eliminates intertidal habitats.
- Construction impacts: Construction of these structures can bury productive habitat, dislocate mobile species, cause turbidity and contaminate coastal waters.

Considerations – Things to Find Out

Need: Shore structures like these were historically designed or installed without considering the consequences of the activity or alternative ways to meet the objective. Consult a physical shorezone expert for options.

Impact assessment: Determine the type of shore being affected (Refer to pages 22 to 33 for a discussion of shore types and their sensitivity to development.). What are the impacts of the proposed project on the marine environment? On adjacent properties and along the coast? Generally, the more natural, the better; the less "hard", the better; and the less straight, the better. Review historical aerial photos, bathymetric charts or talk to long time residents to identify long-term sedimentary processes in the area. This may help you to anticipate changes to deposition and/or erosion as a result of the proposed seawall or revetment. Identify biological resources and habitats that need to be avoided or protected.

Regulatory requirements: See Chapter 3 of the DFO Guide for *Shoreline Structures Environmental Design* (For More Information) for guidance on project review processes and requirements under the federal *Fisheries Act* and other regulations.

Provincial lease or licence: The province has jurisdiction over foreshore and inland waters; you must apply for a lease, licence or permit to occupy or use this area from Land and Water British Columbia Inc.

Local government requirements: Some local governments require a development permit to build within shore areas. Check with the municipal or regional district development services department.

Port, harbour or estuary management plan: Many ports, harbours and estuaries have specific plans in place. These plans often identify areas where shore structures won't incur significant environmental impacts. Check with the applicable port authority or local government.

Impacts on navigation: The protection of navigable waters affects the design and construction of marine structures. Check with the Coast Guard of Fisheries and Oceans Canada (DFO) or your local government.

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions that may apply to your site or activities.

Professional assistance: As can be seen from this list, many approvals can be required to build these structures, due in large part to the number of things these structures can affect. For this reason it is wise to hire a qualified professional to assist in assessing the coastal resources and processes, developing site plans that achieve your objectives while minimizing impacts to the shore, and finding options that deliver the project more effectively and at reduced cost. You must conduct all necessary regulatory assessments and obtain all appropriate approvals: These may include cultural or archeological assessments if there has been First Nations activity on your land or cumulative environmental impact assessments if the project triggers CEAA (the Canadian *Environmental Assessment Act*.) Qualified professional experts should be aware of all the applicable regulatory requirements and guidelines that would apply to your project and should understand how to meet them.

For More Information

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DFO Fact Sheet: Marine Guide to Preventing Shoreline Erosion. Outlines fish habitat issues associated with foreshore erosion control structures, impact assessment requirements, BMPs and local DFO contacts for additional information or advice. This fact sheet is available at *DFO's website*.

"Alternative Bank Protection Methods for Puget Sound shorelines (Parts 1-5)"- A series of five guidebooks and case studies on alternative approaches to coastal foreshore protection .These are available at the *Washington Department of Ecology- Shorelands Environmental Assistance web site.*

Regional District of Comox Strathcona

Revetments are shore protection measures designed to reduce shore erosion. When these shore protection measures are installed they frequently have unintended effects on adjacent properties such as localized scouring. The need for coastal revetments too frequently arises when buildings are located too close to the active shore.

David Reid

In urban areas, seawalls are often part of a public waterfront walkway.

Goodbye beach?

Tourists and surfers come from all over the world to enjoy Vancouver Island's west coast beaches. A few of them like it so much, they pay more than $1 million for beachfront property.

When a severe January storm carved away a chunk of their beach, the homeowners panicked. From their winter homes all over North America they telephoned instructions to a contractor to build a sea wall. Contrary to advice from experts on marine foreshore processes, they built a two metre high wall, 300 m long, at great expense.

"The seawall will change the character of the beach permanently", said one neighbour. "It will trap water behind it, undercut vegetation, change the dunes and become a collection spot for debris. We have to live with nature. We have a dynamic, exciting, high energy beach, and I want it to stay that way."

Fisheries and Oceans Canada

Human activities that interfere with natural shore processes can lead to irreparable damage.

Piers, Wharves and Jetties

Piers, wharves and jetties are pile-based structures designed to provide safe moorage for ships, tugs and commercial fishing boats. They may be located within a harbour protected by breakwaters. A pier normally extends at right angles to shore into deep water, providing moorage on both sides. Wharves generally run parallel to shore (often called a marginal wharf) with storage for industrial commodities such as wood products. Jetties technically are not used for mooring boats but are linear structures, similar to breakwaters, built out from shore and used to control sedimentation at the mouth of a river; e.g., Steveston Jetty on the Fraser River.

Mike Tarbotton

Whether for industrial, commercial, or recreational use, the construction of a pier or jetty must consider not only the impact of the structure itself, but also the impacts of its related activities.

What Can Happen

Piers, wharves, and jetties can have a significant impact on coastal processes and associated biological communities. Some specific impacts include:

- Shading: Shading can affect the vigour of such intertidal and subtidal plant communities as marsh plants, eelgrass and kelp beds. Shading impacts may be chronic (reduced productivity) or acute (elimination of plant communities, leaving affected areas barren.)
- Disruption of sediment drift: This results in updrift beach formation and downdrift shore erosion.
- Intensified wave reflection and resonance: This may cause localized shore erosion or could make a facility inaccessible to small boats at certain times. Wave reflection is most severe for structures with a vertical face.
- Short term disruption: Construction and dredging can bury productive habitat, and cause turbidity and discharge of contaminants.

Considerations – Things to Find Out

Need: Shore structures like these are often undertaken without considering the consequences of the activity or alternative ways to meet the intended objective. Consult a physical shorezone expert for advice on location or structural options.

Impact assessment: Determine the type of shore being affected .(Refer to pages 22 to 33 for a discussion of shore types and their sensitivity to development.) Review long-term sedimentary processes in the area. Identify biological resources and habitats that must be avoided or protected.

Regulatory requirements: See Chapter 3 of *Shoreline Structures Environmental Design* (For More Information) for guidance on project review processes and requirements under the federal *Fisheries Act* and other regulations.

Provincial lease or licence: The province has jurisdiction over foreshore and inland waters (refer to Chapter 4, Coastal Planning and Approvals). Get a lease, licence or permit from Land and Water British Columbia Inc.

Local government requirements: Some local governments require development permits to build on shore areas. Check with the municipal or regional district development services department.

Port, harbour or estuary management plan: Many ports, harbours and estuaries in developed areas have specific plans in place. These plans often identify areas where you can build a shore structure without incurring significant environmental impacts. Check with the applicable port authority or local government.

Impacts on navigation: Contact Navigable Waters Protection Division (Coast Guard) of Fisheries and Oceans Canada (DFO) for requirements under the *Navigable Waters Protection Act.*

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions of such activities.

Professional assistance: As can be seen from this list, many approvals can be required to build these structures, due in large part to the number of things these structures can affect. For this reason it is wise to hire a qualified professional to assist in assessing the coastal resources and processes, developing site plans that achieve your objectives while minimizing impacts to the shore, and finding options that deliver the project more effectively and at reduced cost. You must conduct all necessary regulatory assessments and obtain all appropriate approvals: These may include cultural or archeological assessments if there has been First Nations activity on your land or cumulative environmental assessments if the project triggers CEAA (the Canadian *Environmental Assessment Act*.) Qualified professional experts should be aware of all the applicable regulatory requirements and guidelines that would apply to your project and should understand how to meet them.

For More Information

"Shoreline Structures Environmental Design: a Guide for Structures along Estuaries and Large Rivers" (M.A. Adams, 2002) This report by Fisheries and Oceans Canada covers project review procedures and design criteria for a variety of shore structures. It also provides detail on shore vegetation and its restoration.

Docks

Docks are also an important part of small craft harbours or marinas and are used for mooring small vessels and pleasure boats. Property owners also install individual docks for mooring recreational craft.

Docks come in various sizes, shapes and designs:

- Fixed or permanent docks are secured to shore and sit above water supported by piles or pipes.
- Floating docks are tethered to shore or connected to a permanent dock by a ramp. They float on buoyant material built into the dock. They can often be removed for winter storage.
- Specialty docks include cantilever, suspension and lift docks. They too may be able to be lifted above the high water mark, or removed.

What Can Happen

The installation of docks can affect the coastal biophysical environment in a variety of ways:

- Shading: Shading caused by the dock can affect the vigour of intertidal and subtidal plant communities, such as marsh plants, eelgrass and kelp beds. These impacts may be chronic (reduced productivity) or acute (wiping out plant communities, leaving the area barren).
- Disruption of shore drift patterns: This can result in updrift beach formation and downdrift shoreline erosion.
- Shore damage: Removal of shore plants and disturbance of soils where docks are attached to land can increase erosion and sedimentation of the intertidal and adjacent subtidal areas.
- Bottom habitat: Installation of footings, pilings and other structures permanently alienates benthic habitat. Dredging to create sufficient depth next to the dock can also disrupt or destroy bottom habitat.
- Operational pollution: Poor refuelling and dock maintenance practices, bilge releases and accidental spills from boats and docks can release contaminants into the nearby waters.

Considerations – Things to Find Out

Need for a new dock: Are there alternative ways of meeting your docking or moorage needs? For example, could you use an existing public or community facility, share an existing dock with a neighbour, or use a mooring buoy?

Design: Select a size and design that fits your needs and minimizes disturbance to the shore and sea floor. If all your boating is in summer, consider a dock that can be removed during the winter. Post-supported, floating and cantilevered docks have progressively less impact on the shore and bottom habitat. Is there a less sensitive area in which to locate a dock?

Impact assessment: Determine the shore type and communities you may be affecting. Refer to pages 22 to 33 of this guide for help in identifying a shore type that may be less sensitive to construction of a dock. Your dock may harmfully alter or destroy fish habitat, so must be authorized by the Department of Fisheries and Oceans (DFO) under the *Fisheries Act*. Check with your local government first.

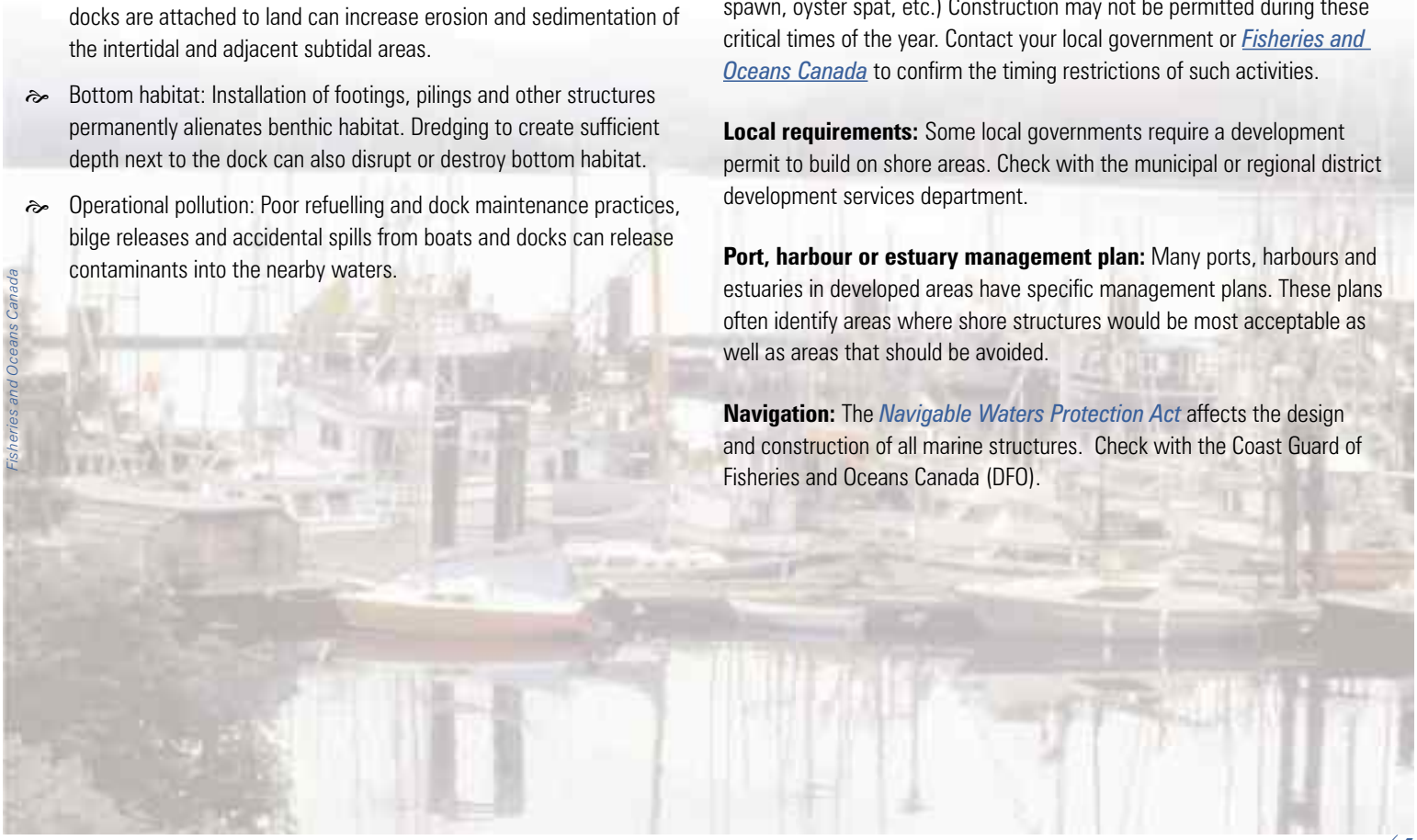
Provincial lease or licence: The province has jurisdiction over foreshore and inland waters (refer to Chapter 4, Coastal Planning and Approvals). Apply for a lease, licence or permit to use these areas from Land and Water British Columbia Inc.

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions of such activities.

Local requirements: Some local governments require a development permit to build on shore areas. Check with the municipal or regional district development services department.

Port, harbour or estuary management plan: Many ports, harbours and estuaries in developed areas have specific management plans. These plans often identify areas where shore structures would be most acceptable as well as areas that should be avoided.

Navigation: The *Navigable Waters Protection Act* affects the design and construction of all marine structures. Check with the Coast Guard of Fisheries and Oceans Canada (DFO).



Fisheries and Oceans Canada

Professional assistance: As can be seen from this list, many approvals can be required to build these structures, due in large part to the number of things these structures can affect. For this reason it is wise to hire a qualified professional to assist in assessing the coastal resources and processes, developing site plans that achieve your objectives while minimizing impacts to the shore, and finding options that deliver the project more effectively and at reduced cost. You must conduct all necessary regulatory assessments and obtain all appropriate approvals: These may include cultural or archeological assessments if there has been First Nations activity on your land or cumulative environmental assessments if the project triggers CEAA (the *Canadian Environmental Assessment Act*.) Qualified professional experts should be aware of all the applicable regulatory requirements and guidelines that would apply to your project and should understand how to meet them.

For More Information

- *"On The Living Edge: Your Handbook for Waterfront Living"* (Chapter 9), published by the *Living by Water Project*, provides many ideas on different types of dock designs, and building materials that are friendly to the marine environment.

- *DFO Marine Guide to Small Boat Moorage* – This fact sheet outlines the impacts from docks, provides environmentally friendly design and construction guidelines, outlines project assessment requirements and identifies local DFO contacts for information and advice. This fact sheet is available at *DFO's website*.

Canadian Wildlife Service

The impacts of residential docks may appear insignificant compared with the massive structures shown on page 64. But because of their numbers, these structures still require careful scrutiny to minimize their potentially destructive environmental impacts.

Dikes

Dikes are designed and constructed for one purpose - to prevent flooding of low lying lands. Dikes are extensive throughout the Fraser River estuary and, to a lesser extent, in other urbanized estuaries (e.g., Squamish and Nanaimo). While the era of large scale dike construction is over, habitat conservation remains a critical issue in the extension, modification and maintenance of existing dikes.

What Can Happen

A typical dike is built within the highly productive flood plain, which is the transition zone between aquatic and upland environments. Dikes can affect the biophysical shore system in three ways:

- They form a permanent barrier between the intertidal and backshore, thereby eliminating marshes, mudflats, and seasonally flooded areas that provide critical seasonal fish and bird habitat.
- They reduce the effect of tides, currents, storms and seasonal fluctuations on water levels. This changes elevations and salinities on both sides of the structure, thereby changing all habitat characteristics and biological community structure and reducing the shoreline's natural resiliency and diversity.
- They accelerate the erosive shear forces at the toe of the dike, which straightens, hardens and simplifies the shoreline and eliminates natural diversity and habitat niches for many organisms.

In addition, dikes must be maintained to ensure they continue to protect the developed areas behind them. Traditionally, this has led to sterile, minimally vegetated structures throughout the foreshore that contribute little to habitat productivity.

Where dikes accelerate adjacent accretion, regular dredging may be required to maintain open navigation channels. This dredging can increase turbidity, mobilize sediment-associated contaminants and trap or bury small aquatic organisms.

Considerations – Things to Find Out

These cautions apply to construction of new dikes as well as to expansion and maintenance of existing dikes.

The need: How significant is the flooding risk? Have you consulted flood risk maps for your area, where they exist? Are there alternative ways to address the local erosion or flooding problem you're trying to solve? Consult a physical shorezone expert for options.

Impact assessment: Define the type of shore being affected (Refer to pages 22 to 33 for a discussion of shore types and their sensitivity to development); determine sediment transport processes; identify biological resources and habitats; etc.

Regulatory requirements: See Chapter 3 of the *DFO Guide to Shoreline Structures Environmental Design* for guidance on project review processes and requirements. Section 3.2 addresses requirements under the federal *Fisheries Act*, and section 3.3 covers other authorities.

Maurice Jassak

image provided by seevancouverbc.com

While the era of large scale dike construction is over, habitat conservation remains a critical issue in the extension, modification and maintenance of existing dikes.

Provincial lease or licence: The province has jurisdiction over foreshore and inland waters (refer to Chapter 4 in this guide, Coastal Planning and Approvals). You must apply to Land and Water British Columbia Inc. for a lease, licence or permit to construct dykes in these areas.

Local government requirements: Some local governments require development permits for dikes; check with the municipal or regional district development services department.

Port, harbour or estuary management plan: Many ports, harbours and estuaries have specific plans that identify areas where you can build on shore without incurring significant environmental impact. Check with the applicable port authority or local government.

Impacts on navigation: Contact the Navigable Waters Protection Division of Fisheries and Oceans Canada (DFO) for requirements under the *Navigable Waters Protection Act*

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or Fisheries and Oceans Canada to confirm the timing restrictions of such activities.

Environmental design and maintenance: Several measures are discussed in Chapter 5 of he DFO Guide to Shoreline Structures Environmental Design. They include setback dikes, the use of vegetation, and ecologically sound maintenance and repair practices.

Professional assistance: As can be seen from this list, many approvals can be required to build these structures, due in large part to the number of things these structures can affect. For this reason it is wise to hire a qualified professional to assist in assessing the coastal resources and processes, developing site plans that achieve your objectives while minimizing impacts to the shore, and finding options that deliver the project more effectively and at reduced cost. You must conduct all necessary regulatory assessments and obtain all appropriate approvals: These may include cultural or archeological assessments if there has been First Nations activity on your land or cumulative environmental assessments if the project triggers CEAA (the *Canadian Environmental Assessment Act.*) Qualified professional experts should be aware of all the applicable regulatory requirements and guidelines that would apply to your project and should understand how to meet them.

For More Information

- *"Shoreline Structures Environmental Design: A Guide for Structures along Estuaries and Large Rivers"* (M.A. Adams, 2002). Chapter 5 is devoted to dikes. While focusing on flood protection, it also presents ways of locating and aligning dikes, establishing vegetation and maintaining dikes to be more habitat friendly.

Marine Discharges

Discharges to the marine environment can be characterized as originating from point or non-point sources. Point or "end-of-pipe" discharges are typically associated with industrial and municipal outfalls. Regulations and vigilance over the last decades have been generally successful in reducing the introduction of pollutants from these sources.

All point-source discharges are subject to one or more federal and/or provincial regulations. Be aware of the rules governing the type of outfall or discharge you are operating.

Non-point source discharges arise from many sources (see sidebar). Their effects are often subtle and gradual, but cumulatively they are recognized as a significant source of pollution in freshwater and marine environments. Highly toxic non-point source discharges from accidental spills or fugitive discharges can be immediately fatal to marine organisms in the vicinity of the spill.

General Considerations

- Non-point source pollution is very difficult to manage. It is hard to identify and control the many sources over a large area. The key is prevention through planning, education, and source control. Wide-scale prevention is necessary because the actions of many individuals contribute to the problem and many people must also be part of the solution.
- The quantity of pollutants originating from any one source, such as a home, business or farm, may be very small. The cumulative effect of hundreds or thousands of small sources within a watershed or discharging to the nearshore can create significant pollution.
- Both point and non-point discharges can kill fish and shellfish, damage human health, affect recreation and tourism and close areas to commercial fishing, aquaculture and/or food harvesting. It also affects aesthetics and lowers real estate values.

While pollutant source reduction or treatment can be expensive, the initial costs are amortized over the lifespan of the facility and often cost less than the ongoing cost of pollution clean-up, penalties and bad press.

Non-point pollution sources

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Land development - *sediment and toxics from clearing and construction*

Ministry of Forests

Agriculture - *fertilizers, manure, pathogens, pesticides and sediment*

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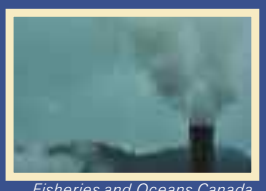
Stormwater runoff - *nutrients, sediments, pathogens and toxins*

Greater Vancouver Regional District

Sewage systems – nutrients, pathogens and pharmaceuticals

Lanarc Consultants Ltd.

Forestry - *sediment, fertilizers, pesticides, debris, ash from burning*



Fisheries and Oceans Canada

Atmospheric deposition – heavy metals, hydrocarbons and emissions from vehicles, heavy industries

Mike Tarbotton

Marine activities - *toxics from vessel operation, maintenance, sewage, spills*

Stormwater Runoff

Stormwater management, historically focused on reducing risks associated with rain and flooding. It did this by building bigger ditches, culverts and pipes to convey water away quickly and conveniently. Water arrived in the receiving stream, lake or coastal shore much faster and in much greater quantities than it would normally, without the benefit of being slowed and filtered through the natural system. This often resulted in erosion and pollution.

Today, managers are trying to balance flood concerns with environmental protection. "Integrated" stormwater management looks beyond pipes and ditches to consider a full range of measures to control surface runoff, thus protecting aquatic habitats.

What Can Happen

In typical urban conditions, stormwater discharge can cause:

- Shore erosion: Sudden and high discharges can erode shore beds and sediments around a stormwater outfall.
- Pollution: Storm water often contains such contaminants as hydrocarbons and heavy metals, washed off streets and parking lots; fecal coliform from cross-connections with sanitary sewers or from leaking septic systems; toxics spilled or dumped in upland areas; atmospheric emissions washed off vegetation, roofs and streets by rainfall.
- Sedimentation: Sediment washed down from construction sites or exposed soils can smother foreshore and intertidal organisms, interfere with suspension feeders and increase turbidity, thereby reducing light penetration and photosynthesis.
- Altered sediment transport: Drainage pipes or outfalls installed across the foreshore can alter longshore sediment drift and change habitat characteristics on both sides of the structure.

Considerations – Things to Find Out

Impact assessment: Define the type of shore being affected (Refer to pages 22 to 33 for a discussion of shore types and their sensitivity to development.); determine sediment transport processes; identify biological resources and habitats in the area; etc.

Regulatory requirements: Stormwater outfalls must not harmfully alter, disrupt or destroy fish habitat or cause the deposit of a deleterious substance under the federal *Fisheries Act*. If the stormwater system has connections with the sanitary sewer, requirements of the provincial *Waste Management Act* will also apply.

Provincial lease or license: The province has jurisdiction over foreshore and inland waters (refer to Chapter 4 in this guide, "Coastal Planning and Approvals"). You may need a lease, license or permit to cross foreshore areas; check with Land and Water British Columbia Inc.

Local government requirements: Some local governments require development permits for outfalls in shore areas. Check with the municipal or regional district development services department. Some municipalities may have bylaws or codes of practice regulating stormwater quality.

Port, harbour or estuary management plan: Many ports, harbours and estuaries have specific plans that identify areas where structures can be built without incurring significant environmental impact. Check with the applicable port authority or local government.

Impacts on navigation: Contact the Navigable Waters Protection Division of Fisheries and Oceans Canada (DFO) for requirements under the *Navigable Waters Protection Act*.

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions of such activities.

Environmental design considerations: There are many ways to reduce or slow down surface runoff "at source" so that it does less damage to the receiving environment. Minimizing the amount of impervious surfaces on a developed site and preserving trees and other greenspace will reduce the volume of stormwater generated. Use "soft" or pervious surfaces (grass, gravel, vegetated swales, paving stone with spaces, turf or "eco-roofing", etc,) wherever possible. You can improve water quality with such devices such as oil-grit interceptors, vegetated swales and settling ponds or constructed wetlands. Avoid using toxic substances that wash down the local storm drain. Check the guidelines listed below.

Professional assistance: Hire a qualified professional to assist in assessing coastal resources and processes, developing site plans that achieve objectives while minimizing impacts, finding options that deliver the project more effectively and meeting applicable regulations.

For More Information

- The provincial Ministry of Water, Land and Air Protection(MWLAP) publishes and updates *"Best Management Practices to Protect Water Quality"* to address non-point source pollution *on their website*.
- MWLAP and Environment Canada have recently published *"Stormwater Planning: A Guidebook for British Columbia"* (2002). Copies are available *from their website*.
- *"Natural Approaches to Stormwater Management"* by the Puget Sound Action Team provides excellent examples of low impact development measures. Copies are available *from their website*.
- The Stormwater Manager's Resource Center (SMRC) is a website managed and published by the *Center for Watershed Protection Inc.*, based in Maryland. It has compiled a comprehensive list of best management practices and education materials.
- The Greater Vancouver Regional District has developed several *Best Management Guides for Stormwater*. These are available on the *GVRD web site*.

Sewage Outfalls

Sewage outfalls carry liquid waste from onshore facilities out to sea. Discharges are usually made at some depth and distance from shore.

In B.C., the collection, treatment and disposal of sewage are typically the responsibility of local governments - municipalities, regional districts or local improvement districts - though there are also some private discharges. Communities experiencing development pressures or having significant liquid waste issues are encouraged, or may be directed by the Minister, to develop a Liquid Waste Management Plan to build and operate sewage facilities as well as addressing other liquid waste issues such as stormwater, on-site sewage systems and source control. Other communities and service providers must meet the requirements of the Municipal Sewage Regulation (MSR) under the *Waste Management Act,* or, if their discharge pre-dates the MSR, they must comply with conditions of a permit that authorizes the discharge.

What Can Happen

Sewage effluent contributes organic material and nutrients to the marine environment, and can also contain toxic contaminants. Siting outfalls in the best spot, relative to currents, tides and flushing rates is important. Otherwise, the sewage can wash up on the adjacent shores or contaminate nearshore waters.

- Increased nutrients can result in dramatic algae growth that depletes oxygen levels in the water, starving local fish and shellfish of oxygen.
- Bacteria from the sewage effluent, if swept shoreward, can make the nearshore waters unsuitable for swimming and other recreation and can seriously contaminate local bivalves, making them unfit to eat.
- Deposition of fine, organic sediments or other contaminants from sewage effluent can smother and destroy benthic (bottom-feeding) invertebrate communities.
- The alignment and construction of an outfall pipe across the foreshore can disrupt sediment drift patterns and deposition, contributing to habitat alteration and loss.

Considerations – Things to Find Out

Impact assessment: The location, design and construction of sewage outfalls are subject to specific impact study requirements under the MSR (see below: For More Information).

Regulatory requirements: The federal *Fisheries Act* prohibits the deposit of a deleterious substance to fishbearing waters and sewage discharges can be deleterious. The provincial Ministry of Water, Land and Air Protection also regulates sewage collection, treatment and disposal under the *Waste Management Act* and Municipal Sewage Regulation. Depending on the facility, a Liquid Waste Management Plan and an Operational Certificate under the Plan, registration under the MSR or a permit are required. Authorization under the federal *Fisheries Act* may also be required if physical habitat alteration or loss is an issue.

Provincial lease or license: The province has jurisdiction over foreshore and inland waters (refer to Chapter 4 in this guide, Coastal Planning and Approvals). You may need a lease, license or permit to build an outfall.

Local government requirements: Some local governments require development permits for outfalls; check with the municipal or regional district development services department

Port, harbour or estuary management plan: Many ports, harbours and estuaries have specific plans that identify areas where shore structures will not incur significant environmental impacts. Check with the applicable port authority or local government.

Impacts on navigation: Contact the Navigable Waters Protection Division of Fisheries and Oceans Canada (DFO) for requirements under the *Navigable Waters Protection Act*.

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions of such activities

Professional assistance: A qualified professional can assist in assessing coastal resources and processes, developing a design that deals with sewage while minimizing the impact and meeting applicable regulations.

For More Information

- *"Environmental Impact Study Guideline - A Companion Document to the Municipal Sewage Regulation"* (MWLAP, December 2000) details the impact assessment requirements for location, design and construction of sewage outfalls. The impact study must determine whether the proposed discharge meets the standards and requirements of the MSR. It is available on *MWLAP's website*.
- Contact the Pollution Prevention Manager in your regional MWLAP office, or the Pollution Prevention Section of MWLAP in Victoria, (250) 387-6663.

Greater Vancouver Regional District

Industrial Wastewater or Cooling Water Discharges

Some industries use outfalls to discharge wastewater or cooling water into the sea. Discharges can occur into both the intertidal zone and subtidal areas, sometimes at depths up to 200 m.

Various regulations cover industrial discharges. They are administered by the Ministry of Water, Land and Air Protection (MWLAP) under the *Waste Management Act*. Some specific industrial discharges are also subject to federal legislation (i.e., the *Fisheries Act* and associated regulations), as is the case for pulp mill and metal mining effluents. Most discharges require a permit, and are subject to environmental assessments prior to approval.

What Can Happen

- Discharges of cooling water or wastewater can heat or contaminate the shore environment. They can also cause thermal shock for species in the immediate vicinity of the discharge. It is important to choose the appropriate site for an outfall to minimize impacts on intertidal and subtidal biota and to ensure optimum treatment of effluents. Proper siting requires good knowledge of the currents, tides, flushing rates and dispersion patterns and often requires some oceanographic modelling.
- Industrial contaminants can impair biological communities around the outfall. For many years, areas near pulp mill effluent discharges were closed to crab harvesting because of dioxins and furans. Changes to pulp bleaching processes mean many of these toxics have been removed from the effluent and the areas are now safe for crabbing and have been reopened to commercial and recreational harvest.
- Some discharges also deposit suspended sediments and/or fine organic material that can smother benthic organisms, deplete oxygen levels and reduce sunlight penetration which inhibits algal photosynthesis.
- The alignment and construction of discharge pipes across the foreshore and nearshore benthic areas can disrupt sediment transport and contribute to habitat alteration or loss.

Considerations – Things to Find Out

Impact assessment: The location, design and construction of industrial outfalls and treatment of effluents are subject to rigorous impact assessment requirements; check with the local MWLAP and DFO office.

Regulatory requirements and approvals: Several specific industrial effluents such as metal mining effluents, pulp mill effluents and sewage effluents are the subject of specific regulations under the Federal *Fisheries Act*. All discharges that are deleterious are subject to the general pollution prevention provisions of the Federal *Fisheries Act*. MWLAP also regulates waste disposal and cooling water discharges.

Provincial lease or license: The province has jurisdiction over the foreshore and inland waters (refer to Chapter 4, Coastal Planning and Approvals). A lease, license or permit may be required; check with *MWLAP or Land and Water B.C. Inc. or visit their website*.

Local government requirements: Some local governments require development permits for any outfalls in shore areas. Check with the municipal or regional district development services department.

Port, harbour or estuary management plan: Many ports, harbours and estuaries have specific plans that identify areas where shore structures will not incur significant environmental impact. Check with the applicable port authority or local government.

Impacts on navigation: Contact the Navigable Waters Protection Division of Fisheries and Oceans Canada (DFO) for outfall siting requirements or restrictions under the *Navigable Waters Protection Act.*

Timing of construction: Restrictions on when construction can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Construction may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions of such activities.

Professional assistance: Hire a qualified professional to assist in assessing coastal resources and processes and to develop a site plan that will minimize the impact of your outfall, while meeting applicable regulations.

Pollution prevention plan: MWLAP's Pollution Prevention (P2) Planning program aims to avoid, eliminate, or reduce the release of polluting substances to the environment. See below for information sources.

For More Information

- Contact the Pollution Prevention Manager in your regional MWLAP office, or the Environmental Management Branch - Industry and Business Section in Victoria. PO Box 9342 Stn. Prov. Gov., Victoria, B.C. V8W 9M1
- For the Pollution Prevention (P2) Planning program: contact the Environmental Management Branch of MWLAP in Victoria, or visit the *Environmental Protection Division's website.*

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Discharges from pulp and paper operations are managed by federal regulations under the ***Fisheries Act*** *and by provincial guidelines that cover liquid effluent, sulphur, and other substances.*

Disposal at Sea

Disposal at sea is the act of deliberately dumping materials into the open ocean as a means of disposing of them. Environment Canada regulates disposal at sea under Part VII of the Canadian *Environmental Protection Act* (CEPA). Through a permitting system, CEPA controls disposal of nonhazardous waste where such disposal is the environmentally preferable and practical option.

Substances commonly dumped in the ocean include dredged and excavation materials; ships, and other manmade structures; scrap metal and other bulky, nontoxic materials. Material destined for ocean disposal must pass a rigorous chemical analysis before a permit is given. The criteria for ocean disposal are conservative, and ocean disposal sites are designated and monitored.

CEPA's requirements do not apply to discharges resulting from offshore mineral exploration and development, from the normal operation of ships and other craft, or from land based sources. Other legislation such as the *Canada Shipping Act, Fisheries Act, Navigable Waters Protection Act*, and provincial waste management legislation regulate these.

In British Columbia, coastal topography and the lack of suitable landfill sites are key constraints in disposing of these types of wastes on land. The annual volume of dredgeate and excavation wastes in the Lower Mainland alone, for which there are no alternative beneficial uses, cannot be accommodated by existing landfill sites. Consequently, ocean disposal has become a practical and economical alternative to landfilling.

In the past, most ocean disposed material originated from maintenance dredging of harbours and channels for navigation and industry. In recent years, the amount of excavated native soils from construction sites has increased and now contributes 25-50% of material that is approved for ocean disposal.

What Can Happen?

- The primary impact of ocean disposal is smothering of benthic communities at the dumpsite by the large amounts of sediment or other sinkables dumped on the sea floor.

Considerations – Things to Find Out

Need. There may be alternatives to ocean disposal. Check the "Users Guide"listed under "For More Information."

Impact assessment: The ocean disposal permit application defines assessment requirements. Each application must also undergo a CEAA screening; see "For More Information."

Regulatory requirements: Environment Canada requires an ocean disposal permit be issued to dispose of any substance in Canadian waters from ships (including foreign vessels in our waters), aircraft, platforms and other artificial structures. All materials must meet Environment Canada clean-up standards and/or regulated screening criteria prior to permit approval. In exceptional circumstances, an emergency permit may be issued. An emergency is defined as a situation where disposal is necessary to avert danger to human life, a ship,aircraft, platform or other structure. Permits are issued for a maximum of one year, and govern timing, handling, storing, loading and placement at a disposal site.

Professional assistance: A qualified professional can assist in assessing whether ocean disposal is the preferred method and meets applicable regulations.

For More Information

- Environment Canada has published a *Users' Guide to the Application Form for Ocean Disposal*, which addresses such things as allowable substances, alternatives, disposal site, management measures and monitoring. Copies of the Guide are available through the Environmental Protection Service of Environment Canada in Ottawa, or visit *their website.*

Environment Canada

Dredgeates and excavated soils from construction form the bulk of materials disposed at sea.

Coastal Industries and Commercial Activities

A wide range of industrial and commercial activities occur along B.C.'s coasts. This section is limited to those activities that are common or increasing: dredging (primarily in ports and harbours), log handling and storage, finfish and shellfish aquaculture.

Many marine industries require access to the ocean and therefore must be situated on the coast, but they are also under close public and government scrutiny. Sound industrial development in coastal environments means that environmental sensitivities and natural hazards must be assessed and addressed as part of the design and operation. Failure to consider shore processes and habitats results ultimately in high costs to the company, taxpayers and/or the environment. It is far less costly to account for and protect ecological values up front than to attempt to repair, restore, and compensate for them after the damage is done. In many cases compensation or remediation may not be feasible.

General Considerations

- Federal or provincial and/or municipal regulations cover siting and operation of virtually all industrial activities. Be aware of the rules governing your particular operation.
- An industrial activity may involve several of the activities covered in previous sections – i.e. land development, marine structures and marine discharges. Review these sections as they apply to your operation.
- Try to minimize interference with shore processes. Also be aware of the risks that shore forces can pose to your industrial activity.

Dredging

Dredged material is usually discarded away from its source. Provincial waste management regulations and provincial and/or local government land use regulations govern dredge spoil dumped on land. Ocean disposal is regulated under the federal *Canadian Environmental Protection Act* (see "Ocean Disposal").

What Can Happen

- Benthic impacts: Dredging changes the nature and bathymetry of benthic bottom-feeding habitat, causing short and/or long term changes to plant, fish and invertebrate communities.
- Sedimentation: Suspension of sediment causes short term changes to water quality. Toxic materials bound to sediments can be mobilized and ingested by filter feeding organisms while settled sediment can smother bottom-dwelling organisms and may alter water chemistry.
- Contaminant release: Sediment-associated contaminants can be re-suspended and carried some distance.
- Alterations to the intertidal zone: Intertidal habitat can be affected by shoreline excavation, infilling and shoreline stabilization works.

Considerations – Things to Find Out

Impact assessment: Determine the nature of the intertidal and benthic substrate, biological communities and whether the site provides fish habitat. Determine whether the bottom sediments may be contaminated.

Regulatory requirements and approvals: As the landlord of foreshore and nearshore areas, Land and Water British Columbia Inc. must approve any dredging, filling, or significant displacement of beach material. Dredging likely will affect fish habitat so an authorization under the federal *Fisheries Act* by Fisheries and Oceans Canada (DFO) may also be required.

Local government requirements: Some local governments may require a development permit for any dredging near shore.

Port, harbour plan or estuary management plan: Many ports, harbours and estuaries in developed areas have specific management plans that may identify areas where dredging is acceptable. Check with the local port authority.

Impacts on navigation: Approval under the *Navigable Waters Protection Act* may be required; contact the Navigable Waters Protection Division of DFO.

Timing: Restrictions on when dredging can occur may apply if sensitive life history stages of organisms will be affected by the proposed activity (e.g., surf smelt or sandlance spawning, herring spawn, oyster spat, etc.) Dredging may not be permitted during these critical times of the year. Contact your local government or *Fisheries and Oceans Canada* to confirm the timing restrictions of such activities.

Professional assistance: A qualified professional may be useful in assessing the coastal resources and processes associated with the project, and may be able to suggest options.

For More Information

- DFO's Central Region publishes a Fact Sheet entitled *"What you should know about Fish Habitat and Dredging".* While intended for Ontario, there are suggestions for "environmentally friendly practices" that are useful for any dredging situation.

Canadian Wildlife Service

Dredging in estuaries or from the sea floor is disruptive. The process requires that the bottom sediment be lifted, stored, and deposited away from its original location.

Marine Log Storage

In British Columbia, coastal forestry operations often move logs by water from logging areas to sorting areas or processing mills. Today, most logs are transported by barge rather than towed booms. However, logs continue to be stored in the water in designated booming areas adjacent to coastal logging operations or while waiting for entry to a mill. Some areas are used only for a short time, while other areas adjacent to dry land sorts or mills may be used for decades.

The state of Alaska is so concerned about environmental damage that it has banned all new log storage and transport sites on water.

What Can Happen

- Benthic impacts: Logs stored in intertidal areas will often ground at low tide, compacting the substrate and smothering benthic or bottom-feeding communities. The sea floor can become a desert, void of all life. Unbundled logs, particularly hemlock, can also sink to the bottom.
- Shading: Logs stored in deep water can shade the sea floor, inhibiting the growth of algae and sea grasses.
- Debris accumulation: Bark and wood debris accumulate on the bottom, particularly in sheltered areas. The decomposing organic material alters sediment chemistry and alienates benthic communities. Larger amounts of decomposing material can also create an oxygen debt, which starves the benthic species of the oxygen they require.
- Natural wood products also contain resin acids that leach into waters and over time can concentrate to toxic levels in sediments and organisms.

Considerations – Things to Find Out

Need: Are there alternative, feasible methods of storing or handling logs at the site?

Assess the impacts: Determine the type of shore and benthic substrate being affected; identify biological resources and habitats; determine sediment transport processes in and around the site; etc.

Provincial lease or licence: The province has jurisdiction over foreshore and inland waters; a lease, licence or permit to use these areas must be obtained from Land and Water British Columbia Inc. (LWBC). Depending on the size and extent of your log supply, you may have to provide a Log Handling and Storage Prospectus. You might also have to get the upland owner's consent if the log storage affects access to deep water. You may also need guarantees of performance and clean-up. Contact the local LWBC office *or visit their website* for details.

Federal approval: Log storage in water that harms fish habitat will also require authorization under the federal *Fisheries Act*. The storage site will also be reviewed for any hazard to navigation, under the *Navigable Waters Protection Act*. Contact the local Fisheries and Oceans Canada office.

Local government approval: You may need zoning or development permits. Check with the applicable municipality or regional district.

Port, harbour or estuary management: Many ports, harbours and estuaries in developed areas have specific plans in place. These plans often identify areas where log storage may not cause significant environmental impacts and therefore be most appropriate. Contact the local port authority or DFO.

Obtain professional assistance: A qualified professional can assist in assessing the coastal resources and processes associated with the site and its surrounding area. The professional can help in developing the site plan, and in determining how to meet all applicable regulations.

For More Information

- The Fraser River Estuary Management Program (FREMP) has developed Log Storage Guidelines. For details, contact FREMP at Suite 501, 5945 Kathleen Avenue, Burnaby B.C., V5H 4J7; Telephone: 604.775.5756, or *through their website*.
- *Guidebook: Best Environmentally Sustainable Management Practices for Log Handling Facilities in B.C.*: Available on the *BC Stewardship Centre website*.

Fisheries and Oceans Canada

Marine log storage is a significant issue in many large coastal estuaries. Storage areas shade benthic vegetation, cause abrasion of bottom-dwelling communities, deposit debris on the bottom and rob the sediment and water of oxygen as the debris decomposes.

Fisheries and Oceans Canada

A floating ramp rises and falls with the tide. This reduces bottom scour and the velocity at which the logs hit the water, which in turn lessens the amount of bark debris and loose limbs generated by the logs.

Fisheries and Oceans Canada

A "sea rake" skims the water and collects bark debris and loose branches before they can sink to the bottom.

Fisheries and Oceans Canada

By using heli-yarding as a method of log transport, logs are carried directly to barges without any water transport at all.

Logging, with care

The Lax Kw'alaams Nation has reactivated an old log dump in Stumaun Bay, north of Prince Rupert, but is operating it with care for the environment. There is an important herring spawn area less than 500 m from the dump, so all log handling activities cease during the spawning period. No wood storage is allowed in the bay, and the barges come in and out only on the high tide, to avoid any benthic damage to the sea floor. There has been no impact to the intertidal habitat, said a pleased Fisheries officer.

Another north coast lumber company has re-evaluated and modified its log handling practices to avoid the benthic impact caused when the logs thundered down a steep skid into the water. Its delivery ramp now floats and the logs are put into the water at high tide when the skid slope is less steep. The logs no longer hit the water at a high velocity, dislodging bark and breaking off branches. This has reduced the amount of debris generated. The company is also using a boom boat with a sea rake or trash screen welded on the front that collects all branches and bark before they can sink. These are deposited on shore for disposal. The company is also working to restore fish habitat, building reefs and providing other habitat for displaced nearshore benthic organisms.

Finfish Aquaculture

The provincial and federal governments regulate aquaculture. The province regulates the location of farms by providing tenure for finfish cultivation on Crown foreshore and inland waters. It also monitors aquaculture operations, making sure they comply with the *Waste Management Act*. DFO is responsible for ensuring that fish habitat and wild fish stocks are protected under the *Fisheries Act*. In 1984 there were 50 companies operating fish farms: now there are 12, owned primarily by multi-national firms.

Environmentally sound management of these facilities depends on finding an appropriate location and having responsible operating practices. Although this has not always been the case, the finfish aquaculture industry now is subject to regulations on location, as well as regulations aimed at reducing potential environmental impacts.

What Can Happen

- Pollution: A major concern is the pollution caused by leftover fish food and wastes from the fish in netpens. These wastes can accumulate on the bottom. They smother habitat and affect sediment and water quality. Other potential pollutants include blood or wastes from fish harvested and processed on site.
- Antibiotics: The use of medicated feed may introduce antibiotics into the environment. There is some concern that this may lead to antibiotic-resistant species.
- Escapes: The use of an introduced species (Atlantic salmon), with their potential for their escape, could lead to competition for food and habitat with native Pacific species. There is also a risk of genetic dilution from escaping pen-reared Chinook.
- Disease spread: Disease and parasites, including sea lice, may spread from farm fish to migrating or local native salmon.
- Predator control: Fish farms attract such potential predators as seals, sea lions, River otters, Great blue herons and some seabirds. Measures to control predator attacks may displace these creatures from key habitat areas, with accompanying declines in local or coastal populations.
- Nuisance factor: Neighbouring upland property owners may find fish farms reduce access to their waterfront, create too much noise and illumination, or are unsightly.

Clive Lance

Finfish aquaculture is a growing industry on the British Columbia coast. Atlantic salmon (a non-native species) accounts for about 65 percent of B.C. production, with the remainder being Pacific species, primarily Chinook and Coho salmon.

Considerations – Things to Find Out

Location: There are rules about where you can establish a finfish farm; contact Land and Water British Columbia Inc. (LWBC) for the latest information *visit their website*.

Provincial approval: The province has jurisdiction over foreshore and inland waters. You must get a licence to use these areas from Land and Water British Columbia Inc. (LWBC). A five-year licence of occupation is issued until the site is determined to be viable; then a longer- term lease can be obtained. Contact the local office of LWBC or *visit their website*.

Aquaculture operations must be licensed under the Aquaculture Regulation of the provincial *Fisheries Act*; contact the *Ministry of Agriculture, Food and Fisheries* for details.

Federal approval: A fish farm that harmfully alters, disrupts or destroys fish habitat will also require authorization under the federal *Fisheries Act*. It is also illegal to deposit a deleterious substance in fish-bearing waters under the federal *Fisheries Act.* All sites will also be reviewed for any hazard to navigation, under the *Navigable Waters Protection Act*. Where any federal legislation or regulation applies, the project will also require a CEAA screening. Contact the local Fisheries and Oceans Canada office.

Escape prevention: The provincial government amended its Aquaculture Regulation in April 2002 to require more stringent escape prevention controls. Contact the *Ministry of Agriculture, Food and Fisheries (MAFF)* or visit its website.

Pollution prevention: The Ministry of Water, Land and Air Protection (MWLAP) is responsible for protecting the marine environment and fish and wildlife species and administers the Aquaculture Waste Control Regulation under the *Waste Management Act* which is available *on their website*.

The regulation addresses fish feed usage, waste disposal (including sewage), application of therapeutics, fish kills, spills and any events of potential contamination. Contact MWLAP's Vancouver Island Region office for further details. The federal *Fisheries Act* also prohibits the deposit of deleterious substances to fish-bearing waters. Noncompliance can result in criminal charges and a hefty fine.

Professional assistance: A qualified professional can assist in assessing coastal resources and processes, developing site plans that achieve objectives while minimizing impacts, finding options that deliver the project more effectively, and meeting applicable regulations.

For More Information

- All three agencies – *DFO, MWLAP and MAFF* – have extensive information related to finfish farming. Visit their websites.

Shellfish Aquaculture

Like finfish farming, shellfish aquaculture is regulated jointly by the provincial and federal government, but the province does most of the administrative activity. Land and Water British Columbia Inc. (LWBC) regulates the location of aquaculture sites by providing tenure on Crown foreshore and inland waters. The Ministry of Agriculture, Food and Fisheries (MAFF) licenses aquaculture operations and is developing a Code of Practice (see below) for the industry. The Ministry of Water, Land and Air Protection (MWLAP) monitors and regulates environmental impacts and waste generation from these operations. The federal Department of Fisheries and Oceans (DFO) reviews projects to prevent infractions to the federal *Fisheries Act* associated with destruction of natural fish habitat. The federal *Navigable Waters Protection Act* also regulates any effects that fish farms have on navigation so you may also need a federal permit.

Environmentally sound management of these facilities depends on finding an appropriate location and having responsible operating practices.

What Can Happen

Concerns that have been raised about the shellfish culture industry include:

- Habitat displacement: Intensive shellfish cultivation may occur in sites that are vital habitats for other marine populations, displacing or destroying native plant communities and animal or fish populations.
- Predator control: Shellfish culture can attract potential predators, such as River otters, seastars and some seabirds (e.g. Scoter species). Measures to control predation may displace these creatures from key habitat areas or eliminate local populations.
- Nuisance factor: Neighbouring upland property owners may find shellfish farms reduce access to their waterfront, create noise or too much illumination, or are unsightly.

Considerations – Things to Find Out

Location: There are rules covering the location of shellfish farms; contact LWBC for the latest information.

Provincial approval: The province has jurisdiction over foreshore and inland waters; a lease, licence or permit to use these areas must be obtained from LWBC. A number of special requirements must be met in applying for a shellfish tenure. You must submit a detailed management plan and show proof of consultation with neighbouring upland owners and leaseholders. Contact the local office of LWBC or visit its website. Shellfish culture operations must be licensed under the Aquaculture Regulation of the provincial *Fisheries Act*; contact the *Ministry of Agriculture, Food and Fisheries* for details. Other regulations under this Act also apply to wild oyster harvest and oyster culture; again, check with the MAFF

Federal approval: A shellfish operation that can harm native fish or shellfish habitat will also require authorization under the federal *Fisheries Act*. The site will also be reviewed for any hazard to navigation, under the *Navigable Waters Protection Act*. Contact the local Fisheries and Oceans Canada office.

Professional assistance: A qualified professional can assist in assessing coastal resources and processes, developing site plans that achieve objectives while minimizing impacts, finding options that deliver the project more effectively, and meeting applicable regulations.

Best management practices: Codes of practice have been developed by MAFF; see below.

For More Information

- The provincial Ministry of Agriculture, Food and Fisheries (MAFF) is developing a Code of Practice for shellfish aquaculture. Compliance with the Code will set the standard for shellfish aquaculture operations in B.C. A copy of the draft Code of Practice and information on its review can be obtained from MAFF or *from its website.*

Shellfish aquaculture is defined as the commercial seeding, growing and harvesting of marine molluscs, bivalves and other invertebrates in a natural or manufactured environment. The primary types grown are oysters and clams.

David Suzuki Foundation

Coastal Living

Managing Use of the Shore

The previous section focused on "development" – when structures are being planned, designed and constructed. This section focuses on "maintenance" – good stewardship practices when living on, using or managing coastal property. It provides a synopsis of coastal use and management issues that may result in harmful impacts, and suggests what to do to avoid or to deal with problems.

Harriet Rueggeberg

The three basic messages from the discussion on development– "don't disrupt, don't harden, don't pollute" – apply equally to coastal management. The way we live on and manage our coastal property can shape the shore - positively and negatively. Through stewardship practices, education and monitoring, individuals and organizations can maintain the natural shore systems.

But stewardship involves more than education, enhancement and restoration. It demands a change of attitude, the understanding that we all can make a difference.

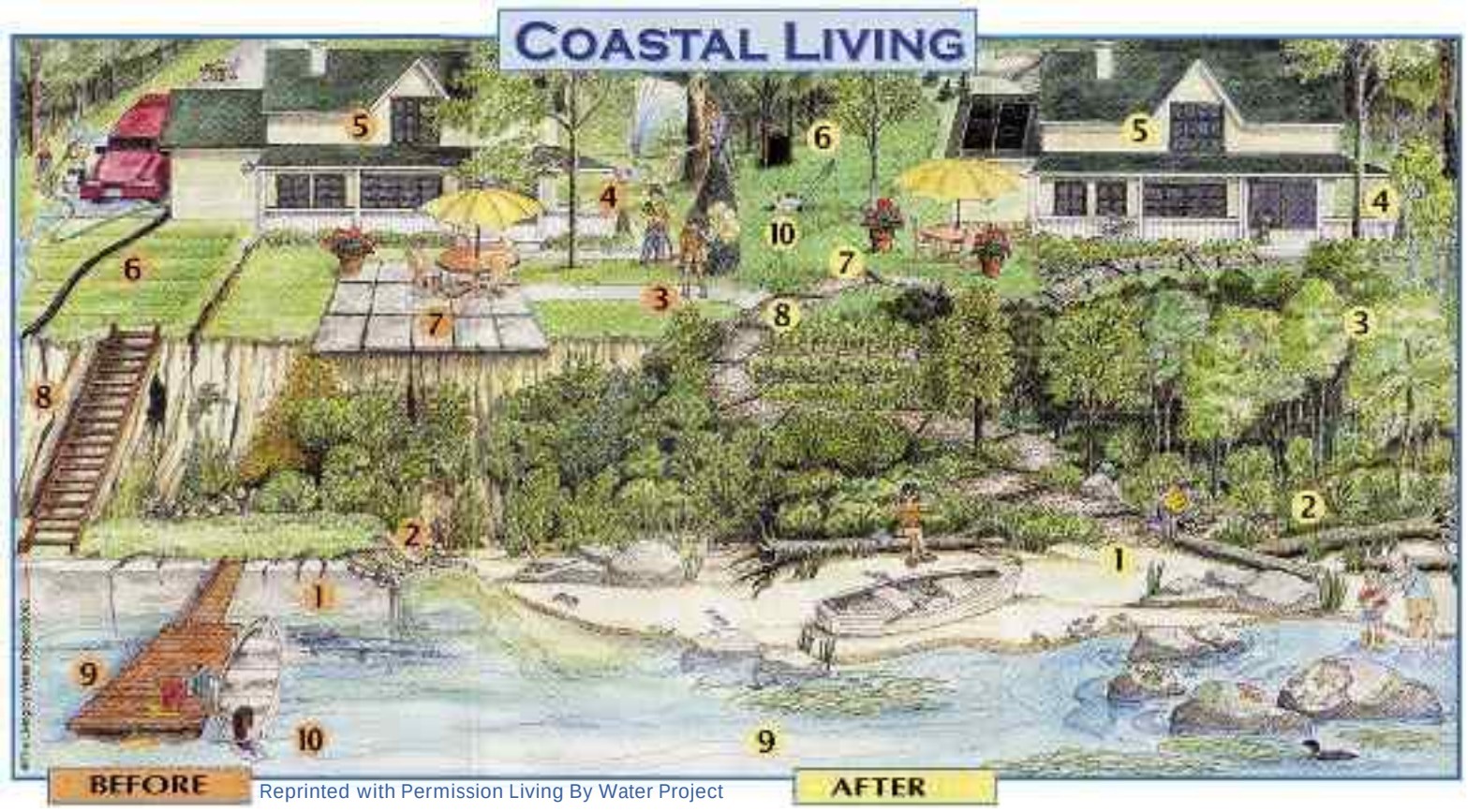
As the immediate neighbour to the shore, landowners may be the most clearly affected by coastal changes. They are also likely to be the first to notice them. Their connection to the shore suggests a special responsibility to act with care and caution, respecting not only their own property, but also their neighbour's. Because of their ability to notice and to take action quickly, local landowners may be in the best position to act as local stewards of our shores.

One of the greatest social values associated with the shore is recreation. Beaches are treasured for swimming, playing and socializing. On rockier coastlines, we enjoy tide pools. Scuba diving is a popular activity. In estuaries, bird and nature watching are primary activities.

But shores aren't just for fun. They are vital for sustaining life. A recent scientific study indicates that the economic value of wild ecosystems far outweighs the value of converting these areas to other uses (*Science,* Aug 9, 2002).

As well as providing recreation, coastal areas regulate our climate, treat our wastes, support transportation, feed us, provide storm and flood protection and attract tourists. Paying for these "free" services would cost us billions of dollars. But unfortunately, we often ignore these unaudited benefits while making short-term economic gains at the expense of long-term preservation of our environment. When we ignore the value of nature's services, we are "cooking the books."

Sustaining the shore and its intrinsic features is essential to our social, economic and environmental well being.



Reprinted with Permission Living By Water Project

1. Hardened shorelines accelerate erosion, eliminate the shoreline's "filtering" ability, degrade habitat.
2. Removal or rearrangement of natural debris leaves your shoreline vulnerable to erosion.
3. Chemical fertilizers and pesticides reduce water quality, are deadly for fish and other wildlife.
4. Cleared "manicured" lots lack shade and privacy. Loss of native plants leads to more erosion, runoff and work for you!
5. Harmful household chemicals and cleaners damage septic systems and degrade water quality.
6. Malfunctioning septic systems and improper waste disposal degrade water quality, can lead to beach closures for swimming and shellfish harvesting.
7. Runoff flows over solid surfaces, accelerating erosion; excess silt degrades habitat for fish and other aquatic critters.
8. Inappropriate beach access, such as steep stairs, destabilizes banks and leads to increased erosion.
9. Private docks, piers and boat ramps destroy eelgrass beds and habitat for fish and other wildlife.
10. Poorly maintained engines leak oils and other petroleum products and waste 25-40% of fuel.

1. Work with an expert to "soften" your shoreline; improve erosion protection with native trees, shrubs, grasses and beach logs.
2. Resist the urge to "tidy up"; let organic debris like beach logs and fallen trees act as a natural seawall.
3. Landscape with low maintenance native plants. Mow lawns high using a mulching mower.
4. Prune trees, rather than removing. Plant native trees and shrubs to reduce erosion and absorb runoff.
5. Use environmentally friendly products and cleaners, or alternatives like baking soda and vinegar.
6. Repair and maintain your septic system (consult an expert). Compost house and yard waste.
7. Reduce solid surfaces and porous materials. Redirect gutter runoff into porous or vegetated areas, away from shore.
8. Share beach access with neighbours, maintaining a narrow winding trail. Avoid accessing steep banks.
9. Use public docks and boat launches where possible; consider replacing your dock with a low impact private access option (e.g. a mooring buoy).
10. Use a well-maintained electric or push mower, and a 4 or 2-stroke boat motor that meets or betters EPA 2006 guidelines.

Give your Shoreline a Make-over!

Issues around Coastal Living

The following table provides a quick review of the main issues associated with living and enjoying the marine shore, and where to look for more detailed guidance on how to live with nature and ensure our activities do no harm.

Issues	Some Things To Do	Resources (See next section for details)
Foreshore care What happens on the beach can affect us all	• Clean up human garbage, but leave logs and natural debris alone unless they threaten your property. Logs washed up by high tides and storms play a vital role in stabilizing the backshore and providing a base for vegetation to establish. • Don't dump or burn garden waste on the beach for the ocean to "take care of." It's unsightly – and if everyone did the same, we'd soon exceed the coast's capacity to absorb it. • Keep fire pits off the intertidal zone – they kill the marine life under and immediately around the area. Use established ones, and share with a neighbour.	*On the Living Edge* *Caring for Our Shores*
Shore vegetation Shore vegetation plays a vital role in stabilizing shores, filtering out excess nutrients and contaminants and providing shade and habitat.	• Resist the urge to cut and mow right to the shore edge! Retain a healthy buffer of native vegetation - tall grasses, shrubs and trees. A width of 15-30 m is ideal, but every bit helps. • Prune trees and shrubs rather than remove them, to open up your frame of view. • Remove only "invasive" plants that choke out native species. • In the upland area, practice good lawn and yard care – leave grass clippings or compost them, don't use fertilizers, herbicides and pesticides. Use biological control agents or eco-friendly products instead. Water only as needed. Try xeriscaping, which minimizes the need for watering.	*On the Living Edge* *Caring for Our Shores* *Shoreline Structures Environmental Design* *Washington State Department of Ecology*
Shore erosion There are many ways to limit or avoid losing your shore.	• Help nature do its job in preventing erosion. Leave logs along the shoreline and retain natural vegetation. Plant additional native grasses, shrubs and trees that will help hold the soil and support the shore. • When planting alone is not enough, try "bio-engineering" approaches that use such natural materials as logs, live stakes and brush bundles called wattles. • Where erosion is severe, more radical measures may be needed. Consult a coastal professional before spending money on shore structures. If you have to reinforce with riprap, be sure that the slope is at least 1:2 (vertical: horizontal) and plant deep-rooted vegetation species above and behind the rock to fill the voids and increase its effectiveness and life span. • Stay away from gabions or vertical retaining walls, if possible. They often deflect wave energy rather than dissipate it, simply moving the erosion problem elsewhere.	*On the Living Edge* *Caring for Our Shores* *DFO Marine Guide to Preventing Shoreline Erosion* *Washington State Department of Ecology*

Steep bluffs and slopes

Rocky bluffs rarely pose a problem, but steep slopes of loose soils, clays or soft, sedimentary rock may be prone to erosion, sloughing or sliding.

- If you're concerned about the stability of your slope, seek the advice of a geotechnical specialist.
- Avoid adding weight-bearing structures (buildings, stairways, parking or storage areas) close to the edge of bluffs or banks.
- Don't dump rocks, leaves or garden debris over the edge of a bluff in hopes of stabilizing the surface. Often the added weight simply aggravates a problem.
- Prune rather than cut trees to improve the view or to build a trail or stairway. Tree removal on a susceptible slope should be done only with advice of a geotechnical expert who can gauge whether certain trees are stabilizing or destabilizing a slope.

On the Living Edge

Washington State Dept. of Ecology

Surface runoff

Roof and surface drainage can be a benefit or a hazard to a shore property.

- Evaluate natural drainage patterns and avoid obstructing the drainage route.
- Minimize paved and other hard, impervious surfaces – these can accelerate surface flows that contribute to erosion. Use gravel or paving stones that allow water to seep into the soil.
- Direct roof gutter, and other runoff to gravel or areas where soil won't become satuated and erode; never discharge at or over the top of a bluff or bank.

On the Living Edge

Caring for Our Shores

Washington State Dept. of Ecology

Septic Systems

Protect the water quality along the coast and save dollars.

- Locate septic fields as far from the shore as possible. Slope the field to direct drainage away from the shore.
- Minimize the amount of water flowing into the septic system. This allows it to work most efficiently without overloading the tank or drain field.
- Pump the tank regularly – every one to three years, depending on use.
- Avoid septic additives, and never pour caustic cleaners and chemicals into the system; they only kill the helpful bacteria in the tank and field.

On the Living Edge

Caring for Our Shores

Septic System Maintenance: Pure and Simple

Pollutants

Controlling what goes on the land and down the drain goes a long way to protecting healthy shores.

- Don't ever flush paints, thinners, and oil and petroleum products into a ditch, stream or storm drain. One way or another, they end up in coastal waters.
- Go easy on fertilizers and avoid using herbicides and pesticides on lawns and gardens; they end up in surface runoff and eventually in coastal waters.
- Avoid harsh chemicals such as solvents, bleach or caustic cleaners at home, on the dock or in the boat. Be especially careful in handling fuel, paints and other chemicals on docks and boats. Check out the guides described above for alternatives that are not toxic to aquatic life. There are many new environmentally sensitive and biodegradable cleaners and products, usually found in stores that sell natural or organic products. If you can't find them locally, ask your retailer to bring them in.

On the Living Edge

Caring for Our Shores

Guide to Green Boating

Protecting the Aquatic Environment

DFO Marine Guide to Preventing Shoreline Erosion

Best Management Practices (BMPs) for Marinas and Small Boatyards in British Columbia

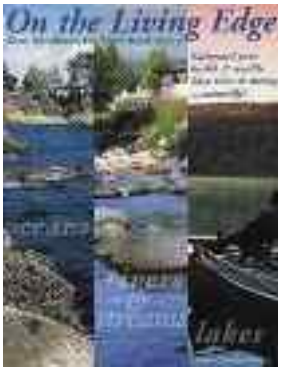
Issues	Some Things To Do	Resources (See next section for details)
Access You can avoid harm to the shore, while enhancing its beauty and enjoyment, if you choose your access route carefully.	~ Focus access points to just one or two hardy spots, to protect the rest of the shore from damage and trampling. ~ Avoid trail proliferation, such as spur trials or multiple access routes to the same area. Consider revegetating all but the one that can best handle increased foot traffic. ~ When building a trail on steep slopes, keep it narrow, choose "soft" surfaced soil, mulch or gravel rather than concrete or pavement and use gently angled switchbacks to reduce the risk of erosion. Minimize cutting into the bank. ~ Put stairs on pilings rather than cinching them to stumps and trees. Avoid cutting into the bank except to pour or install pilings. ~ On very steep slopes that may be destabilized by a trail or stairs, look for alternatives – like sharing with a neighbour whose property is less hazardous.	*On the Living Edge* *Access Near Aquatic Areas*
Docks, ramps, and floats Getting your boat to the water can also affect the shore.	~ See pages 65 and 66 of this guide for information on planning, designing and building docks. Perhaps there is an alternative to building a personal dock that requires a lot of maintenance and upkeep. ~ Don't use designs that require fill or dredging; docks should protect habitat and allow the free flow of water beneath them. Some ramps may be useable only at certain tides. ~ If you buy a property with a dock, ensure it has a lease or licence of occupation from the province and that it is transferred to you. ~ Maintain your dock using environmentally friendly products - check out the guides listed here for ideas.	*On the Living Edge* *Marine Guide to Small Boat Launches* *Marine Guide to Small Boat Moorage* *Shoreline Structures Environmental Design* *The Dock Primer* *Best Management Practices (BMPs) for Marinas and Small Boatyards in British Columbia*
Recreation Careful boating, camping and other recreational uses of the shore can avoid pollution, erosion and disturbance of wildlife and habitat.	~ Observe whales, sea lions, seals, otters and marine birds from a distance — avoid going too close to their haul outs and rookeries; do not feed, chase or harass them. Slow down and reduce your wake/wash and noise levels. ~ Do not disturb wildlife in estuaries or wetlands, avoid walking on vegetation in wetlands, and do not discharge any sewage, grey water or bilge near estuaries and coastal wetlands. ~ Respect shellfish growing sites - they may be someone's livelihood. (Look for stakes or cement blocks and signs marking shore based leases.) Do not remove shellfish, growing bags and other related structures from the water or the shore, don't discharge wastes from your boat near aquaculture sites, and watch your pets. ~ Don't overharvest any marine resources, including seaweed, as this can eliminate important habitats and cause populations to crash to below sustainable levels.	*Caring for Our Shores* *Guide to Green Boating* *Protecting the Aquatic Environment*

Stewardship Resources

Many excellent resources can help you learn how to live and work in harmony with the shore, whether you are an owner, planner, developer, regulator, or property manager.

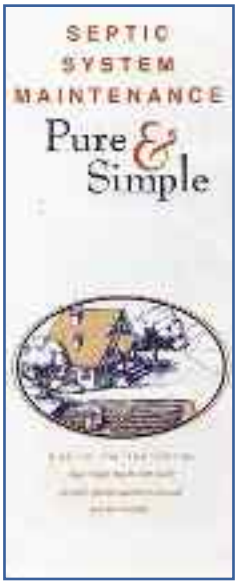
On the Living Edge: Your Handbook for Waterfront Living

On the Living Edge is a recent publication of the Living by Water Project (LWP). Focusing on shores of all types, the Project provides programs, services and materials to promote the value of keeping these shores healthy. Its emphasis is on what all of us can do to help care for our shores. On the Living Edge is written by and for waterfront residents, providing practical information for enjoying and protecting their natural surroundings and investments. For a copy of On the Living Edge, contact the *Living by Water Project*.



Septic Systems

Septic System Maintenance: Pure and Simple provides a simple, step-by-step guide for homeowners on septic system maintenance and trouble-shooting. Published by Environment Canada, it can be obtained from *the Simon Fraser University website.*



Caring for Our Shores handbook

This booklet advises coastal landowners in the Strait of Georgia on how to conserve the marine environment. Beginning with an introduction to marine life and habitats, it addresses various aspects of "living on the ocean." It covers mapping and monitoring the shore, and legal rights and responsibilities. Copies are available from the *Cowichan Community Land Trust Society* and the *Marine Ecology Station in Sidney*.

Washington State Department of Ecology

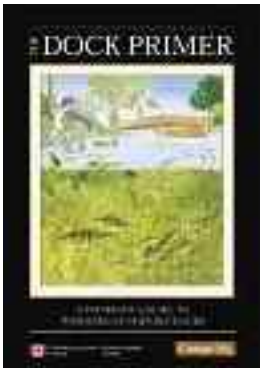
This agency has a series of useful web-based guides for landowners living on coastal bluffs:

- Slope Stabilization and Erosion Control Using Vegetation: A Manual of Practice for Coastal Property Owners.
- Vegetation Management: A Guide for Puget Sound Bluff Property Owners.
- Surface Water and Groundwater on Coastal Bluffs: A Guide for Puget Sound Property Owners.

For more information *visit their website*.

Dock Building

The Dock Primer, published by Fisheries and Oceans Canada and Cottage Life, is a cottagers' and homeowner's guide to waterfront-friendly dock construction and maintenance. It's based on the premise that a dock has to work in harmony with the natural shoreline and with the ways that landowners wish to use the shoreline. It's available *online from Fisheries and Oceans Canada.*



DFO Marine Guides

FACTSHEET

The Habitat and Enhancement Branch of Fisheries and Oceans Canada has published a series of "fact sheets" on marine activities, including:

- Marine Guide to Preventing Shoreline Erosion
- Marine Guide to Small Boat Launches
- Marine Guide to Small Boat Moorage

These guides briefly describe impacts to marine ecosystems, project considerations and regulatory requirements. Contact the local DFO office or download them from the *Pacific Region's website*.

Shoreline Structures Environmental Design

This extensive reference describes the structure and function of major nearshore and estuarine habitats, the regulatory review procedures associated with marine projects and environmental design criteria for piers, wharves, dikes and other structures. It also discusses marine plant restoration in detail. Copies are available from Fisheries and Oceans Canada and Environment Canada or on the *B.C. Stewardship Centre website.*

Be Whale Wise

This brochure provides guidelines for wise and careful marine wildlife viewing in order to minimize our impact on aquatic wildlife while permitting us to observe them in their natural environment

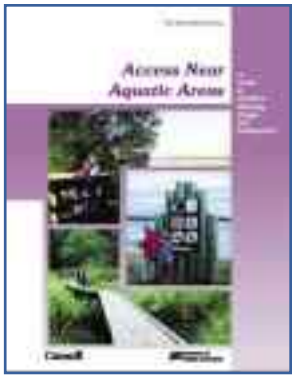
It is availble through The *Whale Museum website*.

Protecting the Aquatic Environment

The Coast Guard also has a guide to help boaters preserve the marine heritage that they enjoy. It covers a range of topics about boating and wise use of the sea. Contact the Office of Boating Safety, or *visit the website* to download a copy.

Managing Trails and Accesses

Another in the Stewardship Series, *Access Near Aquatic Areas: a Guide to Sensitive Planning, Design and Management* is applicable to freshwater, marine and estuarine environments. Its main audiences are parks planners and maintenance staff, landscape architects, consultants and community conservation groups. It is available at the *BC Stewardship Centre website*.



Guide to Green Boating

The Georgia Strait Alliance's award-winning Green Boating Program helps boaters, clubs and marinas keep our coastal waters clean and enjoyable. The 16-page Guide to Green Boating is full of useful information and tips about environmentally friendly boat maintenance and use. Contact the Alliance for a copy or download it *from the website*.

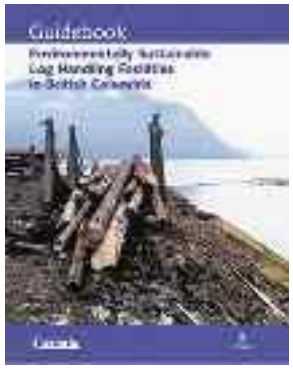
BMPs for Marinas and Small Boatyards

Best Management Practices (BMPs) for Marinas and Small Boatyards in British Columbia, a 1995 report prepared by PCA Consultants Ltd. for the Fraser River Action Plan, is aimed at all facilities where ship or boat building and repair activities are conducted near water. Waste minimization and the 3R's (recovery, recycle and reuse) are emphasized throughout the BMPs. It can be viewed *online.*

Guidebook: Environmentally Sustainable Log Handling Facifities in British Columbia

This guidebook is intended to assist proponents and regulatory agency staff to ensure compliance of log handling operations with environmental legislation. It provides information on application procedures, defines critical, important and marginal fish habitat and outlines a variety of best management practices for log handling in the aquatic environment.

It is available on the *BC Stewardship Centre website.*



Voluntary Stewardship Programs

Many non-profit organizations help to educate the public about coastal stewardship and work with communities and property owners to preserve the natural shorescape. Many groups act as watchdogs or wardens of their local areas, monitoring local conditions, restoring local shores, and organizing clean-up operations.

Programs such as Adopt-a-Beach or Oceans Day are often sponsored by local groups and governments to encourage people to monitor and maintain shores. Some organizations also hold conservation covenants with landowners, allowing them to oversee the resource management of a shore property.

Shorekeepers is a program funded by Fisheries and Oceans Canada. It helps people learn how to monitor physical, chemical and biological changes in coastal areas. *Learn more about it by visiting the Shorekeepers' website.*

You can find out more about stewardship organizations and programs in British Columbia and across the country by visiting the *B.C. Stewardship Centre* or the *Stewardship Canada website*.

Fisheries and Oceans Canada Shorekeepers Guide

Shorekeepers' volunteers survey sites in the Saanich Inlet where habitat restoration and salmon stock re-introduction is planned.

Community Events

There are a number of celebrations that take place in Canada and around the world that relate to coastal stewardship.

Oceans Day was first declared in 1992 during the Earth Summit in Rio de Janeiro. Oceans Day is more than a celebration of the oceans -- it is about learning and doing. Participants learn how the oceans give us life and discuss ways to restore and maintain the oceans' health. The purpose of Oceans Day is to raise public awareness about the role that the ocean plays in daily lives, even for those who live far from coastlines. Oceans Day celebrations are co-coordinated by the *Canadian Wildlife Federation*. For more information visit their website.

The **Great Canadian Shoreline CleanUp** is part of an international effort to help reduce debris in oceans and waterways. In the past 10 years, more than 1.5 million volunteers from 90 countries, including Canada, have participated in the annual International Coastal CleanUp. CleanUps do more than just collect trash: They get communities working together to create solutions to keep our oceans and waterways clean. Data on the types and amounts of debris collected are recorded and forwarded to the Vancouver Aquarium Marine Sciences Centre where the results for Canada are tallied and relayed to the Ocean Conservancy for global processing. *The Vancouver Aquarium organizes the Great Canadian Shoreline CleanUp each September*. For more information email them or visit their website.

At a local level, the communities along the north shore of the Fraser River welcome back the Coho salmon each fall with a **Coho Festival.** The main events take place the first Sunday after Labour Day. Call 604 926 6956 or *visit the website*.

The Brant Festival happens early each April, when the communities of Parksville and Qualicum celebrate the return of the Brant Geese, known as the talkative little sea goose. Art shows, nature walks and other activities help the visitors understand the web of life. For more information you can *visit their website*.

Educational Resources

There are many coastal education/stewardship resources. *The Marine and Aquatic Educator's Resources Guide* *lists most of them* – here is a sample:

- **Beside the Sea** - Produced by Fisheries and Oceans Canada, this package of marine-oriented science activities assists teachers in coastal communities to incorporate learning about the marine environment into their teaching curricula.
- **Once Upon a Seashore: A Curriculum for Grades K-6** by Gloria Snively – This beautifully illustrated resource uses the seashore as a source of inspiration for integrating the subject areas into art, creative writing, drama, music, science, mathematics and social studies. The curriculum focuses on teaching basic ecology concepts: tidal cycle, habitat, predator-prey, food chains, life cycles and, above all, conservation.
- **Beach Explorations: A Curriculum for Grades 5-10** by Gloria Snively – This resource guide helps students understand basic seashore ecology.
- **Salish Sea: A Handbook for Educators** - This is an innovative teaching tool for communicating marine conservation messages to students through the medium of music. The handbook includes a Salish Sea CD, featuring singer-songwriter Holly Arntzen, accompanied by choirs from the Saanich School District.
- **Wild B.C.** - is a B.C. government-sponsored education program seeking to foster appreciation, knowledge and understanding of the natural world in British Columbia. The program provides a collection of high-quality, experiential-learning education resources and programs. For more information *visit their website.*

- **Environmental Educators' Provincial Specialist Association** (EEPSA) - is a provincial specialist association of the B.C. Teachers Federation. In B.C., environmental education has been designated a non-core, integrated element of the school curriculum. Virtually every school subject has connections to environmental education. As a result, the spectrum of teachers and educational organizations involved in environmental education is vast. For more information *visit their website.*
- **Northwest Aquatic and Marine Educators** (NAME) - is a non-profit chapter of the National Marine Educators Association. NAME was founded to give marine and aquatic educators and other professionals a network to share their interest in and dedication to the water environment.
- **Vancouver Aquarium Marine Science Centre** - Besides hosting thousands of visitors each year, the Vancouver Aquarium provides a number of interesting public programs and events and conducts extensive research. For more information *visit their website.*
- **Shorekeepers and Reefkeepers** - is a citizen science program of Fisheries and Oceans Canada that trains volunteers to monitor shores and reefs and provide data to track ecosystem health. For more information *visit their website.*

Non-governmental Organizations

An array of non-governmental organizations can help with understanding the impact of coastal processes and promoting coastal stewardship. Here are a few:

- **Bamfield Marine Sciences Centre** – provides year-round research facilities and technical assistance to scientists from five western Canadian universities and visiting scientists, offers courses for undergraduate and graduate students in marine sciences, and runs a public education program for schools and interested groups of all ages. Its web site has educational material on oceans and marine animals. For more information *visit their website.*
- **Canadian Parks and Wilderness Society** – works to promote the protection of parks and other places of natural significance. For more information *visit their website.*
- **The David Suzuki Foundation** - has a Marine Conservation Program that addresses issues related to the conservation of oceans and marine habitat, sustainable fisheries and aquaculture. For more information *visit their website.*

- **Ducks Unlimited Canada** - aimed at conserving Canadian waterfowl by protecting, enhancing, and restoring and managing important wetlands and associated uplands. For more information *visit their website*
- **Georgia Strait Alliance** - formed to protect and restore the marine environment of the Strait of Georgia. It has been highly successful in promoting awareness of marine pollutants and in lobbying for marine protected areas: (250) 753 3459 or *visit their website*.
- **Islands Trust Fund**- a conservation land trust established through provincial legislation in 1990 and administered by the Islands Trust Board. The fund uses voluntary conservation methods (land donations, conservation covenants (easements), land acquisition, public education, etc.) to help preserve and protect the significant natural and cultural areas and the rural character in the Islands Trust Area. The fund now owns 12 properties and holds 26 conservation covenants. For more information *visit their website.*
- **Living by Water Project** - provides services and products for informing the public about shoreline stewardship. These include workshops, handbooks, videos, shoreline notes, posters, and an activity book on how to become a "shoreline ambassador." For more information *visit their website.*
- **The Living Oceans Society** – is a non-profit research and public education organization committed to conserving marine biological diversity, in order to ensure a healthy ocean and healthy coastal communities. For more information *visit their website*
- **Marine Ecology Station** – is dedicated to the exploration, understanding, and stewardship of Northeast Pacific marine life. The Station is in Sidney B.C., and provides hands-on laboratory and field activities for students of all ages in a unique floating lab. For more information *visit their website.*

John Austin

- **SeaChange Marine Conservation Society** – provides marine education leadership as well as stewardship programs. Students grow eelgrass in a classroom aquarium, monitor its growth, and then plant the young eelgrass: For more information *visit their website.*
- **Veins of Life Watershed Society** – develops education programs on marine mammals and do's and don't for safely watching them in the wild. For more information or for a Whale Wise poster *visit their website.*.

References

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Canadian Wildlife Service

A Season for Stewardship

By Kofi Annan

Action starts with governments. They bear the primary responsibility for fulfilling the commitments they made at the 1992 Earth Summit and since. But the richest countries must lead the way. They have the wealth and the technology, and they contribute disproportionately to global environmental problems. …

Governments cannot do the job alone, however. Citizens' groups have a critical role, as partners, advocates and watchdogs. So do commercial enterprises. I hope corporations understand that the world is not asking them to do something different from their normal business; rather, it is asking them to do their normal business differently…

The choice is not between development and environment… Development that does not sensibly manage the environment will prove short-lived. …One in every two jobs worldwide -- in agriculture, forestry and fisheries -- depends directly on the sustainability of ecosystems.

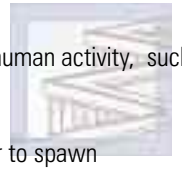
The world today, facing the twin challenges of poverty and pollution, needs to usher in a season of transformation and stewardship -- a season in which we make a long overdue investment in a secure future.

Kofi Annan is the Secretary-General of the United Nations

Glossary

A ACCRETION: Gradual growth of land or beach over a long period of time as natural processes of waves, currents, tides or winds deposit material

ALGAL BLOOM: Unusual growth of small planktonic algae. Blooms may colour the water and affect its taste.



ALTERED SHORES: Shores that have been modified by human activity, such as dredging, or building structures

ANADROMOUS: Migrating from the ocean to freshwater to spawn

AQUACULTURE: The rearing or cultivation of fin fish or shellfish for human consumption, primarily done in the sea but also may occur on land or the intertidal zone

ARCHIPELAGO: A group of islands separated by narrow channels

B BACKSHORE: The area of shore lying between the average high tide level and the vegetation, affected by waves only during severe storms

BASIN: A large watershed area that typically combines the drainage of several rivers and streams. The Georgia Basin is 4,755,671 hectares in size; the Nanaimo River watershed (basin) is 82,051 hectares.

BATHYMETRY: The measurement of the depths of water in the ocean

BEACH: A strip of unconsolidated sand or gravel on the coast line, which is created where wave action deposits sedimentary material

BEDROCK: Solid rock, often underlying looser material

BENCH: Level or gently sloping plain that slopes towards the water

BENTHIC: That part of the sea inhabited by marine organisms that live in or on the bottom

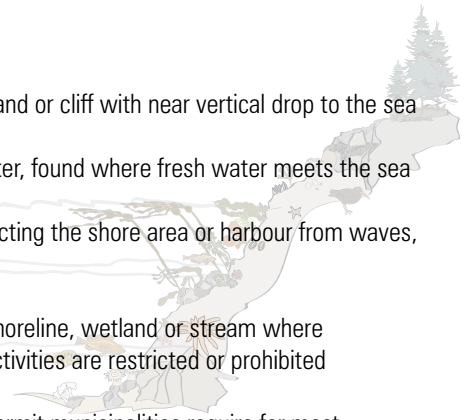
BERM: A terrace or shelf along the top or bottom of a slope. They can be manmade or formed by wave action along the backshore of a beach.

BEST MANAGEMENT PRACTICE (BMP): A recommended method for carrying out an activity so that it has the least impact on the environment: this can include the safest way to build a dock, control flooding, prevent erosion, or prevent algae on your deck.

BIODIVERSITY: The variety of plant and animal species found in a specific habitat, high biodiversity is generally considered a sign of a healthy environment

BIOTIC: Describes the animal and plant life of a specific habitat, and the biological, chemical and physical factors that determine their numbers and distribution

BIVALVES: Molluscs with a hinged shell, usually attached to rock or other structures or found burrowing into sediment



BLUFFS: Steep, prominent headland or cliff with near vertical drop to the sea

BRACKISH: Moderately salty water, found where fresh water meets the sea

BREAKWATER: A structure protecting the shore area or harbour from waves, usually built of rock or concrete

BUFFER: An area adjacent to a shoreline, wetland or stream where development or other harmful activities are restricted or prohibited

BUILDING PERMIT: The type of permit municipalities require for most construction projects.

BULKHEAD: Small low seawall designed to keep land from eroding behind it

C CHANNEL: A natural stream that conveys water or a ditch or other water conveyance structure excavated for the flow of water

COAST: The point where land, ocean and air meet, extending to the limit of the highest tide

CONDUIT: Any channel intended to convey water, whether open or closed

CONSERVATION COVENANT: A voluntary written agreement under the *Land Title Act* made between a landowner and a covenant holder, in which the landowner promises to protect the land as designated in the covenant

CONSERVATION EASEMENT: Voluntary agreements that allow an individual to set aside private property to limit the type or amount of development on their property. Easements relieve property owners of the burden of managing these areas by shifting responsibility to a private organization or government agency better equipped to handle maintenance and monitoring issues.

CONTAMINANTS: Harmful or undesirable substances that pollute the environment

CONTINENTAL DRIFT: The gradual movement of continents

CONTINENTAL SHELF: The section of the sea floor between the beach and where the sea floor starts to slope sharply

COVENANT: In real property law, a promise made by a landowner to do, or not do, something in relation to the land.

CURRENT: Horizontal movement of water

D DAM: A barrier constructed to confine or raise water for storage or diversion

DELTA: Area of deposited sediment, roughly triangular in shape, formed where a river or stream carrying sediment meets a low-energy body of water, such as a n ocean bay

DENSITY BONUS: A land use planning measure that allows more intensive development in exchange for something for the public good, such as a park

DEPOSITION: Accumulation of solid material, carried by and laid down by water

DEPOSITIONAL SHORE: Beaches or sand spits are examples of depositional shores, created by the accumulation of sediment carried in and deposited by water

DEVELOPMENT PERMIT AREAS: Municipalities can designate environmentally sensitive areas and require development permits before any land in those areas can be subdivided, altered or built upon

DIFFRACTION: The process that occurs when sand or water travelling in a straight path bends around an obstacle

DIKE: Any constructed embankment or levee intended to confine or control water; often one built along the banks of a river to prevent flooding of lowlands

DIOXINS: A group of highly toxic chlorinated organic compounds that can travel long distances and bioaccumulate in the fat of humans and wildlife

DISCHARGES: NON-POINT Diffuse pollution source that has no specific point of discharge. It may arise from such activities as agriculture, urban stormwater runoff, car washes, forestry or marine operations .

DISCHARGES: POINT Pollution which comes from a specific source and has a discrete and obvious point of discharge such as a sewage or stormwater pipe or an industrial outfall

DISTURBED AREA: An area in which the natural vegetation or soil cover has been removed or the landform has been altered making it more susceptible to erosion.

DOCK: A manufactured structure that either floats on water or is attached to the land, and is used for mooring boats or for recreation

DRAINAGE: The removal of excess surface water or ground water from land by means of surface or subsurface drains

DRAINAGE AREA (WATERSHED): The land area into which all water, including runoff from surrounding land, drains or discharges to a common point

DREDGING: The act of removing sediment from the sea bottom, usually to accommodate shipping

DUNE: A sandhill, on the landward side of the high tide limit, created by air-borne sand from the beach accumulating above the drift zone

E

ECOSYSTEM: All the living organisms in a biological community, and the chemical and physical factors that affect them

EELGRASS: Underwater marine grass (Zostera marina) with long narrow leaves, that provides ideal habitat for small fish, spawning herring and many other organisms

ENVIRONMENTAL IMPACT ASSESSMENT: The act of judging or evaluating the impact a human action will have on the environment

EROSION: Wearing away of the land surface by running water, wind, ice, or other geological agents, including gravity

ESTUARY: A coastal feature formed when a river or stream meets the sea and where fresh and salt water mix

EUTROPHICATION: The process of over-enrichment of water bodies by the addition of nutrients often typified by the presence of algal blooms

F

FECAL COLIFORM: *Escherichia coli* and similar bacteria that are found in the intestinal tract of humans and animals, the presence of which in water indicates fecal pollution and potentially adverse contamination by disease-causing organisms.

FLOODPLAIN: Areas adjacent to a stream or river that are subject to flooding or inundation during periods of high runoff or severe storms

FLUSHING: The process of water exchange. Areas with strong currents and high waves are flushed more frequently than those with less energetic processes.

FOOTPRINT: The space taken up by a structure that sits on the seabed or on the water surface

FORESHORE: The area of the shore that lies between the high and low water levels and that is flooded twice daily by the tide

G

GABION: A flexible woven-wire basket filled with small stones that may be arranged to form revetments, retaining walls and groynes, to prevent erosion.

GRAVEL: An unconsolidated aggregate consisting of small stones that range in size from 2-60mm in diameter.

GREENWAY: A linked and linear network of trails and accesses that are designed to suit one or a variety of compatible purposes (e.g., conservation of natural or environmentally sensitive areas, passive recreation, wildlife viewing, buffer between competing land uses, etc.)

GREY WATER: Waste water discharges other than sewage that originates from industrial or home sources including cooling water or water from sinks or showers

GROUND COVER: Plants that are low-growing and provide a thick vegetative mat that protects the soil as well as providing some beautification

GROYNE: A wall built perpendicular to the shoreline, intended to trap sand and deflect waves away from the beach. Sediments being carried by longshore drift will accumulate on the forward edge of a groyne and erode on the opposite side of the structure.

H

HABITAT: All parts of the natural environment that support an organism or set of organisms throughout its entire life cycle

HARDENED SHORE: A natural shore that has been altered by the addition of seawalls, riprap, sheet metal or other concrete, rock or "hard" structures

HEAVY METALS: Metals with high molecular weights that are generally toxic to animal life and human health if naturally occurring concentrations are exceeded. Examples include, arsenic, chromium, lead and mercury.

HERBICIDES: Chemicals developed to control or eradicate plants

HHW: High High Water mark, denotes the upper limit of tidal action, and is used to define property boundaries and public right of way

HIGH ENERGY SHORES: A shore exposed to considerable wave and current action

HYDROGRAPHER: A person who specializes in the measurement and description of the physical features of the ocean

I

INFAUNAL: Benthic fauna living in the substrate and especially in a soft sea bottom

INSECTICIDES: Chemicals developed to control or eradicate insects

INTERTIDAL: Similar to foreshore--the shore area bounded by the low low and high high tide levels

INVERTEBRATES: Animals without a backbone

K

KELP: Large blade shaped brown seaweed, (Nerocystis luetkeana) can grow as long as 60 m and provides useful habitat for fish and other marine organisms; has no roots but is anchored by tendrils up to 10 m long, which cling to rock. Gas filled bubbles on fronds act as floats to keep the kelp just below the surface.

L

LEE: The side away from the wind or waves, therefore more sheltered

LEGAL SURVEY: A study to ascertain the physical boundaries of a piece of land, carried out by a licensed surveyor

LOCK-BLOCK: System of interlocking concrete blocks sometimes used for seawalls or other coastal structures

LONGSHORE CURRENT: Current moving parallel to shore

LONGSHORE DRIFT: Sediment transported by wave and currents moving parallel to shore

LOT: A parcel of undivided land.

LOW ENERGY SHORES: Shores that are protected, for example, by an island from current or wave action

M

MEDIUM ENERGY SHORES: Shores with moderate exposure to current and wave action

MICROHABITAT: A small community, such as the space between rocks, that provides the features and functions that small organisms depend on to feed, rest or reproduce

MIGRATORY: Organisms that move from one place to another to complete their life cycle (eg; salmon, many species of waterfowl, marine mammals.)

MOORAGE: A secure place for boats to tie up

MUDFLAT: Gently sloping muddy or sandy bottom coastal area usually covered by water at high tide

N

NEARSHORE: The area of the continental shelf where the waves break. The region of land extending from the backshore to the beginning of the offshore zone.

NUTRIENT: A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Phosphorus and nitrogen, which are contained in fertilizers, are the most common nutrients that contribute to eutrophication.

O

OCP (OFFICIAL COMMUNITY PLAN): A municipal statement of policy on permitted land use

OFFSHORE: Comparatively flat underwater zone that extends from the toe of the steeper shoreface to the edge of the continental shelf

OSMOREGULATORY: Maintaining a constant osmotic pressure in the tissues of living organisms. For anadromous species like salmon osmoregulation allows them to balance the salt or freshwater concentrations both inside and outside their bodies so they can become either freshwater or marine dwelling organisms.

OUTFALL: The point where water flows out of a constructed conduit or drain

OUTLET: The point at which water discharges from a stream, river, lake, tidal basin, channel or drainage area

P

POCKET BEACH: A beach tucked between rocky headlands

PRECIPITATION: Moisture in the form of rain, snow, dew, hail or sleet that returns to earth from the atmosphere through condensation

PREDATION: When one animal preys upon or eats another

PRETREATMENT: Techniques employed in stormwater management to provide storage or filtering to remove coarse materials in effluents before they enter the treatment system

PROTOZOANS: Single celled animals --the bottom of the food chain

R

REFLECTION: A wave that returns seaward when it hits a steep beach or a barrier such as a seawall

REFRACTION: The process by which the direction of the wave changes. The portion of the wave moving in shallower waters slows down, causing the wave crest to bend.

RESIDENTIAL DEVELOPMENT: Land area that has been zoned and subdivided into smaller parcels for the purpose of housing

REVETMENT: Hard, smooth masonry surface used to protect a bank or bluff from erosion

RIPARIAN: The land area that borders a stream or river or other water body that is frequently of inundated.

RIPARIAN AREA: Vegetation zone that separates land from water, consisting of various emergent aquatic plants, as well as grasses, sedges and shrubs that thrive near water

RIPARIAN RIGHTS: In common law, a person who owns land adjacent to water has certain rights to access and use the water. These are known as riparian rights. The landowner also owns any land that occurs through accretion.

RIPRAP: Broken rock, cobbles, or boulders placed on earthen surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water (waves)

RUNOFF: Water originating from rain or melting snow that flows across the ground or other surface before reaching streams, rivers or the ocean

S

SALINITY: Measure of dissolved salt and minerals in water. The open ocean typically has 33 to 38 parts per thousand salinity.

SALT MARSH: Flat poorly drained coastal swamp that is flooded by most high tides

SAND: Loose material made up of particles of rock and shells, usually between .06 and 2 mm in diameter

SCOURING: Result of erosion of bottom sediments, usually by water flowing at high speed

SEAWALL: A freestanding structure, parallel to the shoreline, designed to protect buildings from the sea

SEDIMENT: Solid material, both mineral and organic, that is transported in suspension

SEDIMENTATION: Soil particles suspended in water that settle in stream beds or along the shoreline

SEPTIC FIELD: The on-site disposal of waste water and sewage into a below ground holding tank, the decomposed organic matter from which seeps into surrounding earth

SESSILE: An immobile organism that is attached to the sea floor, or to other substrate

SETBACK: The minimum distance requirement set by a government authority for location of a structure in relation to water bodies, wells, septic fields or other structures.

SHADING: Loss of sunlight caused by vegetative canopies or structures such as a docks, piers or materials such as suspended solids; which affect growth of vegetation and survival of aquatic organisms

SHELLFISH: Molluscs or crustaceans with hard external covering (crab, oyster, prawn, mussel) that are eaten by humans

SHOAL: An offshore shallow sandbank or bar that makes waves begin to curl and break before they reach the shore

SILT: Unconsolidated sediment with particle sizes 0.002-0.06 mm (between clay and sand).

SLUMPING: Slippage or sliding of a mass of unconsolidated sediment down an underwater slope, sometimes triggered by an earthquake

SMOLT: Young silver bright salmon making its first trip to the sea

SPECIES AT RISK: Animal and plant species that are declining or threatened with extinction.

SPIT: Small point of land or long narrow shoal, usually sand, extending like a finger from land into the sea.

STABILIZATION: Providing adequate measures, vegetative and/or structural, that will prevent erosion from occurring.

STAKEHOLDER: Any agency, organization, or individual who has an interest in or will be affected by process or decision

STEWARDSHIP: The act of caring for nature or taking responsibility for the environmentally friendly use of resources: Being a custodian of something we do not own

STORM SURGE: The temporary rise in local sea level caused by a storm, which can lead to flooding and erosion

STORMWATER OUTFALL: A discharge point for stormwater runoff that has been collected in pipes or ditches

STRAIGHTENED SHORES: Human alteration of the shorelines natural curves with structures as retaining walls, bulkheads, berms or dikes

SUBSTANTIAL PERFORMANCE: The point in the construction process when a structure is ready for use or occupancy

SUBSTRATE: The bottom layer or base upon which animals and/or plants live

SWALE: An open drainage channel or depression designed to detain and filter stormwater runoff.

T

TENURE: A condition under which real estate is held or used

TIDES: Change in sea level caused by the gravitational pull of the moon on the earth. There are two high tides and two low tides each day.

TOE (OF SLOPE): The bottom of a slope, where it meets the ground or levels out

TOE WALL: Subsurface portion of the downstream wall of a structure, built to prevent flowing water from eroding under the structure - otherwise known as a cutoff wall

TOPOGRAPHY: The precise detailed mapping of the surface features of a region

TOTAL SUSPENDED SOLIDS: The total amount of particulate matter that is suspended in the water column

TOXICS: Poisonous substances

TOXINS: Poison produced by a living organism. e.g., Escherichia coli (E.coli)

TRANSPORT: In marine terms, transport refers to the movement of sediment. Transport shores may appear stable to an observer but they only look that way because the wave action transports sediment in and out in relatively equal amounts.

TSUNAMI: A huge tidal wave usually generated by an underwater earthquake or volcano

TURBIDITY: Reduced water clarity caused by the presence of suspended sediment such as clay or sand in the water

U

UPLAND: The dryland area above and landward of the ordinary high water mark, and shoreward of the backshore

V

VARIANCE: A special allowance granted to a developer which permits the use of designs that are different from the requirements of the current code

VEGETATION: All the plant life in a particular region (flora) - the root systems of which are naturally useful in preventing erosion

W

WATERSHED: A geographic area of land bounded by the height of land that causes waters to drain to a shared destination. A watershed captures precipitation, filters and stores water, and determines its rate of release. A drainage basin

WATTLE: A bundle of cuttings from live woody material that are tied together with butt ends alternated and tapered. They are planted in shallow trenches, held in place by stakes, and then covered with soil. They are used to re-establish vegetation and prevent erosion.

WAVES: A moving ridge of water usually caused by the wind upon the surface of the ocean, which then curls and breaks on shore

WETLANDS: A low area where the land is saturated with water , often referred to as marsh, swamp, fen, bog

X

XERISCAPING: Landscaping that uses drought-tolerant vegetation instead of turf to reduce the amount of water required to maintain a lawn or flowerbed.

Z

ZONING: A set of regulations and requirements that govern the use, placement, spacing and size of buildings and lots within a specific area. Zoning on the ocean means identifying, permitting and regulating certain areas for certain human activities.

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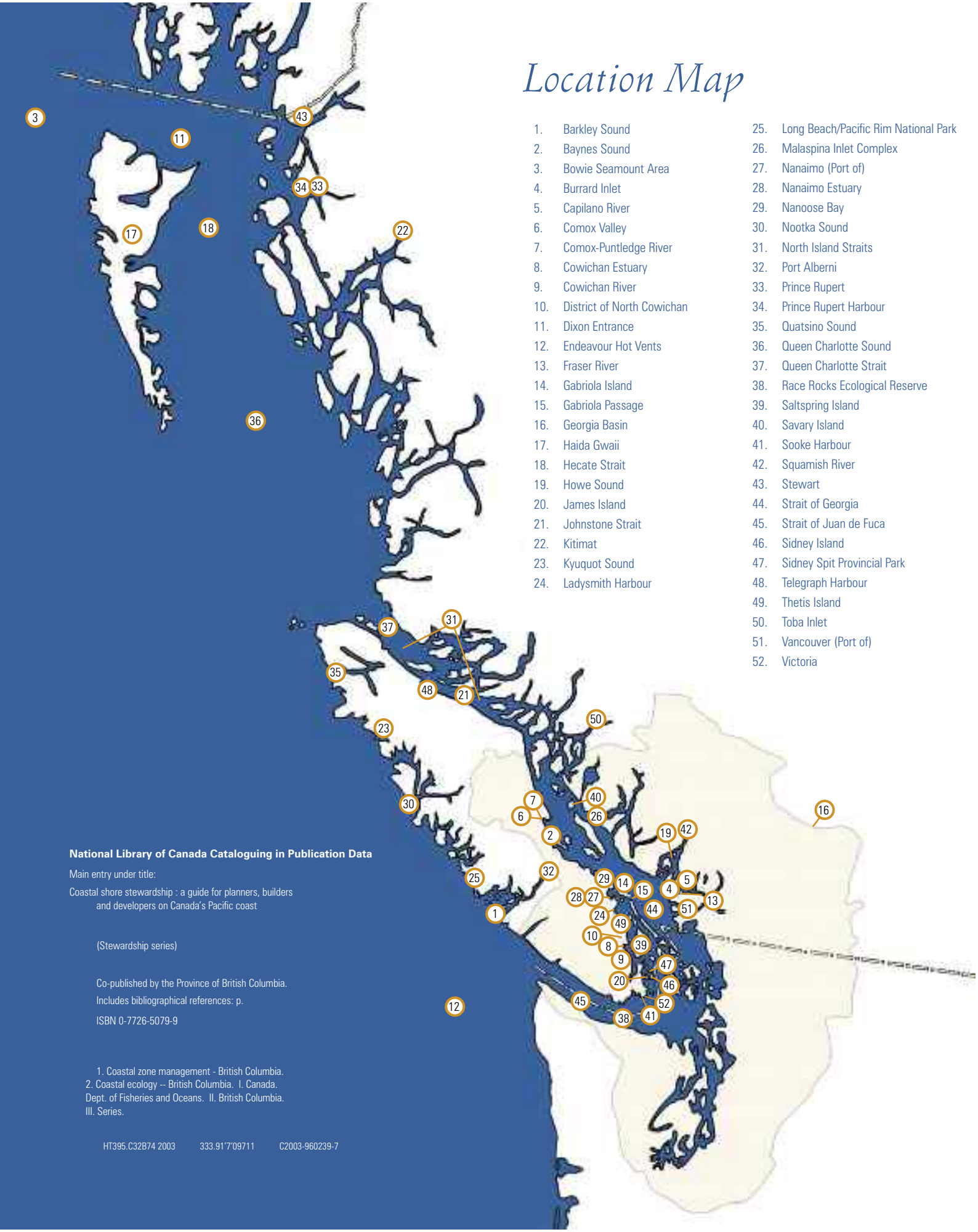
Location Map



1. Barkley Sound
2. Baynes Sound
3. Bowie Seamount Area
4. Burrard Inlet
5. Capilano River
6. Comox Valley
7. Comox-Puntledge River
8. Cowichan Estuary
9. Cowichan River
10. District of North Cowichan
11. Dixon Entrance
12. Endeavour Hot Vents
13. Fraser River
14. Gabriola Island
15. Gabriola Passage
16. Georgia Basin
17. Haida Gwaii
18. Hecate Strait
19. Howe Sound
20. James Island
21. Johnstone Strait
22. Kitimat
23. Kyuquot Sound
24. Ladysmith Harbour
25. Long Beach/Pacific Rim National Park
26. Malaspina Inlet Complex
27. Nanaimo (Port of)
28. Nanaimo Estuary
29. Nanoose Bay
30. Nootka Sound
31. North Island Straits
32. Port Alberni
33. Prince Rupert
34. Prince Rupert Harbour
35. Quatsino Sound
36. Queen Charlotte Sound
37. Queen Charlotte Strait
38. Race Rocks Ecological Reserve
39. Saltspring Island
40. Savary Island
41. Sooke Harbour
42. Squamish River
43. Stewart
44. Strait of Georgia
45. Strait of Juan de Fuca
46. Sidney Island
47. Sidney Spit Provincial Park
48. Telegraph Harbour
49. Thetis Island
50. Toba Inlet
51. Vancouver (Port of)
52. Victoria

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This guide will be helpful if you are:

- Interested in finding out about coastal shore processes,
- Concerned about nearshore water quality, and how it will affect ecosystem health or your recreational use and enjoyment of coastal areas,
- Wondering how a community planning process can protect coastal wetlands and estuaries,
- Interested in finding out more about how federal and provincial agencies are working with local governments and businesses to protect coastal resources,
- Planning a development on or near the shore.

Christy Wilson

Why Should we Care about our Shores?

The purpose of the guide is to:

- Identify some of the pressing concerns related to coastal resource management,
- Provide information about coastal processes, the various habitats types of the shore zone and the species that inhabit them,
- Describe a range of shore types and development sensitivities associated with each,
- Illustrate how local and regional land planning decisions are made and suggest how coastal resources can be protected as part of this process,
- Outline best management practices to guide coastal development and illustrate how coastal developments and activities can be undertaken without destroying fragile coastal processes.