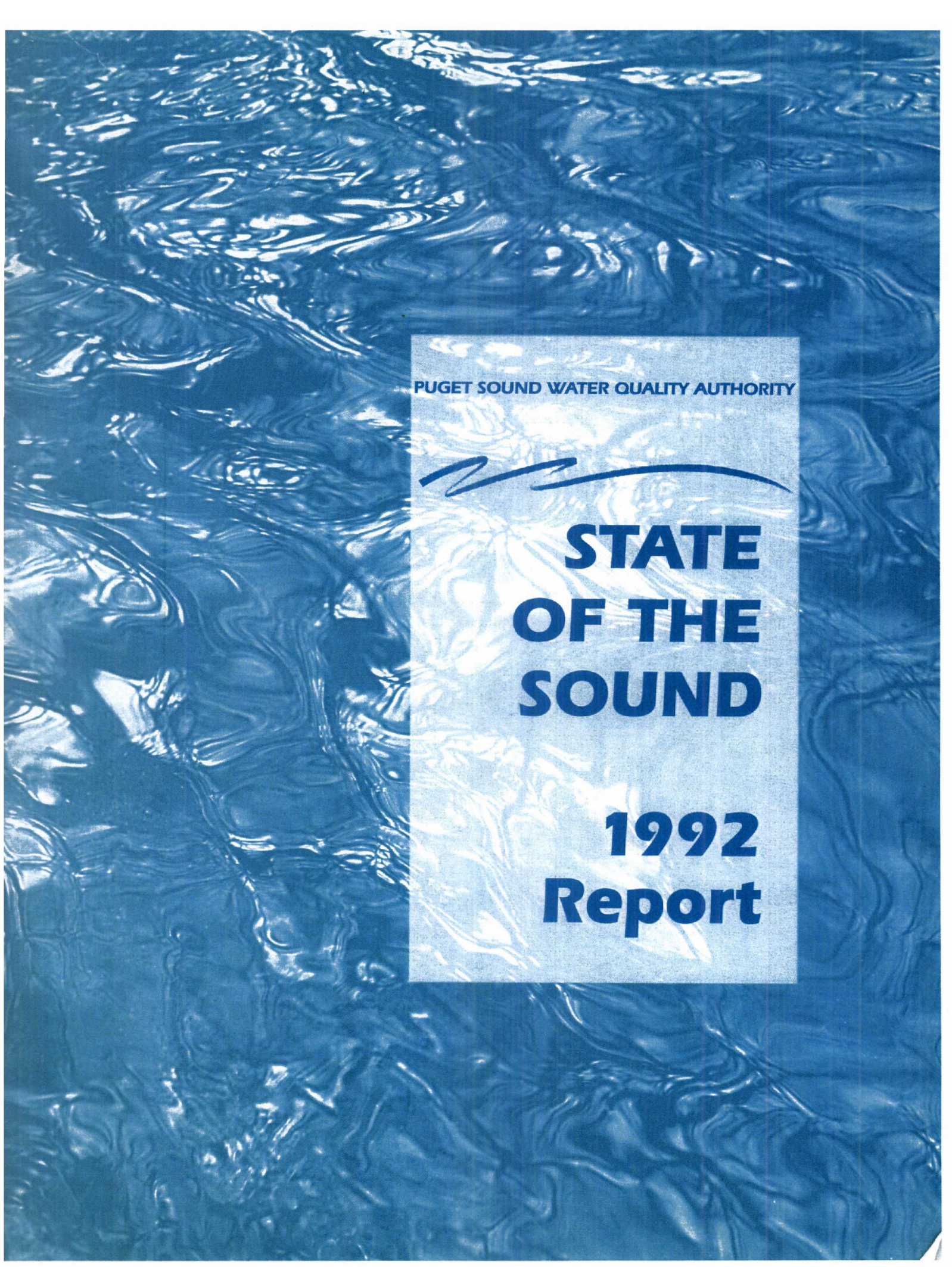
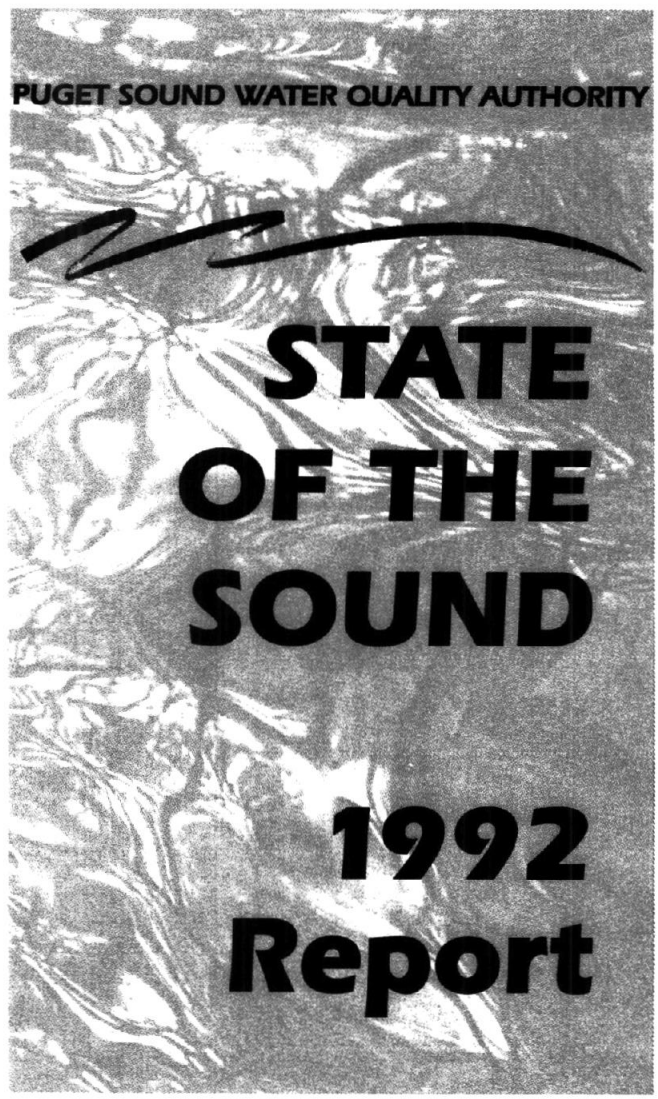


PUGET SOUND WATER QUALITY AUTHORITY

STATE OF THE SOUND

1992 Report



JUNE 1992

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This document satisfies the requirements of RCW 90.70.055 as the 1992 annual report on plan revisions and implementation and the 1992 State of the Sound Report.

PUGET SOUND WATER QUALITY AUTHORITY

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June 1992

To the Governor, the Legislature and other readers:

This is the third State of the Sound Report. The report summarizes what is known about the Sound, its resources, and the trends that threaten it. When the Puget Sound Water Quality Authority was formed in 1985 to develop a comprehensive strategy to protect the Sound and its resources, we all knew we had a long road to travel. Now, five and a half years after the first Puget Sound Water Quality Management Plan was adopted, we are seeing signs of success.

From stream rehabilitation efforts that have enticed salmon back, to watershed management projects that involve citizens in protecting the Sound, the Puget Sound community has responded to the challenge of stewardship. One year ago the Environmental Protection Agency approved the plan as a Comprehensive Conservation and Management Plan —the first estuary plan in the nation to receive such approval. Many specific actions called for in the plan have been fully or partially implemented. For example, we now have standards for sediment quality, more pumpouts for boaters, water quality field agents in five Puget Sound counties, improved local stormwater programs, effective and coordinated cleanup programs in six of our urban bays, and capital projects to correct serious problems created by combined sewer overflows. For three years the Puget Sound Ambient Monitoring Program—a coordinated effort involving six state agencies—has collected data which will be extremely useful in understanding the changing condition of the Puget Sound ecosystem. Legislation approved in 1992 gives counties authority to create shellfish protection districts, providing us an important tool to reverse the trend of shellfish bed closures. The Authority's Public Involvement and Education Fund (PIE Fund) has seeded over 100 local, innovative projects that have reached over one million residents of the state.

Consistent, adequate funding has been key to implementation of the Puget Sound plan. In 1991 the Governor proposed and the legislature approved a doubling of funds for state agencies to carry out the plan. In 1986 the legislature created the Centennial Clean Water Fund which has been critical to the basin's local governments as they take actions to protect the Sound. Our congressional delegation is seeking increased federal funding for implementation of the plan.

As we noted in the second State of the Sound report, the Sound will be slow to show the results of our efforts to protect it. The rapid growth of the basin's population will compound all of the challenges which we face, and we must anticipate that our attention to protecting the Sound will yield both good news and bad news. For example, while salmon are returning to some of the Sound's streams, harvesting of shellfish has been restricted in many areas.

We have made progress, but our job is not done. We must maintain and increase funding for actions outlined in the Puget Sound plan. We must continue to emphasize prevention of pollution, a long-term commitment to the Sound's protection, active involvement of all of the citizens of the Sound and the state in this effort, and innovative, effective and practical actions to preserve this beautiful and bountiful place for future generations.

Sincerely,

Nancy McKay

Nancy McKay
Executive Director
Puget Sound Water Quality Authority

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Many people contributed to this report. Authority staff and board members provided invaluable assistance in the compilation and review of the report. The following individuals also assisted greatly in the compilation of information, providing valuable comments and advice along the way:

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CONTENTS

INTRODUCTION

The region's rapidly growing population continues to push Puget Sound's resources to the limit, presenting new challenges for all those involved in its protection. The *1992 State of the Sound* sets the stage for some of the actions that will be necessary to protect and enhance the Sound in the 90s and beyond.

The 1980s marked a turning point for Puget Sound. Early in the decade, public attention focused on the health of Puget Sound as it continued to show signs of deterioration. Resources and habitats once viewed as inexhaustible in their bounty and unlimited in their ability to assimilate pollutants were recognized for their vulnerability to such problems as chemical contamination in fish tissue, bacterial pollution of shellfish, contamination of bottom sediments, and widespread degradation of shoreline areas.

In 1985 the legislature established the Puget Sound Water Quality Authority and charged the agency with developing and overseeing the implementation of a long-term comprehensive plan to protect and restore Puget Sound. The Authority issued the *Puget Sound Water Quality Management Plan* in 1987, followed by revisions in 1989 and 1991. While the Authority is responsible for developing the plan and coordinating its implementation, the activities and programs are carried out through a concerted effort involving federal, state, local, and tribal governments, and businesses, civic organizations, and citizens of the entire region.

Complementing these responsibilities, the legislature directed the Authority to regularly prepare a State of the Sound report describing the condition of Puget Sound and related activities to protect the resources and habitats.

The *1992 State of the Sound* is divided into four sections. The first two chapters provide background information on the resources and values of Puget Sound and the environmental effects of the basin's growing population. If you are familiar with this information, you may want to concentrate on the third chapter, which outlines the current health of the Sound, or the fourth chapter, which describes the region's efforts to protect and restore the Sound's natural environment, focusing on implementation of the Puget Sound plan. Much of the information in chapter three is summarized from the *1991 Puget Sound Update*, a separate publication of the Authority which presents the latest findings of the Puget Sound Ambient Monitoring Program.

CHAPTER 1

Photo courtesy Puget Sound Regional Council

The Resources and Values of Puget Sound

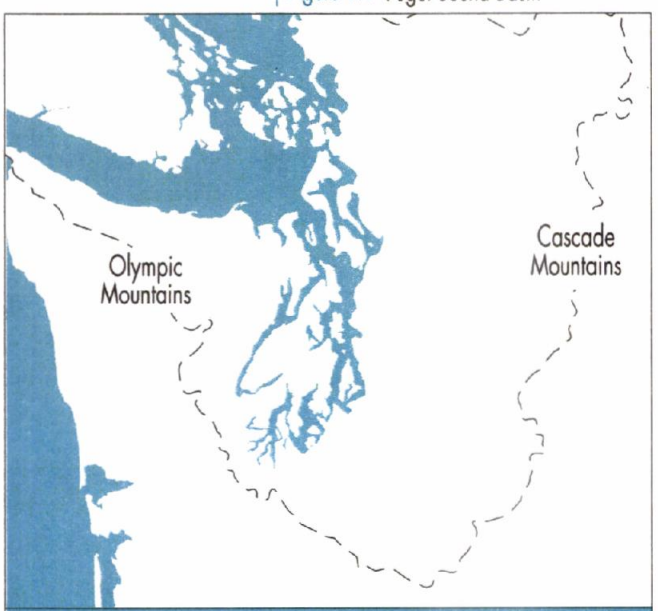
Puget Sound offers a breadth of landscapes unique in the world—the rocky shores of the San Juan Islands, the forested slopes of the Olympic Mountains, Skagit Valley's fertile floodplain, and rich, tidal mudflats in the southern inlets. The health of the Sound depends on these rich and diverse environments. We begin our discussion on the state of Puget Sound with a brief look at its resources and values.

WHERE LAND AND SEA MEET

Nestled between the Cascade and Olympic Mountains in northwest Washington, the Puget Sound basin covers more than 16,000 square miles of land and water (Figure 1.1). The basin's surface area is roughly 80 percent land and 20 percent water. At the heart of the basin lies Puget Sound—an intricate network of bays, inlets, and waterways that extend some 90 miles inland from the Strait of Juan de Fuca. The basin's rivers, streams, and ground and surface water flow into Puget Sound.

Puget Sound's striking terrain is largely the result of extensive glacial and tectonic activity. Other geologic processes, including weathering, erosion, and sedimentation, have further defined the region's landforms and physical characteristics. The upland soil and climate dictate much of the character and ecology of Puget Sound. The region's soils are relatively immature with shallow accumulations of organic material. Only along the southern and western margins of the basin and in the lower reaches of the river valleys are the soils more fertile. Plant cover is dominated by dense coniferous forests interspersed with a variety of deciduous woodlands, wetlands, and grass and shrub prairies. The soil and plant cover provide not only important and diverse habitat for wildlife, but also protection against the region's precipitation and runoff, naturally slowing, storing, and cleansing the water as it drains to the Sound.

Figure 1.1 Puget Sound Basin



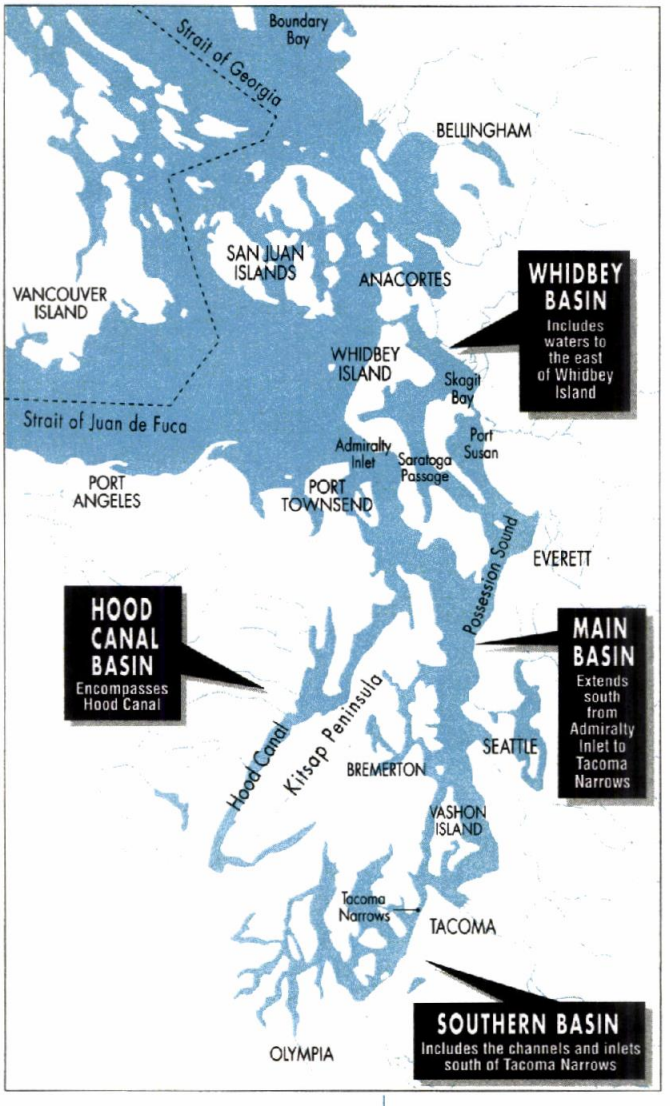
Traditionally, the name Puget Sound applied to the salt waters south of Admiralty Inlet—the channel between Port Townsend and Whidbey Island. This did not include Hood Canal, Saratoga Passage, or Port Susan. And the residents of Bellingham and Friday Harbor lived far to the north of Puget Sound. This definition is referred to as Puget Sound proper.

The legal definition of Puget Sound includes all salt waters of Washington inside the international boundary line between the state and British Columbia in Canada. Thus, Bellingham Bay and the waters among the San Juan Islands, as well as Hood Canal, are now referred to as part of Puget Sound. This area is usually called the Puget Sound basin. The Puget Sound plan applies to this entire area and the rivers, lakes, and streams of Washington state that drain into Puget Sound and the Strait of Juan de Fuca.

Puget Sound is an estuary—a semi-enclosed glacial fjord where water from the ocean is partially mixed with fresh water that drains from the surrounding land. Marine water flows from the ocean to the Sound mainly through the Strait of Juan de Fuca. Made up of a series of underwater valleys and ridges, called basins and sills, Puget Sound reaches a maximum depth of 930 feet just north of Seattle. A shallow sill—about 195 feet deep—at Admiralty Inlet separates the deeper waters of the Strait of Juan de Fuca from the deeper waters of Puget Sound proper. Similarly, sills in the area of the San Juan Islands separate the Strait of Juan de Fuca from the Strait of Georgia.

South of Admiralty Inlet, Puget Sound proper consists of four interconnected basins (Burns, 1985) (Figure 1.2). The largest and deepest of these, the Main Basin, consists of two sub-basins and extends some 60 miles from Admiralty Inlet to the Tacoma Narrows. The Main Basin contains roughly 60 percent of the total volume of the four Puget Sound basins. Around the Tacoma Narrows, a shallow sill separates the Main Basin from the Southern Basin. Although it contains only a small portion of the Sound's volume, the Southern Basin's numerous islands, shallow inlets, and winding shoreline make it the most complex of the four basins. To the north and east of the Main Basin (but not separated by a sill) is the Whidbey Basin. This basin lies to the east of Whidbey Island and includes the waters of Possession Sound, Port Susan, Saratoga Passage, and Skagit

Figure 1.2 Location Map



Bay. The smallest of the four basins, in terms of area, is the Hood Canal Basin on the western side of the Sound. This long, narrow channel branches from the Main Basin south of Admiralty Inlet and extends about 80 miles south between the Olympic Mountains and the Kitsap Peninsula.

Close to 2,250 miles of coastline (Hagen, 1958) flank greater Puget Sound. The shoreline environment is a complex mixture of beaches, bluffs, deltas, mudflats, and wetlands. Forming a bridge between land and ocean, they nurture some of the most dynamic and productive habitats in the world.

THE ESTUARY AT WORK

The waters of Puget Sound move in a typical estuarine pattern—seaward at the surface and landward at the lower depths. This circulation pattern is influenced by a number of factors, including the action of the tides, the configuration of waterways, and the presence of fresh water.

Lighter fresh water from land enters the estuary and tends to flow over the salty seawater. As this happens, friction and turbulence cause some of the seawater to mix with the fresh water, creating a brackish (moderately salty) layer at the surface. This surface layer, which ranges from 30 to 190 feet deep in different parts of the Sound, flows seaward while denser marine water is drawn into the deeper layers of the estuary.

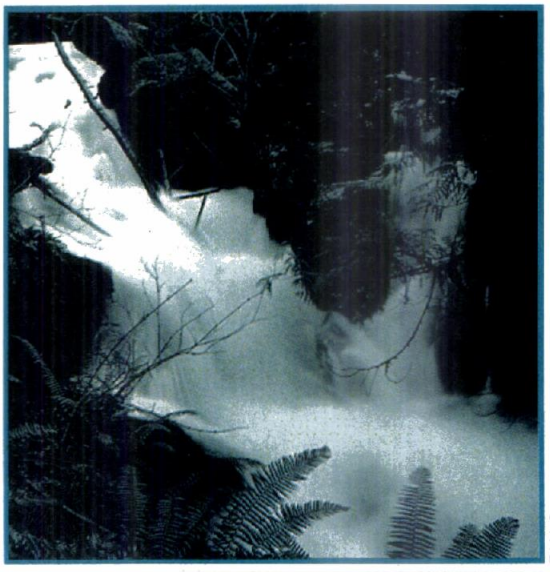
The two-layer circulation system is disturbed by shallow sills which recirculate water from the surface back into the depths of the basin. In particular, sills at the Tacoma Narrows and Admiralty Inlet have a tremendous influence on the movement of water through the basin.

Puget Sound's large tidal range also affects the flow of water—the difference between high and low tide is close to 12 feet at Seattle, significantly more than in other estuaries, such as Chesapeake Bay. This results in a large amount of water moving in and out of the estuary with the tide. When the tide rises, water is forced into the Southern Basin. On the falling tide, water from the Southern Basin is forced northward as a mixed, shallow water flow to become part of the seaward-moving surface flow in the Main Basin. This circulation pattern acts as a pump to raise deep water toward the surface at the south end of the Main Basin. Mixing at the Admiralty Inlet sill draws seaward-moving surface water down into the inward-moving salty water from the Strait of Juan de Fuca (Duxbury, 1991, personal communication). Oceanographers estimate that one-quarter to one-half of the brackish surface water that flows toward Admiralty Inlet is recirculated back into the Main Basin (Ebbesmeyer and Barnes, 1980; Cokelet, et al., 1988).

In addition to the influence of sills and tidal action, water flow is complicated by the islands, narrow passages, and changes in water depth that characterize Puget Sound. In some of the shallow, semi-enclosed bays of the Southern Basin, for example, water tends to move quite sluggishly. In contrast, water is funneled at high speeds through some of the passages connecting with the main system.

These estuarine circulation patterns also affect the millions of tons of sediment and other materials transported to or resuspended in the Sound.

However, unlike the waters that eventually move seaward, most particles are permanently trapped in the basin. Particles temporarily suspended in the surface layer tend to settle in the deeper layer faster than they can be carried out to sea. Once in the lower layer they may move back toward land and settle over a wide area, with the smallest particles settling farthest from their source. In the Main Basin, only a small fraction of the particles initially present in the surface water are carried past Admiralty Inlet (Baker, 1984).



T.W. Ransom

FRESHWATER RESOURCES

The continual flow of fresh water into Puget Sound has a tremendous influence on the character of the estuary. This movement of water includes surface runoff, groundwater discharge, and direct precipitation.

Seasonal and annual precipitation patterns vary dramatically across the region due to the effects of the mountainous terrain on marine air masses. Annual precipitation amounts range from 15 to 30 inches in the rainshadow areas between the northern Olympic Mountains and the San Juan Islands, to more than 200 inches in the upper elevations of the Olympics. About three-quarters of the precipitation falls during the rainy season between October and March. Surface runoff, in turn, is also greatest at these times, particularly in December and January. Groundwater baseflow and meltwater from the snowpack and glaciers augment surface flows during the spring and summer months.

ANNUALLY, ABOUT 39 MILLION ACRE-FEET OF FRESH WATER FLOWS FROM THE RIVERS OF THE BASIN

The cycling of fresh water through the basin has created a drainage network of more than 10,000 streams and rivers, each carrying sediments, nutrients, and other materials to the Sound. Annually, about 39 million acre-feet of fresh water flows from the rivers of the watershed. Of this total, about 33 million acre-feet, or over 10 trillion gallons, flows into the channels of Puget Sound proper (Williams, 1984).

Ten rivers account for nearly 85 percent of the basin's annual surface water runoff: the Nooksack, Skagit, Snohomish, Stillaguamish, Cedar/Lake Washington Canal, Duwamish/Green, Puyallup, Nisqually, Skokomish, and Elwah rivers (Williams, 1984). Three of these rivers—the Skagit, Snohomish, and Stillaguamish—empty into the Whidbey Basin between Skagit Bay and Possession Sound and account for nearly 60 percent of the runoff into the four Puget Sound basins (Burns, 1985). With portions of their watersheds located in Canada, the Nooksack and Skagit rivers are influenced by land-use activities outside the Puget Sound planning area.

In discussing the region's freshwater resources, it is important to include the Fraser River, which empties into the Strait of Georgia at Vancouver, British Columbia. Although it is outside the formal Puget Sound planning area, the Fraser River is the dominant source of fresh water for the regional estuarine system, providing up to 60 percent of the dilution for the entire southern passage around Vancouver Island (Thomson, 1981). The contribution of fresh water from the Fraser River is nearly three times larger than the volume of all rivers that flow into Puget Sound proper (Burns, 1985; Kennett and McPhee, 1988).

Groundwater is another major source of fresh water affecting the character of the Sound. Local studies reveal significant discharges of groundwater to surface and marine waters. On a regional scale, estimates of groundwater flow into Puget Sound are unavailable, but the contribution is thought to be sizeable. To better understand the character of the basin's freshwater resources, the U.S. Geological Survey recently initiated a regional assessment of the basin's groundwater system (Vaccaro, 1991, personal communication). Results of the study, conducted as part of the nation's Regional Aquifer System Analysis Program, will be available in a few years.

THE VALUES OF PUGET SOUND

In practical terms, we sometimes define the Sound's value according to the economic benefits of its water-dependent activities, such as shipping, boating, fishing, and shellfishing. But the value of Puget Sound also includes religious and cultural values that are fundamental in the lives of many people in the region, particularly the tribal communities. It includes aesthetic values that are often highly personal and abstract, such as the beauty of a landscape. And it includes environmental values that are vital to the long-term health of the region—flood control, water quality protection, and nutrient cycling.

Following is an overview of some of the Sound's more prominent environmental and economic values.

Habitats and Environmental Values

The Puget Sound ecosystem is a diverse collection of marine, freshwater, and terrestrial habitats. The local marine environment alone supports over 220 species of fish, 26 species of marine mammals, 100 species of seabirds, shore birds and waterfowl, and many more invertebrate and plant species (Washington State Department of Wildlife, 1991; Puget Sound Water Quality Authority (Authority), 1991). Although sometimes viewed as separate worlds, the habitats of the Sound and the surrounding watersheds are closely linked by the movement of life, water, and energy through the region.

The vast food web within these habitats links the survival of the smallest plants and animals to that of the largest. Losing any one of the life forms in the web could also affect our own well-being.

Open Water Habitats

The open water habitats of Puget Sound are affected by nutrients, sunlight, currents, fresh water, sediments, and weather. Due in part to these numerous and ever changing factors, open water habitats sustain a variety of organisms. These include small, free-floating plants and animals called phytoplankton and zooplankton, as well as free-swimming fish, mammals, and seabirds.

Open water habitats are an important part of the ecosystem's highly productive food web. The Main Basin is not only one of the most productive areas of the Sound, it has one of the highest phytoplankton production rates of all deep water estuaries in the world (Strickland, 1983). Phytoplankton are an important building block of the region's food web. Much of the phytoplankton growth takes place in the upper 60 feet of the water column between spring and fall when sunlight is plentiful. Stability of the water column and availability of nutrients to the upper layer are also necessary for this growth. Once primary production begins, the entire food web prospers. Zooplankton, which include larvae from shrimp, clams, snails, crab, barnacles, sponges, starfish, worms, sea cucumbers, sand dollars, smelt, cod, and sole, increase in numbers as they feed on the phytoplankton. Zoo-plankton move into the rich surface layer in search of food, warmer water, and stronger currents (Strickland, 1983). The zooplankton, in turn, become a rich supply of food for the larger fish, birds, and mammals of the Sound as water circulates food over the entire depth of the Main Basin.

Puget Sound: A Way of Life for Northwest Tribes

The springs and rivers that flow to the Sound are the veins and arteries of the lands we revere. The water is the blood. The Sound is the heart of my people, and all the creatures that exist there are my brethren. The fish can be harvested to feed our children, but only if we appreciate them as gifts of Nature and do not abuse the privilege. For a thousand generations, Indian people have been able to depend on these gifts for sustenance, civilization, and culture.

Now, in the blink of an eye, the rivers of the Sound are poisoned.

Few people today realize that the world was once a paradise. My grandfathers could easily gather all forms of food and natural medicines they needed to survive. Fish filled the rivers and beaches were rich with shellfish. There was hard work, but there was also ample time for every person to learn from the elders of their tribe, to personally experience the wonders of nature.

But we must live in this modern world and do what we can to keep it liveable. We must have sustenance. We must also respect our ancestry. We have learned from today's civilization, but there is also much that all people can learn from the wisdom of the ages. Indian and non-Indian alike must listen to the lessons passed along through the generations, lessons that kept this land and its resources healthy and pure from time immemorial.

The non-Indian approach to Nature has been different from ours in many ways. He separates himself from his environment through the removal of forests and the pouring of concrete. But the connection is still there, and he must open his eyes to it. Take only what you need. Use all that you take. Let the riches that you enjoy be those that nature intends. Teach your children the beauty of the swimming fish and the wandering bear before you buy them the fishing rod or the hunting rifle. Pursue inner happiness before the superficial. Care for Nature, for without her your children will not survive.

We must all work together in order to sustain our life here.

—Bill Frank Jr., Chairman, Northwest Indian Fisheries Commission

Benthic Habitats

The Sound's bottom, or benthic, habitats are another vital link in the productive ecosystem. The composition of these communities varies considerably depending on the texture and character of bottom material, water depth, and exposure to the rising and falling tides. The distribution of sediments is determined largely by the size and source of the sediments, topography of the underwater basins, and currents and tidal action of the estuary. Sand, cobbles, and rocks are commonly found in areas with swiftly moving water. Finer sediments such as silt and clay tend to settle in areas of the Sound with weaker currents.

Soft-bottom habitats of silt and clay are generally very productive habitats—home to a variety of organisms that live on the surface and burrow into the sediments. The fallout of decayed organic material (detritus) from the overlying waters is an important source of food for these communities. Clams, worms, shrimp, sea cucumbers, sea urchins, hydrocorals, and brachiopods are common to soft-bottom areas, as are popular sport fish such as flounder and sole.

Hard-bottom habitats of gravel, cobbles, and rocks are found in areas with greater wave exposure and water movement, such as the western shore of Whidbey Island and the sills at Admiralty Inlet and the Tacoma Narrows. Rocky bottom surfaces, or substrates, provide a firm base to which many animals and plants, in shallow water, can attach. Some organisms find food and shelter within the less stable sand and gravel bottoms. Organisms common to the coarse-sediment areas include worms, shrimp, chiton, scallops, starfish, rockfish, lingcod, sea urchins, copepods, octopuses, cockles, clams, and geoducks.

Nearshore Habitats

Nearshore habitats cover the tidal and shallow subtidal areas of the shoreline. The availability of sunlight and the presence of vegetation help distinguish these areas from the deeper benthic habitats. Although virtually all areas of the shoreline support some form of plant life, the nearshore habitats are sometimes classified according to the prevalence of vegetation. Throughout the basin, unvegetated habitats such as beaches cover about seven times more area than vegetated nearshore habitats such as salt marshes and eelgrass beds (Boule', et al., 1983).

The Sound's intertidal gravel, sand, and mudflats support many of the region's prized shellfish and wildlife populations. Amphipods, worms, shrimp, snails, and clams are common to these areas, providing valuable food for diving ducks, juvenile salmon, raccoons, and numerous other mammals, birds, and fish. These habitats also provide valuable spawning grounds for many species of marine fish. Oysters are found in both the warmer, hard-bottom areas and attached to hard surfaces atop softer sediments, especially other oyster shells. Seaweeds such as green sea lettuce, brown rockweed, red algae, and brown kelp are also found in hard-bottom areas. The plants attach to the bottom by a holdfast that secures them against wave action and currents; they provide valuable habitat for many species of fish, including salmon and herring.

Eelgrass beds flourish in fine-sediment segments of the lower tidal region. These flowering, perennial plants establish dense beds of roots, rhizomes, and leaves that stabilize bottom sediments and attract large numbers and varieties of plants and animals. While some animals feed directly on the plants, many others feed on either the detritus that accumulates around the beds or the microalgae, seaweeds, organic coatings, bacteria, and mi-

The Benefits of Wetlands

Puget Sound wetlands take many forms—tidal marshes, eelgrass meadows, shrub and scrub wetlands, bogs, and wet meadows to name a few. These diverse areas provide economic and environmental benefits that, in many cases, have been overlooked and abused. In many respects, we are just beginning to understand the values of wetlands and their role in the larger ecosystem.

As key components of the basin's drainage system, wetlands absorb and store water during periods of heavy rain and runoff. This significantly reduces peak river flows and related effects of flooding. The storage and infiltration of water also helps recharge groundwater supplies. During drier periods, wetlands serve as reservoirs that help maintain surface flows and protect critical habitats. The vegetation and gentle slopes slow the movement of water, allowing sediments, nutrients, and chemicals to settle out before reaching and affecting other resources. This vital function helps maintain the quality of water that flows into the basin's rivers, groundwater, and eventually Puget Sound.

Healthy wetland systems serve numerous other functions as well. They stabilize streambanks and protect shores against the damage of waves. Salmon and other fish use wetlands as nurseries and spawning grounds; seabirds, waterfowl, and other birds use them to breed and nest. Entire food webs benefit from wetlands. They serve as vital areas of nutrient cycling for ecosystems. Additionally, wetlands support harvestable resources such as fish, shellfish, and berries.

—Ginny Broadhurst, Wetlands Program Lead, Puget Sound Water Quality Authority

crofauna that colonize on the leaves. Herring and snails add to the plant coverings by depositing eggs on the blades. Eelgrass beds and other wetland habitats, including the Nisqually and Skagit flats, Padilla Bay, and Dungeness Spit, are important feeding grounds for bird populations along the Pacific flyway (Evans-Hamilton, 1987).

Salt marshes are found in the upper intertidal region of the shore such as the delta areas of the Skagit, Snohomish, and Nisqually rivers. These highly productive habitats are governed largely by salinity, substrate texture, and the frequency and duration of inundation (Authority, 1990). Marsh vegetation includes salt-tolerant grasses, sedges, and other nonwoody plants. The marshes provide food and shelter for crab, shrimp, juvenile salmon, birds, and many upland animals (Thom, 1987). They also provide critical spawning habitat for many species of fish and shellfish.

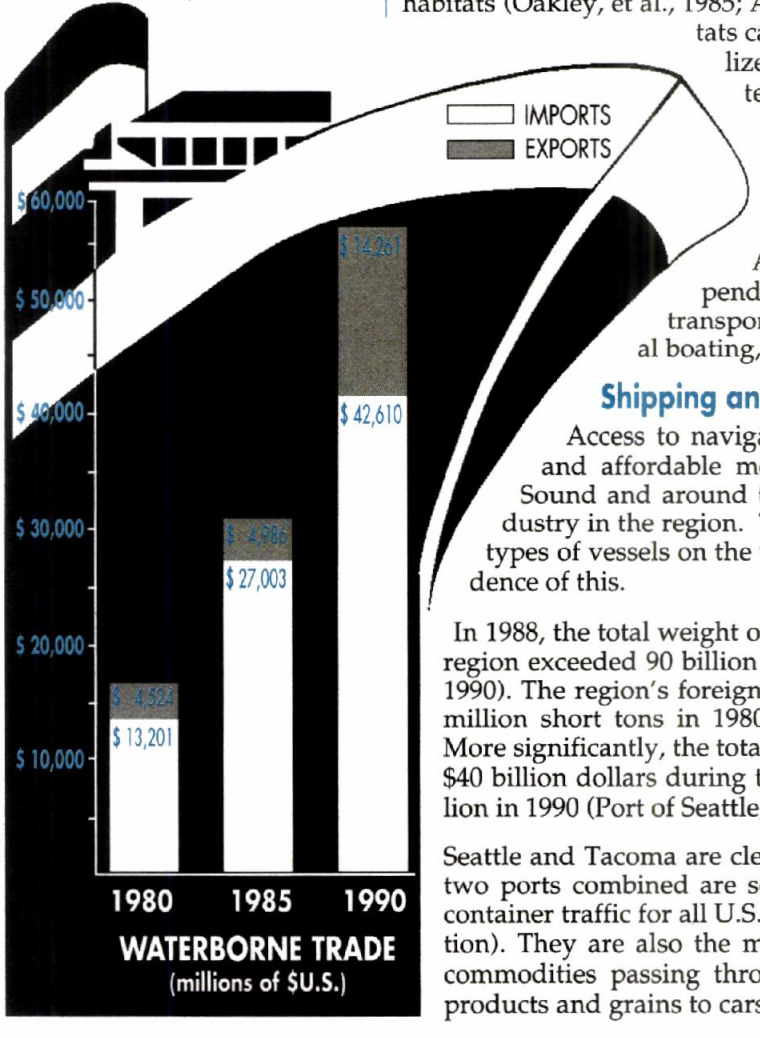
Freshwater and Riparian Habitats

Lakes, rivers, and freshwater wetlands are collectively referred to as freshwater habitats. Freshwater wetlands, like their estuarine counterparts, are transitional environments between water and land. They include lacustrine wetlands (shallow, vegetated areas associated with lakes), riverine wetlands (in river channels), and palustrine wetlands (other areas that are continuously or periodically wet such as bogs, swamps, and wet meadows). Wetlands serve a variety of functions, ranging from fish and wildlife habitat to flood and erosion control.

Freshwater habitats are strongly dependent on the health of adjacent riparian habitats. Located along the banks of rivers, lakes, and wetlands, riparian habitats are highly productive habitats that provide animals with food, water, and cover, as well as travel and escape corridors. For these reasons, the abundance of wildlife found in riparian zones and wetlands is greater than in any other terrestrial habitat. In western Washington well over 80 percent of all wildlife species rely on wetland and riparian habitats (Oakley, et al., 1985; Authority, 1990). In addition, riparian habitats can help control erosion and pollution, stabilize streambanks, and moderate stream temperatures.

Figure 1.3 Waterborne Trade in the Puget Sound Region: 1980-1990

Reference: Port of Seattle, 1991



Economic Values

Puget Sound plays an integral role in the region's successful and growing economy. Among the economic activities that are dependent on Puget Sound are shipping and transportation, fishing and shellfishing, recreational boating, and tourism.

Shipping and Transportation

Access to navigable water has allowed for the convenient and affordable movement of people and goods across the Sound and around the world. Marine shipping is a major industry in the region. The crowd of ferries, cargo ships, and other types of vessels on the waterways of the Sound provides clear evidence of this.

In 1988, the total weight of waterborne commerce in the Puget Sound region exceeded 90 billion short tons (U.S. Army Corps of Engineers, 1990). The region's foreign waterborne trade increased from about 31 million short tons in 1980 to almost 35 million short tons in 1990. More significantly, the total value of traded goods increased by almost $40 billion dollars during the same period, climbing to nearly $57 billion in 1990 (Port of Seattle, 1991) (Figure 1.3).

Seattle and Tacoma are clearly the region's leading ports. In fact, the two ports combined are second only to Los Angeles/Long Beach in container traffic for all U.S. ports (Hannus, 1991, personal communication). They are also the most diversified of the region's ports. Key commodities passing through the region's ports range from wood products and grains to cars and petroleum. Certain commodities tend

to dominate other areas of the Sound—petroleum at the refineries in Anacortes Harbor, logs and related wood products in Olympia, Port Angeles, and Everett.

Puget Sound ports estimated in 1989 that the shipping industry provided nearly 2,000 jobs at the marine terminals and another 71,000 related jobs in Puget Sound (Washington Public Ports Association, 1989). In a separate study, the Port of Tacoma estimated that in 1988 its activities alone supported nearly 70,000 jobs statewide. (Port of Tacoma, 1990).

The waterways are also vital transportation links among the coastal communities of the Sound. In 1990 more than 21 million people traveled the Sound on the state's ferry system, compared to roughly 17 million passengers in 1984 (Washington State Department of Transportation, 1991). The number of vehicles carried by ferries in 1990 exceeded 9.1 million, an increase of approximately 22 percent since 1984.

Fisheries and Aquaculture

The fish and shellfish of Puget Sound are important symbols of the region's heritage. Salmon, clams, oysters, and other sea life are also valuable economic resources in the state's fishing and aquaculture industries. In 1990 the total commercial value (ex-vessel or farm-gate value) of the Sound's fisheries was $73.5 million (Figure 1.5) (Washington State Department of Fisheries (Fisheries), 1991a). The five-year average from 1986 to 1990 was slightly higher at $77.5 million. The retail value of these catches was substantially higher—perhaps three times—than the reported commercial values. Salmon and shellfish continue to anchor the region's fishing and aquaculture industries, followed by a variety of other species including herring, cod, trout, perch, sole, and flounder, as well as algae, sea urchin roe, and sea cucumbers.

Recreational fishing has an added impact on the Sound's economy, the success of which rests largely on the health of the fish and shellfish. In 1988 the Puget Sound region accounted for well over 50 percent of the state's recreational salmon catch, including over 306,000 salmon from marine waters and another 90,000 salmon from the rivers of the watershed (Fisheries, 1991b). In the same year, Hood Canal yielded a recreational shrimp catch of over 142,000 pounds and the 1986 recreational oyster harvest was 58,000 pounds. Recreational clam diggers collected about 3.3 million pounds of hardshell clams from around the Sound in 1988 (Fisheries, 1991b).

FISHERY	1990 CATCH WEIGHT	1990 CATCH VALUE (U.S. dollars)
Salmon	33,767,036 lbs.	$43,740,822
Other Anadromous	2,414,473 lbs.	$ 5,914,936
Shellfish	20,232,010 lbs.	$21,910,491
Baitfish	1,609,268 lbs.	$ 703,799
Groundfish	3,959,802 lbs.	$ 1,229,604
TOTALS	61,982,589 lbs.	$73,499,652

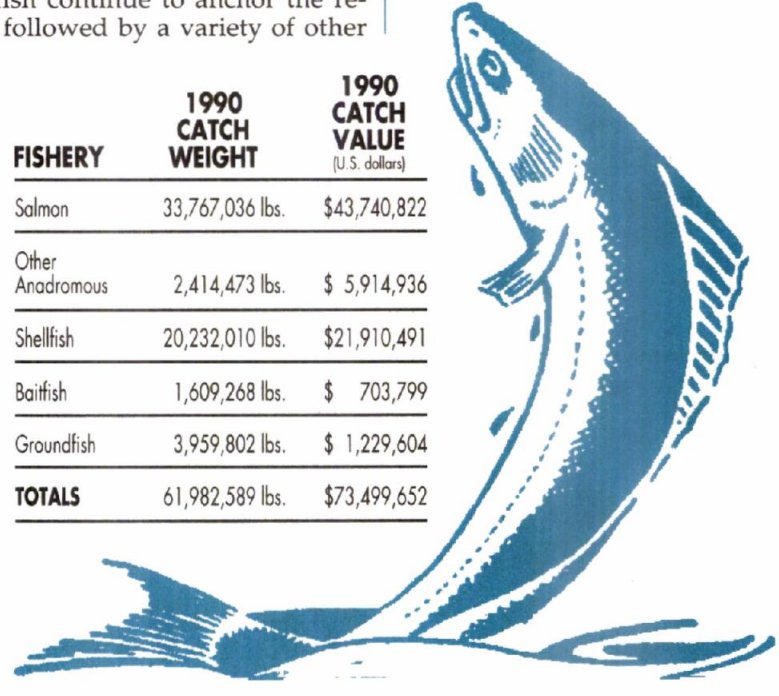


Figure 1.5 1990 Commercial Catch Value of Puget Sound Fisheries

Reference: Washington State Department of Fisheries, 1991a

Tourism

The variety of the region's natural environments makes Puget Sound an attractive travel destination. Whether it's kayaking in the San Juans or strolling along the Seattle waterfront, the basin teems with vacation and day-trip opportunities. During the 1980s, statewide revenues from tourism doubled and related employment increased by about 50 percent. Estimates for 1989 indicate that tourism and travel in Washington generated between $4.2 and $5 billion in revenue, and supported between 80,000 and 90,000 jobs in the state. The Puget Sound region accounted for nearly 80 percent of these statewide revenues and 75 percent of the jobs (Washington State Department of Trade and Economic Development, 1990a and 1990b).

Recreational Boating

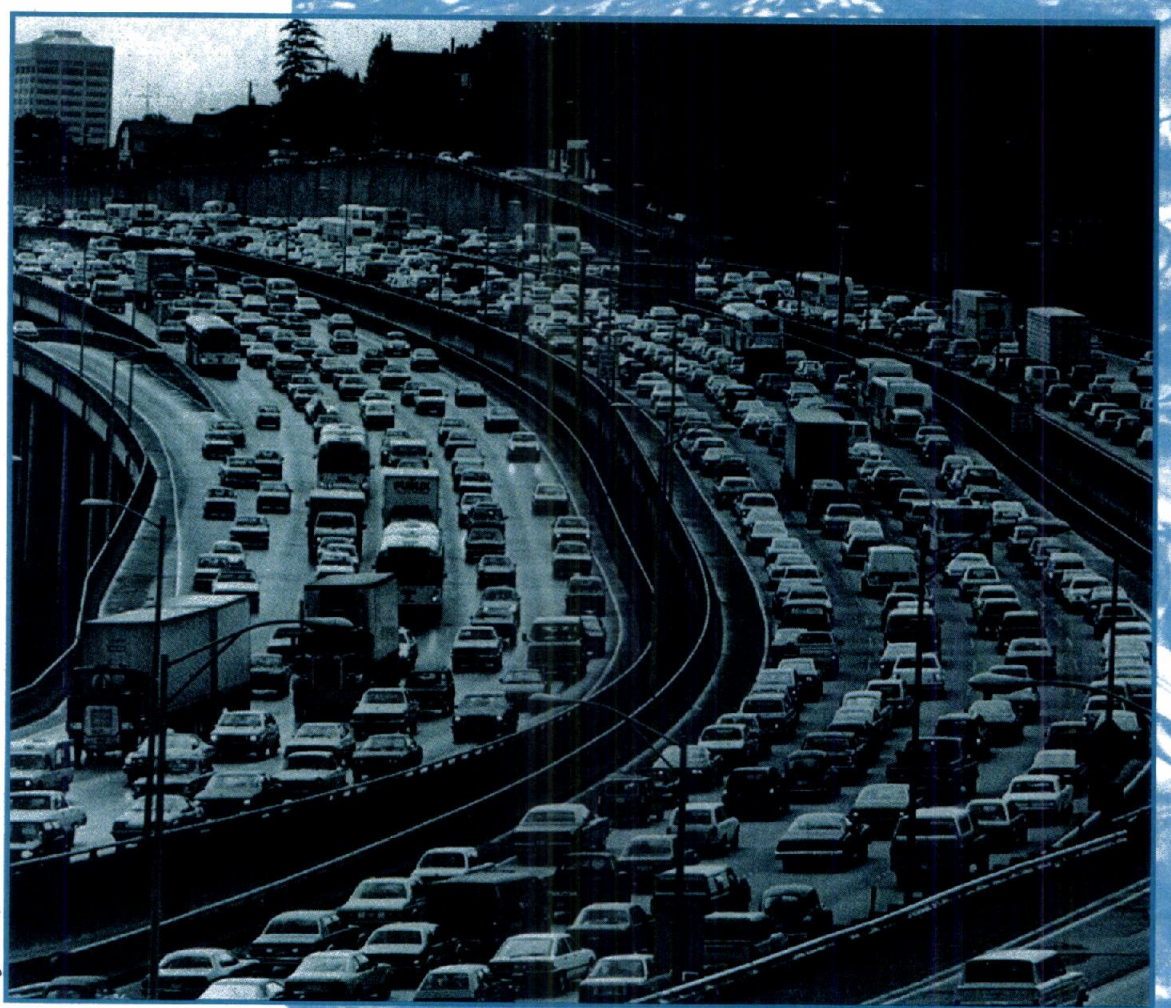
Thousands of residents and tourists enjoy the waters and shores of the Sound in a variety of boating activities. In 1990 Washington residents owned nearly 656,000 boats, kayaks, canoes, rowboats, sailboards, and

other watercraft, the vast majority of which were located in the Puget Sound region (Stokes, 1991). Almost 80 percent of the state's 350 marinas and over 85 percent of the state's 39,400 moorage slips are located along the shores of Puget Sound (Goodwin, 1991). In 1989 the recreational boating industry had an estimated impact of $2.14 billion on the state's economy, including nearly $1.5 billion in direct output and over $660 million in wages, rents, profits, and taxes. This industry employed an estimated 21,000 people statewide in manufacturing, retail and wholesale trade, and boating services (Stokes, 1991). At least 80 percent of this activity can be attributed to the Puget Sound region (Authority, 1988; Schlomann, 1991).

THE REST OF THE STORY

This chapter's descriptions of the resources and values of Puget Sound border on the ideal—clean waters, lush habitats, productive food webs, and extensive use of the valuable resources. But the information serves only as a backdrop for the sobering challenges that today face the region. How does the region's growing population affect the quality of Puget Sound? Does the way in which we use the land and resources hurt the environment? The ensuing chapters address these and other questions, looking first at the reasons behind the threats to Puget Sound, then assessing the health of Puget Sound and its resources, and finally outlining some of the ongoing efforts to manage and protect these resources.

CHAPTER 2



Greg Gilbert, Seattle Times

People and Puget Sound: Growing Impacts

The Puget Sound region is witnessing tremendous change. Rural settings are being overwhelmed by housing and commercial developments. Forests and meadows are being replaced by roads, homes, office buildings, and shopping malls. These changes are taking a toll on the health of the region's most vital resource—Puget Sound.

It is ironic that the very resources that fostered the region's prosperity are now suffering the consequences of its success. Groundfish and salmon fisheries, shellfish beds, and wetland resources have been damaged by aspects of this growth such as sewage, industrial wastewater, stormwater runoff, marinas, and logging. The situation in the Puget Sound basin has been compared to the problems in Los Angeles during the era when smog developed. Puget Sound is entering its own era of underwater smog.

To understand the challenges facing the Sound, we need to understand how our land uses and personal actions affect the health of the estuary—how isolated and seemingly insignificant activities impact the resources of Puget Sound. This chapter first touches on the pressing issues of growth and land use in the Puget Sound basin, and then examines the ways that people affect the habitats and resources of the Sound.

Photo courtesy Puget Sound Regional Council

STRESS ON THE ENVIRONMENT STEMS FROM THE WAY WE HAVE GROWN, NOT SIMPLY FROM GROWTH ITSELF

POPULATION AND LAND USE

Over the past few years, the Puget Sound region has experienced extraordinary growth in its population, economy, and related development. These changes have awakened the Puget Sound community to both the perils of growth and the challenges of growth management. The region has experienced rapid growth at other times in its history, but for a number of reasons, today's changes are affecting the character of the region in new and threatening ways. One reason is that while the growth percentages may not be unprecedented, the absolute increases in population and land-use activities are. Another is that the growth is occurring in all areas of the basin, not just the central Puget Sound region. And a third reason is our perception of the changes. As we continue to witness the side-effects of growth, we face difficult questions about our ability and willingness to protect the region's quality of life and natural resources.

In the opinion of many, the region's growing and sprawling population poses the single greatest threat to the health of Puget Sound. The basin's current population is about 3.4 million people, three-quarters of which live in King, Pierce, and Snohomish counties. Between 1980 and 1990, the basin's population grew by almost 620,000 people, an increase of 23 percent. A number of areas experienced substantially higher growth rates, particularly Snohomish (38 percent), Island (37 percent), Thurston (30 percent), Kitsap (29 percent), San Juan (28 percent), and Jefferson (28 percent) counties (Figure 2.1). Population forecasts for the next 20 years foretell continuing changes for the Puget Sound region. The basin's population is expected to increase by another 1.1 million people by the year 2010. Roughly two-thirds of this growth is expected to occur along the urban corridor of Pierce, King, and Snohomish counties. In King County alone, the population is growing by over 23,000 people each year. A population the size of Bremerton is added to the 12-county region every eight months.

In discussing the effects of growth, population increases are only part of the picture. For example, between 1970 and 1990, the population of central Puget Sound (Pierce, King, Snohomish, and Kitsap counties) increased by 38 percent. During the same period, land consumed by new developments rose 87 percent (Puget Sound Council of Governments, 1990). These relationships are supported by earlier figures in the 1986 State of the Sound report which estimated that a 20 percent surge in population between 1987 and 2000 would be accompanied by a 62 percent increase in urban and suburban land uses, and a 73 percent increase in rural residential land uses. As stated by one observer, "the stress on the region's environment stems from the way we have grown, not simply from growth itself" (King, 1991).

Where development occurs is another critical point. More and more, land uses are encroaching upon the most sensitive of the basin's remaining habitats. Growth pressures are also sending development further upstream in most areas of the basin. And waterfront homes are frequently built on marginal soils that cannot filter out pollutants very well, adding to water quality problems. This pattern of development negatively affects entire watersheds.

Taking into account the inherent impacts of intensifying land uses, the future does not bode well for the resources of Puget Sound. Considering the many sources of pollution that already affect the basin and the habitat losses that continue to occur each day, what will be the condition of Puget Sound when another one, two, or three million people live in the basin?

THE COST OF GROWTH

Ecosystems such as those in Puget Sound are dynamic—continuously and naturally changing in form and character. But these ecosystems cannot withstand the types of changes that are occurring as a result of unmanaged growth and development.

The complexity of our water quality problems reflects the diversity of our land uses and lifestyles, our misuse of natural resources, and the sheer number of people now living in the basin. Actions taken by individuals on their private property often affect public resources or the private property of others. Filling a wetland may destroy habitat necessary for the reproduction of salmon or cause a neighbor's property to flood. Paving a parking lot may help cause stormwater to scour the life out of a creek or to flood a homeowner downhill. Simple actions, even on our own private

Figure 2.1

PUGET SOUND POPULATIONS, 1980 — 2010

COUNTY	1980 CENSUS	1990 CENSUS	CHANGE 1980-90	2000 FORECAST[2]	2010 FORECAST[2]
San Juan	7,838	10,035	28%	13,029	15,103
Jefferson	15,965	20,406	28%	24,142	28,333
Mason	31,184	38,341	23%	47,671	56,190
Island	44,048	60,195	37%	73,687	89,152
Clallam	51,648	56,204	9%	61,294	65,584
Skagit	64,138	79,555	24%	84,927	94,728
Whatcom	106,701	127,780	20%	141,097	156,168
Thurston	124,264	161,238	30%	202,897	242,036
Kitsap	147,152	189,731	29%	218,805	254,958
Snohomish	337,720	465,642	38%	578,314	698,961
Pierce	485,643	586,203	21%	673,800	762,590
King	1,269,749	1,507,319	19%	1,739,516	1,967,524
PUGET SOUND TOTAL[1]	2,686,050	3,302,649	23%	3,859,179	4,431,327
Other Counties	1,446,106	1,564,043	8%	1,652,871	1,744,285
STATE TOTAL	4,132,156	4,866,692	18%	5,512,050	6,175,612

1 A small portion of the 12-county population is located outside the Puget Sound watershed.

2 Forecasts adjusted by +2.7 percent to reflect 1990 census figures. OFM forecasts published August 1989.

Reference: Office of Financial Management, 1990, 1991

property, have consequences for others. We all live downstream from someone.

Whether it's lawn care in Puyallup, land clearing in Sequim, manufacturing in Bellingham, or driving along Interstate 5, virtually all our activities can pose a significant threat to Puget Sound. Some actions cause immediate problems, others affect water quality only when combined with other activities over an extended period of time.

Contamination of Water and Sediments

Contaminants are substances that are not naturally present in the environment or that are present in such unusually high concentrations that they damage resources and habitats. As a society, we produce, use, and dispose of a tremendous variety of natural and synthetic materials that can potentially affect water quality. They include organic materials (ranging from natural organic matter to manufactured chemicals), inorganic chemicals (such as metals and nutrients), biological contaminants (bacteria and viruses), and sediments. The effect contaminants have on the environment depends on a number of complicated, interactive factors. These include the physical and chemical properties of each contaminant, how and where it is transported, and whether the contaminant changes form when exposed to natural elements and other pollutants (Connell and Miller, 1984).

Contaminants make their way to the Sound along a number of pathways, ranging from erosion to atmospheric deposition. But clearly the most significant carrier is water. As water cycles through the ecosystem, it flushes a wide mix of contaminants from the basin—fertilizers and pesticides from lawns and farms, oils and fluids from roads and parking lots, soils and nutrients from fields and building sites, industrial discharges, and human waste and household chemicals from sewers and septic systems.

Contaminants generally enter the Sound either dissolved in water or attached to sediments or particles carried by water. The more soluble a contaminant is, the longer it will remain in the water column and the better chance it has to eventually leave the Sound. Contaminants that easily bond to particles, on the other hand, tend to settle out of the water column relatively quickly. Where they settle depends on their size and density, as well as the strength and direction of the currents.

Because many contaminants attach readily to particles, contamination in bottom sediments is far more concentrated than it is in the water column. Once considered sinks or burial places for contaminants, bottom sediments are now considered important sources of recontamination in the water column and food web as chemicals are released from the sediments long after settling to the bottom. Highly contaminated areas, or hot spots, are found mostly in the Sound's urban bays. This is the result of past industrial activity, concentrated populations and land uses, contributions of pollution and sediments from tributary rivers, and poor circulation patterns that trap particles inside the bays.

Once settled, a contaminant's effect on the environment depends on a number of factors—continual changes in chemical inputs; chemical interactions between contaminants, seawater, and other substances; and internal changes that occur as plants and animals accumulate or transform

Why are Shellfish Beds Continuing to Close?

Since 1980, pollution has resulted in the downgrade of 16 commercial shellfish beds around Puget Sound to restrict harvesting. In several cases, the beds were totally closed to commercial harvesting. Recreational beaches are also being threatened with pollution, especially in urban areas of the Sound. Two major state parks on Hood Canal—Dosewallips and Belfair—were closed to shellfish harvesting by the state Parks and Recreation Commission due to fecal contamination.

Over the past decade, the rate of closures and downgrades has accelerated. Early on, most closures were caused by point source pollution, such as malfunctioning or inadequate municipal or industrial treatment plants. But in recent years, most closures have been caused by nonpoint pollution sources, including failing on-site septic systems, runoff from agricultural lands, sewage discharges from watercraft, and stormwater.

Nonpoint source pollution is difficult to identify and even more difficult to correct because it originates from such dispersed and varied sources. The sources can vary dramatically from one watershed to the next. Closures in the southern half of the Dosewallips flats, for example, have been attributed to over 400 harbor seals that defecate directly on the shellfish beds. At North Bay, a number of old septic systems discharging directly and indirectly to the beds have caused that area to be downgraded. In most other locations there are a number of sources that contribute to the problem. At Burley Lagoon, for instance, runoff from non-commercial farms and failing septic systems have been identified as the reasons for the closure.

Nonpoint source pollution has been around a long time. But, in many respects, the problems we see today are a product of growth: pollution sources are intensifying with increases in population densities. If improperly managed growth continues along shorelines and in shellfish watersheds, we can expect additional downgrades or closures.

—Gary Plews, Washington Department of Health

T.W. Ransom

UNLIKE THE WATERS THAT EVENTUALLY MOVE SEAWARD, MOST SEDIMENTS ARE TRAPPED IN THE BASIN

the substances.

Because of their potential toxicity, synthetic organics and heavy metals are chemicals of particular concern in the Sound's bottom sediments. Synthetic organics, such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (DDT for example), are compounds created by humans. These substances are readily absorbed by organisms, accumulate in their tissues, and cause mutations, cancer, skin disease, reproductive abnormalities, or death. Natural organics can also be harmful to marine life when present in unusually high concentrations. Petroleum hydrocarbons, for example, are naturally occurring organic molecules that become harmful when introduced to the ecosystem in large quantities. Heavy metals such as lead, copper, and mercury also exist naturally, but some metals alter their form in the presence of other chemicals and can accumulate in the tissues of plants and animals. Mercury, for example, is only moderately harmful until it forms methyl mercury which accumulates in the liver and muscle tissue of animals where it may cause disabilities and death.

Degradation of Habitats

We also affect the environment through our direct use and development of the basin's resources and habitats. In water quality terms, these changes often have a double-edged effect on the environment. When we alter or destroy valuable habitats, we lose natural functions that are critical to the health of the ecosystem—open areas for groundwater recharge, buffers or undisturbed areas that trap and assimilate contaminants, vegetation that protects stream temperatures, and cover and food supplies for fish and wildlife populations. In their place come roads, parking lots, and septic systems that add to the basinwide loading of contaminants. In short, every acre we convert from its natural state to developed land adds to the cumulative impact of the human population while lessening the environment's natural ability to assimilate these impacts without sustaining harm.

For example, as we alter the basin's wetlands system, we reduce the environment's natural ability to reduce surface water flows and to absorb and break down contaminants, thus increasing our vulnerability to flooding and pollution. Despite these social and economic consequences, wetland losses continue. Roughly 50 percent of the state's freshwater and marine wetlands have already been lost to development. The state continues to lose between 900 and 2,000 acres of wetlands each year (Canning, 1989). Early in the century, wetlands were routinely drained and filled for agricultural and industrial purposes. In the Puget Sound region, around 70 percent of the tidally influenced emergent wetlands have been lost to diking, dredging, and filling (Washington State Department of Ecology, 1989). In recent years, the pace has slowed somewhat due to an increased awareness of the value and function of wetlands, the dwindling supply of accessible wetland property, and stronger regulations governing the use and development of wetlands.

SOURCES OF POLLUTION

Although the sources of pollution that threaten Puget Sound are numerous and disperse, many have one thing in common—people. The way we work, live, and play directly influences the amount and types of pollutants that make their way into the Sound. Whether it's doing laundry, constructing a new building, changing the oil in a car, or applying manure to a field, even our most routine activities have the potential to degrade water quality.

The following discussion outlines the major pollution sources that affect the health of Puget Sound.

Municipal and Industrial Facilities

Municipal sewage treatment facilities are significant sources of contamination to Puget Sound. Contaminants released from these facilities vary dramatically depending on the population of the community, the types of homes and businesses served by the system, and the level of treatment. Illustrating the influence of land use, the Municipality of Metropolitan Seattle (Metro) estimated in the mid-1980s that residential sewage flows to the West Point plant contributed about 60 percent to the total flow, almost 40 percent of the conventional contaminants and 55 percent of the extractable organics. In contrast, commercial sources contributed less than 20 percent of the total flow, but over 40 percent of the metals and volatile organics (Galvin, et al., 1984).

There are three types of sewage treatment. Primary treatment is the simplest form of treatment and leaves the most contaminants in the water. It is a physical process of settling and skimming that removes about half the metals and conventional pollutants (bacteria, nutrients, biochemical oxygen demand, or BOD, and total suspended solids) from wastewater (Galvin, et al., 1984). Secondary treatment generally involves biological processes, removing 85 to 95 percent of the conventional pollutants, three-quarters of the metals, and a variable percentage of other toxic pollutants from wastewater. More stringent levels of treatment, such as tertiary treatment, can involve a variety of processes aimed at further reducing the concentration of particular contaminants. The LOTT (Lacey, Olympia, Tumwater, Thurston County) regional treatment facility which currently contributes to a nutrient enrichment problem in Budd Inlet, is being redesigned to remove 95 percent of the total organic nitrogen from the plant effluent.

There are 26 major municipal treatment plants in the Puget Sound basin, all of which are required to provide at least secondary levels of treatment (Figure 2.2). Eighteen of these facilities are already providing secondary treatment while the remaining eight plants are in various stages of upgrading from primary to secondary treatment. Only the LOTT facility in Olympia is currently required to upgrade to tertiary treatment. While the levels of treatment are improving, the basinwide flow of wastewater through these facilities is also on the rise due to population increases, offsetting some of the positive effects of the improvements.

A primary by-product of the treatment process is sewage sludge. As plants upgrade to secondary treatment, sludge production approximately doubles. Treatment provides a tangible benefit to the receiving waters of Puget Sound, but presents a problem regarding reuse or disposal of sludge. Depending on its chemical and physical properties, sludge can be a valuable resource (which can be spread on forest or agricultural lands) or a hazardous product. It is often rich in nutrients and high in contaminants such as metals and pathogens. Efforts to minimize contaminants in wastewater thus increase opportunities to recycle and effectively use the sludge.

MAJOR MUNICIPAL DISCHARGES IN PUGET SOUND

SOURCE	FACILITY TYPE[1]	DISCHARGE TO	AVERAGE DRY WEATHER DESIGN FLOW (MGD)*
Anacortes, city of	Sewer Systems, P	Guemes Channel	0.05
Bellingham, city of	Sewer System, P	Bellingham Bay	19.60
Bremerton, city of	Sewer System, S	Sinclair Inlet	10.10
Central Kitsap	Sewer System, S	Pt. Orchard Bay	4.80
Chambers Creek	Conv. Act. Sludge, S	Puget Sound	18.00
Midway Sewer Dist.	Sewer System, S	P.S.–East Passage	4.32
Edmonds, city of	Sewer System, S	Puget Sound	7.00
Enumclaw, city of	Sewer System, S	White River	2.40
Everett, city of	Sewer System, S	Snohomish River	10.60
Lakota Water/Sewer	Sewer System, S	P.S.–Dumas Bay	10.00
Lynnwood, city of	Sewer System, S	Browns Bay	4.50
Metro, Alki	Sewer System, P	P.S.–Main Basin	5.30
Metro, Carkeek Pk.	Sewer System, P	P.S.–Main Basin	3.50
Metro, Renton	Act. Sludge, S	P.S.–Main Basin	125.00
Metro, Richmond B.	Sewer System, P	P.S.–Main Basin	1.57
Metro, West Point	Sewer System, P	P.S.–Main Basin	125.00
Miller Creek	Sewer System, S	P.S.–Main Basin	4.80
Mt. Vernon, city of	Sewer System, S	Skagit River	3.96
LOTT (Olympia)	Act. Sludge, S	Budd Inlet	16.30
Pt. Angeles, city of	Sewer System, P	St. of Juan de Fuca	3.20
Puyallup, city of	Sewer System, S	Puyallup River	4.78
Salmon Creek	Sewer System, S	P.S.–Main Basin	6.40
Shelton, city of	Sewer System, S	Oakland Bay	1.80
Sumner, city of	Conv. Act. Sludge, S	White River	2.00
Tacoma, Central	Sewer System, S	Puyallup River	38.00
Tacoma, North	Sewer System, P	Comm. Bay	10.00

Figure 2.2

[1] P = Primary Treatment, S = Secondary Treatment
* MGD = million gallons per day

Reference: Department of Ecology, 1991

Industrial facilities are another significant source of pollution. Across the basin, industries account for roughly one-third of the freshwater use and are major contributors of certain contaminants to the Sound (Authority, 1988). Industries either discharge wastewater to municipal treatment facilities or provide on-site treatment with direct discharge. Over the years, the basin's major industries have significantly improved their wastewater treatment methods and resulting discharges.

Industries that rely on municipal sewage facilities often use pretreatment processes to first remove toxic contaminants and conventional pollutants from their waste stream. These processes reduce contaminants that may interfere with or pass through the municipal treatment process, thus improving the quality of the effluent and related by-products. Metro credits pretreatment processes with helping to dramatically improve the quality of its sludge over the past decade. Between 1981 and 1990, the level of metals in Metro's sludge declined by 76 percent for cadmium, 70 percent for chromium, 57 percent for copper, 60 percent for lead, 52 percent for nickel, 50 percent for mercury, and 26 percent for zinc. While a variety of factors and programs contributed to each of these reductions, the declines in cadmium and chromium, in particular, are largely attributed to industrial pretreatment (Municipality of Metropolitan Seattle, 1991).

Combined Sewer Overflows

Many of the basin's municipal wastewater systems handle both sanitary sewage and stormwater runoff. When it rains, a number of these systems are unable to handle the combined flow of sewage and stormwater, resulting in overflows or discharges of untreated wastewater. Once considered relatively harmless, combined sewer overflows are now viewed as significant sources of pollution. Combined sewer overflows often discharge directly to sensitive streambank and shoreline areas of the basin.

Figure 2.3

PUGET SOUND COMBINED SEWER OVERFLOW SITES

SYSTEM	VOLUME* Million gallons per year	DISCHARGE TO	Number of Outfalls
Anacortes	15.7	Guemes Channel	3
Bellingham	2.8	Bellingham Bay	1
Bremerton	50.3	Sinclair Inlet Pt.Orchard Pt. Wash. Narrows	16
Everett	442.0	Pt. Gardner Snohomish River	16
Metro	1,850.0	Elliott Bay Duwamish River Lake Union the Ship Canal	25
Mt. Vernon	117.0	Skagit River	2
Olympia	0	Budd Inlet	3
Pt. Angeles	10.0	Pt. Angeles Harbor	7
Seattle	305.0	Elliott Bay Duwamish River Lake Union the Ship Canal Portage Bay Montlake Cut	66
Snohomish	2.5	Snohomish River	2

* *Estimates provided by dischargers.*

Reference: Department of Ecology, 1991

At present, there are still a number of uncorrected combined sewer overflow discharge sites in the basin, some overflowing infrequently, others on a regular basis. As outlined in Figure 2.3 overflow sites are located throughout the Puget Sound region. Local governments are at different stages in developing and implementing plans to reduce or eliminate the flows.

Although sewage and stormwater flows are separated to reduce or eliminate the untreated discharges, as long as urbanization continues to generate large volumes of sewage and runoff, proper management of the entire wastewater flow will remain a challenging problem.

Stormwater Runoff

Stormwater is another significant source of contamination in many areas of the basin. While surface runoff occurs throughout the region, stormwater generally refers to runoff from the urban and suburban areas of the basin—industrial, commercial and residential lands, highways, and related construction activities. In these areas, ground covered by pavement and concrete prevents stormwater from running its natural course and filtering into the ground. Water flowing over rooftops, parking lots, and other impervious surfaces, as well as construction sites and other exposed areas, collects and carries an assortment of contaminants toward the Sound—sediments, nutrients such as fertilizers, bacteria and viruses, and toxic materials such as arsenic, cadmium, chromium, copper, lead, mercury, organic pesticides, and petroleum products (Galvin, 1987). Stormwater pollutant concentrations and runoff volumes are often comparable to effluent flows from

sewage treatment facilities and other direct pollution discharges. Some stormwater flows are treated; many are not. Not surprisingly, the effects of stormwater can be particularly significant near storm drain outfalls. In addition, heightened runoff volumes from developed land often exacerbate streambed scouring and flooding, and affect habitat and fisheries.

Stormwater is controlled or treated primarily through the use of best management practices. This includes treatment practices (e.g., detention/retention basins) as well as source control practices which are more preventive in nature (e.g., vegetated buffers around construction sites). Of the many strategies for managing stormwater, the use of biofiltration techniques is receiving much attention. Vegetated swales, for example, are constructed channels lined with grass or other vegetation that reduce the rate of runoff and promote sedimentation and infiltration. Maintenance of the swales and other best management practices requires proper disposal of the accumulated sediments and contaminants. Other control strategies include public education, litter control, reduction of impervious surfaces, wetland preservation, erosion prevention, detention/retention facilities, constructed wetlands, oil/water separators, and treatment of stormwater (National Association of Industrial and Office Parks, 1990).

Oil and Chemical Spills

Oil and chemical spills occur throughout the basin, but their effects are particularly devastating when they occur directly in the water. Depending on the type of oil or chemical, the material often remains on the surface where it directly affects surface habitats and bird and mammal populations. Substances that settle to the bottom or wash ashore have equally damaging effects on bottom and nearshore habitats. Figure 2.4 shows the large oil spills in Puget Sound to which the state has responded over the past two years.

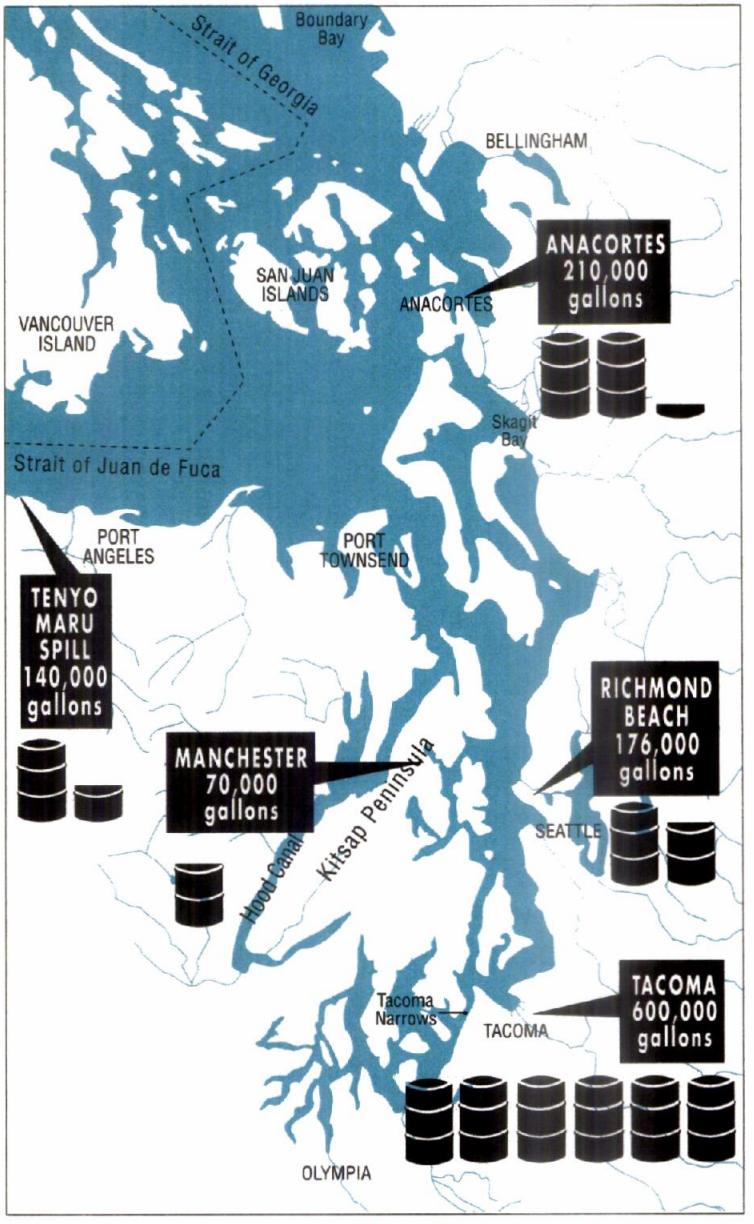


Figure 2.4 Large Oil Spills Affecting Puget Sound, 1990-1991

Reference: Department of Ecology, 1991

Although much attention is given to spills involving oil barges and tankers, the problem is much broader than this. Other sources include chronic, small-volume spills that occur in the harbors, marinas, and upland areas of the basin.

Dredged Material Disposal

The dredging and disposal of sediments can increase turbidity and temporarily block sunlight to aquatic plants, bury bottom dwelling organisms, and foul the gills of animals. Historically, dredging practices relocated contaminated sediments from one part of the Sound to another. Today, however, most dredging projects have relatively minor impacts since special management conditions are imposed by federal and state agencies to avoid unacceptable adverse effects.

The Puget Sound Dredged Disposal Analysis Program and subsequent management efforts have provided a basis for unconfined, open water disposal of cleaner dredged materials in Puget Sound. Sites which contain contaminated sediments warrant special considerations in removing

the dredged material. Because there are currently no public multiuser disposal sites (for navigation or cleanup purposes), contaminated sediments are either left in place or require very costly handling and disposal (Urabeck, personal communication, 1991).

Nonpoint Sources

Nonpoint sources of pollution occur throughout the watershed. The term nonpoint describes pollution that originates from a number of dispersed activities and sources rather than a larger, more distinct source, such as a discharge pipe for a municipal treatment plant or industry. Typical nonpoint sources include wastewater from failing on-site septic systems, animal wastes from hobby and commercial farms, pesticides and fertilizers, sewage, paints and oils from boats and marinas, chemicals and debris from forest practices, and sediments from a variety of land uses. Although these dispersed activities may seem trivial when compared to larger, more focused sources of pollution, their cumulative contribution to the basin's water quality problems is enormous.

On-Site Sewage Disposal Systems

The failure of on-site sewage disposal systems is an important source of contamination that falls under the nonpoint source category. Although septic systems are generally considered failed only when effluent collects on the surface or the system no longer passes wastewater, damage to water resources can occur long before these symptoms appear. There are a number of reasons why septic systems fail—poor construction, improper use, inadequate maintenance, or unsuitable site conditions related to soils, water table, or lot size. The Department of Health estimated in 1985 that there were approximately 383,000 septic systems in the Puget Sound area, and about 11,000 new systems were being built each year (Authority, 1986). There may now be over 450,000 systems around the waters of Puget Sound. Health professionals also estimate that basinwide, 3.5 to five percent of the septic systems fail each year (Authority, 1988). More detailed surveys tend to support an average failure rate of five percent, although rates of 40 percent and higher have been documented in areas with restrictions on shellfish harvesting.

Failing and poorly maintained septic systems present imminent threats to both human health and environmental quality. In addition to household chemicals that may be improperly disposed of through on-site systems, household wastewater contains viruses, bacteria, and other microorganisms that could cause gastrointestinal infections, typhoid, cholera, and hepatitis. Contamination by fecal coliform bacteria (which is used as an indicator of the presence of pathogens) has restricted commercial and recreational shellfish harvesting in a number of the Sound's bays and inlets.

THE EFFECTS OF URBANIZATION ON WATER SYSTEMS RANGE FROM FLOODING AND STREAM EROSION TO HABITAT LOSS

Bob Brittain, King Co. Surface Water Management

Agriculture

Habitat and water quality degradation also stem from a variety of animal and crop production activities. Cropping practices disturb soils and ground cover, resulting in increased runoff and contamination from chemicals and sediments. Improper manure management, overgrazed pastures, and poorly controlled animal access to stream corridors degrade water quality. The related effects include contamination from sediments, fecal bacteria, nutrients, salts, and pesticides, as well as damage to riparian and wetland habitats.

Water quality problems and habitat degradation resulting from agricultural sources can be significantly reduced through the use of best management practices on hobby and commercial farms. Best management

practices include improvements such as stream fencing and buffering, streambank revegetation, contour farming, conservation tillage, nutrient and pesticide management, and animal waste management. The Department of Ecology is developing a waste discharge permitting program for the state's commercial dairy operations that will result in more widespread use of best management practices.

Forestry

Roughly 80 percent basin's land area is covered by forests. About half of these lands are actively managed for commercial harvest (Authority, 1986). Annually, 50,000 to 75,000 acres of timber are harvested in the Puget Sound region (Authority, 1989). Typical forest practices that can degrade water and sediment quality include road construction, maintenance and abandonment; site preparation; clearcut and partial cut practices; removal of streamside vegetation; salvage logging; herbicide and pesticide spraying; and poor management of logging slash and debris.

Effects of these practices include sedimentation, chemical contamination, elevated stream temperatures, higher runoff volumes, and the loss of fish and wildlife habitat. Issues currently receiving much attention through public, private, and cooperative management programs (such as the Forest Practices Board and the Timber/Fish/Wildlife Agreement) include enhanced protection of wetlands, riparian zones, and other habitats critical to fish and wildlife populations; the timing, sizing, and location of timber harvests; chemical applications; and the cumulative effects of forest practices.

Marinas and Recreational Boating

Recreational boating is especially popular in Puget Sound. Unfortunately, however, practices associated with boating can affect the marine environment, particularly around marinas and popular moorage spots. In addition to direct habitat losses and shellfish bed closures caused by marina developments, environmental impacts are attributed to sewage, antifouling paints, household chemicals, plastics and other garbage, and fuels and fluids from engines and fuel docks. Some of the contaminants include fecal bacteria, heavy metals, organic chemicals, detergents, solvents, and petroleum hydrocarbons.

One of the more important issues related to marinas and boating is sewage disposal and its effect on the basin's shellfish. Sewage discharges increase the biochemical oxygen demand and introduce disease-carrying bacteria to the waters. Studies have found elevated fecal coliform concentrations in areas of concentrated boating activity (Milliken and Lee, 1990; Washington Department of Health, 1989).

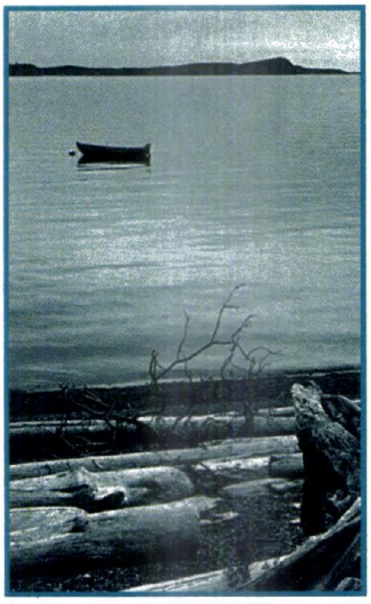
CHAPTER 3

Photo courtesy Department of Ecology

The Health of Puget Sound

Virtually no area of the basin has escaped the effects of contamination and degradation. Serious problems are restricted to areas near the shorelines and urban bays. However as the human population expands, signs of contamination are emerging in places that were once considered immune to pollution—areas such as rural bays and the deep basins of the Sound. Additionally, widespread degradation of natural shoreline areas has diminished the quality and quantity of critical fish and wildlife habitat.

Although little is known about the cumulative effects of human activities on the biological populations of Puget Sound, it is hard to ignore the indications that our presence is taking a toll on the basin's environment. Closures of shellfish beds to harvesting, diseases in bottomfish, and occasional fish kills are directly related to the contaminants we dispose of in the Sound. Many seabirds are less abundant because their habitat is being lost to development. Some fish runs have been severely reduced because of habitat loss and overfishing. Even stands of native seagrasses and populations of shellfish are threatened by competition from dominant non-native species.



T.W. Ransom

POLLUTION IS TAKING A TOLL ON RURAL BAYS ONCE CONSIDERED IMMUNE TO THE EFFECTS OF POLLUTION

MEASURING THE SOUND'S HEALTH

Information on the extent of pollution in the Puget Sound basin comes from a variety of sources. Many studies have been done on sediment contamination in the urban bays at Seattle, Tacoma, Bremerton, Bellingham, and Everett. Federal Superfund investigations have included portions of Commencement Bay, Elliott Bay, and Eagle Harbor. Dischargers and dredgers also collect information on levels of contamination near populated shorelines.

The Puget Sound Ambient Monitoring Program (PSAMP) was established in 1988 to provide comprehensive information on contamination at sites remote from discharges. Over the next decade, PSAMP will provide crucial measurements about the long-term trends in pollution and habitat loss throughout Puget Sound.

SEDIMENT QUALITY

Sediments—the sand and mud that lie on the bottom of Puget Sound—are an important part of the basin's ecology. The health of many plants and animals living on or near the bottom depends on sediments that are free of contaminants.

In general, sediments in the nearshore areas of urbanized bays are more contaminated than those in open water or less developed areas (PTI, 1988). Scientists have studied sediment contamination in Seattle's Elliott Bay, Commencement Bay in Tacoma, Everett Harbor, Bremerton's Sinclair Inlet, and Bellingham Bay. Their findings reveal contamination from stormwater and sewage discharges, and from past and present industrial practices. Also contributing to the problem are shoreline modifications, such as bulkheading, which disrupt the natural movement of sediments.

Sediments in the nearshore areas of less developed bays may also be contaminated due to stormwater runoff, sewage discharge, and past and present industrial practices. Among these areas are Eagle Harbor, located on Bainbridge Island, and Shilshole Bay, at the mouth of the Lake Washington Ship Canal (Malins et al., 1985; Tetra Tech, 1988a).

Sediments in Puget Sound are often contaminated with elevated concentrations of toxic metals such as lead, copper, and mercury, and with organic compounds such as PCBs and polynuclear aromatic hydrocarbons (PAHs).

Metal Contamination

In central Puget Sound, metal concentrations in sediments show a gradual increase from the start of industrial times (about 1860), reach a peak between 1930 and 1950, then show a decrease in recent decades (Romberg et al., 1984; Bloom and Crecelius, 1987). This downward turn may be due in part to the gradual switch to unleaded gasoline and the pretreatment of industrial wastes by industries prior to their release to municipal sewer systems (Romberg et al., 1984; Crecelius and Bloom, 1988).

At least 10 bays and harbors in Puget Sound contain sites that do not meet state sediment quality standards and minimum cleanup levels for metals (Authority, 1992a). These elevated contamination levels threaten the health of bottom-dwelling animals in the bays.

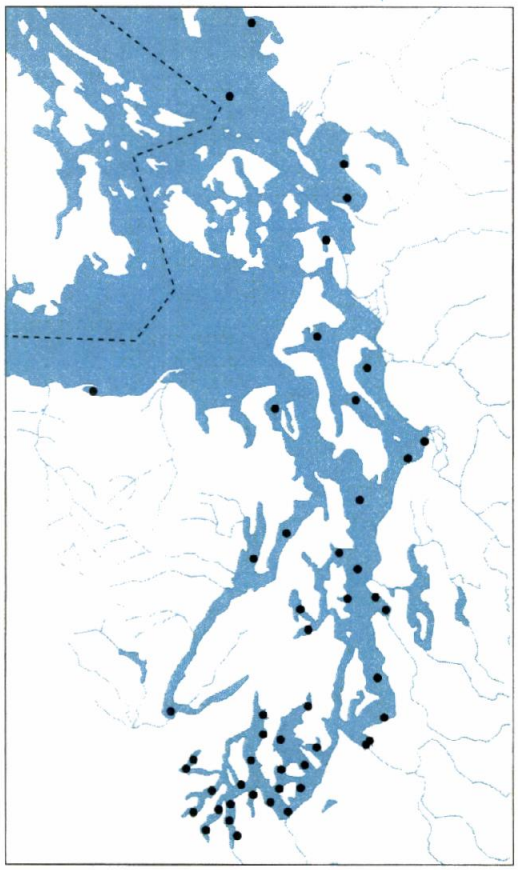
The Department of Ecology (Ecology) found measurable levels of metals in sediments at all 50 Puget Sound Ambient Monitoring Program sites during 1989 and 1990 (Tetra Tech, 1990; Striplin et al., in preparation) (Figure 3.1). These sites are generally located away from major pollution sources in order to track long-term water quality changes. The levels of metals were, for the most part, below the state's sediment quality standards (WAC 173-204). The lowest levels of metals were generally found at monitoring locations away from the urban bays and other known sources of contamination.

Many of the metals that can contaminate sediments occur naturally in soils in the Pacific Northwest. Consequently, their presence in detectable amounts may not be indicative of contamination related to human activities in these areas. Most metal concentrations found during 1989 and 1990 were similar to those that have been measured in past Puget Sound studies (Long, 1982; Dexter et al., 1985).

Organic Chemical Contamination

Portions of at least 18 bays and harbors in the basin do not meet the state sediment quality standards for organic compounds (Authority, 1992a).

Figure 3.1 1990 sediment quality monitoring locations



Reference: Striplin et al., in preparation

The highest concentrations of toxic organic compounds were found in the urban bays and the lowest levels were found away from known contamination sources. Sediments at several PSAMP stations monitored in 1989 and 1990 exceeded the state sediment standards for PAHs and other organics. Similar levels of toxic organic chemicals have been found in past Puget Sound studies (Malins et al., 1985; Dexter et al., 1985). As with the metals, the monitoring program cannot document a change in toxic organic chemicals in Puget Sound sediments from the late 1970s or early 1980s to 1990.

Measuring Sediment Contamination

The benthic, or bottom-dwelling, species that live in Puget Sound reveal quite a bit about the effect of contaminated sediments on biological populations. Worms, clams, snails, and shrimp-like creatures are among the basin's benthic sea life. The number of species and the number of individuals per species found on the Sound's bottom are affected by many factors, including sediment grain size, water depth, amount of organic matter present, salinity of the water between sediment particles, degree of contamination, and interactions among species.

Scientists evaluate certain benthic species as pollution-tolerant or pollution-sensitive. These designations are used to evaluate the health of the water and sediments to which the communities are exposed.

Although Ecology scientists found pollution-tolerant species at all Puget Sound Ambient Monitoring Program stations,

they were numerically dominant in the urban embayments (Tetra Tech, 1990; Striplin et al., in preparation). These sites included the City Waterway and the Blair/Sitcum Waterway in Commencement Bay, Eagle Harbor at Bainbridge Island, and Elliott Bay. All of these locations are in the vicinity of federal Superfund sites and are highly contaminated with an array of metal and/or organic compounds.

Sediment bioassays are used to measure the toxicity of sediments to marine organisms. During 1989 sediments from Dyes Inlet, Sinclair Inlet, Port Susan, and several south Sound inlets were found to be toxic (Tetra Tech, 1990; Striplin et al., in preparation). Previous Puget Sound studies show similar findings in urban bays and other areas, such as East Passage. Sediments taken from the rural areas and deep basins have generally shown no toxicity (Crecelius et al. 1989).

MARINE WATER QUALITY

Water quality refers to the health of the water column, which includes water between the floor of Puget Sound and the water surface. Poor water quality may affect aquatic organisms or diminish human uses of the water column and nearshore resources. Examples of water quality problems include low amounts of dissolved oxygen, which can cause fish kills; high concentrations of algae and pathogens, which can contaminate shellfish beds; mats of malodorous algae; and pollution from spills and discharges.

Basinwide, the health of the Sound's water column is generally good. Puget Sound does not experience the large-scale algal blooms, fish kills, beach closures, or fishery bans that characterize other industrialized estuaries.

On a more local scale though, Puget Sound does have water quality problems in both urban and rural areas—small-scale algal blooms and fish kills occur on occasion; shellfish harvesting is restricted in a growing number of areas due to fecal contamination from human and animal wastes; and commercial fishing for bottomfish is prohibited in many parts of Puget Sound due to concerns about chemical contamination.

Water Column Monitoring

Puget Sound's water quality problems are generally localized, most notably fecal coliform contamination in the nearshore areas and enclosed bays.

Water samples from several south Sound bays had dissolved ammonia levels well above Puget Sound Main Basin concentrations (considered to be background levels), including stations in Budd Inlet, Eld Inlet, Totten Inlet, and Oakland Bay. In most of these bays, excessive amounts of ammonia are probably supplied by a combination of sewage treatment plants, upstream sources, failing septic systems close to shore, and other nonpoint runoff. Ammonia can be toxic to many marine organisms, including juvenile salmon.

The 1989-1990 PSAMP stations generally represented the deep basins, open water areas, and a few south Sound bays. Until more intensive monitoring can be initiated in areas with known or suspected water quality problems, we will have limited information about the quality of the bays, inlets, and nearshore Puget Sound waters in many areas.

Fecal Contamination of Puget Sound Waters

Some areas sampled in 1989 and 1990 had levels of fecal contamination high enough to warrant restrictions on com-

ALTHOUGH THERE ARE LARGE POPULATIONS OF FISH IN PUGET SOUND BIOLOGISTS HAVE NOTICED DECLINES IN SOME SPECIES

mercial shellfish harvesting. The Sound's isolated embayments and other nearshore areas are more vulnerable to fecal contamination than the basin's mid-channels, where natural processes of dilution and bacterial die-off tend to keep the waters cleaner (Authority, 1986b).

Fecal contamination in urban areas and nearshore waters is often directly related to the proximity of sewage outfalls, storm drains, and pets on the beach. Although fecal contamination in urban areas has been largely controlled through improvements to point source discharges, scientists continue to find periodic high bacterial counts. Nonpoint sources, including stormwater, sewer overflows caused by storms, and runoff, may account for this contamination.

Long-Term Trends in Water Quality

Small changes have been seen in several water column parameters from the 1950s to the present, although no major Soundwide changes have been found (Tetra Tech, 1988b). The small changes include a slight rise in surface water temperature in most areas of the Sound, a decrease in biochemical oxygen demand from pulp mill effluent, a decrease in deep water salinity, and both increases and decreases in dissolved nutrients and dissolved oxygen in localized areas (Dexter et al., 1985; Tetra Tech, 1988b). An increase in phosphate concentrations was also observed in the urban areas between the early 1970s and the mid-1980s which might be the result of human population growth and increased development in the Puget Sound basin. The toxicity of water to oyster larvae from the vicinity of pulp mills reached a peak during the 1960s and has declined drastically since the 1970s as a result of major improvements in the treatment of wastewater from the mills (Cardwell and Woelke, 1979).

PUGET SOUND FISH

More than 220 species of fish make their home in Puget Sound. They live in many different habitats and occupy many different positions in the marine food web. Despite the abundance of fish in Puget Sound, biologists are noticing declines in some species.

Healthy fish populations require adequate amounts of clean, productive habitat. The ability of the Puget Sound basin to support fish has been seriously reduced by the outright loss of habitats as a result of filling, dredging, the construction of dams and other obstructions, and the reduction of stream flows. The remaining habitat has often been damaged by increased sedimentation and pollution from stormwater runoff. The supply of some fish species has been supplemented by hatchery production, but some populations may have been further reduced by overfishing or changes in predation.

Fisheries biologists are challenged with managing fish runs to protect the fish populations, while allowing for a reasonable harvest by commercial fishermen and recreational anglers. Often the fisheries managers do not have sufficient monitoring information to determine the cause of a decline in a fish population and must act conservatively to protect the stock. Fisheries closures, reduced seasons, and limited numbers of commercial fishing licenses are the result.

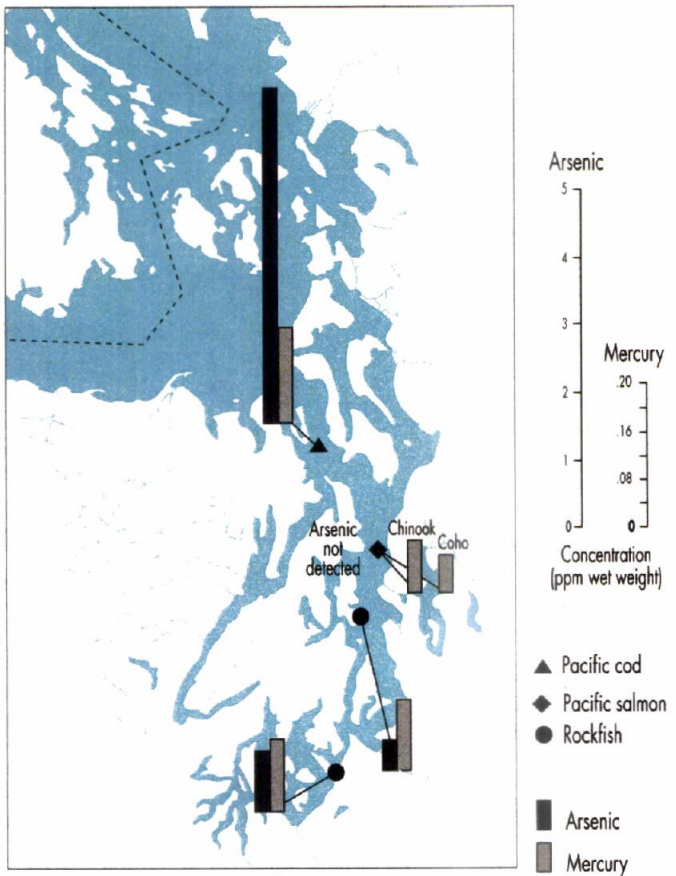
Contamination in Fish

As part of PSAMP, the Department of Fisheries (Fisheries) monitors metal and organic contaminants in Puget Sound fish for two reasons. The first is to observe patterns and trends in the exposure of fish to contaminated food organisms and habitat. High exposures may cause diseases in fish or reduce their ability to reproduce. The second reason is to assess whether fish with contaminated tissues pose a health risk to people and other predators who may eat the fish.

Varying levels of arsenic, copper, mercury, and lead were detected in

Puget Sound fish, as illustrated in Figure 3.2. Although these metals occur naturally in Puget Sound sediments, soils, and seawater, high concentrations are discharged into the basin from urban and industrial activities. In particular, Pacific Northwest marine waters have naturally high levels of arsenic. Mercury and copper are common industrial contaminants, while automobile exhaust particles washed from the air and land carry a significant amount of contaminants to the Sound. The ASARCO smelter near Commencement Bay was a heavy contributor of arsenic to Puget Sound until it was closed in the early 1980s.

Figure 3.2 Concentration of arsenic and mercury at 1990 PSAMP fish stations



Reference: O'Neill and Schmitt, in preparation

The levels of metals found in fish tissue samples are similar to those found in previous studies, with a few exceptions. Past studies of rockfish indicated higher levels of arsenic and lower levels of mercury than the more recent 1990 PSAMP study (Gahler et al., 1982; Landolt et al., 1985, 1987). Past studies also showed higher levels of arsenic, copper, lead, mercury, PCBs, and DDE (a breakdown product of the pesticide DDT) (EVS, 1979; Malins et al., 1982; Galvin et al., 1984; Tetra Tech, 1988c) in salmon tissue from Puget Sound and the Fraser River in British Columbia.

There are no natural sources of organic contaminants such as PCBs and pesticides. Their presence in fish is traceable to human uses. Very few toxic organics were found in the fish tested under PSAMP during 1989 and 1990 (O'Neill and Schmitt, in preparation). Low levels of PCBs were found in the English sole from the urban bays; low levels of the organic contaminants PCB, DDE, and phenanthrene (a low molecular weight PAH) showed up in the rockfish tissue; no organic contaminants were found in the Pacific cod tissue; and minute traces of DDE were detected in the salmon (O'Neill and Schmitt, in preparation).

It should be noted that many types of fish break down and metabolize PAHs. Thus, fish may suffer disease from PAH exposures and have no measurable PAHs in their muscle tissue.

In comparing the concentrations of several chemicals detected in the PSAMP samples with Environmental Protection Agency (EPA) reference levels, the Department of Health (Health) is confident that the concentrations are not a threat to human health (Department of Health, in preparation a).

Bottomfish Liver Disease

Liver disease in bottomfish can indicate the presence of contaminants in marine water. At six of the 10 sites sampled for bottomfish in 1989, PSAMP investigators found no prevalence of abnormal liver conditions. At Port Gardner, located near urban Everett Harbor, the fish sampled had a very low prevalence of liver abnormalities. In the three urban bays sampled (Sinclair Inlet, Commencement Bay, and Elliott Bay), investigators found higher levels of liver abnormalities (O'Neill and Schmitt, 1991).

The amount of liver abnormalities in bottomfish found by PSAMP investigators in 1989 is similar to that found in recent studies in Puget Sound. Most studies of liver abnormalities in English sole have focused in and around the urban bays. Scientists have shown that most sole living in the rural bays and the open areas of the Sound rarely suffer from liver disease (Malins et al., 1985; Crecelius et al., 1989; PTI, 1991). The highest occurrences of malignant tumors (cancer) in fish livers have been found in

Eagle Harbor and in the Duwamish waterways—areas known to contain high levels of organic contaminants, particularly PAHs (McCain et al., 1988).

SHELLFISH

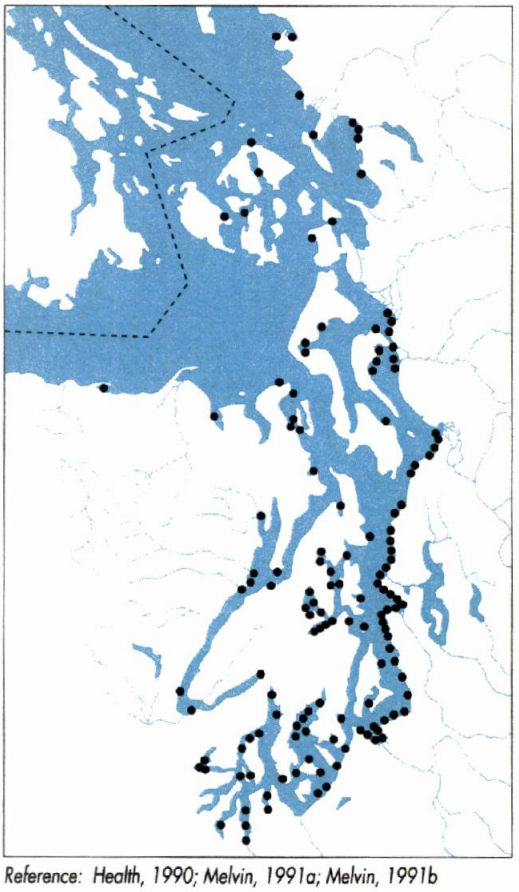
There are three types of potential threats to public health from consuming contaminated shellfish: pathogens (disease-causing organisms such as bacteria and viruses), paralytic shellfish poisoning (PSP), and chemical contamination. Another type of shellfish poisoning, domoic acid, has to date not been detected in Puget Sound shellfish.

The Department of Health routinely monitors commercial shellfish and shellfish growing waters to ensure public health. Shellfish beds in many parts of the Sound have been reclassified since the 1950s to restrict commercial shellfishing (Figure 3.3). Since 1987, Department of Health investigators have been monitoring recreational shellfish beaches as well. The agency prohibits commercial shellfishing along the eastern shore of the Main Basin from Tacoma to Everett and in other areas of the Sound due to potential bacterial and chemical contamination caused by discharges from storm drains, residences, sewage treatment plants, and industries. Health officials have identified many recreational beaches that are also being affected by these discharges.

Since 1981, Health has restricted or prohibited shellfish harvesting from over 16,000 acres of commercial shellfish beds. In 1981, 17 percent of the Sound's commercial shellfish beds were restricted. By 1990 that figure rose to 38 percent (Health, 1990). Most recently, all of Liberty Bay and parts of Case Inlet (North Bay) were downgraded in May 1991 (Melvin, 1991a; 1991b).

Bacterial Contamination in Shellfish

Figure 3.3 Shellfish beds where commercial harvest is not permitted



Reference: Health, 1990; Melvin, 1991a; Melvin, 1991b

Pathogens, which are transmitted to the water from humans and other animals via their feces, can be absorbed by shellfish. The amount of contamination in shellfish varies seasonally, mainly as a result of rainfall events and runoff patterns. Typically, fecal coliform bacteria are found most frequently in marine waters following heavy rains, and throughout the winter in the Puget Sound area. High bacterial counts have also been measured during the summer in areas with heavy boat traffic and around marinas due to discharges of human wastes (Health, 1989).

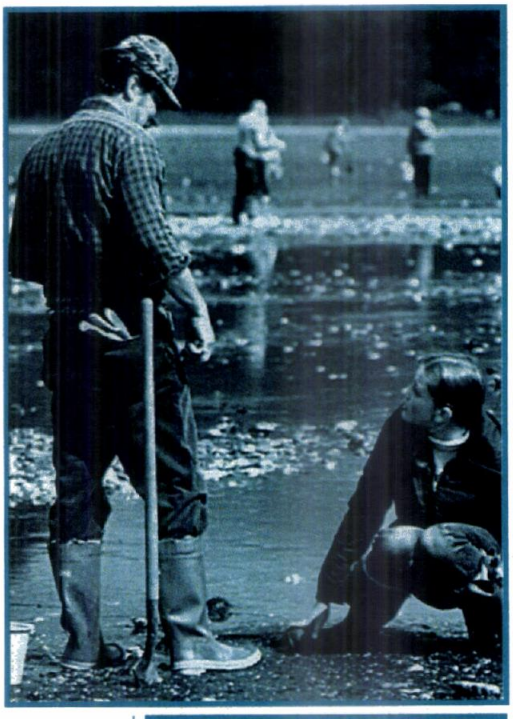
Although fecal coliform bacteria do not cause disease, their presence indicates contamination with fecal matter which can carry a variety of disease-causing organisms.

As a part of the monitoring program, Department of Health investigators measure the fecal coliform content of shellfish from 10 recreational beaches in Puget Sound every three months. The tissues of shellfish from seven of the 10 beaches generally showed low levels of fecal coliform. However, tissues of shellfish from the other beaches were higher and generally failed to meet state fecal coliform standards for commercial shellfish harvesting (Health, in preparation b). The three contaminated beaches were Belfair State Park near Lynch Cove in Hood Canal, Walker County Park near Shelton in the south Sound, and Dosewallips State Park in Hood Canal. Failing septic systems are the suspected cause of pollution at Belfair; stormwater runoff from an urban area and proximity to a sewage treatment plant discharge are blamed at Walker; and contamination by harbor seal feces is responsible for pollution at Dosewallips.

Based on these results, officials from Health and the state

Parks and Recreation Commission (Parks) closed the beaches to recreational shellfish harvesting at Belfair State Park and Dosewallips State Park. In an effort to reopen the beach at Belfair State Park to shellfish harvest, Health, with assistance from Ecology, is working with Mason County to develop a plan for a community sewage treatment system. At Dosewallips State Park, the Parks and Recreation Commission is installing barriers to prevent seals from entering some of the river sloughs. Parks is also installing log rafts offshore to encourage seals to haul out and rest away from the beach.

The 1989-91 PSAMP results confirm previous Health findings of high levels of fecal coliform in the water and shellfish tissue at Walker County Park. The park is located near Shelton's wastewater treatment plant outfall and may be affected by stormwater discharges and other nonpoint sources of pollution. Health officials have restricted recreational shellfish harvesting on the beach. Based on the complex contamination problems at Walker Park, Health officials are not optimistic that the beach will be reopened to shellfish harvesting in the near future.



THE DEPARTMENT OF HEALTH MONITORS RECREATIONAL SHELLFISH BEDS TO PROTECT PUBLIC HEALTH

Chemical Contamination in Shellfish

Department of Health scientists found that shellfish tissue from four PSAMP beaches sampled in May 1990 contained arsenic, cadmium, copper, mercury, lead, and zinc (Health, in preparation b). The observed levels are relatively low and not of immediate concern to shellfish consumers.

Health investigators found very little evidence of organic contaminants in the shellfish sampled (Health, in preparation b). Past studies of shellfish in Puget Sound have revealed organic contaminants, particularly PCBs and organochlorine pesticides such as DDT (Mearns et al., 1988; NOAA, 1989). Scientists believe that levels of PCBs and organochlorine pesticides have declined in the environment in recent years because the manufacture and use of these chemicals has sharply decreased over the past two decades. The absence of significant chemical contamination in the 1990 PSAMP samples may be evidence of this decline.

PSP Contamination in Shellfish

Paralytic shellfish poisoning (PSP), commonly known as red tide, is a naturally occurring nerve toxin which can accumulate in the tissues of shellfish that filter certain dinoflagelate algae from the water. The algae, which is responsible for PSP, grows rapidly in Puget Sound waters on a frequent but unpredictable basis. As with other changes in plant growth, these rapid growths may be associated with nutrient loadings. When sufficient levels of this algae are present in the water, shellfish can concentrate enough toxin to make their meat dangerous, if not fatal, to humans. Because of the potential life-threatening nature of PSP, Department of Health scientists routinely monitor shellfish from commercial and recreational shellfish areas for PSP.

Shellfish from nine of 16 Puget Sound beaches sampled had enough PSP in their tissue to warrant closing the beaches to public shellfish harvesting on at least one occasion between October 1989 and December 1990 (Health, in preparation b). Some of the beaches were contaminated in both summer and fall or winter (Health, in preparation b). In the past, scientists believed that PSP outbreaks in Puget Sound were generally a summertime event. They now recognize that PSP outbreaks can occur at other times of the year as well (Health, 1990).

Bivalve shellfish from six of the 16 PSAMP beaches were contaminated with PSP toxin between 1988 and 1989 (Health, in preparation b). Northern Puget Sound sites contained higher levels of PSP than those in the south Sound. This indicates a change from studies conducted two

years earlier, when shellfish from the northern parts of Puget Sound generally had lower PSP levels than shellfish from beaches in the south Sound.

MARINE MAMMALS

Marine mammals are heavily dependent on good water quality and undisturbed habitat for their health. Monitoring animals at the top of the Puget Sound food web allows us to follow the passage of contaminants through the web.

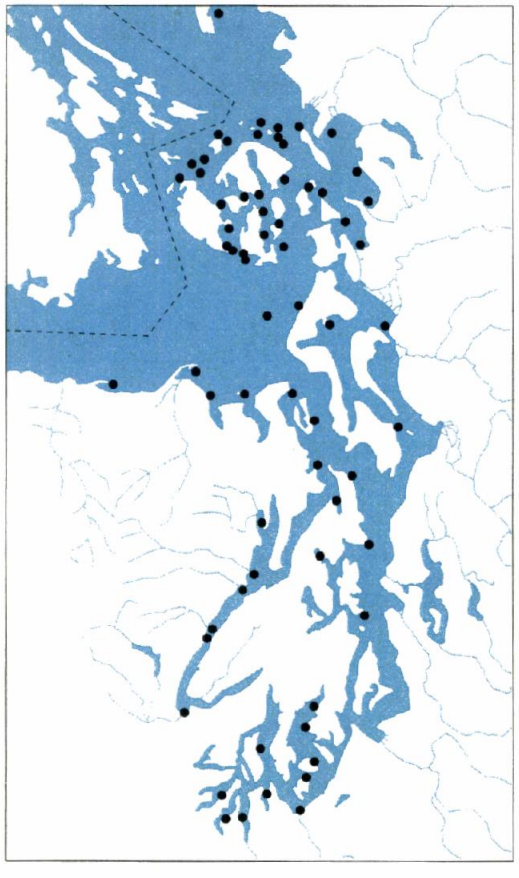
Twenty-seven species of marine mammals live in or sometimes frequent Puget Sound. Five are resident—harbor seals, Dall's porpoises, harbor porpoises, Minke whales, and orcas or killer whales. Three more are common migrants—California sea lions, stellar sea lions, and gray whales. Another 18 species of whales, seals, and porpoises are occasional, rare, or accidental visitors to the region.

People and their activities disturb marine mammals in a number of indirect ways—through commercial and recreational fishing, which can alter the marine mammals' food supply; by shoreline development projects, which can destroy and degrade marine mammal habitat; and by releasing toxic chemicals into Puget Sound, which can accumulate in marine mammal tissue.

There are many incidences of people unlawfully harassing marine mammals in Puget Sound. Generally, people do not want to disturb the animals but are seeking a closer look. Without proper training or facilities to allow the public to view marine mammals without disturbing them, this harassment will continue. Marine mammals which haul out on land to rest, to mate, and to bear their young, like seals and sea lions, are particularly susceptible to harassment.

Scientists are unsure whether the overall populations of marine mammals are affected by these disturbances. There is sufficient evidence, however, that human disturbances cause the animals stress (Calambokidis et al., 1991a). Shifts in feeding and pupping territories, toxic contaminants in blubber and internal organs, and shifts in population sizes that are occurring in Puget Sound are among the signs of stress.

Figure 3.4 Harbor seal haulout sites in Puget Sound



Harbor Seals

Wildlife biologists estimate that approximately 6,000 harbor seals live in Washington's inland waters, which includes Puget Sound, the coastal estuaries, and the Strait of Juan de Fuca. Harbor seals are ideal study subjects because they appear to be year-round residents in Puget Sound. Wildlife biologists have studied populations of harbor seals at their preferred haulout sites in the south Sound, north Sound, and Hood Canal (Figure 3.4).

Historically, studies found high levels of contaminants in the bodies of Puget Sound harbor seals, particularly PCBs and DDT in the blubber of south Sound seals (Calambokidis et al., 1988). Scientists believe that levels of these contaminants have declined since the 1970s, although there is evidence that PCBs, DDT, and other contaminants are still present in significant concentrations in harbor seals in several parts of the Sound (Calambokidis et al. 1985). Scientists have found evidence of premature births and birth defects in harbor seals in the south Sound, which may be related to contaminants (Newby, 1971; Newby, 1973; Calambokidis et al., 1978).

Harbor Porpoises

Although they were once abundant throughout Puget Sound, since the 1940s harbor porpoises have been found only in the Strait of Juan de Fuca, Admiralty Inlet, around the San Juan Islands, and near the outer Washington coast (Osborne et al., 1988). Wildlife biologists believe that the disappearance of harbor porpoises from Puget Sound south of Admiralty Inlet is due largely to human disturbances like ship traffic, capture in fishing nets, and perhaps contamination (Calambokidis et al., 1991b). Scientists have very little information on contaminants in harbor porpoises. They have found that some Washington coast/Straits harbor porpoises have PCBs and DDT in their blubber comparable to levels in Puget Sound harbor seals (Calambokidis and Barlow, 1991). Natural resource scientists and managers from other countries suspect that PCBs and DDT have caused reproductive problems and population declines in harbor porpoises (Otterlind, 1976; Wolff, 1982).

Gray Whales

Gray whales are migrants which are spotted regularly in many locations in Puget Sound and the Strait of Juan de Fuca (Calambokidis et al., 1991b). Biologists believe that many of these whales may spend up to four months feeding in the Sound.

In recent years a number of gray whales have died in Puget Sound and surrounding waters. In most cases scientists have not been able to determine the cause of death. Some whales found along the Washington coast apparently died after being tangled in fishing nets, after collisions with boats, and after attacks by orca whales (Calambokidis, personal communication, 1991). Despite intense public interest and speculation on the role of contaminants in the death of gray whales, preliminary results from chemical analyses of tissues from recently stranded gray whales indicate that the levels of contaminants were too low to cause any harmful effects (Varanasi, personal communication, 1991). Until more information becomes available, scientists cannot evaluate the extent to which contaminants may be affecting these animals.

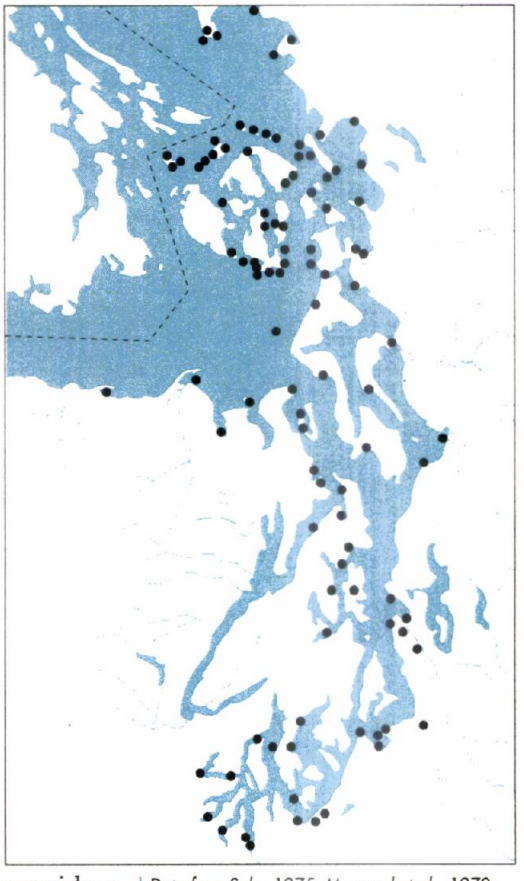
BIRDS OF PUGET SOUND

Birds suffer directly and indirectly from human development and industrialization in the Puget Sound basin. Direct threats to birds include hunting, death from oil spills, poisoning from the ingestion of lead shot, and tangling in marine debris. Indirect threats include reproductive problems from the accumulation of toxics and loss of habitat critical to bird rearing, feeding, and refuge.

Waterfowl which visit Puget Sound as a stopover on the Pacific flyway, as well as those who breed and live year-round in Puget Sound, include 26 species of ducks, 10 types of geese, and two species of swans. The large and relatively undeveloped estuaries and uplands of northern Puget Sound, including Port Susan and Skagit, Padilla, and Samish bays, provide a winter home for enormous flocks of waterfowl.

Marine birds spend their lives in salt water, feeding on fish and marine invertebrates and sleeping on the surface of the water. Most marine birds go ashore only to nest, choosing protected and inaccessible sites (Figure 3.5). These birds are extremely vulnerable to human disturbances and have left nesting sites as humans encroach on their habitat. Dramatic declines in populations of marbled murrelets (Cummins et al., 1990), for example, could result in the birds being listed as an endangered species. While disturbances in Puget Sound and other marine waters may account for part of the decline, cutting of old growth forests where the birds nest

Figure 3.5 Breeding colony sites for marine birds in Puget Sound



Data from Salo, 1975; Manuwal et al., 1979; Wahl et al., 1981; Wahl and Speich, 1984; Calambokidis et al., 1985; Speich and Wahl, 1989

is probably responsible for the sharpest decline. Double-crested cormorants have left most of their historical nesting sites on four of the San Juan Islands for the isolation and inaccessibility of Smith and Protection Islands in northern Puget Sound where their numbers are increasing (Henny et al., 1989).

Contaminants in Puget Sound Birds

The tissues of many types of Puget Sound waterfowl, marine birds, raptors, and shorebirds sampled under PSAMP contained low levels of contaminants, especially DDE (a breakdown product of the pesticide DDT) and PCBs (Riley et al., 1983). Low levels of lead and mercury were found in many bald eagle nestlings from the San Juan Islands (Wiemeyer et al., 1989). And scientists found that some Puget Sound marine birds have had reproductive problems.

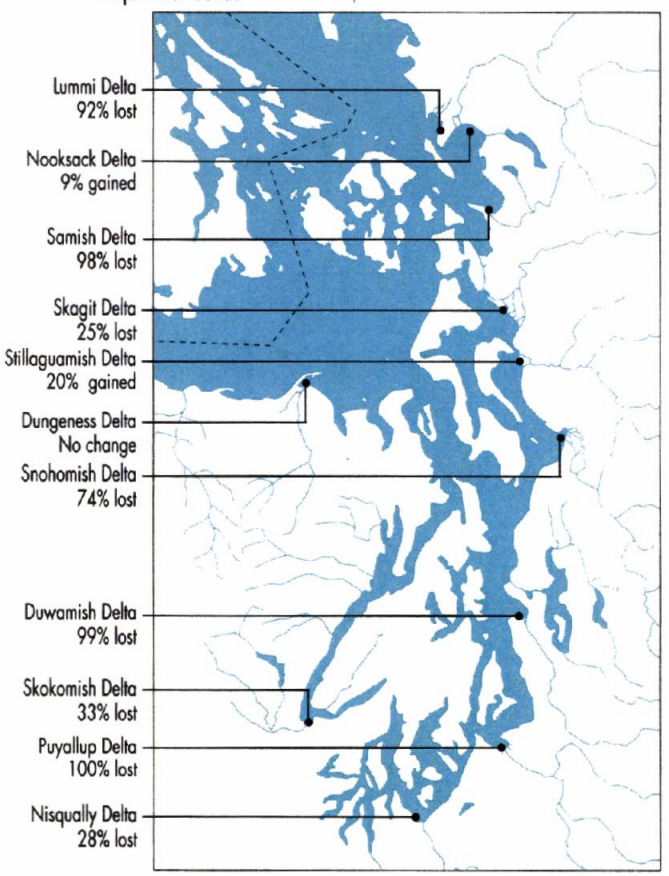
There is limited evidence that these problems are caused by contaminants. There is evidence, however, from other areas that contaminants have affected the reproductive success of raptors, including bald eagles (Hickey and Anderson, 1968; Reichel et al., 1984), osprey (Wiemeyer et al. 1978), peregrine falcons (Lindberg and Odsjo, 1983), and merlins (Fox and Donald, 1980).

A recent study of metals in marine birds and waterfowl wintering in Commencement Bay (Henny et al., 1990; Henny et al., in press) revealed that the bottom-feeding surf scoters, a type of waterfowl, accumulated much higher levels of cadmium and mercury than the western grebes (marine birds) which feed on fish. The difference in the rate at which the scoters and grebes accumulate toxics may reflect the higher level of contamination in Commencement Bay sediments and bottom-dwelling animals, as compared to the fish swimming through the bay.

NEARSHORE HABITAT

Many of the Sound's aquatic organisms spend at least part of their lives in the narrow, fringing eelgrass meadows, kelp beds, and salt marshes of Puget Sound. These vegetated nearshore habitats provide feeding and nursery grounds for juvenile salmon and other fish; food and refuge for many marine invertebrates which form the base of the benthic food web; and refuge, feeding, and stopping grounds for birds.

Figure 3.6 Changes in salt marshes in major river deltas



Reference: Bortleson et al., 1980; Hutchinson, 1988

The growth and development of the Puget Sound area over the past hundred years has severely degraded and reduced areas of nearshore habitat, particularly in the deltas of the largest rivers. Dredging and filling for nearshore development projects, building seawalls and bulkheads to reduce shoreline erosion, and dumping of debris on beaches has diminished both the quantity and quality of valuable nearshore habitat (Boule et al., 1983).

Historical Changes in Salt Marshes and Eelgrass and Kelp Beds

Puget Sound once had broad expanses of salt marshes in the Puyallup, Skagit, and Duwamish deltas, but they have been largely eliminated through diking and filling. (Figure 3.6) The few broad areas of vegetated nearshore habitat that still exist in Puget Sound include the sweeping eelgrass beds of Padilla Bay and the remnant salt marshes of the Skagit,

Nisqually, and Stillaguamish river deltas.

Eelgrass meadows are perhaps the most productive and fragile of the nearshore habitats common to Puget Sound, providing critical rearing and feeding areas for young fish and crab. Scientists estimate that, at a minimum, 15 to 25 percent of the Sound's shoreline is fringed by eelgrass (Albright et al., 1980).

Before human activities began to affect them, freshwater wetlands in the Puget Sound basin probably covered an area three to four times as large as the saltwater wetlands (Nesbit, 1885). Around 70 percent of the tidally influenced wetlands in Puget Sound have been lost to development (Ecology, 1989). Statewide, an estimated 900 to 2,000 acres of wetlands are developed each year (Canning, 1989), with more than half of the loss occurring in the Puget Sound region.

Kelp is a large benthic algae that forms dense forests in shallow offshore waters and is an important shelter, nursery ground, and food source for many types of fish, invertebrates, and marine plants. Department of Wildlife biologists estimate that between 1912 and 1977 the length of shoreline covered by kelp beds increased by 53 percent (Thom and Hallum, 1990). Scientists believe that the increase is due to changes in water quality factors such as nutrients and turbidity, as well as increased rocky substrata (Thom, personal communication, 1991).

FRESH WATER

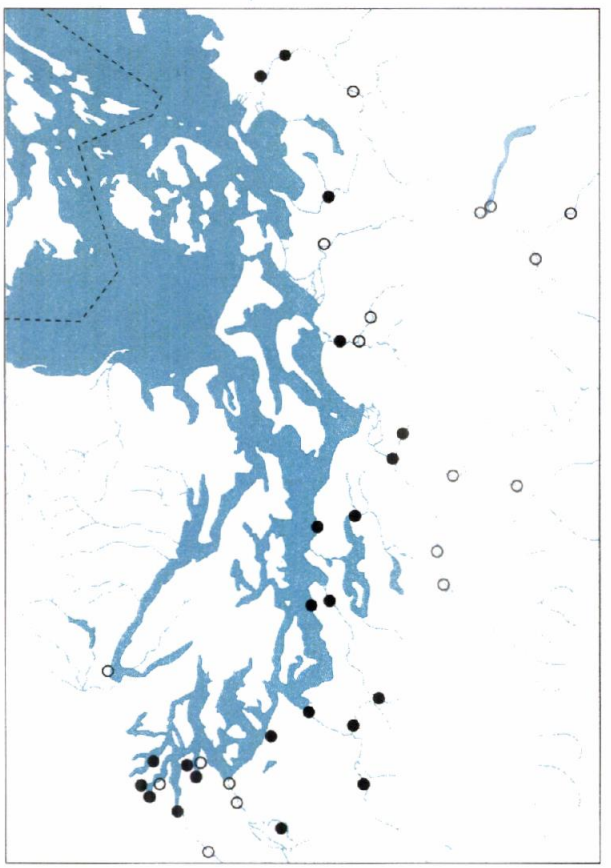
The fresh water that drains into Puget Sound carries a complex mixture of particles and dissolved material, including sediment, dissolved nutrients, toxic chemicals (like pesticides, herbicides, metals), oil and grease, and miscellaneous organic matter. Many pathogens—as indicated by fecal coliform bacteria—enter the nearshore areas of Puget Sound from rivers and streams, as well as from storm drains. Urban, suburban, agricultural, rural, and managed forest areas contribute bacteria and viruses that affect the use of nearshore shellfish beds and recreational beaches.

Water quality and habitats in Puget Sound rivers and streams are also threatened by physical scouring of the streambeds by sediments, burial of critical habitat and biological resources by excessive sedimentation, and contaminants carried by excessive runoff (often the result of vegetation removal and development by humans in upstream areas).

Monitoring Fresh Water

Scientists with Ecology monitor water quality in the 10 major rivers of the Puget Sound basin. Based on results collected over the past few years, water quality in most of the rivers is good, but samples from downstream areas of several rivers failed to meet the state water quality standards for fecal coliform bacteria between 1988 and 1990 (Figure 3.7). In general the rivers met water quality standards for dissolved oxygen, pH, and temperature. Ecology scientists and others have noticed some trends in water quality conditions in Puget Sound rivers over the past 10 years, including increased levels of dissolved oxygen, particles, and fecal coliform bacteria, as well as decreased levels of ammonia and other nutrients in the Green/Duwamish River; and increased dissolved oxygen and particles, and decreased fecal coliform in the Skagit River. Some of these changes are related to improvements in sewage treatment.

Figure 3.7 PSAMP sites that did not meet freshwater fecal coliform standards for 1988-1990



● Exceeded standard of 100/100 ml
○ No exceedance

References: Hofstad, 1990; Starry, 1990a; Hopkins et al., in preparation; Metro, 1990; Starry, 1990b; Moor, 1990; King County and Metro, 1989

CHAPTER 4

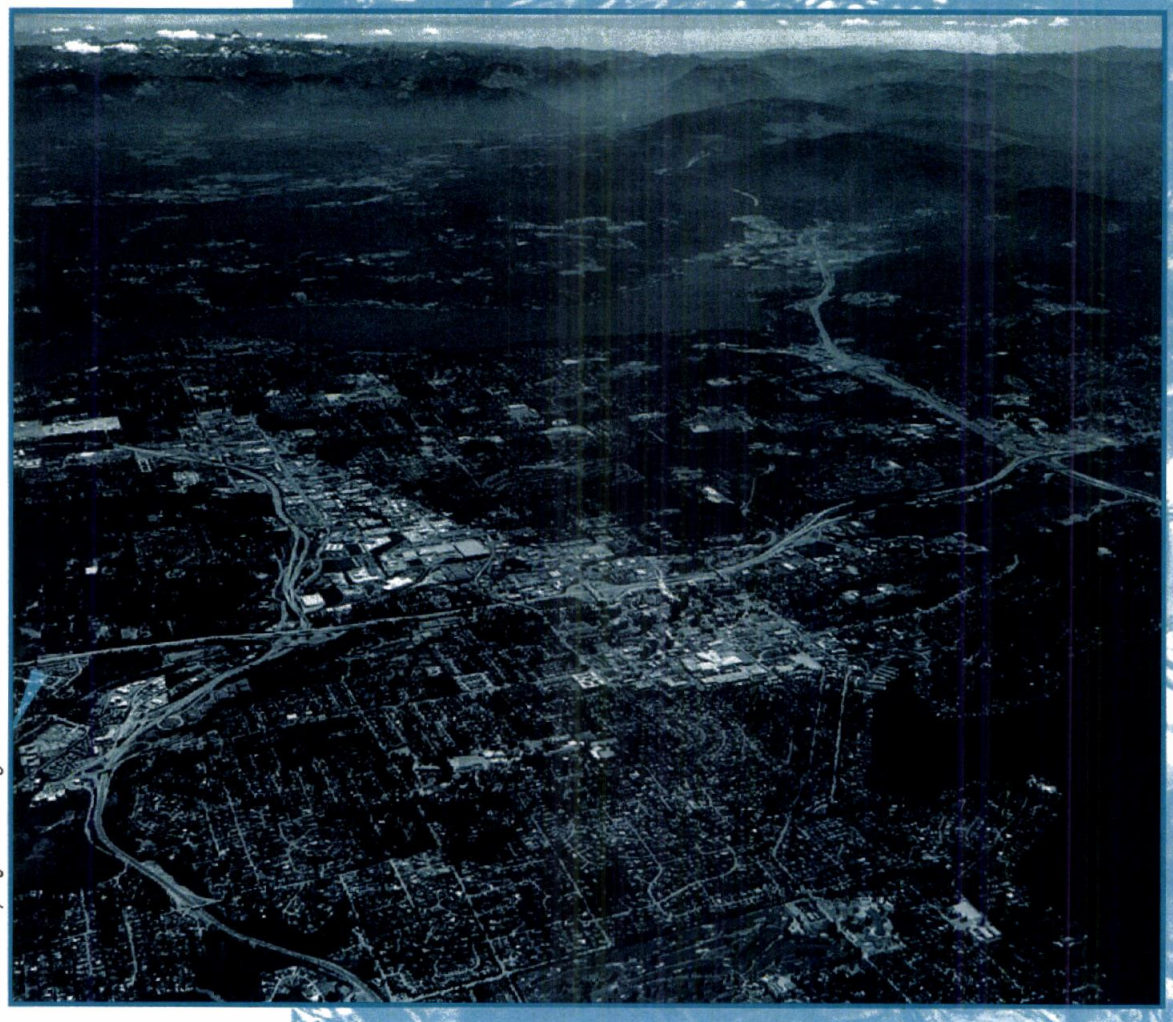


Photo courtesy Puget Sound Regional Council

Sound Actions

The 1980s marked a turning point for Puget Sound. Early in the decade, public attention focused on the health of Puget Sound as its resources continued to show signs of deterioration. Despite significant public and private investments in environmental protection over the preceding decades, the region's fragmented managerial approach was failing to adequately protect the Sound's natural resources. It was increasingly apparent that protection of Puget Sound hinged not only on improved public programs, but on changes in the personal actions and habits of the basin's growing population.

Although a number of agencies and governments were already working on these issues, their independent efforts lacked the direction, coordination, commitment, and accountability that a cooperative approach could provide. In 1985 the legislature established the Puget Sound Water Quality Authority to develop and oversee the implementation of a comprehensive management plan to protect and restore the Sound's resources.

THE PUGET SOUND PLAN

In 1987 the Authority released a plan outlining the actions and partnerships necessary for a coordinated protection strategy—the *1987 Puget Sound Water Quality Management Plan*—followed by revisions in 1989 and 1991. Support at the federal level helped bolster efforts to protect the basin. In 1988 Puget Sound was designated an Estuary of National Significance under the Federal Clean Water Act. And in 1991 the Environmental Protection Agency (EPA) approved the plan as the federal Comprehensive Conservation and Management Plan for Puget Sound. It was the first estuary plan in the nation to receive such approval and it has served as a model for other estuaries throughout the United States and the world.

The strength of the Puget Sound plan stems in part from its emphasis on prevention and, where needed, aggressive action for cleanup and remediation. The plan views the protection of Puget Sound as a shared responsibility among the people, governments, businesses, and organizations of the region. To the extent possible, authors of the plan made use of the region's institutional structure, believing that coordination within the existing framework was the most expedient and effective way to carry out legislative directives. However, the Authority also established fresh programs and new approaches to fill gaps and improve upon existing protection efforts.

The 1991 Puget Sound plan includes 15 different programs, each being an action plan for an issue, such as shellfish protection, wetlands, contaminated sediments, research, and education. Although they constitute a single, comprehensive strategy for Puget Sound, the programs have been implemented with varying degrees of success. Reasons for this include the need to set priorities given limited funds, differing levels of performance among the implementing agencies and governments, and differences in the complexity of the issues which each program addresses.

While the plan is a pivotal tool for protecting the basin's resources, it is neither a clearinghouse for all the programs related to Puget Sound, nor is it the answer to all that ails the Sound. A number of private and public programs, old and new, affect the health of the Sound. The Authority fully recognizes the incredible breadth and complexity of the basin's environmental issues and has designed the plan so that it supports and dovetails with such programs as the Growth Management Act, the Chelan Agreement, and the Timber/Fish/Wildlife Agreement. Other programs, such as the Shoreline Management Act and the State Environmental Policy Act, are unaffected by the plan and continue to serve central roles in protecting the basin's natural resources.

While the plan may not directly address all of the basin's activities and programs, it does take into account the challenges facing the region, and

focuses on those efforts most essential to preserving the habitats and resources of Puget Sound. This chapter examines progress on these key efforts.

ESTUARY MANAGEMENT AND PLAN IMPLEMENTATION

The management and protection of Puget Sound is a complex and challenging undertaking. It involves bridging traditional jurisdictional boundaries and pulling together federal and state agencies, local and tribal governments, businesses, individuals, and organizations to carry out the plan's coordinated protection strategy.

The Estuary Management and Plan Implementation Program provides structure and focus to meet this challenge and effectively implement the Puget Sound plan. Recognizing that it is often easier to develop a plan than it is to coordinate its implementation, the Authority added this program to the 1991 plan to institute better coordination, funding, enforcement, and consistency during the implementation phase.

Program Goals

- Formalize the Puget Sound Estuary Program management structure.
- Obtain adequate funding for the plan.
- Require greater accountability and efficiency among implementing agencies.
- Provide for strong enforcement at all levels of government.
- Ensure that federal activities, including the operation of large federal facilities, are consistent with the provisions of the plan.

Program Status

Under a cooperative agreement between EPA and the state of Washington, this program is carried out by the Puget Sound Estuary Program management committee. EPA, the Authority, and the Washington Department of Ecology (Ecology) co-manage the program. EPA provides federal funding, technical assistance, and oversight of implementation activities by federal agencies. The Authority guides development and implementation of the Puget Sound plan. And Ecology takes the lead in implementing many of the plan programs.

EPA's approval of the 1991 plan as a comprehensive conservation and management plan ushers in a new era for Puget Sound. It is the first opportunity in the country to develop a process for ensuring consistency between federal activities and the comprehensive estuary management plan as required by the Clean Water Act. EPA, Ecology, and the Authority are currently working on this federal consistency process and related interagency agreements.

The Authority has also refined the planning and reporting requirements used by agencies and governments in carrying out the plan. These groups now have greater responsibility in defining tasks, setting target dates, reporting progress, and developing future work proposals—all of which should enhance the implementation process and better protect the Sound.

EPA's Perspective on the 1991 Puget Sound Plan

All agencies, organizations, and individuals who helped develop the *1991 Puget Sound Water Quality Management Plan* and its 1987 and 1989 precursors should be very proud of their accomplishments to date. William Reilly, EPA Administrator, visited Seattle in May 1991 to officially approve the plan. Of the 17 estuaries participating in the national program, Puget Sound is the first to complete its comprehensive plan and establish a blueprint for action to protect and restore the Sound. The Puget Sound plan also serves as a model for the 16 other estuary program participants as well as other nonparticipating estuaries around the country that are interested in addressing their environmental issues.

Environmental plans are of little or no value unless they are implemented. A strength of the Puget Sound effort has been the decision to implement obviously needed actions early in the program while concurrently conducting additional planning. Examples of early implementation are the Urban Bay Action Program, initiated in 1986 to control toxic inputs to urban bays, and initiation in 1989 of the comprehensive ambient monitoring program to begin establishing environmental baselines so that the effectiveness of control efforts could be determined in later years.

Washington and the residents of the region are to be congratulated for their commitment to protecting and restoring the quality of Puget Sound. While substantial and significant progress has been made, our efforts must be sustained or even enhanced to protect the Sound, a national treasure, against the pressures of rapidly increasing population and development.

—Jack Gakstatter, EPA Region 10

1991 PUGET SOUND PLAN COST ESTIMATES[1]
By Program

PROGRAM	87-89 Biennium (estimated actual)	89-91 Biennium (estimated actual)	91-93 Biennium (estimated actual)	93-95 Biennium (estimated full implementation)	95-97 Biennium (estimated full implementation)
Authority Activities	$ 2,176,058	$ 2,905,934	$ 2,709,440	$ 2,278,405	$ 2,787,444
Estuary Mgt. & Plan Implementation	$ 965,011	$ 694,917	$ 900,908	$ 3,967,218	$ 3,824,134
Education & Public Involvement	$ 1,985,380	$ 1,410,168	$ 1,865,920	$ 7,456,523	$ 8,826,262
Puget Sound Foundation	$ 0	$ 0	$ 0	$ 377,154	$ 369,154
Habitat Protection	$ 0	$ 15,000	$ 0	$ 3,549,524	$ 3,649,524
Household Hazardous Waste	$ 32,000	$ 203,184	$ 0	$ 488,158	$ 403,738
Laboratory Support	$ 78,584	$ 1,028,684	$ 1,387,591	$ 2,080,967	$ 2,072,698
Municipal & Industrial Discharges	$ 2,056,909	$ 4,768,840	$ 5,924,292	$ 14,205,626	$ 18,134,782
Monitoring	$ 776,245	$ 2,477,222	$ 5,565,077	$ 7,189,073	$ 7,009,074
Nonpoint Source Pollution	$ 11,560,023	$ 11,568,552	$ 13,227,045	$ 13,291,302	$ 13,150,942
Research	$ 179,287	$ 96,000	$ 170,114	$ 340,804	$ 309,194
Contaminated Sediments & Dredging	$ 1,435,776	$ 2,144,114	$ 3,242,172	$ 4,089,387	$ 4,212,294
Shellfish Protection	$ 1,507,142	$ 3,160,078	$ 3,750,507	$ 7,216,264	$ 7,190,976
Spill Prevention & Response	$ 124,713	$ 301,296	$ 7,233,000	$ 7,233,000	$ 7,233,000
Stormwater & CSOs	$ 693,038	$ 3,465,948	$ 4,712,739	$ 15,177,616	$ 21,827,107
Wetlands Protection	$ 1,057,733	$ 3,609,816[2]	$ 3,820,195	$ 24,814,956	$ 24,855,027
PROGRAM TOTALS	$ 24,632,899	$ 37,849,753	$ 54,509,000	$113,829,570	$125,309,506

Table 4.1

[1] 1987-89 costs are based largely on plan estimates. 1993-95 and 1995-97 costs are estimates of full implementation of the Puget Sound plan.

[2] Includes $1,525,000 as a one-time revenue source from the Aquatic Lands Enhancement

Reference: Puget Sound Water Quality Authority, 1992b

Plan Funding

The Authority works closely with the governments and agencies responsible for protection programs to estimate the full cost of plan implementation and to secure funding for the highest priority programs.

Since initial adoption of the plan in December 1986, actual funding at all levels of government has been less than the estimated amount needed for full implementation. These funding shortfalls have scaled back and delayed efforts to protect and clean up Puget Sound. While recognizing the competing priorities and funding limitations at all levels of government, the Authority continues to stress the environmental and fiscal advantages of making adequate investments now in pollution prevention, rather than spending more on cleanup in the future.

The plan calls for the development of long-term funding mechanisms at all levels of government. The Estuary Management and Plan Implementation Program proposes that two sources of revenue be identified—one at the state level to establish a competitive grants program for local and tribal governments and other groups to help carry out their responsibilities under the plan, and a second to enable local governments to raise revenue to protect the shellfish resource from nonpoint source pollution.

Legislation drafted by the Authority and passed by the legislature in 1992 enables counties to create shellfish protection districts for this purpose. The legislation is discussed in more detail under the Shellfish Protection Program on page 51. Establishment of a state grants program dedicated to plan implementation has yet to be considered by the legislature.

Changes to the statute governing the Authority made during the 1990 legislative session have improved accountability for state spending on plan implementation. The governor's budget office—the Office of Financial Management—now submits a stand alone Puget Sound plan implementation budget as part of the overall budget package. This allows the legislature to clearly see and consider the amount of funding requested for state agencies to carry out plan activities.

The legislature now writes provisos into the budget bill to limit the use of

1991 PUGET SOUND PLAN COST ESTIMATES[1]
By Funding Source

FUNDING SOURCE	87-89 Biennium (estimated actual)	89-91 Biennium (estimated actual)	91-93 Biennium (estimated actual)	93-95 Biennium (estimated full implementation)	95-97 Biennium (estimated full implementation)
Puget Sound Grants Program	$ 0	$ 0	$ 0	$ 4,818,608	$ 5,058,608
Aquatic Lands Enhancement Acct.	$ 0	$ 1,525,000[2]	$ 0	$ 0	$ 0
State Capital Funds	$ 1,049,000	$ 414,982	$ 0	$ 21,411,376	$ 22,411,376
Centennial Clean Water Account	$ 8,516,737	$ 10,469,784	$ 10,469,500	$ 9,869,500	$ 9,869,500
Federal Funding Sources	$ 327,565	$ 1,916,342	$ 1,998,266	$ 1,306,178	$ 1,306,178
Oil Spill Fee	$ 0	$ 0	$ 7,103,952	$ 7,103,952	$ 7,103,952
Local Funding Sources	$ 3,542,461	$ 6,276,304	$ 7,814,690	$ 12,124,900	$ 18,505,032
Motor Vehicle Fund	$ 0	$ 110,750	$ 410,750	$ 1,223,232	$ 1,223,232
Permit Fee	$ 1,618,000	$ 2,785,090	$ 5,309,296	$ 10,935,450	$ 13,004,761
Private Funding Sources	$ 0	$ 0	$ 134,236	$ 567,828	$ 528,218
State General Fund	$ 9,505,752	$ 14,141,625	$ 20,072,150	$ 39,230,165	$ 41,772,789
Toxics Account	$ 0	$ 140,000	$ 703,460	$ 3,771,681	$ 4,049,160
Tribal Funding Sources	$ 73,384	$ 74,130	$ 493,700	$ 466,700	$ 466,700
FUNDING TOTALS	$ 24,632,899	$ 37,849,753	$ 54,509,000	$113,829,570	$125,309,506

Table 4.2

1 1987-89 costs are based largely on plan estimates. 1988-91 and 1991-93 costs for state agencies are based on agency reports of actual spending. 1989-91 and 1991-93 federal agency and tribal and local government costs are based on plan estimates. 1993-95 and 1995-97 costs are estimates for full implementation of the Puget Sound plan.

2 These funds were made available by the Department of Natural Resources as a one time revenue source for wetlands acquisition and inventory. This will not be repeated in future biennia.

Reference: Puget Sound Water Quality Authority, 1992b

funds to plan implementation. This earmarking makes it easier to track agency expenditures and to ensure that the funds are effectively used for the intended purposes. In previous years, many state agencies were unable or unwilling to provide accurate budget information on their use of plan implementation dollars.

State support for plan implementation increased markedly with the 1991-93 budget. State spending on plan programs from the general fund, wastewater discharge permit fees and the oil spill prevention fee climbed from around $11 million during the 1987-89 biennium to over $33 million for the 1991-93 period.

Tables 4.1 and 4.2 provide summaries of plan spending and estimates of costs of full plan implementation. Overall plan spending is apportioned in the tables according to plan programs and funding sources.

EDUCATION AND PUBLIC INVOLVEMENT

People have a tremendous impact on the health of Puget Sound. For this reason, the Authority has placed great emphasis on education and public involvement. Education is critical in fostering awareness of the Sound's importance as a vital regional and national resource, and in stimulating the changes in actions and attitudes needed to effectively protect it. Improved public involvement is essential for people to participate in and contribute ideas and other talents to the programs and decision-making processes that affect Puget Sound.

Program Goals

- Inform, educate, and involve individuals, groups, businesses, industry, and government in the cleanup and protection of Puget Sound.
- Increase understanding of the Sound's ecosystem.
- Create the kind of commitment necessary to sustain efforts to improve and protect water quality over the long-term.

Program Strategy

- Establish a public involvement policy to be followed by agencies and governments implementing the plan.

- Increase assistance to state agencies and tribal governments for coordinated education programs on marine and freshwater habitats, water quality policy issues, and volunteer action.
- Establish field agents to coordinate among local and regional education and public involvement programs.
- Establish a Public Involvement and Education Fund (PIE Fund) to support short-term public involvement and education efforts.
- Establish the Puget Sound Foundation to support long-term education and public involvement efforts.

Program Status

Both the 1989 and 1991 plans outlined vigorous and innovative ways to make education a significant part of Puget Sound protection and cleanup efforts. One of the plan's notable successes is the PIE Fund. The legislature appropriated $1.1 million for the fund in both the 1989-91 and 1991-93 biennia. To date, over 100 small-scale, locally based education projects have been funded, and the results speak for themselves—thousands of volunteers and other program participants have been directly involved in the education of over a million Puget Sound residents on issues and actions affecting the Sound.

In addition to the achievements of the PIE Fund, other parts of the program have been carried out by a variety of public and private groups, reflecting a growing understanding of the role of education in resource management. These include the following activities:

Special Projects—The legislature appropriated funds for specific education projects, including a "Ship's Naturalist" program carried out in cooperation with Washington State Ferries, a conference for volunteers and staff of the region's marine science centers, and teacher training on water quality issues.

Education Policy—Ecology adopted an education policy which reflects a long-range education strategy. The policy establishes a coordinated agency education team and reinforces the agency's waste reduction program which is organized around target audiences.

K-12 Environmental Education—The State Board of Education unanimously adopted a rule declaring environmental education an integral part of the basic K-12 curriculum.

Governor's Council on Environmental Education—As part of the Washington Environment 2010 project, the governor issued an executive order forming a Governor's Council on Environmental Education. The council is made up of the directors of the state Departments of Ecology, Fisheries, Agriculture, Health, Energy, the Authority, the Superintendent of Public Instruction, the Commissioner of Public Lands, and a representative of the Interagency Committee on Outdoor Recreation.

Water Quality Field Agents—Working together, the University of Washington Sea Grant Program and Washington State University Cooperative Extension established water quality field agents in Thurston, Mason, Kitsap, and Jefferson counties, a Puget Sound coordinator, and a Puget Sound water quality newsletter that publicizes field agent activities.

Agricultural Education—Conservation districts hired educational staff, created videos and demonstration farms,

Evaluating PIE Fund Activities

Many people agree that education is an essential component of any resource management strategy, but few agree on ways to evaluate educational programs and their outcomes. As a result, many programs operate without specific measurable objectives and with no systematic way of determining whether a program is succeeding or failing.

In order to create useful program models, evaluation methods have been built into the PIE Fund projects. In 1989, the Authority contracted with Dr. James Long of Cooperative Extension, Washington State University, to establish an evaluation process and to evaluate the effectiveness of the individual PIE projects and the program as a whole.

In its analysis, Long's team found that all of the projects attained their stated objectives for program participation. The projects were most successful in attaining the intended reactions from participants and in attaining their objectives for learning. Thirty-three percent of the projects attained desired behavior changes among participants. Fourteen percent reached end results of preservation or enhancement of water quality in Puget Sound.

Long's team also recommended incorporating evaluation criteria into the initial design phase to more effectively determine a project's success. Those criteria were used in the evaluation of proposals for Round 5.

The PIE process has generated innovative and exciting environmental education and public involvement programs. Dr. Long's contribution to the process—a systematic way to measure the program's success—will extend the usefulness of PIE models beyond their intended audiences. Audiences and participants will learn about Puget Sound's priceless resources, and educators and program developers will learn from their successes and failures just what educational techniques are most effective in preserving and enhancing water quality in Puget Sound.

—Robert Steelquist,
Public Involvement and Education Program Lead
Puget Sound Water Quality Authority

EDUCATION OF YOUTH IS CRITICAL IN FOSTERING AWARENESS OF THE SOUND AS A VITAL REGIONAL AND NATIONAL RESOURCE

S. Hindle

and co-sponsored PIE Fund projects.

Puget Sound Fund—Puget Sound Bank created the Puget Sound Fund and provided corporate philanthropic support to many of the Sound's education activities and projects.

State Agency Education Programs—The state Parks Commission developed a boater education program, the Department of Natural Resources (Natural Resources) developed a marine plastics debris education program, and the Departments of Fisheries and Wildlife expanded their aquatic education programs. The Department of Wildlife is also installing interpretive kiosks at their fish hatcheries.

All of these activities, combined with the awareness and education brought about by other efforts, such as the region's watershed management projects, have reinforced the direction and goals of the long-range education and public involvement strategy.

But many challenges remain. Although the Environmental Education Resolution mandates environmental education as part of basic education, the Superintendent of Public Instruction (SPI) has not received adequate funding to carry out its responsibilities under the Puget Sound plan. Substitute reimbursement for districts, identified as a "cost of doing business" in effective teacher training in environmental education, has not been funded by SPI or agencies that conduct teacher training workshops as part of their agency environmental education programs. Interpretive programs in the Departments of Fisheries, Wildlife, Natural Resources, and State Parks are not coordinated. However, the state and federal fish and wildlife agencies are coordinating training for aquatic resources, education, and hatchery interpretation. Although Point Defiance Aquarium, Snake Lake Nature Center, the Poulsbo Marine Science Center, and Nisqually Reach Nature Center have received funding for major capital improvements, other marine interpretive and educational centers need capital improvements.

MUNICIPAL AND INDUSTRIAL DISCHARGES

Municipal and industrial facilities discharge an array of contaminants to Puget Sound. While efforts to control and treat conventional pollutants are generally proving successful, keeping up with the increasing amount of wastewater produced by the region's growing population is not an easy task.

Program Goal

- Improve the control of toxic and conventional contaminants discharged to Puget Sound by industries and municipalities, thereby reducing and eventually eliminating harm from such contaminants.

Program Strategy

- Require that all waste discharge permits include appropriate monitoring requirements and limitations on toxicants and other pollutants of concern.
- Develop the tools to make these permit improvements, including the permit writers manual, data management, lab support, quality assurance, spill control, technical assistance and training, and public involvement.
- Allocate substantially increased resources to urban bay action teams and the pretreatment of industrial wastewater before it enters public sewage treatment plants.
- Devote substantially increased resources to the inspection and enforcement of waste discharge permits for industrial and municipal discharges.

◆ Identify and control unpermitted discharges.

Program Status

Despite decades of attention to point sources of pollution, the control of contaminants from municipal and industrial facilities continues to generate a number of critical and complicated issues. These include efficient administration of the permit program, the backlog of unpermitted and illegal discharges, slow progress toward controlling toxics, and appeals of permit requirements by major dischargers.

To address these challenges, Ecology is working on the following:

Water Quality Standards—Ecology drafted revisions to the state water quality standards (Chapter 173-203 WAC) in 1991. The revisions include updated criteria for toxic compounds contained in EPA's Quality Criteria for Water, an updated antidegradation policy, wetlands water quality criteria, language clarifying the use of toxicity testing and biological assessments, and the development of a human health risk level for setting limits on carcinogens in water. These added provisions will help control toxics and other pollutants discharged by industrial and municipal facilities. Adoption of the rule has been delayed until later in 1992 due to controversy related to the wetlands water quality criteria.

Sediment Management Standards—Ecology adopted Sediment Management Standards in March 1991. The rule includes sediment impact zone criteria and a corresponding review process, both of which have been integrated into the permitting process. EPA approved the rule under the federal Clean Water Act. The rule is discussed in greater detail under the Contaminated Sediments and Dredging Program in this chapter.

Wastewater Discharge Permits—In December 1990, Ecology proposed revisions to the Wastewater Discharge Permit Fees rule (Chapter 173-224 WAC) that would increase permit fees to fully recover eligible permit program costs as required under the authorizing statute (Chapter 90.48 RCW). During the 1991 session, the legislature raised the municipal fee cap from five to 15 cents per household each month. This will allow for the use of a sliding fee scale by municipalities, depending on their size, and will place a more equitable portion of the financial burden on municipalities rather than industries. The 1991 legislative action also established a $7.5 million statewide annual permit fee cap.

Concern about efficient use of the permit fees and Ecology's overall administration of the program continue to be prominent issues. There remains a backlog of expired permits and unpermitted discharges. In 1990 Ecology asked the Governor's Efficiency Commission to prepare a study of the agency's wastewater discharge program. The study concluded that,"unless the effectiveness of water quality program management is significantly increased and the efficiency of the wastewater discharge permit process significantly improved, comprehensive program service levels cannot be attained with the projected $18.6 million cost estimate...current services will continue to be inadequate to meet the state's water quality mandate..." (Washington State Committee for Efficiency and Accountability in Government, 1990).

Two of the most significant issues in this program are

Public Involvement in Developing the Sediment Management Standards

When was the last time you thought about contaminated mud? The fact is, polluted sediments are a serious environmental and human health threat in some parts of Puget Sound. Fortunately, a number of interested citizens have worked with the Department of Ecology over the past several years to tackle the problem. Their work has resulted in the development of Washington's Sediment Management Standards, the first such standards in the nation.

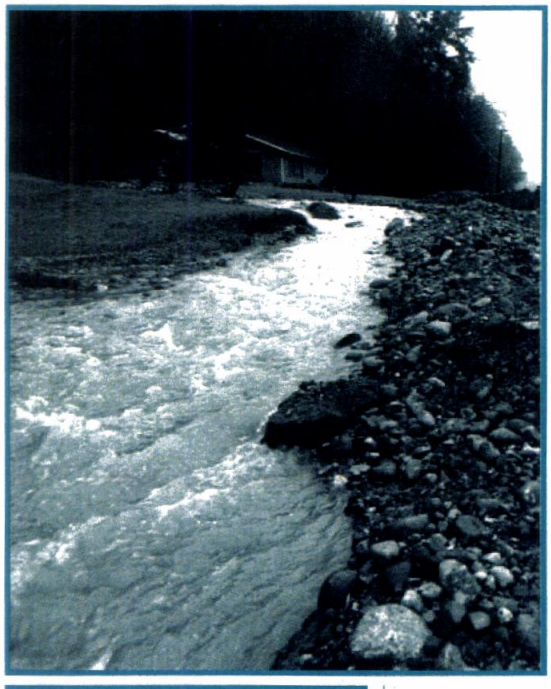
Two advisory committees helped develop the rule, including representatives from industry, environmental organizations, tribes, local governments, and other parties affected by or interested in sediment management issues. Their involvement allowed us to hear the wide range of concerns regarding sediment management and to incorporate those concerns into the standards.

The groups faced a number of difficult issues. There were no existing state or federal regulations upon which to model their work, there was little certainty about some technical aspects of sediment contamination, and there was the challenge of creating a regulation that integrated aspects of water quality, solid waste, and hazardous waste cleanup laws. The issues were complex and sometimes contentious, but in the end, the groups came up with a workable and scientifically acceptable rule.

The resulting regulation was adopted in March 1991. It includes a narrative sediment quality standard for all sediments in the state, chemical and biological limits for sediment contaminants in Puget Sound, measures to control contamination sources, and a process to guide sediment cleanups. The rule is being used as a model in other parts of the country.

Sediment contamination is still not a well-known or easily recognized problem. It's a problem that is easily placed "out of sight and out of mind." But thanks to the hard work of a handful of active and interested citizens, Washington now has sediment standards that provide a strong base for further protection of the inhabitants of Puget Sound.

—Tom Luster, Sediment Management Unit, Department of Ecology



Bob Britain, King County Surface Water Management

STORMWATER COLLECTS AND CARRIES A VARIETY OF CONTAMINANTS TO THE SOUND

toxic limits and monitoring requirements in discharge permits. Although the phase-in of these added permit conditions over the past two years has been relatively slow, Ecology continues to make significant progress with certain groups of permits. Many of the added conditions were appealed by a number of major dischargers. Litigation related to permit conditions has delayed implementation of several plan elements. In cases where new permit conditions are appealed, the old, less restrictive conditions remain in effect when the Pollution Control Hearings Board grants a stay.

The following is an overview of other key elements in the Municipal and Industrial Discharges Program:

Public Involvement—The plan requires meaningful public involvement in wastewater discharge permit decisions as well as technical outreach to the regulated community. Outreach to dischargers was funded in the 1991-93 biennium and is planned for the coming years. Ecology recently released a strategy to improve its efforts in these areas. The department has established permit coordinator positions and a toll-free telephone line to provide public access to the permitting process and related discharge issues.

Permit Writing—The permit writers manual, an important tool for improving the permit program, has been drafted by Ecology and is in use. Completion of the manual has been delayed for reasons that include the challenges of a rapidly changing program, resource limitations, and litigation by dischargers of permits containing new biomonitoring conditions. Training sessions and technical assistance for permit writers were also delayed by the litigation, but have resumed.

Enforcement—Ecology has issued an enforcement policy manual to be used by staff, and the department is conducting enforcement training on a regular basis. Ecology also publishes a quarterly enforcement trend report which indicates that higher penalties are being assessed and dischargers are increasingly attentive to the need for compliance.

Data Management—The complexity and volume of data have greatly increased over time. Permit writers, managers, and the regulated community have difficulty obtaining timely and complete information. Ecology is upgrading the data management system, but at a delayed pace due largely to limited resources.

Inspections—Although Ecology has conducted certain types of inspections at frequencies that meet or slightly exceed Puget Sound plan requirements, some types of inspections have fallen far below plan targets due in part to limited resources. Policies for unannounced Class I inspections have been developed, but the rate of inspections may be further slowed if implemented according to the schedule proposed by the Efficiency Commission study rather than the Puget Sound plan. Inspections have occurred frequently in some areas around the Sound through the Urban Bay Action Program.

STORMWATER AND COMBINED SEWER OVERFLOWS

Both nationally and in Puget Sound, stormwater remains one of the most poorly managed sources of pollution. Many valuable stream corridors, other aquatic habitats, and private and public property are damaged by unmanaged stormwater runoff.

In contrast with the major municipal and industrial sources, stormwater and combined sewer overflows have only recently received close attention as significant sources of pollution. Realizing that there are no quick

fixes to stormwater runoff problems, the plan takes a long-term approach and aims to avoid, if possible, end-of-the-pipe controls.

Program Goals

- Protect shellfish beds, fish habitat, and other resources.
- Prevent the contamination of sediments from urban runoff and combined sewer overflows.
- Achieve standards for water and sediment quality by reducing and eventually eliminating harm from stormwater runoff and combined sewer overflows throughout the Puget Sound basin.

Program Strategy

- Require cities and counties, in conjunction with growth management requirements, to develop programs to prevent and manage stormwater runoff through source control and best management practices.
- Develop municipal stormwater National Pollutant Discharge Elimination System (NPDES) permits which incorporate best management practices for the Sound's largest cities and counties, and phase in permits for smaller jurisdictions as additional federal regulations are developed.
- Provide technical assistance through a state technical manual, model ordinances, and training for local governments.
- Require management of highway runoff.
- Require all cities with combined sewer overflows in the Puget Sound basin to develop and implement plans providing for the greatest reasonable reduction of overflow events.

Program Status

Stormwater

This program approaches the stormwater problem in a comprehensive manner, focusing on best management practices, education, and technical assistance as the preferred methods to control runoff. The emphasis is on source control and best management practices because keeping pollutants out of stormwater and using natural filtration is much cheaper than dealing with polluted discharges after they are washed into lakes, streams, and Puget Sound. The program also emphasizes the need to maintain stormwater facilities. Ecology is directed to develop technical guidance and provide ongoing assistance to facilitate the development of stormwater programs.

All cities and counties in the basin are required to have basic preventative stormwater programs in place by July 1994. This coincides with growth management planning deadlines. In areas that are already urbanized, the plan additionally requires local governments to identify and address existing stormwater problems. For now, urban areas required to develop more comprehensive programs include Seattle, Tacoma, and unincorporated King, Snohomish, and Pierce counties.

Federal NPDES regulations are also driving the development of local stormwater programs. Currently, the NPDES program applies only to the five most urbanized counties. The law prohibits non-stormwater discharges to storm sewers, requires controls to reduce the discharge of pollutants to the maximum extent practicable, and sub-

Coordinated Stormwater Management in Thurston County

Thurston County and the cities of Lacey, Olympia, and Tumwater are clustered at the southern end of Puget Sound. Our jurisdictional boundaries overlay a tangle of streams, lakes, and aquifers—an integrated freshwater system which must be managed accordingly. Without a joint effort, one jurisdiction might protect a stream for the 10-year storm event while just downstream an adjacent jurisdiction provides protection for the 25-year event. Or perhaps stormwater quality treatment is required in one jurisdiction and not in another.

Recognizing the need for joint stewardship, cooperation among the four jurisdictions has increased over the years to where we now have a standing committee managing almost a dozen projects. Program managers from the four jurisdictions meet weekly to review progress on jointly funded projects, to plan strategies for funding and implementation of capital projects, and to monitor the success of the program. In addition, the four public works directors meet once a month to provide broad direction to the stormwater program.

The cooperative approach includes sharing staff and management talents, grant funds, space for project construction, and the burden of writing seemingly endless interlocal agreements. Staff have also formulated some rather sophisticated policies for deciding each jurisdiction's share of the costs, including how to handle jointly funded projects which may be annexed to a single jurisdiction at some point in the future.

Continuous communication, another mechanism that makes it work, will soon include computers in the four jurisdictions linked by phone lines allowing for quicker communication and file transfers. But probably the single biggest factor for the program's success is the fact that staff truly want it to work. This common vision transcends boundaries which otherwise might stand in the way.

—Thomas Holz, Design Engineer, Thurston County Department of Public Works

Bob Brittain, King County Surface Water Management

RUNOFF FROM DEVELOPED LAND INCREASES FLOODING PROBLEMS AND HABITAT DEGRADATION

jects industrial stormwater sources to best available technology/best conventional technology-based standards. Ecology is the delegated state agency that administers the NPDES program. Additional federal regulations for smaller jurisdictions are likely within the next two years. Smaller jurisdictions will be affected to the extent that industries within their boundaries may be subject to NPDES regulations.

To address issues identified in the Puget Sound plan, Ecology adopted a highway runoff rule in June 1991. This regulation lays the framework for the Washington Department of Transportation's (Transportation) program to control runoff from state highways in the Puget Sound basin. In summary, the rule requires Transportation to adopt a stormwater management manual; develop and implement a vegetation management program with emphasis on reducing the use of roadside chemicals; incorporate water quality best management practices into all new construction projects; and inventory the existing highway system and set priorities for best management practices.

Combined Sewer Overflows

The other major part of this plan program addresses combined sewer overflows. In 1985, the state passed legislation requiring all municipalities with combined sewer overflows to develop plans for the greatest possible reduction at the earliest date. The legislation required submittal of the plans by January 1988. Ecology developed a companion regulation (Chapter 173-245 WAC) and combined sewer overflow reduction guidelines to help implement the program. In a 1987 report to the legislature, Ecology defined "greatest reasonable reduction" as one overflow per year at each overflow location. In addition, Ecology has negotiated interim goals of 75 percent and 79 percent reductions of combined sewer overflow volumes systemwide over the next 20 years with Metro and Seattle respectively. There are currently 141 combined sewer overflow sites in Puget Sound, down from 170 in 1987 (Ecology, 1991).

As of August 1991, combined sewer overflow reduction plans for Seattle, Metro, Bellingham, Everett, and Anacortes had been approved. Ecology had written administrative orders extending the submittal dates for five other jurisdictions. The city of Port Angeles has submitted its plan to Ecology, and the cities of Olympia, Bremerton, Mount Vernon, and Snohomish were at various stages of monitoring and plan development. Jurisdictions are required to update their plans every five years.

CONTAMINATED SEDIMENTS AND DREDGING

Many of the contaminants entering Puget Sound are not flushed out to the ocean, but instead remain in the basin's bottom sediments. For this reason, the sediments in Puget Sound are often more contaminated than the water itself. This poses the greatest threat to sea animals that feed and live in the sediments and, in turn, to birds and mammals that eat those sea animals.

Program Goals

- Reduce and ultimately eliminate adverse effects on biological resources and humans from sediment contamination throughout the Sound.

Program Strategy

- Reduce or eliminate discharges of toxic contaminants.
- Cap, treat, or remove contaminated sediments.
- Classify sediments with adverse biological effects and significant human health risks.
- Control sources of contaminants causing sediments to fail the state standards.
- Establish rules and sites for disposal of dredged materials.
- Expand Ecology's Urban Bay Action Program to provide additional source control and to consider cleanup actions for existing areas of high sediment contamination levels.

Program Status

Major portions of the 1987 and 1989 Puget Sound plans focused on the Puget Sound Dredged Disposal Analysis Program, a cooperative effort involving the U.S. Army Corps of Engineers, EPA, and the state Departments of Natural Resources and Ecology. Representatives of these agencies developed procedures to evaluate sediments and establish sites for the unconfined, open water disposal of dredged sediments.

Sediment Management Standards

Building on these accomplishments, Ecology adopted the Sediment Management Standards in March 1991. The rule is a significant milestone in implementing the sediment policies of the Puget Sound plan. The main components of the regulation are as follows:

Sediment Quality Standards—The regulation establishes quantitative limits for 47 chemicals. A sediment sample that exceeds one of the criteria may undergo direct biological testing to see if it causes any adverse biological effects.

Source Control—The standards are used to control sediment contamination from ongoing, permitted sources. Where dischargers use best available control technologies but still exceed the standards, sediment impact zones may be established. To qualify for this provision a discharger would have to use best management practices, increase sediment monitoring in the discharge area, manage the impact zone, and submit a cleanup plan for the impact zone once its use is discontinued.

Sediment Cleanup—The regulation establishes a process for identifying and ranking contaminated sediment sites for cleanup. It also establishes cleanup standards for actions conducted under the Model Toxics Control Act and related rules.

The standards address the ecological effects of contamination on marine sediments in Puget Sound. Ecology plans to amend the regulation at a later date to address human health and freshwater sediment criteria (Ecology, 1991).

Standards for the confined disposal of sediments are being developed by Ecology in a separate rule. The confined disposal standards will be used by Ecology, shoreline jurisdictions, and local health departments in approving or denying permits for the use or disposal of material that does not meet unconfined disposal standards. The rule is scheduled for adoption in summer 1992.

St. Paul Remedial Action and Habitat Restoration Project

"It's beautiful," said Dana Rasmussen, EPA's Regional Administrator. She was admiring the marine life thriving on 17 acres of Commencement Bay's new intertidal and subtidal habitat. The area was restored three years ago when clean sediment was used to cap a contaminated hot spot which had resulted from 36 years of untreated wastewater discharges into the bay.

Restoring St. Paul's water quality and habitat involved four simultaneous actions:

New Outfall—Although the wastewater already received secondary treatment, the outfall caused problems because of its location and low dilution ratio. A new outfall was completed extending 800 feet into the bay.

Remedial Action—Approximately 17 acres of contaminated sediments were capped with clean sediments from the Puyallup River.

Source Control—By collecting and providing secondary treatment to stormwater, building chip containment facilities, and continuing the ongoing chemical source control program, the Simpson Tacoma Kraft Mill eliminates more than one million pounds of potential chemical pollutants each year.

Monitoring—The project has been monitored since the fall of 1987 with positive results. The area has begun recolonizing with marine organisms, but must be monitored closely to ensure the long-term effectiveness of the cap.

Cleanup cost $5 million and was paid for with private money. This effort took cooperation from a variety of groups that have not often managed to find common ground: industry, Indian tribes, environmentalists, and federal, state, and local agencies. These groups formed an extraordinary public-private partnership to facilitate a timely and responsible cleanup.

—David McEntee
Simpson Tacoma Kraft Company

An Ecology study concluded that multiuser confined disposal sites are urgently needed and that the demand will only increase as the volume of contaminated material increases. Issues identified for further study included siting, funding, and institutional arrangements, as well as liability. The issue of liability may require added legislative or regulatory attention.

The Contaminated Sediments and Dredging Program also requires Ecology and other state and federal agencies to investigate sites and conduct cleanup. As part of this effort, Ecology now maintains an inventory of Puget Sound locations that violate sediment standards.

Areas investigated for contaminated sediments include portions of Commencement Bay, Elliott Bay, Everett Harbor, Sinclair/Dyes Inlet, and Budd Inlet. Much of the work is conducted under Ecology's Urban Bay Action Program. Action plans are being implemented for Elliott Bay, Commencement Bay, Lake Union/Ship Canal, Everett Harbor, and Sinclair Dyes Inlets. Plans are being developed for Budd Inlet and Bellingham Bay.

These investigations have resulted in a number of sediment cleanup projects around the Sound. As part of a Superfund cleanup project, contaminated sediments have been capped along the St. Paul Waterway of Commencement Bay. Simpson Tacoma Kraft (formerly Champion) is the first site in the Commencement Bay Superfund area to be considered clean by EPA. A cleanup program in Elliott Bay includes the removal of sediments from drains and planning for both combined sewer overflows and municipal wastewater treatment facilities to reduce effluent toxics. Metro has expended considerable effort to identify and control sources near the Denny Way combined sewer overflow. Contaminated sediments at the Denny Way site have been capped with clean sediments as part of a pilot project to assess how effectively capping isolates contaminants from benthic organisms, fish, and the water column.

NONPOINT SOURCE POLLUTION

The growing amount of nonpoint source pollution resulting from growth, development, and the day-to-day activities of the basin's citizens is degrading the resources of Puget Sound. Polluted runoff from parking lots, highways, pastures, logging sites, and failed septic systems is a significant source of pollution in the basin.

Program Goal

- Reduce the amounts of pathogens, toxics, sediments, and nutrients entering Puget Sound from nonpoint sources, and where possible prevent them altogether.

Program Strategy

- Develop and implement local watershed management plans through a collaborative process involving state, federal, and local resources.
- Supplement watershed management plans with education and preventive programs.
- Develop or enhance state programs and regulations for those nonpoint sources that are most effectively controlled at the state level.

Program Status

The heart of the Nonpoint Source Pollution Program is the local watershed action program, which involves the public in the development of a plan to effectively identify and control the pollution sources in their watershed. The Authority adopted a rule (Chapter 400-12 WAC; revised November 1991) to guide local governments in the watershed ranking, planning, and implementation process.

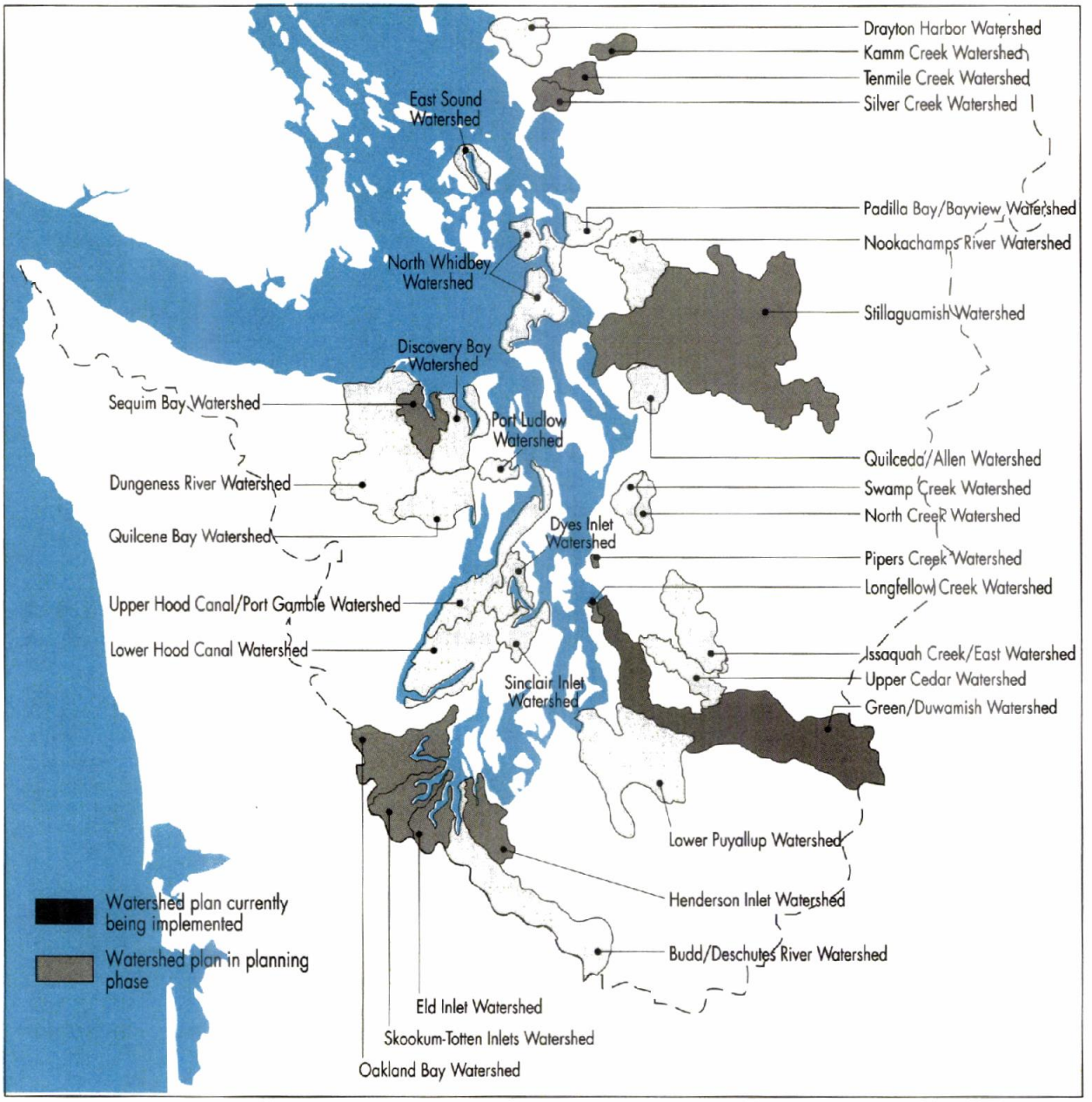


Figure 4.1 Status of Puget Sound Watershed Plans

In the Puget Sound region, 130 watersheds have been identified and ranked. Twelve watershed plans are being implemented in nine Puget Sound counties. Another 20 plans are in various stages of development (Figure 4.1). All Puget Sound counties are now participating in the watershed planning process. Nearly $16 million from the Centennial Clean Water Fund has been used to support watershed planning and implementation, along with some federal and local assistance.

The watershed program has been highly successful in generating a great deal of enthusiasm among local governments and citizens for controlling nonpoint pollution problems. The educational aspect of the program has been working well, with watershed tours, workshops, stream team activities, PIE Fund projects, and public participation in the planning process all contributing to a growing sense of stewardship for local bays, streams, and the Sound.

Another success has been the creation of local loan programs for nonpoint source pollution. Following Jefferson County's lead, five other Puget Sound counties—San Juan, Whatcom, Thurston, Mason, and Clallam—have obtained loans from the State Revolving Fund, administered by Ecology, to provide local property owners with low-interest loans to address a variety of nonpoint problems, ranging from the repair of septic systems to the installation of agricultural best management practices.

Along with the many positive results, the watershed program also faces a number of serious challenges. One of these is the problem of limited funding. Each year, only 10 percent of the Centennial Clean Water Fund can be allocated for nonpoint source grants statewide. This is too little money to help sustain both the development and implementation of the growing number of watershed plans. Another problem is that local governments are increasingly burdened with multiple planning requirements for growth management, flood control, stormwater management, and other public programs, placing extreme demands on local resources and volunteers. Finally, there is a growing impatience with this type of approach because of the time lag between planning and actual water quality improvements. To hasten at least development of the plans, the Authority revised the watershed planning rule in 1991 to streamline the planning process and to make the program less burdensome for local governments.

Growth Management and Watershed Planning: Bringing the Pieces Together in Whatcom County

A diversity of approaches are being taken by counties to comply with the mandates of the Growth Management Act. For our part in Whatcom County, as we sort through the critical areas and natural resource areas, we have been impressed with the overlapping and integrated nature of each element.

Needless to say, our early efforts to fit these pieces into neat, self-contained regulatory boxes have proven difficult. For instance, setting out to identify isolated wetlands has become a relatively fruitless exercise. We have discovered few wetlands in Whatcom County that are truly isolated. In most cases, they are part of a larger wetland (and wildlife) system, slowly releasing water to the county's thousands of small streams and drainage ditches.

As we inventory critical and natural resource areas, we are rediscovering the region's dynamic and integrated ecosystems. For example, we are learning that the health and stability of lowland systems are dramatically impacted by the degree of stability in the forested upland areas. It is not adequate to address them separately.

In response, we are approaching the inventory, as well as the development of policies and regulations, in a comprehensive manner. For instance, we have adopted watersheds as our fundamental environmental planning units. Basin planning will allow us to more readily inventory systems rather than individual parts of the watershed, and will enable us to assess the cumulative impacts of existing and future land-use activities.

Like many other rural counties, we are struggling to put the pieces together. But we believe we have found a course of action that we can build upon in years to come; one that is soundly rooted in both environmental and growth management.

—Terry Galvin, Assistant Planner, Whatcom County Planning Departme

In addition to the watershed program, this program addresses a number of nonpoint issues on a Soundwide basis. Efforts to address these issues include:

Dairy Waste—Dairy waste management plans are being implemented in priority watersheds with help from the Soil Conservation Service as well as federal funding under Section 319 of the Clean Water Act. The Washington Conservation Commission provides grants to conservation districts to assist with this work. In addition, Ecology is developing a waste discharge permitting program for commercial dairy operators.

Septic Systems—The Department of Health is revising state regulations for on-site septics, but has encountered a number of budgetary and legal delays.

Pesticides—The plan directs Washington State University Cooperative Extension to design pilot pesticide usage surveys for selected watersheds, and to establish, with the assistance of other designated agencies and an advisory group, a Puget Sound Pest Management Information program. No state funding has yet been allocated to achieve this.

EPA, through a cooperative agreement with the Authority, Ecology, Cooperative Extension, and the Departments of Health and Agriculture, is funding a number of projects that address urban pesticides statewide, with some focus on Puget Sound.

Forestry—The State Forest Practices Board is considering the adoption of several regulations dealing with the impacts of forest activities on water quality and habitat. These are being reviewed using the Timber/Fish/Wildlife Agreement as the basis for negotiations.

Boating—The State Parks and Recreation Commission (Parks) has the lead for most of the plan's marina and boating elements. Parks operates an environmental education program for boaters developed with the assistance of a Puget Sound boaters' task force. Additionally, Parks has installed pumpout stations in five priority state parks and has funded the installation of five other pumpouts in private marinas around Puget Sound through a new sewage pumpout grants program. This grants program was established through legislation that the boaters' task force helped develop.

EPA and the Authority provided money through a PIE Fund project to design, construct, and install portable pumpout units in seven marinas, and to educate boaters

on the importance of using pumpouts. The Authority is now considering how to expand the pumpout program to speed up the installation of pumpouts and other methods for disposal of boat sewage. The plan directs Ecology to develop guidelines under the Shoreline Management Act on standards for the siting, design, renovation, and expansion of marinas, but the agency has not received funding to do this. Ecology is requiring local governments that amend their marina programs to include requirements for best management practices, education programs, and sewage pumpout facilities.

SHELLFISH PROTECTION

Shellfish are important symbols of the region's heritage and quality of life, evidence of how well we are caring for the basin's natural environment. Shellfish accumulate certain contaminants as they filter food from the waters of Puget Sound. For this reason they are key indicators of the basin's health—in essence, "the canary in the mine."

Program Goals

- Protect water quality in shellfish growing areas.
- Prevent contamination of commercial and recreational shellfish beds so that shellfish are safe for human consumption.
- Reduce contamination of shellfish beds sufficiently to allow reopening of at least one shellfish bed each year.

Program Strategy

- Adopt policies to ensure that pollution source control programs protect shellfish.
- Respond to existing and potential shellfish contamination with an aggressive restoration and protection program.
- Monitor commercial and recreational shellfish areas for toxic contaminants and indicators of pathogenic organisms.
- Increase public involvement and education in shellfish protection.

Program Status

The Shellfish Protection Program provides a comprehensive approach for restoring commercial and recreational shellfish beds throughout the basin and for preventing future closures. Over the past few years, the program has led or contributed to a number of activities, including the following:

Monitoring—The Department of Health is conducting a monitoring program in commercial and recreational shellfish areas. The Authority has sponsored citizen monitoring projects through such groups as Adopt-A-Beach.

Responding to Downgrades—The Departments of Ecology and Health are working on an interagency agreement that will govern their response to downgrades in the classification of commercial or recreational shellfish beds, including a strategy for correcting the contamination sources.

Recreational Shellfish—Ecology and Health are developing a recreational shellfish protection plan with the help

Strategies for Action: Pipers Creek Watershed Plan

The main reason for developing a watershed action plan is to generate just that—actions or changes. To better protect water resources in the Pipers Creek watershed, the Seattle Drainage and Wastewater Utility developed an action plan using a two-fold strategy. We relied on a broad strategy to generate consensus among key players and to produce a planning document that would be easily adopted; and a detailed strategy to develop specific recommendations that would be readily put into practice.

The watershed management committee came up with many great ideas, but realized that success depended on whether those ideas could be fully implemented. We spent a great deal of effort researching the feasibility of each recommendation, considering whether implementation was impeded or favored by such criteria as costs, effectiveness, reliability, and public acceptance. The broad strategy also relied on extensive public involvement, neighborhood-based initiatives, and creative efforts to secure funding for the larger programs.

Clarity about not only what to do, but by whom, how much, and when are also critical issues that must be addressed during the planning process. We also worked to see how recommendations could be combined with existing programs to minimize financial impacts.

The difference between a good idea and a successful action often lies in implementation. And to successfully implement a watershed action plan, attention must be given to implementation throughout the course of the project—from the start of the planning process. After a plan is agreed upon, you can't just kick back and watch things happen. The role of the lead agency as a catalyst and motivational force is very important in carrying out the plan.

—Cindy Thrush, Pipers Creek Action Plan, Project Manager, City of Seattle

T.W. Ransom

of a number of parties.

Watershed Management—Seven of the first 12 watershed management plans, all of which have been approved by Ecology, address pollution problems in areas with important shellfish resources.

Priority List—Ecology and Health have developed a list of priority commercial and recreational shellfish beds that are threatened by pollution.

Public Education—The Departments of Ecology, Health, Fisheries, and Natural Resources, the Washington Sea Grant Program, and the Authority have set up an innovative outreach program to educate the public on shellfish protection and to prevent the harvest of contaminated shellfish. This includes the annual Low Tide celebration and Asian language information materials.

Restoration—EPA funded a shellfish bed restoration project at Penrose State Park.

THE SOUND'S SHELLFISH ARE INCREASINGLY THREATENED BY NONPOINT POLLUTION

While some progress is occurring, the Sound's productive shellfish beds are increasingly threatened by pollution from the basin's growing population and changing land uses. Unless pollution control programs are implemented more quickly and aggressively, current efforts to protect shellfish may not be enough to forestall future closures. Not only have no shellfish beds been reopened, but the Department of Health closed two more commercial shellfish beds in spring 1991 and a number of other closures may be forthcoming in 1992 if corrective actions are not taken soon to reduce or prevent further contamination.

A key part of the plan's shellfish protection strategy—local government shellfish protection programs—remains largely unimplemented. This strategy is designed to provide state grants and technical assistance to local governments for on-the-ground programs to protect priority shellfish beds in areas not scheduled to participate in the watershed management program for at least two years. The local programs, in turn, would identify and correct problem sources such as failing septics, farm wastes, and stormwater outfalls. They would also assess the need to revise local land-use ordinances.

Two important initiatives are underway that should help foster this type of local action. The first involves state shellfish protection legislation drafted by the Authority and signed into law in 1992. This legislation requires counties to create a shellfish protection district and establish a program within 180 days of a pollution-related shellfish bed closure or restriction. Formation of a district will enable local financing for the programs through sources such as tax revenues, inspection fees, charges or rates, or grants. Jurisdictions with shellfish protection districts will also receive priority consideration for state water quality funding. The second initiative involves a short-term program developed by Ecology to provide financial and technical assistance to local governments to clean up and restore priority shellfish areas. Grant recipients, to be selected in summer 1992, will have to develop a long-term strategy for funding shellfish bed protection and restoration by, for example, establishing a shellfish protection district.

HOUSEHOLD HAZARDOUS WASTE

The household chemicals we use and throw away—cosmetics, cleansers, paint thinners, and pesticides—are all potential sources of pollution to Puget Sound.

Program Goal

◆ To help guide the cooperative efforts of Ecology, Washington State University Cooperative Extension, and a number of other agencies and groups to educate homeowners and retailers on household hazardous waste issues, less toxic alternatives, and the proper use and disposal of pesticides.

Program Status

A major part of this program—the phased funding of local hazardous waste management plans, as outlined in the Puget Sound plan—has been completed. All 12 Puget Sound counties have prepared hazardous waste management plans and are in various stages of implementation.

The other major part of this program is ongoing education coordinated by Ecology, Cooperative Extension, and the Authority. However, these activities were not funded for the 1991-93 biennium.

Ecology has received enough money to support a limited number of education services, including a recycling hotline, fact sheets and other educational materials and publications, and technical assistance. Additionally, Ecology plans to host workshops to train local staff on household hazardous waste issues.

Cooperative Extension staff also provide information on the proper use and disposal of pesticides through their Master Gardener program. They continue to update information developed under the Sound Gardening project and distribute this material statewide. (Sound Gardening was a PIE Fund project initiated in King County.) Additionally, they are developing a manual on best management practices for commercial pesticide applicators.

Staff from Cooperative Extension, the Authority, and the Departments of Ecology, Agriculture, and Health are participating in an urban pesticide steering committee organized by EPA, Region 10. The committee is addressing pollution problems resulting from the application, storage, and disposal of pesticides and fertilizers in the urban environment. So far, the committee has directed EPA funding to six pesticide education projects and has hosted a summit addressing critical urban pesticide issues.

WETLANDS PROTECTION

As in other areas of the country, Puget Sound wetlands are being altered and destroyed to make way for a variety of activities and land uses. The plan's Wetlands Protection Program is designed to ensure that federal and state agencies, and local and tribal governments establish coordinated programs to protect wetlands.

Program Goals

◆ No net loss of wetlands function and acreage in the short term.

◆ A measurable net gain of wetlands function and acreage in the Puget Sound planning area in the long term.

Program Strategy

◆ Identify and preserve high quality wetlands.

◆ Help local governments develop effective wetland protection programs that tie into the goals and planning process of the Growth Management Act.

◆ Develop and implement a program for protecting wetlands on state-owned uplands and aquatic lands, including nearshore habitats.

◆ Develop and implement a long-range wetlands education strategy.

◆ Develop and implement a strategy to inventory wetlands and track

AS KEY COMPONENTS OF THE BASIN'S DRAINAGE SYSTEM, WETLANDS

Bob Brittain, King County Surface Water Management

ABSORB AND STORE RAIN AND RUNOFF

wetland conditions.

- Develop and implement a strategy to improve interagency coordination.
- Develop and implement a program to restore selected wetlands.

Program Status

In September 1991, the Authority adopted the local government wetlands protection program into the Puget Sound plan. The Authority's program recommends integrating regulatory and non-regulatory components such as comprehensive planning, preservation, education, and restoration into local comprehensive protection programs. The program also incorporates Ecology's model wetlands protection ordinance, which provides standards for local governments to use in developing their wetland regulations. These recommendations are consistent with the requirements of the Growth Management Act, which is discussed later in this section.

The 1987 and 1989 versions of the plan directed Ecology and the Department of Natural Resources (Natural Resources) to develop criteria for identifying wetlands and to compile a list of high quality wetland sites nominated by citizens. The legislature appropriated $1 million to Natural Resources in the 1991-93 biennium to acquire wetlands from the nearly 5,000 acres of wetlands on the list. Private organizations such as The Nature Conservancy and local land trusts are also active in wetlands acquisition.

Public education efforts have been very successful on a number of fronts. Ecology has produced brochures, classroom materials, videos, and booklets on wetland functions, preservation, and regulations, and a landowner's guide to wetlands protection. Ecology and King County have completed a wetlands preservation guidebook for local governments. PIE Fund projects have produced slide shows, seminars, and newsletters on wetlands, and have generally raised awareness in several communities on wetlands issues. Grants from Ecology have helped local governments provide materials and presentations to the public on wetlands. Budget cutbacks in the 1991-93 biennium have reduced wetlands education programs.

In April 1990, the governor issued an executive order (90-04) directing all state agencies, within available resources, to use their authority to help implement applicable portions of the plan's Wetlands Protection Program. The order directed Ecology to develop statewide policies and standards for a wetlands rating system, mitigation, buffers, restoration, and enhancement. State agencies were to adopt these policies and standards as part of their State Environmental Policy Act policies. Agencies were also directed to condition or deny development permits, to the extent legally permissible, to assure wetlands protection. The Authority was directed to continue its efforts to ensure full implementation of the wetlands elements of the Puget Sound plan.

In spite of these actions, the state of Washington still does not have comprehensive, statewide legislation for wetlands protection. The state's Shoreline Management Act regulates only shorelines and associated wetlands, meaning that upland freshwater wetlands generally are not covered by any state regulation. The responsibility for wetlands protection has fallen on local governments, acting under the requirements of the 1990 Growth Management Act, to develop protection programs for critical areas.

Growth management planning provides a major opportunity to improve

wetlands protection in the Puget Sound region. Local governments are required to enact interim regulations for critical area protection, to prepare comprehensive land-use plans which incorporate critical areas protection by 1993, and to adopt final regulations for critical areas protection by 1994. Because there are no minimum standards required statewide, the result may be inconsistent regional wetland protection with each local government choosing specific standards and implementing their own ordinances. A few local governments, such as Island, Thurston, and King counties, have had well-developed wetlands protection ordinances for some time; however most have not.

At the federal level, recent actions may change the way wetlands are defined and delineated across the nation. If proposed revisions to the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* are approved, the scope of the regulations would change dramatically, so that fewer wetlands would actually fall under the wetlands definition for regulatory purposes. Changes to the Nationwide Permit Program, administered by the U.S. Army Corps of Engineers, have also been proposed. Although changes at the national level would be less restrictive of wetlands filling, the Corps' Seattle district has adopted its own, more protective, regional conditions.

Related to many of the issues discussed above, the following are some important needs for the Puget Sound region regarding wetlands protection:

Minimum Standards—Probably the most pressing problem for the region is the lack of minimum standards for wetland regulations. Although local governments are implementing wetland regulations to comply with the Growth Management Act, these regulations will provide inconsistent, patchwork protection throughout the Sound. Without minimum standards for wetlands protection, there is little assurance that local regulations will be adequate.

Research—Decision-makers need better technical information on wetland functions, processes, and values in order to enact fair and consistent policies. Research priorities are not well established, and few mechanisms exist for sharing research data.

Education—A more coordinated effort is needed to educate the public about how wetlands work, why they are valuable, and why they need protection.

Inventories—A major obstacle in evaluating the loss of wetlands is the lack of comprehensive inventory and permit tracking systems. The Nationwide Wetlands Inventory was a large-scale effort that provided only about 60 percent coverage. The data needs to be supplemented with more accurate field information. Ecology recently acquired a Geographic Information System (GIS) to begin a comprehensive wetland inventory project. A few local governments (for example King, Snohomish, Thurston, and Pierce counties) have completed wetlands inventories for portions of their jurisdictions. Costs and staffing are a problem for many local governments.

Acquisition—Public funding for acquisition of valuable wetlands is important to wetlands protection, yet only minimal amounts of money have been appropriated for this task. The 1991 state budget allocated $1.1 million to the Department of Natural Resources for the purchase of some of these wetlands.

Urban Bay Action Program Targets Local Pollution Problems

The Urban Bay Action Program provides a geographical focus to pollution control and cleanup for Puget Sound urban bays. The program currently includes Commencement Bay, Elliott Bay, Lake Union, Sinclair/Dyes Inlets, Bellingham Bay, Everett Harbor, and Budd Inlet. Ecology's Toxics Cleanup Program oversees the program. For each bay included in the program, a team of state and local agencies develops and implements an action plan. These teams are referred to as urban bay action teams (UBATS). Work groups, comprised of a variety of stakeholders, provide guidance to UBATS as action plans are developed and updated.

Contaminated sediments are a priority concern for most Puget Sound urban bays. Sources of sediment contamination include toxics in stormwater, sewage and industrial wastewater, polluted groundwater seeps, and spills. Toxics in stormwater originate from a wide variety of sources, for example, industries, businesses, homes, cars and trucks, and pesticide and other chemical applications. Other concerns include nutrient enrichment (Budd Inlet) and other types of water pollution.

Reflecting the need for comprehensive and innovative solutions, the action teams use a variety of regulatory and nonregulatory tools to improve the condition of the bays. Examples include holding small business workshops on best management practices to control pollution to Lake Union, inspecting businesses for illegal connections to storm sewers that empty into Elliott Bay, posting multilingual signs around Dyes Inlet warning the public about recreational seafood consumption, and taking regulatory actions against businesses to control toxic discharges to Commencement Bay.

—Dave Smith
Toxics Cleanup Program Unit Supervisor
Department of Ecology

Mitigation—Mitigation is an accepted, but uncertain, strategy for compensating the loss of wetlands. Mitigation of project-related losses is still a developing science, and even well-designed projects may not function as intended. A review of wetland mitigation projects under Section 404 permits by Rylko and Storm (1991) found that 35 percent of the permit records lacked clear descriptions and detailed baseline data about the affected areas and the areas planned for restoration or creation. Recommendations from the report call for increased compensation ratios, consistent enforcement of mitigation requirements under Section 404, and implementation of alternative methods for achieving no net loss.

Restoration—Non-compensatory wetlands restoration is gaining attention as a way to obtain increased wetlands acreage. An important pilot project is currently underway. Jointly funded by EPA and the U.S. Fish and Wildlife Service, the project targets several sites in the Duwamish and Snohomish estuaries. The goal is to restore wetland values and functions, and to gain experience for the development of future restoration projects. The project also emphasizes restoration of the estuary as a functioning ecosystem rather than restoration of wetland characteristics at individual sites. Although there is hope that restoration can increase wetland acreage in Puget Sound, the long-term success of restoration remains to be seen.

FISH AND WILDLIFE HABITAT PROTECTION

Puget Sound's vitality is dependent on the health of the basin's diverse and interdependent habitats. The Authority added the Fish and Wildlife Habitat Protection Program to the 1991 Puget Sound plan to better manage the basin's habitats from a regional perspective.

Program Goal

- Ensure that federal, state, local, and tribal agencies coordinate their habitat protection programs so there is no short-term net loss and there is a long-term net gain of aquatic, riparian, and other habitats important to water quality protection in the Puget Sound basin.

PUGET SOUND'S VITALITY DEPENDS ON THE HEALTH OF ITS DIVERSE AND INTERDEPENDENT HABITATS

T.W. Ransom

Program Strategy

- Encourage and support proactive efforts by state and federal resource agencies, local governments, tribes, and private organizations to protect rapidly disappearing aquatic systems in the short term.
- Coordinate among existing agencies and governments to effectively protect and manage Puget Sound fish and wildlife habitat over the long term by providing integrated solutions for habitat protection.

Program Status

Fish and wildlife habitat protection first appeared as an issue on the unfinished agendas of the 1987 and 1989 plans. In response to extensive public comment on the importance of habitat preservation, the Authority prepared an issue paper on fish and wildlife habitat protection, then followed up with development of the program for the 1991 plan.

The primary goal of the Puget Sound plan's habitat program is increased, mutually beneficial coordination of activities by all levels of government, in their many overlapping roles related to habitat protection.

In the 1991-93 biennium, state agencies received no funds to implement the program. Several of those agencies—Fisheries, Natural Resources, and Wildlife—have lead roles in the program. The U.S. Fish and Wildlife Service has acknowledged the need for increased and com-

prehensive attention to habitat protection issues through the recent development of its Puget Sound Initiative and a Puget Sound Program. The federal program plan for 1992 provides some staff support for initiation of the Puget Sound plan's habitat program and funding for other habitat-oriented efforts in the region.

MONITORING

Studies assessing the health of Puget Sound's natural resources have historically been limited both in their geographical coverage and duration. The primary purpose of the Monitoring Program is to implement a long-term, comprehensive monitoring program, known as the Puget Sound Ambient Monitoring Program (PSAMP). Monitoring is critical to understanding long-term trends in the health of the Sound.

Program Goals

- Assist agency decision-making by characterizing trends over time and space, and identifying problem areas.
- Take measurements to support specific program elements and measure the success of the Puget Sound plan by providing a permanent record of significant natural and human-caused changes in key environmental indicators over time.
- Provide an ongoing assessment of the health of the basin and the risk to human health from consuming Puget Sound seafood.

Program Strategy

- Establish an institutional structure to manage the monitoring program.
- Implement the monitoring program design, data management system, and quality assurance plan recommended by the Monitoring Management Committee in 1988.
- Collect, analyze, interpret, and report data in a manner that is useful to water quality managers and the public.
- Annually review the monitoring program to ensure that the most appropriate and cost-effective monitoring elements are included.

Program Status

The 1987 Puget Sound plan directed the Authority to form a monitoring management committee consisting of representatives from local and tribal governments; state, federal, and Canadian agencies; industry; the scientific community; and the public. Members of the committee were appointed to provide the Authority with recommendations for a monitoring program. The committee's initial review of PSAMP and ongoing refinements provide the basis for the monitoring program, which was adopted in 1988.

As PSAMP entered the implementation phase, an institutional structure was formed to manage and coordinate the program. The PSAMP steering committee was formed in August 1988 and continues to meet monthly. The steering committee consists of representatives from the implementing agencies—the state Departments of Ecology, Fisheries, Health, Natural Resources, and Wildlife, and the U.S. Fish and Wildlife Service—as well as the Authority, EPA, and local and tribal governments.

During the 1990 legislative session, the legislature added a section to the Authority's enabling legislation which directs implementation of the monitoring program. A total of $1.1 million in state and federal money was spent on PSAMP implementation in the 1989-1991 biennium. A total of $5.6 million in state funds has been allocated for PSAMP during the 1991-1993 biennium.

Significant monitoring accomplishments between 1988 and 1991 include:

◆ Ecology sampled and analyzed sediments from 50 sites in Puget Sound during spring 1989, 1990, and 1991.

◆ Fisheries sampled and analyzed bottomfish and recreational fish for toxic chemicals in muscle tissue and liver histopathology (bottomfish only).

◆ Health has sampled and analyzed shellfish tissue for bacterial contamination quarterly since November 1989, for chemical contamination annually since May 1990, and has gathered data on shellfish abundance and paralytic shellfish poisoning (PSP).

◆ Ecology redesigned some marine water column and fresh water sampling efforts to better accommodate PSAMP goals.

◆ Ecology, Fisheries, and Health prepared technical reports on PSAMP sediment, fish, and shellfish monitoring. Authority staff prepared the first and second annual Puget Sound Update monitoring reports in 1990 and 1991.

◆ Between 1989 and 1991, the Department of Natural Resources evaluated several techniques for conducting the nearshore habitat inventory and monitoring program. The selected technique was partially implemented during fiscal year 1991.

◆ Authority staff developed databases to manage monitoring information, including the Puget Sound Geographic Information System, developed in conjunction with Department of Natural Resources staff.

◆ The Department of Natural Resources, with funding from EPA and the Authority, has updated the information contained in the Puget Sound Environmental Atlas. This data will be part of the Puget Sound Geographic Information System.

◆ Citizen groups assisted PSAMP agencies with sample collection under the agency's PIE Fund.

THE MOST SERIOUS CONTAMINATION IS GENERALLY FOUND AROUND URBAN BAYS AND SHORELINES

Overall, each participating agency has been working toward the goals of the monitoring program. Fisheries has carried out PSAMP monitoring of fish tissue creatively and diligently with minimal funding during the 1989-91 biennium. Health has also carried out their monitoring assignments well. Ecology has used PSAMP and current agency funds to monitor sediments, marine and fresh water, and to establish their central PSAMP database. Wildlife and Natural Resources have also been reliable participants in the monitoring process although they did not receive PSAMP implementation funds until the start of the 1991-1993 biennium. EPA has provided invaluable funding, expertise, and effort throughout the development and initial implementation of the program. Metro has represented local government in the PSAMP process and has provided expertise and interest in the program. The tribes have participated in the process sporadically.

Photo courtesy Department of Ecology

The U.S. Fish and Wildlife Service joined the program's steering committee as an implementing agency in October 1991. In spring 1992, under their Puget Sound Initiative, they will begin monitoring contaminants in birds as part of PSAMP.

Additional funding in the 1991-93 biennium is allowing for increased fish, shellfish, marine water, sediment, and freshwater monitoring, as well as the initiation of bird, marine mammal, and nearshore habitat monitoring. Increased emphasis is also being placed on data analysis and reporting.

With increased funding for PSAMP this biennium, most monitoring tasks are now well underway. Substantial funding is still needed for chemical analyses and other contracts. Legislative cuts in contracts will affect several tasks of the monitoring

program, notably sediment quality analysis, fish tissue analysis, and chemical contamination in shellfish.

LABORATORY SUPPORT

Program Goal

- Assure the quality, consistency, and timeliness of all laboratory tests necessary to help protect and enhance the resources of Puget Sound.

Program Strategy

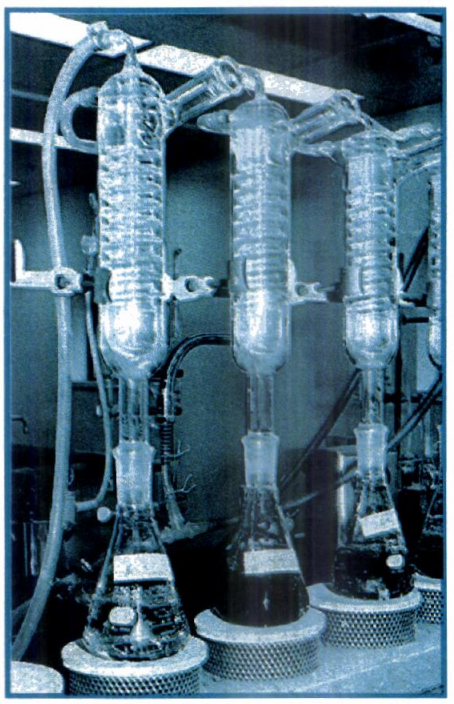
- Establish a laboratory certification program administered by Ecology that will review the capability of environmental laboratories to generate data of known quality.
- Assure that adequate laboratory support exists for agency and other sampling programs.
- Develop and update protocols and guidelines to standardize data collection, analysis, and transfer within Puget Sound.
- Develop and encourage the use of uniform quality assurance guidelines for data collected under all Puget Sound programs.

Program Status

In 1987 the legislature authorized Ecology to establish a laboratory certification program. In March 1988, Ecology established a quality assurance section in Manchester, separate from the Manchester lab. The section is responsible for the lab certification (or accreditation) program, as well as other quality assurance aspects of Ecology programs. Ecology adopted a rule for the laboratory certification program in April 1989, and received the first application for lab accreditation in August 1989. Related rules requiring dischargers to use accredited labs were adopted in October 1990. These rules established a special status known as "registration" for certain labs associated with dischargers. Registered labs participate in a program to prepare for accreditation. As of December 1991, Ecology had accredited 73 laboratories, including the EPA/Ecology lab at Manchester.

QUALITY, CONSISTENCY, AND TIMELINESS OF LAB TESTS ARE NECESSARY TO HELP PROTECT PUGET SOUND

Ecology completed the first laboratory plan in March 1989 and will update the plan biennially. The first plan and the draft of the second plan specifically recommended increasing the quality of data produced by the Manchester lab, improving the turnaround time for samples and data, increasing lab capacity, and improving sample tracking in the lab system. Ecology has implemented many changes to improve services and data quality and is currently producing accurate and precise results within their prescribed holding times for a wide range of environmental variables. Ecology has implemented a new cost-allocation system which allows the lab to operate more efficiently, resulting in more accurate and reliable tracking of costs. The system is funded by user-fees that reflect real costs. Ecology has the ability to perform same-day contracting of samples above the capacity of the Manchester lab.



In January 1991, the Puget Sound Estuary Program Management Committee adopted a process to develop standard procedures for chemical and biological analyses conducted in the Puget Sound basin. These procedures are referred to as the *Puget Sound Protocols and Guidelines*. In May 1991, the management committee adopted the first four protocols and guidelines for conventional water quality variables and metals in fresh water, microbiological studies, subtidal macroinvertebrate assemblages, and fish pathology studies.

Ecology released its *Guidelines and Specifications for Preparing Quality Assurance Project Plans* in May 1991. The quality assurance section, which prepared the document, has been providing technical assistance to Ecology project managers in the development and review

of quality assurance project plans. Ecology is considering whether further action to require the use of the guidelines and specifications in all Ecology Puget Sound projects is needed.

SPILL PREVENTION AND RESPONSE

Program Goals

- Emphasize spill prevention strategies.
- Enhance response capabilities in Puget Sound and its tributaries.
- Ensure that spill prevention and response actions of state agencies are coordinated among themselves and with federal, local, tribal, and private efforts.

Program Strategy

- Identify the tools and resources needed to protect Puget Sound from spills.
- Implement a comprehensive spill prevention and response program using current regulations, and enacting new legislation if necessary.

Program Status

Recent activity in the area of spill prevention and response is highlighted by the Oil Spill Prevention Act passed by the 1991 legislature, and final adoption of the revised, statewide Spill Contingency Plan.

In summary, the Act establishes a $25 million response fund and increases the minimum level of financial responsibility to ensure that responsible parties have adequate financial backing to clean up a spill and pay for environmental damages. In addition to its focus on prevention, the Act provides major enhancements to the state's capabilities in the areas of spill response and wildlife rescue.

The Oil Spill Prevention Act addresses many recommendations from the States/B.C. Task Force. (The task force was assembled after the Exxon Valdez and Nestucca oil spills, and includes representatives from California, Oregon, Washington, Alaska, and British Columbia.) The Act establishes a new Office of Marine Safety, a new Marine Oversight Board, and four Regional Marine Safety Committees. The Office of Marine Safety is created to provide the state expertise on marine transportation safety. The new office will be responsible for spill prevention and contingency plans for vessels, while Ecology will handle on-shore facilities and continue to manage spill response activities statewide. Other recommendations of the task force addressed by the Act include the following:

Vessel Design and Traffic Management—The Office of Marine Safety has been given the task of reviewing tank vessel inspection programs conducted by the Coast Guard and other federal agencies to determine if the programs provide best achievable protection. If the Office of Marine Safety determines that the inspection programs are inadequate, then it will adopt rules for a state tank vessel inspection program. In addition, the Office is expected to adopt rules for vessel screening by July 1992, and establish regional marine safety committees which will be responsible for planning for the safe navigation and operation of tankers, barges, and other vessels within each region.

Personnel—The Act added representation to the board of pilotage commissioners which is responsible for examining and licensing pilots. The added representation includes the Administrator of the Office of Marine Safety and a representative from an environmental organization concerned with marine issues. The Act also calls for the adoption of rules to certify personnel in charge of the transfer, storage, and handling of oil, addressing such issues as minimum training requirements and continuing education requirements.

Funding and Financial Responsibilities—The Act establishes a five cent fee on each barrel of oil delivered to marine terminals to cover administrative costs and to establish a response fund. Three cents of this goes into an administrative account to carry out the oil spill prevention and response program, and two cents goes into the response account (up to $25 million) to defray state agency costs in responding to spills where expenses exceed $50,000. The Act also increases financial requirements to ensure that those responsible for spills have the financial backing to clean up spills and pay for environmental damage. In addition, the minimum level of financial liability for tank vessels has been increased to $500 million, and onshore and offshore facilities must maintain financial responsibility determined by Ecology. Enforcement provisions require contingency plans and the demonstration of financial responsibility.

Regulatory Oversight—The Office of Marine Safety and the Maritime Commission are given oversight authority for prevention plans, response plans, cleanup requirements, and vessel inspections.

Education—The Act provides for the Washington Sea Grants program to develop and conduct a voluntary spill prevention education program.

Outstanding issues of the task force, such as research coordination, spill response enhancements, multi-state/providence compact, and coordination of studies, will be addressed by the administrative and regulatory bodies established under the act.

The 1991 plan called for Ecology to complete major revisions to the statewide Contingency Plan for Spills of Oil and Hazardous Substances, including the responsibilities of state agencies, state and tribal governments, and industry, operating procedures for major oil spills, a dispersant use policy, and disposal of recovered oil. The Spill Contingency Plan was revised in July 1991, although some appendices remain in draft form. Issues still under consideration include draft guidelines for treating and disposing of oily waste from spills, and an interim policy on dispersants which are currently not approved for use in the nearshore and offshore waters of Puget Sound.

Ecology has also developed a draft rule addressing contingency plans for individual facilities. The Office of Marine Safety has developed a draft rule addressing contingency plans for vessels.

RESEARCH

Program Goals

- Establish and maintain a system of priorities and funding for research and its dissemination.
- Add to our knowledge of the physical and biological systems of Puget Sound through research.
- Research and identify the causes and solutions of pollution problems.
- Assist decision-making activities of regulatory and management agencies while stimulating creativity and excellence in research.

Program Strategy

- Maintain the Puget Sound Research Program in order to promote the coordination and funding of Puget Sound research.
- Establish a renewable list of priorities for sponsorship by the program.
- Assist in making the results of research available for decision-making.

The Authority will coordinate the program and complete certain tasks within it, while assigning other tasks and long-term maintenance of the program to the Puget Sound Foundation.

Program Status

In February 1987, the Committee on Research in Puget Sound was established to make recommendations to the Authority on such issues as research priorities, institutional needs, data management, research reserves, and the publication and dissemination of research results. The group was organized into two subcommittees.

One subcommittee focused on the development of research priorities. Its work resulted in the Authority adopting four long-term research goals and six research priorities in the 1989 plan. Three of the four goals consisted of improving our understanding of the effects of conventional pollutants, toxic pollutants, and habitat alterations on the resources of Puget Sound, while the fourth goal related to improving the effectiveness of environmental decision-making in the region. The initial research priorities concerned:

- The effects of agricultural runoff.
- The effects and cycling of nutrients.
- The effects of contaminants in the sea surface microlayer.
- The fate and effects of effluent chemicals.
- The effect of water quality changes on wetlands and the role of wetlands in watershed hydrology.
- The regional functions and values of wetlands.

Since adoption of the list, a seventh priority dealing with the effects of pesticides has been identified. The list is to be reviewed, revised as appropriate, and re-adopted on a biennial basis by the Puget Sound Foundation and the Authority.

Working from this list of priorities, the Committee on Research in Puget Sound has convened a number of meetings on research topics related to the condition and management of Puget Sound. These have included two regional conferences on Puget Sound research and a seminar on Puget Sound sediments. Proceedings from these meetings are available through the Authority and can be found at most public libraries around the Sound.

A second subcommittee worked to identify an appropriate institutional structure for coordinating and funding research, disseminating research results, and using research results in decision-making. Based on their analysis, the committee recommended a nonprofit foundation as the best institutional structure for the region's research endeavors. This recommendation was later combined with those of the Education and Public Involvement Advisory Group and the Puget Sound Finance Committee in a position paper advocating the formation of a Puget Sound Foundation which would foster the goals and priorities for both the education and research programs. The 1990 legislature authorized the Authority to create the Puget Sound Foundation as a public nonprofit corporation, and in the 1991 plan, the Authority designated the Puget Sound Foundation as the agent responsible for long-term funding and implementation of the research and education programs.

PROTECTION EFFORTS MUST BE SUSTAINED AND ENHANCED TO KEEP UP WITH THE PRESSURES OF GROWTH

Photo courtesy Puget Sound Regional Council

Until the Foundation is fully operational, the Authority will maintain focus and continuity for the Research Program. The Authority has requested that the Committee on Research in Puget Sound continue to provide oversight and to fulfill a number of program functions, including assisting with development of the Foundation, fostering and coordinating efforts to translate and disseminate information, and providing a source of expertise

and review relative to research activities in the Puget Sound region.

Although scientific study has been widely endorsed as an important need in the Puget Sound region, funding for the Research Program has not been forthcoming from the state. The Authority has been able to direct a portion of the federal funding for the Puget Sound Estuary Program toward research activities. These funds, however, have been severely reduced in fiscal year 1992. The Authority and the Committee on Research traditionally have worked cooperatively with many groups in both public and private sectors to fund and sponsor research-related activities, such as conferences and publications.

PUGET SOUND FOUNDATION

The Puget Sound Foundtion is intended to fund and coordinate research and education programs on Puget Sound, and to assume responsibility for certain elements of the research and education programs.

Program Goal

- To undertake long-term solutions to the problems of coordinating, implementing, and funding research and education activities which enhance the health, responsible use, and diversity of Puget Sound.

Program Status

The need for ongoing institutional structures to coordinate program strategies and funding has been addressed by a number of advisory groups to the Authority, including the Subcommittee on Institutional Issues of the Committee on Research in Puget Sound, the Education and Public Involvement Advisory Group, the Monitoring Management Committee, and the Puget Sound Finance Committee. In 1989, the Combined Committee for a Puget Sound Foundation, which was formed by representatives of these groups, adopted a proposal to create a nonprofit corporation to ensure long-term coordination and funding of research and educational efforts related to Puget Sound.

In 1990, the legislature authorized the Authority to create the Puget Sound Foundation, a public nonprofit foundation. As conceived by the Combined Committee, the Foundation is primarily designed to generate permanent, regionally controlled funding for research and education from private and public sources, including federal and state agencies, and to disperse such funding to deserving projects through a grants program.

The Foundation's structure, which would include a board of directors, research council, education council and management council, was developed to ensure that experts in a range of disciplines would be available to provide independent advice and guidance to the processes of establishing priorities, recommending grant awards, and translating and disseminating program results. The design further emphasizes coordination and participation in the activities of the Foundation (especially the setting of research and education priorities) by the scientific community, educators, industry, tribes, citizen groups, local governments, and state and federal regulatory and resource management agencies.

The Authority is working with the governor's office to appoint an initial board of directors which would legally establish the Puget Sound Foundation. Once in place, its work would focus on development of a permanent, long-term board and initial fundraising for operations of the Foundation and the grants program.

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