Shared Waters: The Vulnerable Inland Sea of British Columbia and Washington

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Map of Puget Sound/Georgia Basin (19K)

In 1992, the premier of British Columbia and the governor of Washington forged an Environmental Cooperation Agreement, which states that "environmental concerns and impacts respect neither physical nor political boundaries." It committed the province and state to "promote and coordinate mutual efforts to ensure the protection, preservation and enhancement of our shared environment for the benefit of current and future generations."

The premier and the governor then created an Environmental Cooperation Council to address numerous issues transcending the boundary between British Columbia and Washington. The council formed an international task force, comprising staff members from federal, provincial and state agencies, to focus on environmental issues in the Strait of Georgia and Puget Sound.

In 1993, the Environmental Cooperation Council appointed a Marine Science Panel of six university and government marine scientists from British Columbia and Washington to bring the best available science to bear on the problems. The scientists were assigned several questions concerning the state of the marine environment. After hearing the views of a wide spectrum of researchers, managers and interest groups at a ground-breaking international public symposium and in small meetings, the panel members presented their results to the council in August 1994. Their work will guide the continuing efforts of the provincial and state governments in coming years.

This document summarizes the independent findings of the British Columbia/Washington Marine Science Panel. The panel described the waters, the basin and the living creatures they support, and examined threats that currently are degrading these resources. The panel recommended several ways in which the governments and citizens of the province and the state can work together to stop the deterioration of their shared marine environment and enhance its condition for future generations.

The Environmental Cooperation Council and the international task force endorse the panel's evaluation process, but these findings are the consensus of the panel alone and do not necessarily represent the views of any federal, provincial or state agency.

The Inland Sea: Its Environment and Living Resources

Along the temperate coastline of western North America lies a spectacular and bountiful inland sea. Thousands of years ago, after the sea filled the basin left behind by retreating glaciers, native peoples settled along its shores and prospered from its plentiful fish and wildlife.

A few generations ago, explorers and settlers from other parts of the world began colonizing the shores of this inland sea. The new settlers drew a boundary line across the inland sea and created two friendly but separate nations, Canada and the United States.

This line could not really divide the inland sea, however. Its waters obey natural boundaries rather than political ones, and the two nations share these waters and the creatures that inhabit them.

The Basin and Its Residents

The inland sea of British Columbia and Washington comprises three natural basins. To the north lies the long, broad, deep and open Strait of Georgia. To the south, Puget Sound is shorter, less deep and subdivided into numerous channels and bays. Connecting the Strait of Georgia and Puget Sound with the Pacific Ocean to the west is the long, open Strait of Juan de Fuca.

Islands-and the narrow, relatively shallow passages between them-define natural boundaries among the three basins. Passages through the San Juan and Gulf islands form the gateway between the Strait of Georgia and the Strait of Juan de Fuca. The main entrance to Puget Sound is through Admiralty Inlet along the western flank of Whidbey Island.

The inland sea is an estuary, a semi-enclosed body of water where sea water from the open Pacific Ocean is diluted by fresh water from numerous rivers, large and small. These rivers originate high in the surrounding glaciated mountains-the Coast Range, the Cascades, and the Vancouver Island and Olympic ranges. Thus the watershed, an integral part of the ecosystem of the shared waters, covers a much greater area than the inland sea alone.

About three-quarters of the fresh water entering the inland sea comes from two rivers that drain large areas surrounding the U.S.-Canada border. The largest, the Fraser River, enters the southern Strait of Georgia, and nearby the Skagit River enters Puget Sound.

The human population living along the shores and in the watershed of the shared waters-fewer than 100,000 people two centuries ago-has expanded to about 5.5 million people today.

The population has concentrated in the Vancouver, Victoria, Seattle and Tacoma urban areas and in smaller cities such as Nanaimo and Bellingham.

People also have dispersed widely into rural areas, forming an almost continuous strip of human settlements all along the shores of the shared waters. The population density is greater on the U.S. side of the border.

Such large numbers of people place heavy demands on the natural environment they inhabit, and those demands grow with the population. Almost half again as many people-about 7 million-are forecast to live in the watershed by the year 2010.

Natural Habitats

Natural habitats are physical, chemical and biological systems that support plant and animal life. If we degrade or destroy these habitats, we reduce or eliminate the life that depends on them.

Like the shared waters that flow back and forth, the plants and animals of the inland sea have no political allegiance. The bottom and the shoreline, together with the rivers and uplands that surround them, form one large natural system of interlinked habitats.

Nearshore Habitats

Habitats lying along the shoreline strip of shallow water and the land immediately adjacent to it can be extremely productive. These nearshore habitats form an essential link in the food web of all the shared waters. Shallow waters shelter the sensitive young of many deep-water fish and shellfish and are home to vital prey for fish, birds and mammals. Nearshore habitats, where the human world on land touches the sea, are extremely vulnerable to degradation and destruction.

In the past, muddy shorelines such as eelgrass beds and mudflats were dismissed as wastelands: too wet and salty for farming, too shallow for shipping and suitable only for diking and filling. Today, however, muddy shores are known to be the most productive nearshore habitats in the inland sea, as productive as good crop land. Accordingly, they have proved to be critical habitat for many species of fish and birds. Mudflats now are classified as coastal wetlands and, like wetlands of all kinds, they play a vital ecological role.

Muddy shores are best known as habitat for commercial and recreatonal shellfish such as oysters, geoducks and crabs. Eelgrass beds are among the most important sites where herring schools lay their roe. Small worms, molluscs, crustaceans and baitfish inhabiting muddy shores are prey for the young of such fish as salmon, sole and flounder, which inhabit deeper water as adults. The same types of prey support both resident shorebirds and millions more migrating on the Pacific Flyway.

The most common type of shoreline along the inland sea contains a mixture of mud and sand along with coarser gravel and cobbles. This variety of bottom materials supports a great diversity of living creatures: seaweeds clinging to rocks, crab and shrimp scavenging the mud for food, clams burrowed between cobbles, and fish, birds and seals prowling for prey.

On the slope between the surrounding uplands and the deep basins, nearshore habitats in the shared waters are much narrower and more limited than the broad marshes bordering the Gulf of Mexico and Atlantic coasts. Human development has already taken a heavy toll on this limited area of shoreline habitat. On Puget Sound, an estimated 58 percent of the original area of coastal wetlands vital to many fish and bird species has been lost. The loss in Georgia Strait is estimated at 18 percent. The losses have been less in British Columbia than in Washington because of British Columbia's relatively longer shorelines and smaller human population.

This destruction began at the turn of the century when mudflats were diked for farming, and expanded with the building of ports, factories, roads and homes. Many sand, gravel and cobble shorelines have been dredged, paved or altered by bulkheads. Despite heightened environmental awareness, this destruction of natural habitat continues today. In some areas-such as the urban waterfronts of Vancouver, Seattle and Tacoma, which once were broad areas of intertidal marsh-the losses are almost 100 percent.

Open Water and Uplands

Sunlight falling on the surface of open water fosters plant and animal growth, which supports the food web throughout the rest of the shared waters. Open water is the domain of plankton, a diverse collection of free-floating plants and animals. These organisms feed a multitude of small forage fish that in turn are prey for larger fishes, birds and mammals. Open water is home to most major adult fish, including salmon, cod, pollock and herring. It is also a nursery area for the eggs and larval stages of many fish and of animals that live on the bottom as adults.

The shared waters move ceaselessly in and out of the inland sea with the tides. Over many tidal cycles, fresh water gradually flows outward near the estuary surface, from rivers toward the sea. Deeper down, a layer of salt water from the Pacific flows into the inland sea. Superimposed on these currents are the effects of the ever-changing winds and the eddies that form over shoals and around headlands.

These water movements affect what happens to any foreign materials, or contaminants, that people discharge into the inland sea. Rivers and tides gradually flush the shared waters out of the inland sea and replace them with fresh and ocean water over the course of about six months. At the same time, local circulation patterns and particles in the water trap some contaminants, keeping them from being flushed to the ocean.

The moving waters bathe kelp beds and reefs close to rocky shores. The prolific kelp and other seaweeds provide food, shelter and camouflage for many

prey species. Reefs harbor a distinctive fish community including rockfish and lingcod, and the birds and mammals that prey on them. Clinging to the rocks is a wide variety of invertebrates that draws divers from around the world: sponges, molluscs, crustaceans, sea stars, urchins and sea cucumbers, as well as many lesser-known species. Especially popular are edible shellfish including mussels and abalone.

Material slowly sinks from the lighted surface waters to cover the deep bottom of the inland sea. This is a dark, cool, stable environment, where the rich sediments support numerous worms, molluscs, crustaceans and other invertebrates. These in turn are food for deep-living fish such as sole and flounder. This remote environment is not pristine, however. Some deep-bottom habitats have been altered by human activities such as fish trawling, disposal of spoils from dredging of chemically contaminated sediments and settling of contaminated particles from discharges and runoff.

The open-water habitat would seem to be difficult to alter or destroy. The water is renewed relatively quickly, so contamination is reversible if the cause can be removed. But because degradation of the open water can affect the entire food web of the inland sea, we must be concerned with threats to this habitat.

Open waters are highly vulnerable to alterations in fresh water supply. Changes in the quantity and timing of river flow can affect salinity and temperature patterns, currents and flushing rates in the shared waters, causing possible unforeseen ecological damage. Reduced spring freshets can disrupt the spring plankton blooms that provide essential food for newly hatched fish. Nutrient loads in rivers can cause overgrowth of algae that die off and deplete the oxygen from the bottom of poorly flushed bays. River diversions take a toll on both adult salmon migrating upstream to spawn and smolts heading to sea.

Upland habitats, from the water's edge to the highest mountains, are also critical to the health of the shared waters. The surrounding watersheds provide vital habitat for numerous animals of the estuary, including the bald eagle, the marbled murrelet and schools of salmon as they hatch at life's beginning and return to spawn at life's end. Watersheds also provide a steady supply of fresh water and clean sediments to the estuary.

Upland habitats around the inland sea have been radically altered by urbanization, agriculture, forestry and river diversion. All of these habitat changes affect fish and wildlife populations, with declines far more common than increases. Careless land use is a prime suspect in the declines of the marbled murrelet, now classified as a threatened species in Washington, and of numerous wild salmonid stocks. Spring floods once nourished nearshore areas with an annual supply of nutrient-rich sediment from coastal lowlands, but flood control has greatly reduced this input.

Fish and Wildlife Populations and Their Status

About 220 fish species swim in the shared waters. Many of these are now less abundant than they were just a few years ago-in some cases, alarmingly so. Most of the population losses are much more severe in Puget Sound than in British Columbia waters.

Salmonids

Eight of these species-five types of salmon, as well as steelhead, dolly varden and cutthroat trout-are anadromous. Anadromous fish are born in fresh water, migrate to salt water to feed and mature, then return to fresh water to spawn.

In 1994, there were extensive and unprecedented closures of salmon fisheries in Washington waters. These closures followed nearly two decades during which salmon runs declined in spite of extensive efforts to boost populations through the use of hatcheries. Even as hatchery outputs soared, some salmon stocks spawning naturally in the wild declined significantly.

About 40 percent of Puget Sound wild salmon stocks are considered depleted, and 10 percent are critically low. Wild stocks are a vital genetic resource, and fishery closures are needed to protect weaker stocks, even though half of the wild stocks are not in danger and hatchery fish are often abundant.

Salmon stocks are in better condition in the Strait of Georgia. Wild Fraser River pink, chum and sockeye stocks, including hatchery stocks, are abundant. Chinook stocks have declined seriously and have not rebounded despite reduced harvests and massive efforts. Coho are still abundant but may be in decline and must be watched carefully.

The exact reasons for the declines in wild salmon stocks are not well understood. Extensive upstream spawning and nursery habitats have been destroyed or degraded, and fishing pressure has been heavy. As hatchery stocks increase, more wild fish are caught along with the hatchery fish, causing excessive catch of wild stocks. Ecological conflicts between wild and hatchery fish, and changes in natural ocean conditions, also may affect how many salmon survive at sea. Additional research on such effects is needed before we will know how best to restore these stocks.

Salmon stocks originate from separate river basins on each side of the international boundary and are studied and managed separately. However, the separate stocks migrate, feed and are caught together. Effective conservation of salmon can be accomplished only through joint management of this international resource.

Marine Fish

Fish that spend their entire lives in salt water are called marine fish. This group includes lingcod, Pacific cod, hake and pollock; baitfish such as herring; flatfish such as sole and flounder; and numerous species of rockfish.

Many marine fish populations in the shared waters have declined in recent years. Throughout the shared waters, stocks of long-lived rockfish are low, and lingcod stocks have collapsed. Herring, hake and pollock stocks are at average levels of abundance in the Strait of Georgia but at low levels in Puget Sound. Pacific cod are badly depleted in the Sound and somewhat depleted in the Strait of Georgia. English sole appear to be at average abundance in both areas. Only the spiny dogfish is in historically high abundance throughout the shared waters.

Overfishing is one likely cause for declines in marine fish stocks. Changes in climate and ocean conditions also may be involved, and predation by marine mammals may prevent some stocks from rebuilding.

Fish caught in open waters are generally uncontaminated and safe to eat. In certain urban and industrial locations on both sides of the border, however, toxic chemicals in sediments affect bottomfish such as English sole, causing degenerative conditions such as liver disease and possibly affecting reproduction. It is not yet clear whether these conditions take a toll on fish populations, however.

Shellfish

Like the fish, several types of shellfish are important recreational and commercial resources. They include molluscs such as mussels, oysters, clams, scallops, abalone and squid, as well as the crustaceans crabs and shrimps. Sea urchins and sea cucumbers also are an important part of the invertebrate harvest. Recently some kinds of snails, chitons and other shellfish have become popular among some recreational gatherers.

Commercial and recreational shellfish generally remain abundant in the shared waters, with the exception of abalone, which has been heavily overfished, and some stocks of shrimp. In many areas, however, oysters, clams and mussels are contaminated by bacteria and possibly viruses originating from sewage and from surface runoff from cities and farms. The bacteria present a risk of gastrointestinal illness to people who eat the shellfish, and viral contamination could spread more serious diseases such as hepatitis. Numerous areas of the shared waters in both Washington and British Columbia are closed to shellfish gathering because of bacterial contamination, and the areas are becoming larger.

Invertebrates and Baitfishes

Most people focus on the prettiest fish, shellfish, birds and mammals or on the species that have the greatest commercial or recreational value. But these animals are supported by many other species that may appear unimportant but are essential to the well-being of the ecosystem.

Without the growth of plants-microscopic algae in the water and on the bottom, and broad fields of seaweeds and eelgrass-there would be no food for marine animals to eat. Without the myriad tiny worms, molluscs and crustaceans that burrow in the mud and crawl over the rocks, without the tiny floating animals of the plankton, and without the small fish that feed on all these creatures, the energy from plant production would be unavailable to larger animals. And without microorganisms to recycle wastes and nutrients, the ecosystem would slowly run out of raw materials to sustain itself.

Seabirds, Waterfowl and Shorebirds

The inland sea is renowned for its abundant flocks of birds. The greatest numbers of birds spend the winter on the shared waters and head north in summer.

Eighteen resident species of seabirds or marine birds, which spend their entire lives on the water, breed in the shared waters. Rhinoceros auklet, tufted puffin, pigeon guillemot, cormorant, oystercatcher and other species number nearly 100,000 pairs. Winter visitors such as common murres, gulls, loons and grebes are much more abundant, with populations approaching 1 million.

Waterfowl living in the shared waters include numerous species of ducks, geese and swans. Four duck species breed locally, while the others feed here during the winter, especially in protected bays. More than 1 million shorebirds spend portions of the winter and spring near river mouths along the inland sea, particularly in the Fraser and Skagit River deltas. Many of these birds migrate from as far south as South America to as far north as the Arctic.

Past chemical contamination caused eggshell thinning and population declines among great blue herons, which are year-round residents in the shared waters. The same conditions beset the bald eagle, peregrine falcon and osprey-all raptors that feed in nearshore wetlands and rivers. The banning of DDT has helped these birds to recover. Chemical contaminants also have been blamed for deformities in some birds in local areas of the shared waters.

While raptors and some gull, goose and cormorant species are proliferating in the shared waters, others birds are suffering. Marbled murrelets, which nest in old-growth forests, are classified as a threatened species in U.S. waters. Common murre numbers in Washington have declined by nearly 90 percent since the late 1970s. Tufted puffins have been scarce for two decades at their breeding sites, mainly on Smith and Protection islands near the international boundary. Although the specific reasons are uncertain, destruction and disturbance of breeding and feeding habitats are prime suspects in these declines.

Marine Mammals

Four pinniped (seal and sea lion) and five cetacean (whale and dolphin) species are often seen in the inland sea, and many other seals, whales and

dolphins visit occasionally.

The most abundant pinniped, the harbor seal, can be seen resting on rocks, small islands, marina floats and buoys throughout the shared waters. California sea lions also are frequently visible to human visitors. Both species are increasing in population, possibly hampering recovery of some fish stocks in parts of the shared waters. In contrast, Steller's sea lion is listed as a threatened species in the United States and is just maintaining its small non-resident population in the shared waters.

Gray whales, recently removed from the endangered species list in the United States, are becoming more frequent visitors to all parts of the shared waters. Orcas (killer whales) are sighted frequently in the straits of Juan de Fuca and Georgia, though they are less common in Puget Sound. Harbor and Dall's porpoises have been sighted less frequently in recent years and are known to be vulnerable to disturbance.

Contamination and Alteration of the Shared Waters-Recovery Times and Priorities

As part of its charge to evaluate conditions in the shared waters and recommend future actions, the British Columbia/Washington Marine Science Panel was assigned specific questions, including the following: What components of the shared waters appear to be the most sensitive to harm from human activities? What types of harm are most serious? Which types of human activities need the most management attention?

To answer these questions, the panel had to decide which of the problems in the shared waters were most harmful and required the most urgent attention. The panel members recommended that (1) before acting, managers scientifically identify the risks that various human activities pose to the shared waters; and (2) the sources of longest-lasting harm to the shared waters be given the highest priority for action.

The sections that follow outline the panel's conclusions on the most serious problems facing the shared waters and the steps recommended to address these problems. They are listed in order of priority, with the most urgent first.

Habitat Degradation and Loss

The long-term well-being of the inland sea is most vulnerable to alteration of its natural habitats. Habitat degradation may cause long-term damage to plants, fish and wildlife. Habitat loss is usually irreversible. When a natural shoreline is converted to a paved industrial site, for example, or when a river is dammed, the ecological damage is essentially permanent. Nearshore areas, along with rivers, streams and adjoining forests in the watershed, have suffered the most serious harm of all habitats in the shared waters. Natural habitat is in effect a non-renewable resource. When people destroy it today, it cannot support future generations of fish and wildlife.

Loss of Fish and Wildlife Populations

Like habitats, fish and wildlife populations are highly vulnerable to activities causing long-term or irreversible harm. Fish, shellfish, invertebrates, birds and mammals all have the potential to recover after limited overharvesting and disturbance if conditions are favorable. However, population declines can reach a point from which recovery is unlikely. Even if an animal does not become extinct, low reproductive rates, environmental conditions and the pressures of competition and predation may keep the population from rebounding.

As a species' population drops, genetic diversity is lost as well. Even if the population numbers are later rebuilt, the genetic loss can weaken the species and make it more vulnerable to many kinds of stress, including competition, predation and disease.

Numerous fish, shellfish, birds and mammals that are vulnerable to human exploitation and disturbance have suffered serious declines in the shared waters. In most cases these declines continue, and recovery is not in sight.

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Environmental recovery times of three years or less are defined as short, three to 30 years are moderate, and 30 years or more are long. Environmental harm that persists for a century or longer is considered irreversible.

Nature has considerable powers of regeneration and recovery. Most ecological harm is reversible if the cause of harm is removed. Given time, both habitats and organisms can recover from damage done to them, unless they are eliminated completely. But some problems require a longer recovery time than others.

The longer it will take for the environment to recover from harm, the more urgent the need to control the actions causing the harm. Actions that cause irreversible harm pose the most serious threat to the shared waters and should receive immediate attention. Actions that cause long-term but reversible harm also merit quick action. We can afford to wait longer to regulate activities causing harm from which the environment recovers more quickly. Whatever the recovery time, preventing damage from occurring is much more effective and less expensive than trying to repair damage already done.

Exotic Species

Irreversible changes in the environment also can be caused by organisms. When a non-native plant or animal is imported into a body of water,

accidentally or intentionally, it may cause harm to both living creatures and their habitats, harm that often cannot be undone. In waters elsewhere-the Great Lakes area, San Francisco Bay and the Black Sea-exotic animals are proliferating in the absence of predators and eating or crowding out native species.

The shared waters of British Columbia and Washington so far have not suffered significant widespread harm from exotic species and have even benefited financially from such imports as the Pacific oyster. However, valuable resources are threatened by some exotic species, such as the oyster drill, which perforates oyster shells and consumes the shellfish. Other exotic species, such as the marsh cordgrass Spartina, which usurps and alters the structure of tideflat habitats, may disrupt the entire food web in some areas. More species may be arriving daily via such routes as the ballast water of ships, raising concerns about widespread and potentially permanent ecological damage.

Freshwater Diversions

Diversion of the fresh water that feeds the inland sea is essentially a form of degradation or loss of riverine habitat, and it alters water motions and chemistry in the estuary as well. The changes we make to divert rivers, such as building dams, are intended to be permanent, and the resulting harm is permanent as well. Although the degradation of riverine habitat here is not yet as extensive as that in the Columbia River basin, diversions of rivers supplying the shared waters are partly implicated in the dramatic declines of wild salmonid stocks.

Toxic Contamination

Toxic contaminants are harmful chemicals that originate from industrial plants, urban runoff and air pollution. These include metals such as cadmium and organic chemicals such as those from petroleum products, including polycyclic aromatic hydrocarbons (PAHs).

On entering marine waters, most of these chemicals rapidly bind to particles in the water. These particles sink to become part of the bottom, creating contaminated sediment areas on the sea bottom near contaminant sources, usually in urban or industrial areas. Here they can affect bottomfish and other organisms.

Most toxic chemicals that accumulate in sediments in the inland sea reside there for long periods of time unless physically removed. However, rivers and coastal erosion provide additional sediment that naturally buries the older deposits. Contaminated sediments also can be buried artificially by capping them with material dredged from less contaminated areas.

Many toxic chemicals enter the shared waters from point sources, such as the effluent pipes from factories and sewage treatment plants, mostly in urban areas. Discharges from point sources have come under tighter regulation over the last decade, and as a result some contaminant levels appear to be decreasing in recently formed sediment layers. However, increasing population around the shared waters may reverse this decline. Toxic chemicals also reach the shared waters from diffuse nonpoint sources via storm sewers, rivers and the atmosphere. Nonpoint sources include runoff from lawns, gardens, farms, cars and streets, and even forests. The contaminants in this runoff include pesticides, fertilizers, oil, antifreeze, herbicides and sediments. Contamination from nonpoint sources has diminished little and remains a difficult challenge for water quality managers.

Oil Spills

Widespread publicity has surrounded the immediate impact of large oil spills on the marine environment. A large spill in the shared waters is highly likely within 20 years. If such a spill occurs, there will be extensive losses of plants and wildlife, commercial and recreational uses, and property values.

Most or all of this damage will be temporary, however. With the possible exception of depleted seabird stocks, the resources of the shared waters will recover in one to two decades if spared excessive additional exploitation and habitat degradation. Meanwhile, we must do all we reasonably can to prevent oil spills by minimizing the risks associated with oil transportation.

Toxic Algae

Outbreaks of toxic planktonic algae-popularly called "red tides"-appear to be more widespread in the shared waters in recent years. Many beaches must be closed to harvesting each summer because shellfish absorb toxins from a certain species of planktonic algae and become unsafe for human consumption. Farmed salmon also have sustained serious losses from toxic outbreaks of other planktonic algal species. Yet these outbreaks have occurred at some level of intensity for hundreds of years and cause little overall harm to natural fish and wildlife populations. Despite continuing research, no relationship has been demonstrated between human activities and toxic algal outbreaks in the shared waters. Current public health measures appear effective at minimizing the danger to shellfish gatherers.

Shellfish Contamination

The area of the shared waters affected by shellfish contamination has been increasing in recent years, prompting closure of beaches to commercial and recreational shellfishing. As the rural population and its discharge of septic and farm wastes expand, the resulting microbial contamination becomes more difficult to control. Fortunately, public health measures have so far been highly effective at preventing shellfish-borne illness in humans, and microbial contamination causes little or no harm to fish and wildlife. The shared waters also would cleanse themselves of this contamination quickly if sources could be controlled.

Water Contamination

Contamination of the water itself is low on the list of long-term threats to the shared waters. Because most contaminants accumulate in sediments, most of the shared waters carry very low levels of these contaminants. Only a few types, such as spilled oil and some components of industrial effluent, are suspended or dissolved in sea water, and so can be spread through the shared waters by currents. At present, most waterborne contaminants are not very toxic and are diluted to low concentrations by the large amounts of river and ocean water flushing through the system.

Municipal and industrial discharges, in particular, are now treated adequately to prevent deterioration in water quality in most of the shared waters. Sewage and other discharges currently cause problems only in poorly flushed embayments, where they must receive more advanced treatment or must be eliminated.

Unknowns

In addition to the problems already facing the shared waters and their resources, a new and unforeseen threat could materialize at any time. We have already had some surprises, such as the unexpected interference of a chemical used in boat antifouling paint, tributyltin (TBT), with reproduction in some invertebrates. In the future, some new synthetic chemical or virulent exotic species might threaten the shared waters. This threat might cause only a slight perturbation or could trigger a system-wide collapse. The best ways to prepare for such a possibility are to minimize the number and kinds of discharges to the shared waters, to continue monitoring the health of the environment, and to maintain the research and management capabilities needed to respond quickly to threats that may appear.

Recommendations for Protecting the Shared Waters

Over the next two decades, the number of people inhabiting the watershed of the shared waters is predicted to increase by almost 50 percent. This population growth will place increasing burdens on the environment. If this prediction proves correct, British Columbia and Washington will have to reduce the collective environmental burdens of shoreline development, fish catch and waste discharge significantly just to maintain our present quality of life and to keep the shared waters from deteriorating further.

Based on the list of priority problems it identified, the British Columbia/Washington Marine Science Panel assembled a series of recommendations for halting environmental decline and charting a new course toward improving the condition of the shared waters. The most important recommendations are listed first.

Prevent Habitat Loss

Given our present rate of population growth and subsequent land development, even the best planning and regulations cannot halt all destruction or degradation of some types of natural habitat. The inventory of nearshore habitats along all of the developed and many of the rural shorelines of the inland sea has reached critically low levels, however, and existing restorative measures are clearly inadequate to replace lost habitats. As a result, the living resources of the shared waters will suffer dearly for every additional loss of natural habitat.

No further loss of nearshore estuarine habitat should be allowed in embayments that already have lost a significant fraction (perhaps more than 30 percent) of their historic habitat area.

No net loss of nearshore estuarine habitat should be permitted along shorelines that have not yet been so severely degraded. Limited nearshore development, dredging and other activities that degrade or destroy habitat might be permitted in such areas. However, to compensate for the losses that are allowed, they must be accompanied by carefully monitored actions to artificially restore or enhance the remaining nearshore habitat.

These are interim measures. It is not clear how much desire or political will we have to stop destroying habitat, and what technical ability we have to repair the harm that has been done. Further research is needed to refine our understanding of how much natural habitat is required to support viable fish and wildlife populations. Ultimately, the citizens of British Columbia and Washington must decide how much of the remaining estuarine habitat they are willing to devote to this cause.

Protect Fish and Wildlife Populations

Most birds, mammals and invertebrates are still abundant in the shared waters, but numerous fish stocks and other animals are under pressure or in serious decline. Overharvesting and habitat degradation are at least partly to blame.

The time has come for state, provincial and federal agencies to shift their management priorities toward protecting fish and wildlife species rather than providing for maximum resource harvests.

Strict harvest limits are needed to prevent further losses of commercial and recreational stocks. Although most fish stocks remain more abundant in British Columbia, they ultimately will face the same pressures and potentially the same fate as Puget Sound stocks unless strong preventive measures are implemented. Salmon species such as Strait of Georgia chinook and coho salmon must be monitored carefully.

Harvest limits alone may not be enough to restore depleted fish populations. Slow reproductive rates of some species such as rockfish, continued loss of natural habitat and even changes in climate may limit the ability of natural populations to recover.

To maximize the ability of the environment to recover, we also must implement an aggressive program of habitat protection and enhancement, coupled with scientific research and monitoring to be sure that our efforts are effective and appropriately targeted.

Fish and wildlife species about which there is little information, including those harvested in non-traditional fisheries, should be managed conservatively to maintain viable population levels.

Create Marine Protected Areas

The establishment of marine protected areas could effectively safeguard both natural habitats and the fish and wildlife that inhabit them. If we set aside a portion of each major type of marine and nearshore habitat in the shared waters, we could protect specific areas against further human encroachment, permit depleted fish and invertebrate stocks to recover, and provide refuge areas for marine mammals and birds. The fish and wildlife in these protected areas could serve as brood stock to help restore depleted populations throughout the shared waters. Creating protected areas might involve closing whole embayments or stretches of coastline to all human intrusion. At the same time other areas might be set aside to protect bottomfish nursery grounds, while allowing fishing in the overlying waters.

Prevent Major Freshwater Diversions

Major freshwater diversion projects on the West Coast have had immense and far-reaching impacts on the marine environment and living resources of the region. Examples include the effects of Columbia River dams on salmon and the effects of river diversion away from San Francisco Bay on salmon, striped bass and waterfowl there.

We should not divert large volumes of fresh water from the rivers that feed the shared waters-at least until the potential impacts on marine plant and animal populations, nearshore and subtidal habitats, and estuarine circulation are more fully understood.

Minimize Introduction of Exotic Species

The shared waters are showing early signs of distress from the intentional and accidental introduction of exotic or non-native species. Furthermore, warnings from other regions affected by exotic species clearly do not bode well for the survival of many native species.

We should make serious efforts to prevent further introductions of exotic species into British Columbia and Washington. The first step should be to establish and enforce strict ballast-water regulations in the shared waters. In addition, protecting natural habitats and enhancement programs should help native marine plants and animals outcompete any introduced competitors. Educating the public also is a vital step toward reducing the intentional and inadvertent importation of exotic species.

Control Toxic Waste Discharges

Today, although some sources of toxic chemicals are being reduced, nonpoint sources remain a major obstacle to controlling sediment and microbial contamination in the shared waters. As the human population and its waste load increase, the toxic burden on sediments, fish and wildlife will grow. Toxic contamination will not be controlled, much less reduced, without considerable additional effort.

It would be very difficult to eliminate all toxic discharges into the shared waters. However, implementing careful controls on all toxic sources could reduce contamination to an acceptable level-one that protects marine life and the wholesomeness of seafood. Efforts to bring all point sources of toxic chemicals under control must continue. We must redouble our efforts to control nonpoint sources of pollution, especially surface water runoff from urban and industrial areas.

Prevent Large Oil Spills

British Columbia and Washington consume large volumes of petroleum products and will continue to do so, making occasional oil spills likely. At the same time, we have a very limited ability to remedy the harm caused by both large oil spills and chronic petroleum inputs to the ocean. This harm is temporary, but it also is unnecessary.

Preventing oil spills is much more cost-effective than cleaning them up. Reducing oil consumption and improving vessel safety are important measures for safeguarding the shared waters ecosystem.

Working Together

On both sides of the international boundary between British Columbia and Washington, numerous local, first nation or tribal, state or provincial, and federal government agencies are responsible for portions of the inland sea. Gaps and overlaps exist between the jurisdictions of these agencies, even on

one side of the border. When the shared waters as a whole are considered, historically there has been limited coordination or cooperation in managing marine resources or protecting the marine environment.

British Columbia and Washington now have taken a step toward joint stewardship of the shared waters. The results of this effort point toward the need for more extensive joint long-term planning for the region's environment and resources. This planning process should involve all levels of government and encompass all aspects of the inland sea and its watersheds, as well as any activities that affect marine resources, extending even to such matters as land use and transportation. These efforts should focus on habitat preservation; on assessment and conservation of stocks of fish, invertebrates, birds and marine mammals; on reducing waste disposal and contaminated runoff; and on developing compatible environmental regulations on both sides of the border.

The long-range planning must be rooted in scientific information. Whenever possible, British Columbia and Washington should coordinate and integrate existing research and monitoring efforts for the shared waters, sediments and living creatures. Joint projects should be initiated as well.

Despite considerable research and regulatory efforts and financial investments, we have failed to protect natural habitats and fish and wildlife populations adequately in the shared waters. The reasons for the failures are complex and unclear. A thorough, independent review of the performance of the agencies that manage the shared waters and its resources would reveal which policies and programs are effective and which should be changed.

Research and audit results should be freely available to scientists and managers of both nationalities and presented at regular joint conferences. Academic and government scientists alike should be encouraged to express their views publicly and to discuss their findings with their colleagues on both sides of the border. The citizens of both the state and the province must have full and open access to the planning process and the scientific information supporting it. Vigorous education programs, through government agencies, schools and community groups, would foster this public participation.

Working Individually: What You Can Do

Ultimately, the condition of the shared waters and surrounding lands depends on each of us as individuals. Puget Sound, the Strait of Georgia and the Strait of Juan de Fuca will never be restored to full ecological health unless we all do our part to reduce our demands on the environment and protect the ecosystem.

Every citizen can contact his or her elected representatives and urge them to work toward better preservation of natural habitats, more protection of fish and wildlife populations, restrictions on freshwater diversions and exotic species imports, closer environmental cooperation between British Columbia and Washington governments, and all of the other recommendations of the Marine Science Panel.

Also, it is important for each of us to change our own behavior to protect the environment. We all can do our best to reduce our use and improper disposal of toxic chemicals, including oil; to conserve and recycle water, forest products and household waste; and to respect the value of fish and wildlife species and the natural habitats that support them. We can also educate ourselves about environmental issues and participate in the public decision-making processes that give each of us a voice in the future of the shared waters.

Additional Reading

British Columbia Ministry of Environment. 1993. State of the Environment Report for British Columbia. Ministry of Environment, Lands and Parks. Victoria; Environment Canada. North Vancouver, B.C.

British Columbia/Washington Marine Science Panel. 1994. The Shared Marine Waters of British Columbia and Washington. Report to the British Columbia/Washington Environmental Cooperation Council.

Puget Sound Water Quality Authority. 1993. Puget Sound Update: Fourth Annual Report of the Puget Sound Ambient Monitoring Program. Puget Sound Water Quality Authority, Olympia, Wash.

Puget Sound Water Quality Authority. 1994. Puget Sound Water Quality Management Plan. Puget Sound Water Quality Authority, Olympia, Wash.

Wilson, R.C.H., R.J. Beamish, F. Aitkens, and J. Bell (eds.). 1994. Review of the Marine Environment and Biota of Strait of Georgia, Puget Sound, and Juan de Fuca Strait: Proceedings of the B.C./Washington Symposium on the Marine Environment, January 13 & 14, 1994. Canadian Technical Report of Fisheries and Aquatic Sciences 1948.

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