CHAPTER 4 PACIFIC REGION

Introduction

Highly diverse habitats and significant aquatic resources make up the more than 27 000 km of Canada's Pacific coastline. The physical features of the British Columbia (B.C.) coastal zone are also diverse and include over 6500 small islands.

One of the most distinctive oceanographic features is the many fjords or inlets: there are over 60 inlets exceeding 10 km in length, and some are as long as 150 km, mostly located along the mainland coast and the west coast of Vancouver Island. The amount of freshwater that flows into the inlets depends on the topography, the time of year, and whether the river is fed primarily by rainfall or snowmelt. Most Vancouver Island rivers are fed by rainfall and reach peak flows during the rainy winter-spring season. Snowmelt-fed rivers predominantly drain into the larger mainland inlets, with freshwater inputs reaching maximum volumes during the freshet, or snowmelt period, beginning in May. Freshwater runoff flows seaward in a

Figure 4-1 British Columbia

brackish surface layer formed as low-density freshwater mixes with, and entrains, heavier seawater from below. The seaward-flowing surface layer of brackish water is offset by an inflowing layer of high-salinity seawater. This two-layer system, commonly known as estuarine circulation, is a prevalent feature of the B.C. coastal zone. Swift tidal currents are also a ubiquitous feature of the B.C. coast. They play an important role in mixing freshwater and seawater, especially in the many constricted passages, channels and narrows on this coast.

The B.C. coast also has several large straits and sounds: from north to south these are Dixon Entrance, Hecate Strait, Queen Charlotte Sound, the Strait of Georgia and Juan de Fuca Strait. Coastal water structure and circulation are controlled by tides, winds and freshwater from the coastal straits and inlets.

The Strait of Georgia is probably the most socio-economically important region of the province. British Columbia's largest river, the Fraser River, discharges into the southern end of the strait. Its discharge is highly seasonal, peaking with the snowmelt in late May to early June. The freshwater leaves the strait mostly via the southern route, undergoing substantial mixing in the swift tidal outflows (Boundary Passage and Haro Strait) through the Gulf Islands before it proceeds out to the open Pacific Ocean through Juan de Fuca Strait. The northern route is more constricted, mainly through Discovery Passage, then Johnstone Strait and Queen Charlotte Strait.

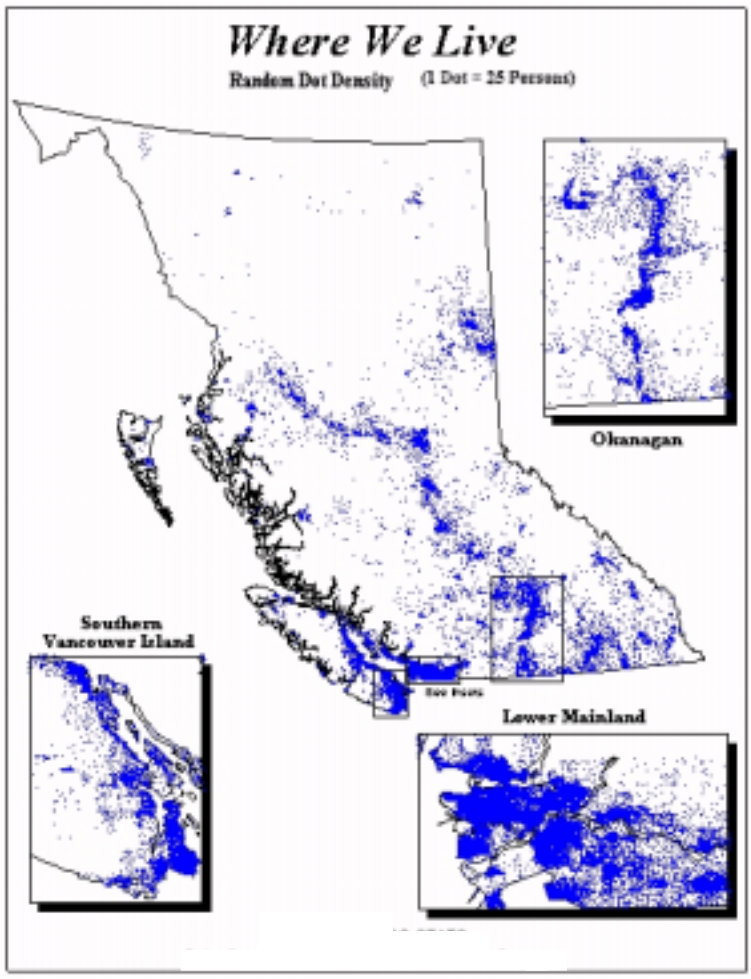
The continental shelf regions of the B.C. coast, like many other shelf regions of the world, support highly productive fisheries. With the exception of the basins of Hecate Strait and Queen Charlotte Sound, the continental shelf is usually not wider than 95 km and typically is much less. Off the west coast of the Queen Charlotte Islands the shelf is almost non-existent.

Approximately 75% of B.C.'s 3.9 million people live within 60 km of the coast (Figure 4-2), and over 70% of the province's economic activity is related to the coastal area. Estuaries are often the location of towns and their associated activities (e.g., pulp, paper and saw mills, marinas, factories). In addition to its economic role, the coast has cultural significance, particularly for Aboriginal peoples.

Although most of B.C.'s coastal population is concentrated in three regional districts at Vancouver, Victoria and Nanaimo, there are opportunities to protect the marine environment from land-based activities all along the coast.

In the Georgia Basin-Puget Sound area (Straits of Georgia and Juan de Fuca, Puget Sound, Figure 4-3), rapid urban growth is a major issue with potentially large impacts on coastal ecosystems, such as the use of shellfish resources. The present population of 6 million in the Basin-Sound area is expected to grow to 9-11 million by 2020. Population growth and associated development have been identified as key challenges to sustainable development.

Figure 4-2 Population Density in British Columbia



(Source: Statistics Canada, 1991 Census; prepared by BC STATS)

4.1 Identification and Assessment of Problems

4.1A Contaminants

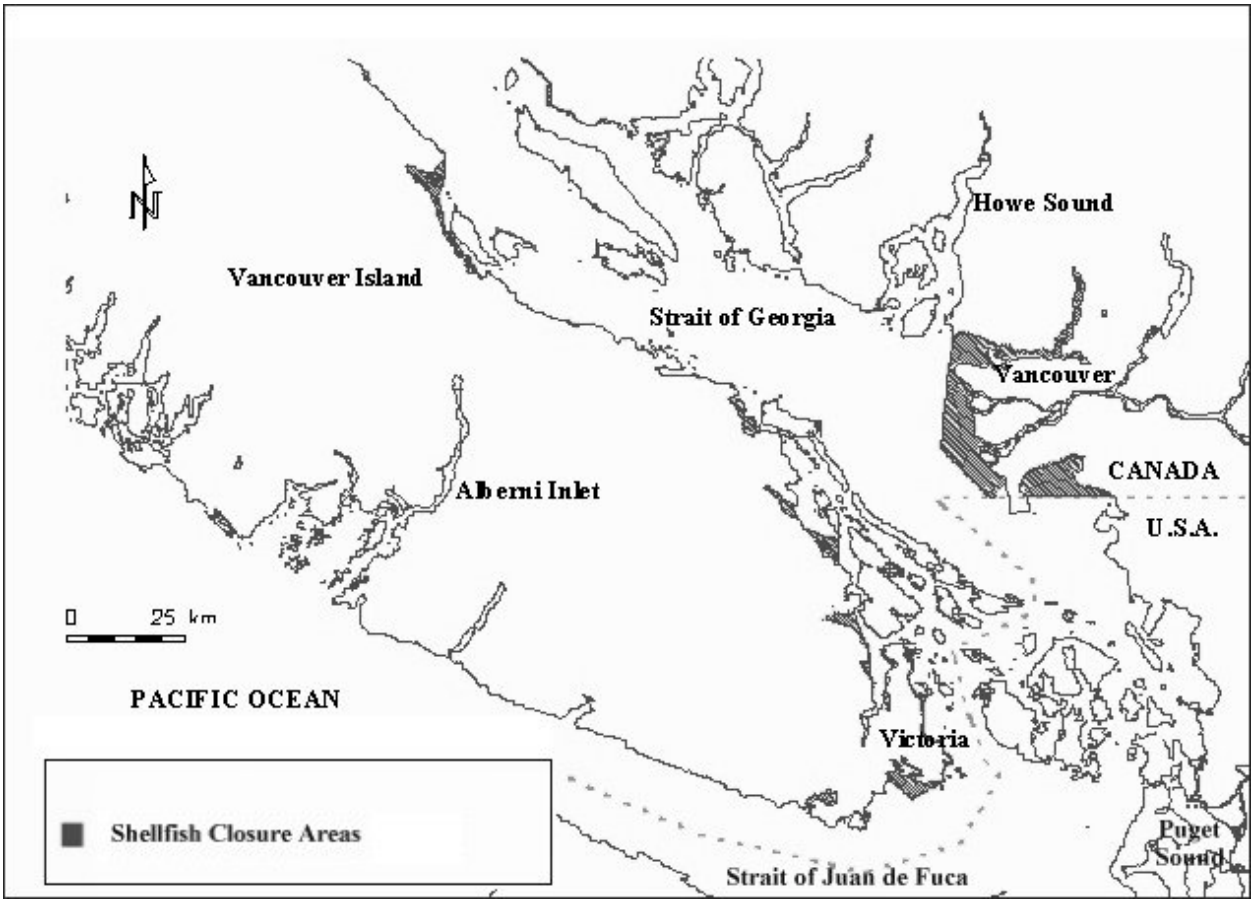
Sewage

On the Pacific coast, bacterial and viral contamination of shellfish is a human health concern. Approximately 25% of the classified shellfish growing area, south of the northernmost end of Vancouver Island, is closed to harvesting of shellfish because of fecal contamination.

There are approximately 180 closure orders in B.C. under the Management of Contaminated Fisheries Regulations pursuant to the Fisheries Act. The majority of these closures are in response to non-point source contamination (e.g., urban runoff including septic seepage, agricultural drainage and boat sewage discharges).

Other locally significant fisheries-related impacts are associated with agricultural runoff and degradation of water quality (acute toxicity because of ammonia, reduced dissolved oxygen and eutrophication).

Figure 4-3 The Georgia Basin-Puget Sound Area Showing Contaminated Shellfish Closures



(Source: Environment Canada, 1997)

Most communities on the Pacific coast dispose of liquid waste into marine waters. For residents without access to municipal sewage collection, on-site sewage systems are the norm. Most communities treat their sewage to some degree — primary treatment reduces suspended solids and floatables; secondary treatment reduces suspended solids, oxygen-demanding substances, and acute toxicity. Sewage effluent contains organic matter that, when degraded, can deplete the dissolved oxygen in poorly flushed waters. Under permit from the B.C. Ministry of Environment, Lands and Parks, most communities discharge treated effluent through deep outfalls, using diffusers for rapid dispersion. Sludge produced from treatment may be sent to landfills, although the recent trend is for reuse as a soil amendment. Most sewage effluent discharged into the ocean in B.C. currently receives only primary treatment.
The core municipalities of the Capital Regional District, which includes Victoria, discharge screened raw sewage into the Strait of Juan de Fuca.

A common and ongoing challenge is fecal coliform contamination from non-point sources such as poorly maintained septic systems and inappropriate agricultural practices. In urban areas during periods of

high runoff, combined sewer overflows allow sewage to be transferred from the sanitary sewer system to the stormwater system, and can result in significant contamination of local waters. Other sources of bacteriological contamination include raw sewage discharges from recreational boats in embayments.

A priority issue is the possible effects of endocrine-disrupting compounds such as nonylphenols and natural estrogens (Henderson, 1997) in municipal, agricultural and industrial wastes. Recent concerns have highlighted the disruption of the reproductive characteristics of fish, thought to be caused by high concentrations of hormones or hormone mimics in sewage effluent and in agricultural runoff. Gender ratios in fish populations can be altered with unknown consequences to local populations. Recent Environment Canada data (Sekela et al., 1997) confirm the presence of a known endocrine disrupter (4-nonylphenol) in sewage effluent and downstream of a municipal outfall in the Fraser River estuary. Effects on fish are under investigation.

Persistent Organic Pollutants

There has been significant contamination in shellfish by persistent organic pollutants (POPs) on the Pacific coast. Less well understood are the potential biological effects of these compounds. Point sources of POPs are well documented, but the loadings and impacts of non-point sources have yet to be addressed.

Nine coastal kraft pulp mills historically used chlorine for bleaching, resulting in effluents containing many chlorinated by-products, including dioxins and furans. Beginning in 1988 and peaking in 1995, about 1200 km^2 of shellfish harvesting areas (crab, prawn, shrimp, oysters, clams) were closed because of contamination by these chemicals. These closures have affected some coastal communities, particularly commercial crab fishers. The B.C. pulp and paper industry spent over a billion dollars to modify its bleaching processes, and stopped using chlorophenate-contaminated wood chips and defoamers that contain dioxin and furan precursors. This expenditure, coupled with the introduction of new provincial and federal regulations, has created an environmental dividend: the burden of dioxins and furans has been reduced by over 97%, and nearly half of the area where harvesting was restricted because of contamination has been reopened (Hagen et al., 1997).

The Canadian Wildlife Service has been monitoring organochlorines in seabird eggs since the early 1970s on the Pacific coast. For this monitoring programme, indicator seabird species were selected to represent coastal, continental shelf and offshore ecosystems. Eggs are collected every four years at a number of colonies and analyzed for organochlorine pesticide and polychlorinated biphenyl (PCB) contaminants. Concentrations of organochlorine pesticides and PCBs have generally declined since the early 1970s in species such as Double-crested Cormorants (*Phalacrocorax auritus*) nesting in areas such as the Strait of Georgia, where they are exposed to industrial and agricultural runoff.

In contrast, organochlorine pesticides such as DDT and hexachlorocyclohexane (HCH)-related compounds have remained relatively stable, particularly in alcid (e.g., Rhinoceros Auklet [*Cerorhinca monocerata*]) and hydrobatid (e.g., Leach's Storm-Petrel [*Oceanodroma leucorhoa*]) species, which forage in offshore locations. Concentrations of those particular compounds are also

substantially higher in west coast populations, and are thought to reflect atmospheric transport from areas of ongoing use in Asia. Long-range atmospheric transport appears to play a major role in delivering organic pollutants to seabird food chains.

Agricultural pesticides are another source of POPs in estuaries where upstream use is high. The use of disinfectants and antibiotics in the aquaculture industry also needs to be properly controlled.

Tributyltin (TBT) anti-fouling paint is highly restricted in Canada. However, due to its high toxicity, international use and continued use on vessels exempt from restrictions, the continued assessment of potential impacts is justified.

Radionuclides

Although there are no Canadian sources (e.g., nuclear reactors) in the Pacific Region, there is concern with any accidental release of stored nuclides at the Hanford, Washington, nuclear facility. The fallout signal from the onset of 1950s atmospheric weapons testing peaked in the early 1960s. Chernobyl inserted a brief but detectable pulse of atmospheric nuclides in 1986. Sediments around the Strait of Georgia generally reflect the fallout signal with some augmentation (focusing) from land runoff (Carpenter and Beasley, 1981). This signal is worldwide, and the main nuclides of concern are cesium-137(Cs) and strontium-90(Sr). Although these nuclides can enter the food web, they do not biomagnify and levels in marine organisms have not been a concern.

Heavy Metals

Although monitoring data are sparse, non-point sources such as stormwater are considered significant. The result is that sediment quality criteria are exceeded locally in harbours and nearshore urban areas.

Two abandoned mines are significant sources of metals and environmental degradation. Acid rock drainage from the abandoned Britannia copper mine on Howe Sound is one of North America's largest unconfined point sources of copper and zinc contamination. Acidity is generated by the bacterial oxidation of sulfides to sulfates and sulfuric acid on exposure to air and water. Leachate continues to enter the marine environment 24 years after mining activity ceased. Metal-laden water drains into Howe Sound from extensive underground workings that penetrate the deposit. The adjacent shoreline is severely degraded and hazardous to juvenile salmon from the Squamish River. Algae are notably absent near the mine, and for 1.5 km along the shore of Howe Sound in both directions (EVS, 1997). The Department of Fisheries and Oceans (DFO) is conducting a two-year assessment of the impact of the discharge on nearshore fish and fish habitat. Preliminary results indicate that the numbers of juvenile salmon are much reduced in the area (Levings, 1997).

Mount Washington, on Vancouver Island, is the site of a small open-pit mine that operated from 1964 to 1967. The exposed rock has oxidized and releases toxic concentrations of copper into the Tsolum River. Until 1985 the Tsolum River supported valuable runs of pink, coho and chum salmon, and was famous for steelhead — a prized sportfish. Toxic levels of copper have reached the river and have been a major impediment to restoring the depleted salmon runs. DFO calculates that losses to the fishery could exceed $2 million a year.

Oils/Hydrocarbons

Non-point source discharges of oil or hydrocarbon products are common. In dense urban areas the concentration of automotive hydrocarbons in stormwater is often high and represents a significant source of these contaminants to nearshore habitats.

A local concern is the tainting of eulachon in the Kitimat River and estuary downstream of an unbleached kraft pulp mill. This migratory, smelt-like fish is culturally important to coastal Haisla people. Fish flavour was impaired at relatively low effluent concentrations in laboratory and field exposures (Colodey et al., 1999). The suspect compounds (terpenes) are hydrocarbons of plant origin, but are only part of a complex effluent and may not be solely responsible for the effects on fish flavour.

Nutrients

Sewage plays only a minor role in the nutrient budget of the Strait of Georgia-Puget Sound system. All anthropogenic sources (point source, non-point source and atmospheric loadings) of nitrogen in this area are very small compared with natural nitrogen inputs from the entrainment of nutrient-rich, deep ocean water. Although no priority locations are identified, there is local concern in poorly flushed bays and inlets — especially from June to August. The areas most sensitive to eutrophication are inlets with low flushing rates that adjoin urbanized shorelines, mainly located along the south and west margins of Puget Sound in Washington State (Mackas and Harrison, 1997).

Contaminated Sediments

There is strong evidence that contamination from PCBs is decreasing in marine sediments in the Strait of Georgia (MacDonald et al., 1992). However, at more contaminated sites, PCBs remain at levels of concern. PCBs have been linked to reproductive problems in English sole in Puget Sound (Casillas et al., 1991; Johnson et al., 1997).

Liver lesions in sole from contaminated coastal areas (e.g., Burrard Inlet) have been previously correlated with high concentrations of polycyclic aromatic hydrocarbons (PAHs) in sediments (Goyette and Boyd, 1989). At Kitimat, PAHs from combustion and spillage of pitch and coke have accumulated in bottom sediments, and levels decrease with distance from the aluminum smelter. Although liver abnormalities in English sole collected from Kitimat Harbour have been demonstrated, the PAHs in the harbour sediments appear to have limited bioavailability (perhaps because of the fine particle size of the associated sediments). They are not acutely toxic to invertebrates and documented effects on the benthic community are minimal (Paine et al., 1996). Health Canada is conducting a human health hazard assessment of PAH levels in clams collected from Kitimat.

Litter

Although there is widespread aesthetic concern about litter, particularly in coastal parks, the level of biological impact associated with this type of contamination is not well documented. Most of the litter debris is polystyrene foam and plastic, including bait bags, oil and water bottles, and food packaging (Environment Canada, 1996). Results of a pilot project conducted between 1995 and 1996 by the National Marine Debris Surveillance Programme indicate that most debris originates from land or land-based activities.

4.1B Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

A significant source of habitat alteration and loss is coastal development, including urbanization, commercial ports, small craft harbours and marinas. Other habitat changes are related to agricultural practices, including water storage and flood control structures (dykes) that alter the physical dynamics of the system such as current velocities and sediment transport regimes. Historically, much habitat has been lost, and each new development can cause direct habitat loss and lead to decreased ecosystem integrity.

Inter-tidal and Sub-tidal Alteration

Eelgrass beds perform an important ecological function along the Pacific coast. They support a variety of organisms including salmon, herring, kelp greenling, sea anemones, jellyfish, snails, sea slugs, small clams, crabs, sea stars, sea cucumbers and isopods. The eelgrass community provides important rearing habitat for juvenile salmon, herring and crabs, and the leaf blades support a wide variety of microscopic and macroscopic fauna and flora, which flourish particularly during the late spring and summer. Eelgrass is also critical for survival of birds migrating along the Pacific Flyway. Threats to the health of this critical habitat include sedimentation from adjacent land use, destruction from coastal developments, marinas and log rafts (causing shading and smothering), and changes in hydrodynamics (affecting distribution and growth patterns). Logging and log handling activities also cause significant habitat loss and degradation through benthic bark deposits and changes in water quality.

Fish farms are a source of organic material from waste food, feces and organisms cleaned off nets. Issues include habitat smothering, blanketing beneath salmon net pens, and the use of antibiotics and pesticides. Currently, there are approximately 80 net pen operations on the B.C. coast producing 25 000 tonnes of salmon annually. Impacts from organic deposits on the sea floor are generally restricted to the immediate vicinity of the farm site. An extensive environmental assessment process concluded that salmon aquaculture as practised in B.C. represents a low environmental risk. Following up on the findings a number of actions will be taken by B.C. to minimize net pen impacts. These include establishing performance-based standards for organic deposits. DFO is in the process of updating draft regional net pen siting guidelines to ensure the protection of coastal habitats and fishery resources in the vicinity of aquaculture operations.

Mineral and Sediment Extraction/Alteration

Sediment dredging in rivers and ocean disposal activities are regulated under the *Fisheries Act* and the *Canadian Environmental Protection Act* respectively. Although there are only a few incidents related to illegal gravel removal each year, the impacts of each one can be highly damaging to fish and fish habitat. However, because of tight controls, ecological impacts in recent years have been minimal. Habitat alteration and loss (smothering) from submarine mine tailings disposal have been caused by historical activities. Hard-bottom communities have been buried under up to 30 m of tailings, which are now being colonized by local soft-bottom species (e.g., at Island Copper, Vancouver Island). In other areas (e.g., Britannia and Mount Washington), historical mine activity has resulted in ongoing releases of toxic

concentrations of dissolved metals (acid rock drainage), as discussed in the heavy metals section above.

Wetland and Saltmarsh Alteration

Biologically, estuarine marshes are the most productive habitat type on the coast. The Fraser River estuary acts as a nursery ground for juvenile fish, and its marshes support the highest density of wintering waterfowl, shorebirds and birds of prey in Canada (Environment Canada, 1996). The Puntledge River at Courtenay (on the east coast of Vancouver Island) forms an estuary that has been progressively affected by land-based activities. Several factors have contributed to its degradation, including urban encroachment, poor land-use practices, dredging and unco-ordinated responses to non-point source pollution issues such as failing septic systems and agricultural runoff. Water quality has declined not only in the estuary, but also in the Puntledge River. Here the effect has been caused by acid rock drainage from the abandoned Mount Washington mine and by a BC Hydro dam that alters flow and temperature regimes. Hundreds of smaller estuaries are healthy, particularly along the central and northern coasts. However, they are at risk from development pressures, including future forestry activities.

Marine Waters and Coastal Watershed Alteration

The major land-based activities affecting coastal watersheds in B.C. are forestry, agriculture, and urban and industrial development. Impacts associated with these activities are mostly sedimentation or erosion of fish spawning and rearing habitat, loss of riparian area, along with alteration of flow regimes in streams.

Urban development alters stream hydrology, and many urban streams have been eliminated by stormwater systems, or they have been channelled or dyked. These effects will increase without careful planning and rigorous compliance monitoring. Of the approximately 300 significant salmon spawning streams in the Fraser River system, about half are located in or flow through the urbanized area of the lower Fraser Valley. These streams provide spawning and rearing habitat for salmon, trout and other fish. Over 80 species of fish frequent the river's estuary and tributary streams. The lower Fraser River's tributaries produce one-half of the coho in the Georgia Strait.

This productive fish habitat has been degraded by development and settlement activities for over 100 years. A 1996 assessment indicates that of the 2000 km of streams in the urban area of the lower Fraser River, 588 km (approximately 30%) have been routed into culverts and are covered. Sediment discharges associated with most developments have also been found to clog the clean gravel required by spawning salmon.

Indirect impacts from urbanization continue to contribute to losses in riparian zones. There has been increased sediment loading to streams, and a spread of impervious surface areas causing degradation of hydrology and water quality.

The Fraser River supports the largest salmon runs in the world. The most significant agricultural impacts on coastal watersheds are in the lower Fraser River valley. One of the most productive agricultural regions of Canada, this area supports intensive hog, poultry, beef and dairy farming, as well as vegetable, berry and grain operations. A

large system of dykes and flood control structures protects valuable agricultural land, but these structures have also resulted in the loss of over 80% of the natural saltmarsh in the delta (Levings and Thom, 1994). A major challenge in the region is improving agricultural practices to minimize further habitat loss, protect groundwater resources and achieve fish habitat restoration.

Coastal habitat alteration can have an impact on a variety of foreshore, inter-tidal and sub-tidal habitats through urban development, coastal infilling, marina construction and log handling facilities. Eelgrass beds show low tolerance to increases in water turbidity from dredging, high foreshore sedimentation rates, increased wastewater discharges and other bottom disturbances. Cumulative effects of many land-use impacts are contributing to a trend of fewer ecologically productive nearshore habitats.

The recent assessment of 10 years of compensation habitat projects in the estuary (Kistritz, 1996) determined whether foreshore development projects in the Fraser River estuary were achieving the guiding principle of "no net loss" (Department of Fisheries and Oceans, 1986). Results suggested that, in areas where compensation was required as a component of the development permit, only 50% of the compensation habitat that had to be replaced at a 2:1 ratio was functioning successfully. The assessment showed that replacing 1 ha of habitat required the construction of 2 ha of replacement marsh habitat (Langer, 1997).

Biological Alteration

Exotic (non-indigenous) species are those that enter ecosystems beyond their natural range through deliberate or inadvertent introduction by humans. Examples on the Pacific coast include the Pacific oyster (*Crassostrea gigas*), deliberately introduced from Japan in the early 1900s for commercial mariculture. It now forms the mainstay of B.C.'s oyster industry.

Accidentally introduced along with the Pacific oyster were the predatory Japanese oyster drill (*Ceratostoma inornatum*), the Manila clam and the seaweed *Sargassum* sp. The Pacific oyster spread rapidly from culture sites. The native Olympic oyster, (*Ostrea lurida)* remains at low levels due to overfishing that occurred prior to the introduction of the Pacific oyster. The oyster drill and *Sargassum* sp. have also become widely established. A 1994 arrival in the Georgia Strait was the dark mahogany clam (*Nuttalia nuttalia*), which is expected to compete with native clam species but is too small to be of commercial value. The green crab was first sighted on the west coast of Vancouver Island. It is believed to have drifted on ocean currents from San Francisco Bay where it was introduced from ballast water.

Habitats of Special Regional Concern

Over 6500 small islands dot the waters along B.C.'s coast. Because of their size they present different management challenges and require different treatment than large islands or the mainland. Larger islands are affected principally by forestry and increasingly by urbanization in the south. Small islands are more vulnerable to stresses such as private land clearing, ecotourism, boating, recreational shellfish harvesting and introduced predators (rats and raccoons). Land development on small islands may be constrained by limited freshwater, poor access, and in some areas by the development controls of B.C. Islands Trust. These controls are not applied coast-wide. However, where they do apply there is no

consistent protection of rare and endangered ecosystem types on land, nor is there sufficient conservation of significant marine areas. For these reasons, small islands are included as a regional concern within the framework of the National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA).

4.2 Establishment of Priorities for Action

4.2A Contaminants

Sewage

Sewage discharges (point) and agricultural and urban stormwater runoff (non-point) are a **high priority**. They have the potential to affect public health and restrict fishery resource use. Year-round closures of shellfish harvesting and seasonal closures of swimming areas are both common. Shellfish harvesting closures because of bacterial contamination occur in almost all areas adjacent to urban and semi-urban development (Figure 4-3), and now total nearly 1000 km^2, up from 710 km^2 in 1989.

Persistent Organic Pollutants

POPs are a **high priority**. The control of the use of TBT antifouling paints is an important objective. Tributylin continues to be used in anti-fouling paints applied to aluminum-hulled and large vessels. Concentrations of the pesticide in sediment from recreational harbours have declined since the ban on its use on small vessels in 1989. Sediments in industrial harbours, such as Vancouver, remain contaminated. There is international concern related to the toxicity of this compound, and additional national and international controls are required. The discharge of chlorinated dioxins and furans from pulp and paper mills to the marine environment has been virtually eliminated. Nonetheless, these compounds continue to be an issue with ongoing crab harvesting closures on the B.C. coast, and further monitoring is being conducted. Storm sewers, combined sewer overflows and agricultural inputs (pesticides, endocrine-disrupting compounds) are emerging issues that require further research and monitoring. Long-range transport of POPs is an identified concern.

Radionuclides

Radionuclides are a **low priority** concern for the Pacific coast as there are no significant local land-based sources (e.g., nuclear power plants).

Heavy Metals

Certain sources of heavy metals are a **high priority**. Acid rock drainage from abandoned mines causes significant ecological impact on adjacent receiving environments. Metal loadings from stormwater inputs in urban harbours have caused local impacts.

Oils/Hydrocarbons

Oils and hydrocarbons are a **medium priority**. Spill prevention initiatives are in place and designed to prevent large-scale spills. Chronic low-level contamination from urban stormwater and combined sewer overflows causes moderate, localized damage.

Nutrients

Nutrients are a **low priority** issue in marine waters. Local concern exists for poorly flushed bays, and the overall marine ecosystem impact is low.

Contaminated Sediments

Contaminated sediments are not widespread and are therefore of **medium priority**. Industrial and urban harbours often contain localized areas of contaminated sediments (e.g., PAHs, metals, PCBs) requiring remediation.

Litter

A **low priority** is given to litter based on its aesthetic impact, although the local biological impact has not been documented.

4.2B Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

The historical habitat losses that have occurred, and the need to prevent new losses, call for a **high priority**. Urbanization and construction of ports, harbours and marinas contribute to the loss of shoreline habitat.

Inter-tidal and Sub-tidal Alteration

Sedimentation impacts of land-use practices can alter important eelgrass beds and are a **medium priority**. Logging and log handling activities can contribute to habitat loss and degradation through log grounding and deposition of bark.

Mineral and Sediment Extraction/Alteration

Controls on dredging have reduced potential impacts. As a result, this activity is given a **low priority**. Historical submarine disposal of mine tailings has caused habitat alteration and destruction.

Wetland and Saltmarsh Alteration

Agriculture, forestry and urbanization (dyking, draining and infilling) have caused significant direct losses of fish and wildlife habitats and are assigned a **high priority**.

Marine Waters and Coastal Watershed Alteration

Significant watershed alteration is a **high priority** and has occurred through urbanization, agriculture and forestry activities. Dyking, draining, infilling and stream alteration (including channelization, changes to the hydrography and sedimentation, and the installation of culverts) have resulted in fewer productive stream habitats, especially in the Georgia Basin. An independent binational review of the shared waters of British Columbia and Washington State identified seven priority actions, the highest priority being to minimize estuarine wetland habitat loss and establish marine protected areas (British Columbia/Washington Marine Science Panel, 1994).

Biological Alteration

The introduction of exotic species via various pathways has the potential for significant ecological impact. Several species introductions have been documented, and prevention is the best approach. A **medium-high priority** has been assigned to this category because the consequence of alien introduction can be severe and irreversible. However, there are controls and preventative practices in place.

4.3 Setting Goals and Management Objectives

Under the NPA, Canada's goals are to:

- protect human health;
- reduce the degradation of the marine environment;
- remediate damaged areas;

- promote the conservation and sustainable use of marine resources; and
- maintain the productive capacity and biodiversity of the marine environment.

In addition to the national objectives, the following are specific regional objectives.

4.3A Contaminants

The general management objective for most of the contaminants is to reduce their presence in the marine environment, primarily through pollution prevention. Where contaminants are released to or occur in the marine environment, the management objective is to apply life-cycle management or remediation to address the problems.

Specific management objectives for each of the contaminants of concern at the national level are as follows.

Sewage — reduction of contamination from sewage and restoration of polluted shellfish growing areas is of particular importance on the Pacific coast.

Persistent Organic Pollutants — the primary objective is to reduce the anthropogenic inputs of POPs and apply life-cycle management to remaining sources.

Radionuclides — radionuclides were not identified as being a concern for the Pacific coast since there are no significant local land-based sources.

Heavy Metals — reduce the discharge of acid rock drainage, and reduce the impact of stormwater discharges.

Oils/Hydrocarbons — reduce inputs to improve coastal water and ecosystem quality.

Nutrients — nutrient input into the marine environment was not identified as being a major concern in the Pacific Region.

Contaminated Sediments — the main objective is to reduce sediment contamination at source.

Litter — increase public awareness to reduce the debris entering the marine environment.

4.3B Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration — through a process of integrated coastal zone management (ICZM), new proposals for shoreline development are more widely reviewed, and decisions are influenced by community objectives:

- where shoreline developments occur, harmful alteration is prevented or mitigated; and
- where residual harmful alteration will occur, compensation will be implemented and monitored for efficacy wherever feasible.

Inter-tidal and Sub-tidal Alteration — pursuant to ICZM objectives, there will be more inventories of habitats. Sensitive marine areas will be identified and protected from developmental impacts wherever feasible.

Mineral and Sediment Extraction/Alteration — restrict dredging and dumping activities in timing and location to ensure protection of valued habitats.

Wetland and Saltmarsh Alteration —

- halt damage in these valuable areas by directing development elsewhere; and

- assess where dykes can be breached to increase productive estuarine habitat.

Marine Waters and Coastal Watershed Alteration — achieve net gain through a reversal of continuing loss and degradation of important habitats, strategic enhancement and habitat restoration.

Biological Alteration —

- prevent inappropriate ship deballast activities nearshore; and
- prevent the accidental escape and introduction of non-indigenous marine species including pathogens.

4.4 Strategies and Actions

Many laws, regulations, policies and programmes of both the B.C. government and the federal government are already in place to meet the goals and objectives of protecting the marine environment from land-based activities. The successful outcome of the strategies and actions designed to meet the stated goals and management objectives will require participation from all levels of government, industry, communities and other non-government sectors.

The following strategies and actions are designed to address the goals and management objectives in the Pacific Region.

4.4A Contaminants

Sewage

- Implement the new provincial municipal sewage regulation that updates standards to protect water quality and ultimately recreational uses of water, human health and fish habitat, as well as streamlining the authorization process.
- Continue to apply existing regulations and ensure compliance and enforcement.
- Promote infrastructure planning for point source discharges.
- Promote the development of liquid waste management plans by municipalities and regional districts.
- Facilitate community action, support land-use planning processes and promote a community-based approach to address point and non-point sources to aid in protecting and restoring shellfish growing areas.
- Encourage implementation of Pleasure Craft Sewage Pollution Prevention Regulations in designated areas, and promote the installation of pump-out facilities where practical.
- Encourage implementation of best management practices for farms and identify areas sensitive to non-point sources of pollution originating from on-site sewage, agriculture and urban stormwater.
- Promote improved collection, treatment and disposal, and support innovative technologies for non-point sources (on-site sewage systems, agriculture, urban stormwater).
- Promote public education.

Persistent Organic Pollutants

- Continue international and national efforts to eliminate use of TBT. Continue dioxin/furan monitoring of affected fisheries to determine when consumption restrictions can be removed.
- Encourage efforts by industry to apply better management practices with regard to the use of pesticides, and promote use of integrated pest management in agriculture operations.

- Develop source controls to eliminate POPs in sewage, stormwater and combined sewer overflows.
- Encourage development of pollution prevention strategies for industries and municipalities.
- Promote the implementation of new treatment strategies and technologies to eliminate tainting from the unbleached pulp and paper mill at Kitimat.
- Encourage increased biological effects measurements as a monitoring approach that might identify problems to be addressed through analytical chemistry.

Radionuclides

- Further action is not required to deal with radionuclides in the Pacific Region.

Heavy Metals

- Reduce impacts of acid rock drainage from abandoned mines through collection and treatment of discharges.
- Promote site and habitat restoration at abandoned mines.
- Develop source controls to eliminate heavy metals in sewage, stormwater and combined sewer overflows.

Oils/Hydrocarbons

- Reduce chronic inputs of oil and other hydrocarbons through better stormwater management.
- Protect identified sensitive areas from impacts of oil spills.
- Ensure fully operational response strategies for major oil spills, and develop new response plans and decision systems as required.
- Educate the public and marine industries about proper oil and fuel handling, recycling and engine maintenance practices.

Nutrients

- Further action is not required at this time to deal with nutrients entering the marine environment in the Pacific Region. However, vigilance is needed for the potential problem of localized eutrophication, particularly in poorly flushed embayments.

Contaminated Sediments

- Develop priority site listings for characterization and remediation where appropriate.

Litter

- Increase public education programmes to reduce the amount of litter entering the marine environment.

4.4B Physical Alteration and Destruction of Habitat

Shoreline Construction/Alteration

- Develop and implement co-ordinated coastal land-use planning processes.
- Apply existing codes of practice; develop new codes specifically focusing on marine foreshore protection.
- Develop and implement stewardship programmes (e.g., shorekeepers) and associated educational packages.
- Carry out regular audit and enforcement activities.

Inter-tidal and Sub-tidal Alteration

As stated in Chapter 3, the purpose of ICZM is to maximize the benefits provided by the coastal zone while minimizing resource-use conflicts and the harmful effects of activities. Goals are conservation, sustainable use and economic diversification in the coastal zone, with a focus on collaborative planning and decision making.

- Implement ICZM; continue co-ordinated environmental project reviews to prevent habitat loss (e.g., Burrard Environmental Review Committee, Fraser Environmental Review Committee).
- Develop guidelines to protect marine sensitive zones (e.g., from logging and log handling activities).
- Consider findings of the Salmon Aquaculture Review (1997) for policies on net pen siting and operational guidelines.
- Establish marine protected areas to conserve and protect marine resources and habitats.
- Protect critical habitats (e.g., eelgrass beds) from sedimentation and other habitat alterations through habitat inventory development, heightened public awareness and enforcement.

Mineral and Sediment Extraction/Alteration

- Ensure channel maintenance dredging is not degrading habitats.
- Ensure that contaminated sediments not meeting *Canadian Environmental Protection Act* ocean disposal criteria are disposed of in approved on-land facilities.

Wetland and Saltmarsh Alteration

- Protect remaining wetlands through integrated area planning, education and stewardship, and development of wetland conservation strategy and guidelines.
- Restore priority habitats wherever possible.
- Establish co-operative working relationships with the agriculture community to ensure development and implementation of best management practices for operations, including the maintenance of farm drainage systems.

Marine Waters and Coastal Watershed Alteration

- Establish and implement estuary management plans and associated technical committees for habitat restoration and prevention of further habitat loss.
- Protect estuaries and foreshore habitats to at least the same degree as upland riparian areas.
- Designate estuaries and other important habitats as "marine sensitive zones" (*B.C. Forest Practices Code Act*).
- Ensure implementation of the estuary and marine provisions of the Riparian Field Guide (*B.C. Forest Practices Code Act*).
- Engage in integrated land-use planning processes.
- Incorporate environmental objectives into Regional Growth Strategies.
- Continue support of the Pacific Estuary Conservation Programme.
- Protect riparian zones and biodiversity through a watershed planning approach that embraces best management practices.
- Contribute to the implementation of the Georgia Basin Ecosystem Initiative to manage growth for healthy, productive and sustainable communities.

Biological Alteration

- Through co-operation with the United States, ensure that a common policy on ballast water management is developed that is consistent with the approach used in a number of B.C. ports.
- In addition to regulatory approaches, prevent introduction of exotic marine species through education programmes directed at aquaculture and live seafood industries, research facilities and the import pet industry.

4.5 Next Steps

Addressing regional priorities will require co-ordinated efforts from all levels of government, individuals, communities and other non-government sectors of society. This will involve a basin or watershed ICZM approach, as exemplified in the Fraser River Estuary Management Plan (FREMP). FREMP is a co-operative effort among federal, provincial and local governments to co-ordinate planning and decision making in the estuary. FREMP partners are Environment Canada, Fisheries and Oceans, B.C. Ministry of Environment, Lands and Parks, Fraser River Port Authority, North Fraser Harbour Commission, and the Greater Vancouver Regional District. In addition to the Georgia Basin Ecosystem Initiative (GBEI), there will be opportunities to address priority issues through federal participation in established provincial land-use planning processes such as Land and Resource Management Plans (for Crown lands) and Regional Growth Strategies, as well as new federal/provincial coastal area planning processes under development. Many of the issues identified in this chapter are associated with population growth and density. They are common to the lower Fraser River and Georgia Basin area. These problems will be addressed in part through the multi-agency GBEI. The purpose of the Initiative is to engage communities, and enhance co-ordination and collaboration among the many government and non-government stakeholders, while achieving measurable improvements in:

- conditions affecting environmental health and human well-being; and
- the capacity of individuals and families, businesses, organizations and all orders of government to deal with issues of sustainability.

The vision statement for the Initiative — "managing growth to achieve healthy, productive and sustainable ecosystems and communities" — reflects the enormous challenge we face to protect ecosystems from unprecedented growth in the region. Application of action plans through an ecosystem approach will afford a real opportunity for governments and stakeholders to tackle these challenges in a manner that is holistic, long-term, consensus-based and inclusive. The GBEI will provide a framework for co-ordinating federal, provincial and regional government support for several existing and developing programmes. For example, the B.C. Ministry of Environment, Lands and Parks Non-Point Source Action Plan is taking a number of actions aimed specifically at reducing non-point source pollution in partnership with federal and local agencies. This will be key to addressing many issues identified within the NPA.

The new provincial municipal sewage regulation updates standards to protect water quality and streamline the authorization process. An independent binational review of the shared waters of B.C. and Washington State identified seven priority actions, the highest priority being to minimize estuarine wetland habitat loss and establish marine protected areas (British Columbia/ Washington Marine Science Panel, 1994). The Puget Sound–Georgia Basin International Task Force depends significantly on Canadian and American agency support and involvement to achieve its objectives, many of which have been identified in the NPA.

Rapid urban growth along the south coast of British Columbia is bringing a shift toward greater awareness among local governments of the need for effective and co-ordinated

environmental action (e.g., FREMP). National and provincial programmes must therefore increasingly provide support and guidance to local governments in order to meet their environmental objectives within the larger framework of the coastal zone. There will be a learning curve to build more effective working relationships, a task particularly difficult in multi-use coastal settings such as the Georgia Basin.

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