STATE OF THE SOUND 2007


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PUGET SOUND ACTION TEAM
Office of the Governor | State of Washington

FRONT COVER PHOTOS:
Orca spinning. | Shutterstock.com/Jason Vandehey;
Ferry leaving dock. | Shutterstock.com/Mark B. Bauschke;
Three young children standing side by side wearing life jackets. | Shutterstock.com/Keith Levit;
West Point Lighthouse. | Shutterstock.com/Hiep Nguyen;
Pike Place Market seafood, fresh local mussels. | Shutterstock.com/Liem Bahneman

BACK COVER PHOTOS:
Squaxin Island shoreline in late summer. | Shutterstock.com/Lawrence Freytag;
Late afternoon in a Puget Sound harbor. | Shutterstock.com;
Thea Foss Waterway, Tacoma. | Shutterstock.com/Lawrence Freytag;
Humpback whale. | Shutterstock.com/Chris Sargent.

PUGET SOUND ACTION TEAM

Office of the Governor | State of Washington

MISSION: PROTECT AND RESTORE PUGET SOUND

Protect and Restore Puget Sound

RAE A. MCNALLY

PHOTOS: (top to bottom) Early morning fog lifts from shoreline home near Sunrise Beach outside of Gig Harbor; Looking north up Hood Canal. | Rae A. McNally; (opposite page) Brant (a species of goose) search shoreline in search of eelgrass during a low tide at Tolmie State Park in Thurston County. | Rae A. McNally.

TABLE OF CONTENTS

PUGET SOUND ACTION TEAM

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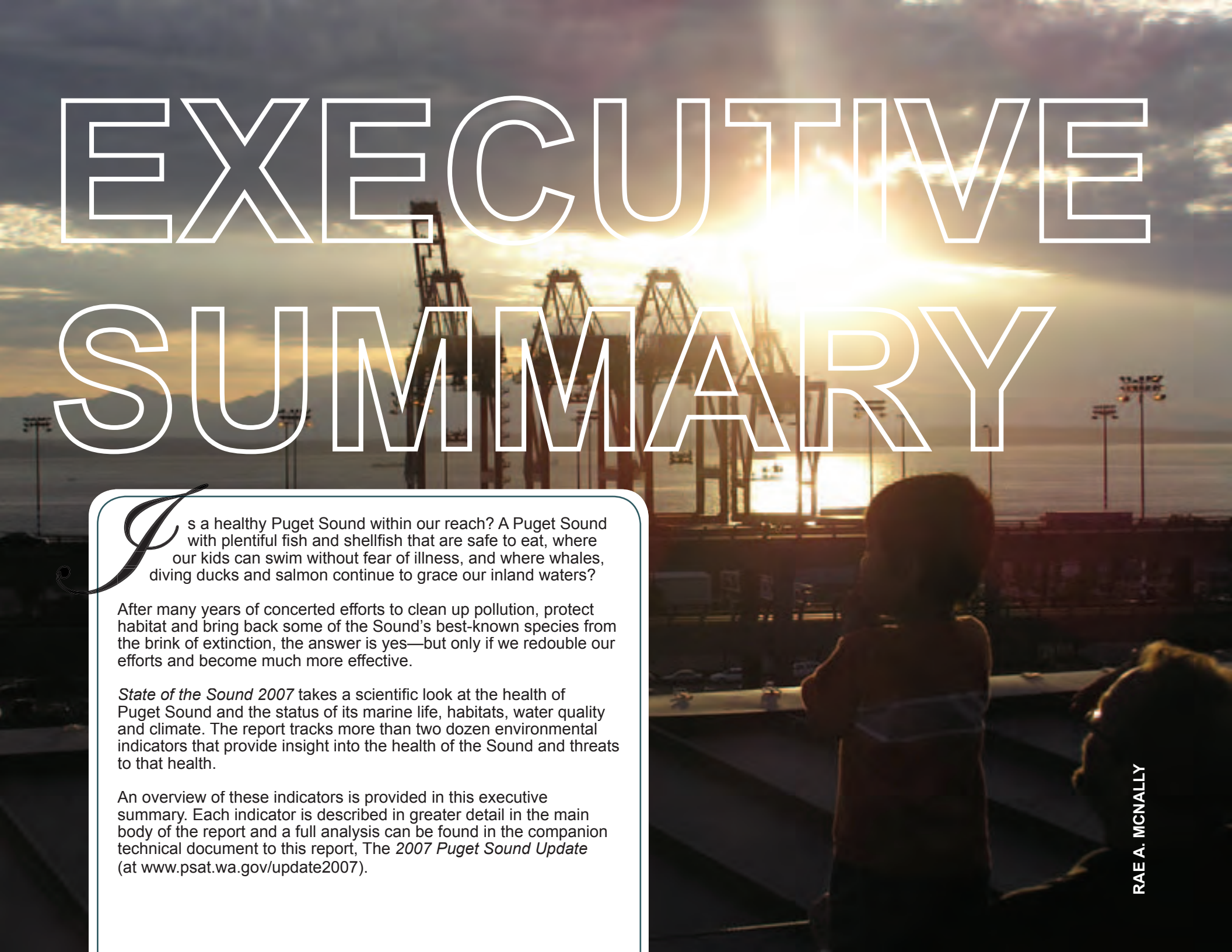
EXECUTIVE SUMMARY

Is a healthy Puget Sound within our reach? A Puget Sound with plentiful fish and shellfish that are safe to eat, where our kids can swim without fear of illness, and where whales, diving ducks and salmon continue to grace our inland waters?

After many years of concerted efforts to clean up pollution, protect habitat and bring back some of the Sound's best-known species from the brink of extinction, the answer is yes—but only if we redouble our efforts and become much more effective.

State of the Sound 2007 takes a scientific look at the health of Puget Sound and the status of its marine life, habitats, water quality and climate. The report tracks more than two dozen environmental indicators that provide insight into the health of the Sound and threats to that health.

An overview of these indicators is provided in this executive summary. Each indicator is described in greater detail in the main body of the report and a full analysis can be found in the companion technical document to this report, The *2007 Puget Sound Update* (at www.psat.wa.gov/update2007).



RAE A. MCNALLY

PHOTOS: (top to bottom) Aerial photo of the Seattle area. | Don Wilson, Port of Seattle; Storm culvert in Drayton Harbor | Linda Farmer; (opposite page) Father and son enjoying a view of the Olympics from the Safeco Field observation deck during a Mariners home game. | Rae A. McNally.

ADVANCES OF THE PUGET SOUND ACTION TEAM

State of the Sound 2007 also charts progress made in 2005 and 2006 by the Puget Sound Action Team to improve Puget Sound's health. The Action Team is made up of federal, state, tribal and local governments and citizens working together to define, coordinate and implement the State of Washington's environmental agenda for Puget Sound.

Over the past two decades many significant steps have been taken on the path to protect Puget Sound. During the past two years there have been more important accomplishments, many of which are documented throughout this report.

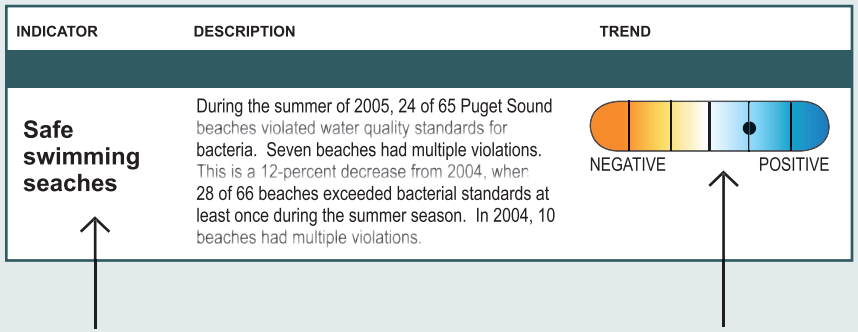
Highlights include:

- 1,200 acres of commercial shellfish harvest areas upgraded as a result of new pollution controls.
- Improved stormwater management at the local level:
  - 81 communities came under stronger stormwater management requirements in January 2007.
  - The number of municipalities carrying out various elements of a comprehensive stormwater program increased significantly.
  - 19 cities and counties worked to change regulations to facilitate low impact development.
- Toxic cleanups finished at 323 land-based sites and 23 water-based sites.
- Hundred of pounds of highly toxic mercury kept out of the waste stream through targeted efforts, and development of new control plans for flame retardants.
- $21 million invested in on-the-ground actions to reduce nutrient pollution and fish kills in Hood Canal through a multi-agency coordinated response.
- All 12 Puget Sound counties put in place more rigorous management programs for septic systems.
- $7 million in new funding allocated to counties to find and fix failing septic systems.
- 200 acres of high quality habitat permanently protected; 400 acres and 17 miles of riparian habitat restored to high quality.
- 600 tons of creosote logs removed from state aquatic lands.
- $21 million allocated to improve sewage treatment at 24 state parks around Puget Sound.
- Recovery plans completed for threatened or endangered Puget Sound chinook; Hood Canal summer chum; bull trout and southern resident killer whales (orca).
- New safeguards, planning and inspection procedures adopted to prevent oil spills.
- New efforts initiated to control tunicates, a recently discovered invasive species.

These achievements, and the many others documented in this report, are the result of the work of thousands of people throughout the region who dedicate their time and energy to protect and restorate Puget Sound. We greatly appreciate their contributions. Their work has been essential to the preservation of a functioning ecosystem.

REPORT CARD

How to use the State of the Sound Report Card



What is an indicator? Indicators synthesize scientific data to help inform us about a topic of interest, in this case Puget Sound's health. Each indicator helps us understand the current condition of some key element of Puget Sound's health, and whether the trend for that key element is positive or negative. Taken together, these indicators paint an overall picture of Puget Sound's health.

How were indicators selected? Selecting indicators was a matter of both choice and opportunity. We consulted scientists and looked at existing research to see what data was available. The selected indicators are those that tell us something important about Puget Sound's current condition and its condition over time (where data was available, measured regularly and over a long enough period).

Status Ratings (dots):

- If the status dot is to the left of center, the status is generally negative, meaning "poor" or "critical" depending on how far to the left.
- If the status dot is to the right of center, the status is generally positive, meaning "good" or "excellent" depending on how far to the right.
- If the status dot is in the middle of the indicator bar, the status is "fair."

Trend Ratings (arrows):

- A trend arrow pointing left indicates a negative trend.
- A trend arrow pointing right indicates a positive trend.
- No trend arrow indicates either a neutral trend, or an unknown trend.

The indicator graphics are based on the Action Team's subjective interpretations of the data and may not fully reflect the views of contributing scientists.

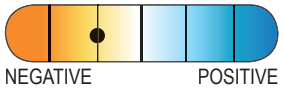
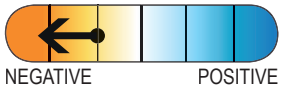
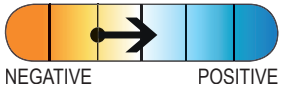
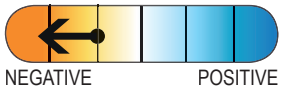
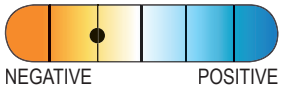
State of the Sound's Water

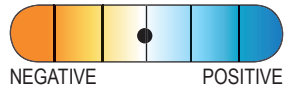
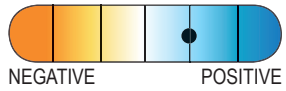
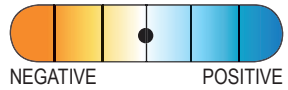
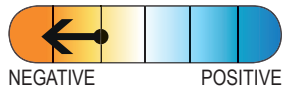
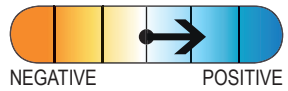
Carved by glaciers and fed by 10,000 rivers and streams, Puget Sound is an ecosystem defined by the movement of water. The health of all living creatures—plants, fish, animals and humans—depend on clean water. While our waters may look pristine, beneath their surfaces they continue to be contaminated by and at risk from a wide array of pollutants.

Over the past century, human activities have introduced a variety of chemicals into the environment at levels that can be poisonous to fish and wildlife and even humans. Long-lived toxic contaminants continue to enter Puget Sound, where some have collected in bottom sediments. From there they can accumulate in harmful levels in fish and wildlife, and can cycle through the ecosystem for years.

Our waters also are vulnerable to nutrient and pathogen pollution from a variety of human and animal waste sources. Nutrient pollution is contributing to low dissolved oxygen conditions and sporadic fish kills in Hood Canal. And other parts of Puget Sound appear to be vulnerable to the same conditions. Pathogen and bacterial pollution has left nearly one-third of the Sound's commercial shellfish growing areas restricted from harvest and the number of shellfish beds threatened with closure has increased. This pollution has also restricted some recreational activities such as swimming.

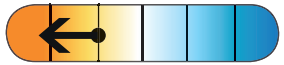
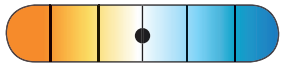
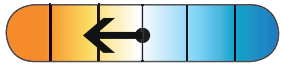
INDICATOR	DESCRIPTION	STATUS/TREND
WATER QUALITY | OVERALL		
Marine water quality	The Department of Ecology is monitoring data from 39 sites throughout Puget Sound. Of these, the eight sites rated of highest concern are southern Hood Canal, Budd Inlet, Penn Cove, Commencement Bay, Elliott Bay, Possession Sound, Saratoga Passage and Sinclair Inlet. Locations of high concern include: Bellingham Bay, Case Inlet, Oakland Bay, Discovery Bay, Strait of Georgia, Carr Inlet, Port Orchard, West Point, Skagit Bay and Port Susan.	NEGATIVE POSITIVE
Marine and fresh water health	In 2004, there were approximately 1,474 listings of "impaired waters" in Puget Sound's fresh and marine waters. Fifty-nine percent of the waters tested were found to be impaired as a result of toxic contamination, pathogens, low dissolved oxygen or high temperatures. Less than one-third of these impaired waters have cleanup plans in place.	NEGATIVE POSITIVE

INDICATOR	DESCRIPTION	STATUS/TREND
WATER QUALITY | TOXIC CONTAMINATION		
Toxics in sediments	Long-lasting chemicals discharged into Puget Sound have accumulated in its mud and sediment and from there into the tissues of living organisms. In a study of 584,000 acres of submerged lands, about one percent (5,700 acres, primarily in urban bays) was found to be contaminated with high levels of toxic substances, and another 31 percent (179,000 acres) was moderately contaminated. PBDEs have been identified as an emerging contaminant of concern in the sediments of Puget Sound.	
Toxics in chinook and coho salmon	Chinook salmon from Puget Sound have two-to-six times the PCBs and five-to-17 times the PBDEs in their bodies compared to other West Coast chinook populations. PCB levels are staying stable but rising PBDE levels measured in Puget Sound seals suggest that PBDE levels in salmon are also increasing. Because of contamination, the Department of Health recently issued a consumption advisory for Puget Sound chinook.	
Toxics in mussels	Mussels feed by filtering large quantities of water and so are valuable indicators of toxic contaminants. Mussel Watch data collected since 1984 shows Puget Sound mussels exceed national averages for PAHs (100-1,000 percent), PCBs (60 percent) and mercury (20 percent). Over time, PCB and PAH concentrations have generally declined; mercury levels have stayed fairly stable.	
Toxics in harbor seals	Because they feed on a wide variety of fish and invertebrates, harbor seals are sentinels of food web contamination. Harbor seal pups in south Puget Sound are seven times more contaminated with PCBs than seal pups from the Georgia Basin. PBDE levels in seals have increased dramatically over the past 20 years, from less than 50 parts per billion in fatty tissue to more than 1,000 ppb.	
Liver disease in English sole	English sole are a bottom-dwelling flatfish that consume invertebrates, shellfish and other organisms living in the sediments. Sole from Seattle's Elliott Bay and Tacoma's Thea Foss Waterway have increased risk (six and four times the risk respectively) of developing liver lesions compared to sole from uncontaminated sites. Soundwide, there has been a general decrease in liver disease from 1999-2005.	

INDICATOR	DESCRIPTION	STATUS/TREND
Oil spills	A major oil spill could be catastrophic for Puget Sound's marine life and the economy. Since 2005, there have been no "major" spills (10,000 gallons or more) and the volume of oil released from such spills has steadily declined in the last 15 years. However, the risk of future spills remains high due to heavy tanker traffic, large quantities of oil transferred over marine waters and an increase in the size of cargo vessels (and their fuel tanks) entering Puget Sound.	
WATER QUALITY | POLLUTION FROM HUMAN AND ANIMAL WASTE		
Safe swimming beaches	During the summer of 2005, 24 of 65 Puget Sound beaches violated water quality standards for bacteria. Seven beaches had multiple violations. This is a 12 percent decrease from 2004 when 28 of 66 beaches exceeded bacterial standards at least once during the summer season. In 2004, 10 beaches had multiple violations.	
Safe, edible shellfish	Shellfish such as clams and oysters can accumulate bacteria, viruses or other harmful pathogens from polluted water. In 2005, nearly one-third of the Sound's commercial shellfish growing areas had restrictions on harvest due to bacterial pollution. Between 1995 and 2005, improved water quality reduced harvest restrictions on 12,617 acres, while 5,218 acres had to be downgraded due to pollution. This 7,400-acre gain is tempered by a high number of areas currently classified as "threatened" with future restrictions.	
WATER QUALITY | STORMWATER RUNOFF		
Impervious surface changes	When native forests and prairies are replaced by rooftops, roads and parking lots, stormwater runoff and related pollution increases dramatically. Between 1991 and 2001, impervious surface increased 10.4 percent regionwide (43 square miles). In 2001, impervious surface covered 7.3 percent of the Puget Sound region below 1,000 feet elevation. Research shows significant decline in biological function when watersheds near or exceed 10 percent in impervious surface.	
Local stormwater management programs	Local governments have lead responsibility for managing stormwater runoff in the region. A 2004 survey found less than 40 percent of responding jurisdictions were implementing at least three-quarters of the elements of a comprehensive stormwater program. The trend is positive, however, as jurisdictions are improving their programs. In December 2006, approximately 81 cities and counties in the region came under heightened stormwater management requirements.	

State of the Sound's Habitat

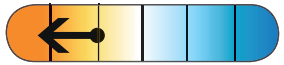
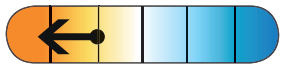
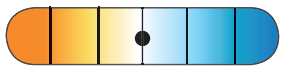
The Puget Sound region contains an amazing variety of habitats, each supporting diverse communities of plant and animal life, and each an integral part of a healthy Puget Sound. Extensive development, land conversion and the establishment of non-native and invasive species over the past 100 years have destroyed many once-intact habitats. As habitats become smaller and more isolated, they are less able to sustain the ecological processes necessary to support life. The loss and alteration of key habitats places more pressure on many of the Sound's living resources, from forage fish to salmon, and marine birds to orca whales.

INDICATOR	DESCRIPTION	STATUS/TREND
HABITAT		
Forest loss in Puget Sound lowlands	Loss of forested lands and corridors can dramatically impact river and stream systems and the species that depend on them. Between 1991 and 2001, approximately 190 square miles of forest (about 2.3 percent of the total forested area of the Puget Sound basin) was converted to other uses. In areas below 1,000 feet elevation, the change was more dramatic: 3.9 percent of total forest area was lost between 1991 and 2001.	
Eelgrass	Eelgrass grows in tidelands and shallow waters along much of Puget Sound's shoreline. Eelgrass habitat plays a critical role in the health of many Puget Sound fish and wildlife species, providing them with food, breeding areas and protective nurseries. Between 2003 and 2004, eelgrass declined Soundwide by four percent, but has not changed measurably since.	
Aquatic nuisance species	Puget Sound has become home to a number of non-native species. Two species of significant concern are tunicates, commonly called sea squirts, and spartina, a type of salt marsh grass. Significant progress has been made in the eradication of spartina. However, the recent establishment and spread of three species of non-native tunicates are a negative trend.	

State of the Sound's Species

The plants and animals living in Puget Sound are the ultimate indicators of the Sound's health, but the picture they paint is troubling. The Sound's diverse web of life is at risk. The building blocks of a healthy environment—clean water, abundant habitat and an intact food web—continue to erode. The effects of this erosion can be seen in declines in eelgrass, forage fish, salmon, rockfish, marine birds and orcas.

Currently, 10 species are listed as threatened or endangered by the state or federal government. An additional 33 marine species in Puget Sound—three invertebrates, 22 fish, seven birds and one mammal—are identified by state or federal governments as species of concern, meaning they are at risk.

INDICATOR	DESCRIPTION	STATUS/TREND
SPECIES		
Orca (killer whales)	In 2005, Puget Sound's southern resident killer whales were added to the federal Endangered Species list, recognition of the precarious state of the species. A draft recovery plan was released in late 2006 and recent births to Puget Sound orca pods are a positive trend, but these animals continue to face serious threats from pollution, declines in prey, increased noise from water vessels, and risk from oil spills.	
Salmon	Wild salmon are a keystone species of the Puget Sound ecosystem. As juveniles, salmon are a food source for other fish and marine birds. Later in life they are a favored prey of orcas. In 2002, out of a total 207 stocks, 81 stocks were listed as healthy, 52 were depressed, 12 were critical and for 62 stocks the status was unknown. Since 1992, seven stocks have become extinct and the number of healthy stocks declined from 93 to 81.	
Groundfish	Puget Sound has more than 150 species of groundfish that live on or near the bottom of the Sound most of their adult lives. While the majority of groundfish stocks are in good condition, many of the harvestable species are in sharp decline. Thirteen species of rockfish are designated by the state as candidates for future listing as threatened or endangered.	

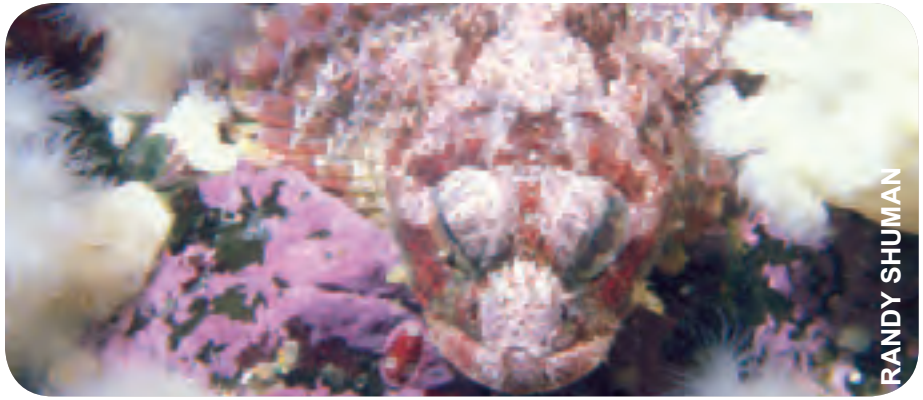


PHOTO: Red Irish Lord. | Randy Shuman.

INDICATOR	DESCRIPTION	STATUS/TREND
Herring	There are 19 designated populations of Pacific herring in Puget Sound. This small fish serves as food for a wide variety of seabirds, marine mammals and predatory fish. Although the overall spawning biomass decreased between 1980 and 1998, the trend has improved slightly since then.	NEGATIVE POSITIVE
Pinto abalone	Pinto abalone are mollusks that live in and help shape the nearshore rocky habitat. Once fairly abundant in the northern Sound, pinto abalone abundance at 10 sites in the San Juan Islands steadily decreased from 1992 to 2005, despite the fact that commercial harvest has never been permitted and statewide recreational harvest was closed in 1994. In 2004, the federal government listed pinto abalone as a species of concern.	NEGATIVE POSITIVE
Marine birds	More than 100 species of marine birds, including seabirds, sea ducks and shorebirds, are either part-time or full-time residents of Puget Sound. Many of these species are at or near the top of the food chain and thus are important indicators of overall ecosystem health. Nineteen of the 30 most common marine bird species in northern Puget Sound decreased by 20 percent or more between 1978 and 2004. Some species declined precipitously.	NEGATIVE POSITIVE

State of the Sound's Climate

Buildup of carbon dioxide and other "greenhouse" gases in the atmosphere are heating the earth and changing our planet and our region. What is still uncertain is how much warming will occur, where, in what time frame and with what impacts. As we hone our knowledge of global climate change, managing for the consequences on the local level becomes more crucial. We have added a section on climate to this year's *State of the Sound* and we will continue to report on changes and trends in this area as it affects the Puget Sound basin.

INDICATOR	DESCRIPTION	STATUS/TREND
CLIMATE		
Temperature	Over the past century, the Puget Sound region warmed at a rate more than double that of average global temperature. The region's waters have warmed as well, albeit more slowly. Projections indicate the region's air temperatures will continue to rise. Even the lowest estimated warming will have negative environmental impacts, including smaller snow packs, warmer rivers and more intense dry spells.	NEGATIVE POSITIVE
Sea level rise	The melting of polar ice sheets, glaciers and ice fields, along with the warming of the ocean's waters and the resulting thermal expansion, are causing global sea levels to rise. In the 20th century, global sea levels increased four-to-eight inches. The best scientific evidence indicates that sea levels will continue to rise, and this will negatively affect Puget Sound's shorelines and nearshore habitats.	NEGATIVE POSITIVE
Stream flow	The timing and magnitude of freshwater flows into Puget Sound influences water temperature, salinity, circulation patterns, habitat characteristics and marine life. Less precipitation falling as snow and earlier spring snowmelt have increased winter stream flows and decreased summer flows. This trend is expected to continue and will have significant consequences for human and ecosystem water needs.	NEGATIVE POSITIVE
Snow pack	The Puget Sound ecosystem and its cities depend on snow pack. Slow-melting mountain snow sustains flows in rivers and streams over long periods and replenishes water reservoirs in the spring. Snow pack measurements show a marked decline since 1950 almost everywhere in the Cascades, exceeding 25 percent at most locations. Declines tended to be greatest at the lower elevations. With rising temperatures, these trends will continue.	NEGATIVE POSITIVE

CONCLUSION

The past two years have seen some good news and positive trends. Yet the future of Puget Sound remains at risk.

The Sound's overall trajectory, as charted in this report, continues to be one of decline, with continuing harm to the clean water, abundant habitat and intact natural processes that are the foundations of a healthy environment.

The pace of growth in the region, coupled with associated increases in impervious surface, alteration and loss of habitat, and pollutants in the air and water, are the drivers of this silent crisis. While the Sound appears beautiful, its web of life is in danger.

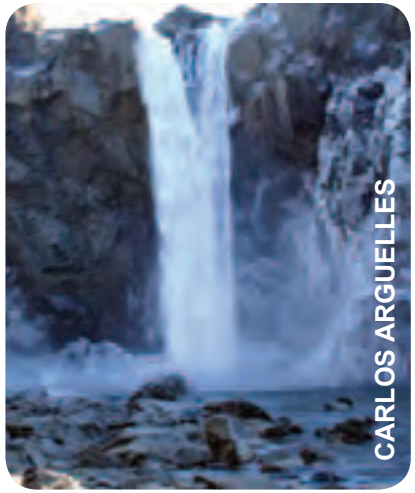
Continuing our current path means further losses in the Sound's fish and wildlife populations as well as the loss of opportunities to enjoy the Sound through harvesting oysters and clams, swimming at its beaches and watching the salmon swim upstream to spawn.

But a healthy Puget Sound can be reached if we are willing to make significant improvements in the way we develop the land and our built environment, use our natural resources and dispose of our wastes. Saving Puget Sound requires changes in our behavior, and a willingness to restrict or modify those actions that cause serious harm to the Sound.

Sustaining a healthy Puget Sound will also require perpetual effort and vigilance. As known threats are reduced or eliminated, new threats and challenges emerge. For example, flame retardants now turning up in fish, mammals and people were compounds we did not even track a decade ago. We will never reach the end point where the Sound is recovered and we can turn away to something else.

The path to a healthy Puget Sound is still available to us, but the decisions required along the way will not necessarily be easy nor inexpensive.

In the final analysis, saving Puget Sound is not about Puget Sound alone. What affects the Sound affects our lives and our future as well. Taking care of Puget Sound is taking care of our homes and our economy. It is taking care of the place that gives us shelter, provides food, maintains our health and makes our lives richer. Taking care of Puget Sound is also taking care of one of the most important legacies we have to pass on to our children and grandchildren.



PHOTOS: (top to bottom) Snowy winter day at Snoqualmie Falls, outside Seattle. | Shutterstock.com/Carlos Arguelles; Lyman Glacier, North Cascades. | Shutterstock.com/Matthew Greytak.

FIGURE 1-01: (right) This map shows the watersheds that drain into Puget Sound. This is the area covered by this report. *Source: Action Team; Sanborn Mapping Solutions; Ecology.*


N
Canada
US
Strait of Georgia
Canada
US
Strait of Juan de Fuca
Bellingham
Friday Harbor
Mount Vernon
Coupeville
Port Townsend
Port Angeles
Everett
Seattle
Bremerton
Tacoma
Shelton
Olympia
Puget Sound Land Classifcations
Cultivated Land
Grassland
Deciduous Forest
Evergreen Forest
Mixed Forest
Scrub Shrub
Forested Wetland
Wetland
Bare Land
Unconsolidated Shoreline
Impervious Areas
Snow/Ice
Miles
0 4 8 16 24 32
PUGET SOUND ACTION TEAM (SOURCES: ACTION TEAM, SANBORN MAPPING SOLUTIONS, ECOLOGY)

INTRODUCTION

The *State of the Sound 2007* reports on the health of Puget Sound and the status of its water quality, habitat, marine life and climate.

The latest report in a continuing series, *State of the Sound 2007* tracks more than two dozen environmental indicators—from eelgrass and orcas to stream flow and oil spills—to provide insight into the current condition of Puget Sound and the threats to its resources. These indicators also help us understand emerging trends.

In addition, *State of the Sound 2007* reports on other leading issues affecting the health of Puget Sound and defines some of the continuing challenges it faces.

This report also charts progress made by the Puget Sound Action Team in 2005 and 2006 to improve Puget Sound's health. The Action Team is made up of federal, state, tribal and local governments, citizens and businesses working together to define, coordinate and implement the State of Washington's environmental agenda for Puget Sound.

RAE A. MCNALLY

Beauty, prosperity and growth

Most of us feel privileged to live in the Puget Sound region. Surrounded by soaring snow-capped peaks, defined by rich river valleys, and filled with islands, rocky beaches and picture-postcard bays and inlets, Puget Sound is a cornerstone of our regional identity, providing recreational, environmental and economic benefits.

The Puget Sound basin is home to a spectacular array of life—200 species of fish, 26 kinds of marine mammals, 100 species of sea birds and thousands of invertebrate species such as clams, oysters and shrimp.

Four million of us make our home here, relying on a healthy Puget Sound ecosystem to supply us with water, food and places to live.

Puget Sound is also at the heart of our state's prosperity. Together, the ports of Seattle and Tacoma are number two in the nation for container traffic. We are a world center for software development and information technology.

But the value of a beautiful, diverse and thriving Puget Sound cannot be measured solely in dollars and cents. This living landscape, with its beauty and bounty that sustain us, is a priceless legacy we inherited from our parents, and it is up to us to pass on this treasure to our children and grandchildren.

PHOTO: (opposite page) Sailboat rounding the south end of Vashon Island. | Rae A. McNally

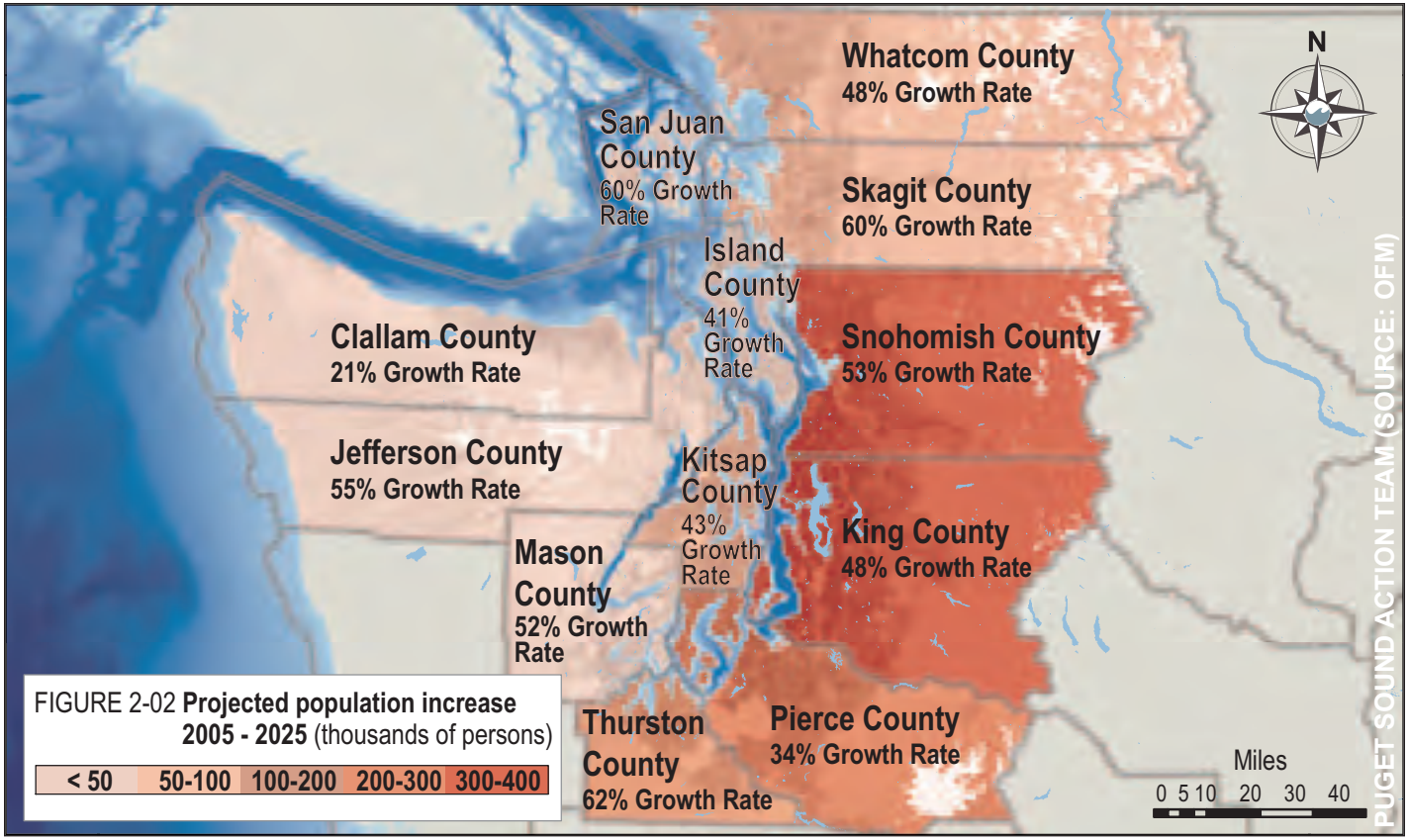


FIGURE 2-02 **Projected population increase 2005 - 2025** (thousands of persons)

Projected growth a continuing concern

The Puget Sound basin includes five of the top 10 fastest-growing counties in the state.

Between 2000 and 2006, Puget Sound counties added 315,965 people, a rate of more than 50,000 people per year.

This rapidly increasing population places significant stress on our natural environment, adding more pavement, more waste, more demands on resources such as fresh water and more destruction of critical habitats.

The projected growth in the region is a continuing concern (**Figure 2-02**). As many as 1.4 million new residents are expected to move into the region by 2025. Under the state's Growth Management Act, local cities and counties must plan for population growth over a projected 20-year period. *Source: Action Team; State of Washington Office of Financial Management (OFM).*

PHOTO: Lime Kiln Lighthouse on San Juan Island. | Shutterstock.com/David Gaylor

PSAMP: Monitoring environmental trends

The data summarized in this report come from the Puget Sound Assessment and Monitoring Program (PSAMP) and other scientific investigations underway in Puget Sound. PSAMP brings together local, state and federal agencies—coordinated by the Puget Sound Action Team—to collect and report information on the condition of the Puget Sound environment. Established in 1988, PSAMP is one of the nation's longest-running marine monitoring programs.

Roughly every two years, PSAMP compiles a report called *The Puget Sound Update*, a technical report on the findings from PSAMP and other research and monitoring efforts. A copy of the *2007 Puget Sound Update* is available online at www.psat.wa.gov/update, or a hard copy can be obtained by calling 800.54.SOUND.

The Puget Sound Action Team coordinates the PSAMP program. Members of PSAMP include:

- Washington State departments of
  - Ecology
  - Fish and Wildlife
  - Natural Resources
  - Health
- Puget Sound Action Team
- King County Department of Natural Resources and Parks
- National Oceanic and Atmospheric Administration's Northwest Fisheries Science Center
- U.S. Fish and Wildlife Service
- University of Washington's Applied Physics Laboratory
- U.S. Environmental Protection Agency

THE PUGET SOUND INITIATIVE

Our previous report, State of the Sound 2004, found that despite significant efforts and investments during the past two decades to preserve the Sound, the scale of the effort was not sufficient for the scale of the problems. Rapid population growth, land conversion and the accompanying increases in impervious surface degradation and loss of habitat; and a slew of toxic contaminants entering the system were challenging government and private-sector efforts to keep even with, or get ahead of, the problems.

Washington Governor Chris Gregoire responded to the situation and launched a Puget Sound Initiative in December 2005 aimed at protecting and restoring the Sound. This initiative included increased funding for critical actions ($52 million in 2006) and new laws for oil transfers and septic system management.

The central element of the initiative was to create a high-level advisory body that would recommend additional actions needed to protect and restore the Sound by 2020. Called The Puget Sound Partnership, this blue-ribbon commission brought together 17 leading citizens, four state legislators and two members of the state's congressional delegation.

The Partnership delivered its final report to the governor in December 2006 with a suite of recommendations intended to scale up and improve our efforts to save Puget Sound.

FIGURE 2-03: (right) This map shows changes in population, population density and impervious surface area in the watersheds of Puget Sound from 1990-2001. To preserve undeveloped land, it is desirable to have growth occur in already developed areas. This map shows where growth is occurring in each watershed as compared to the increase in impervious surface and the overall population growth rate.

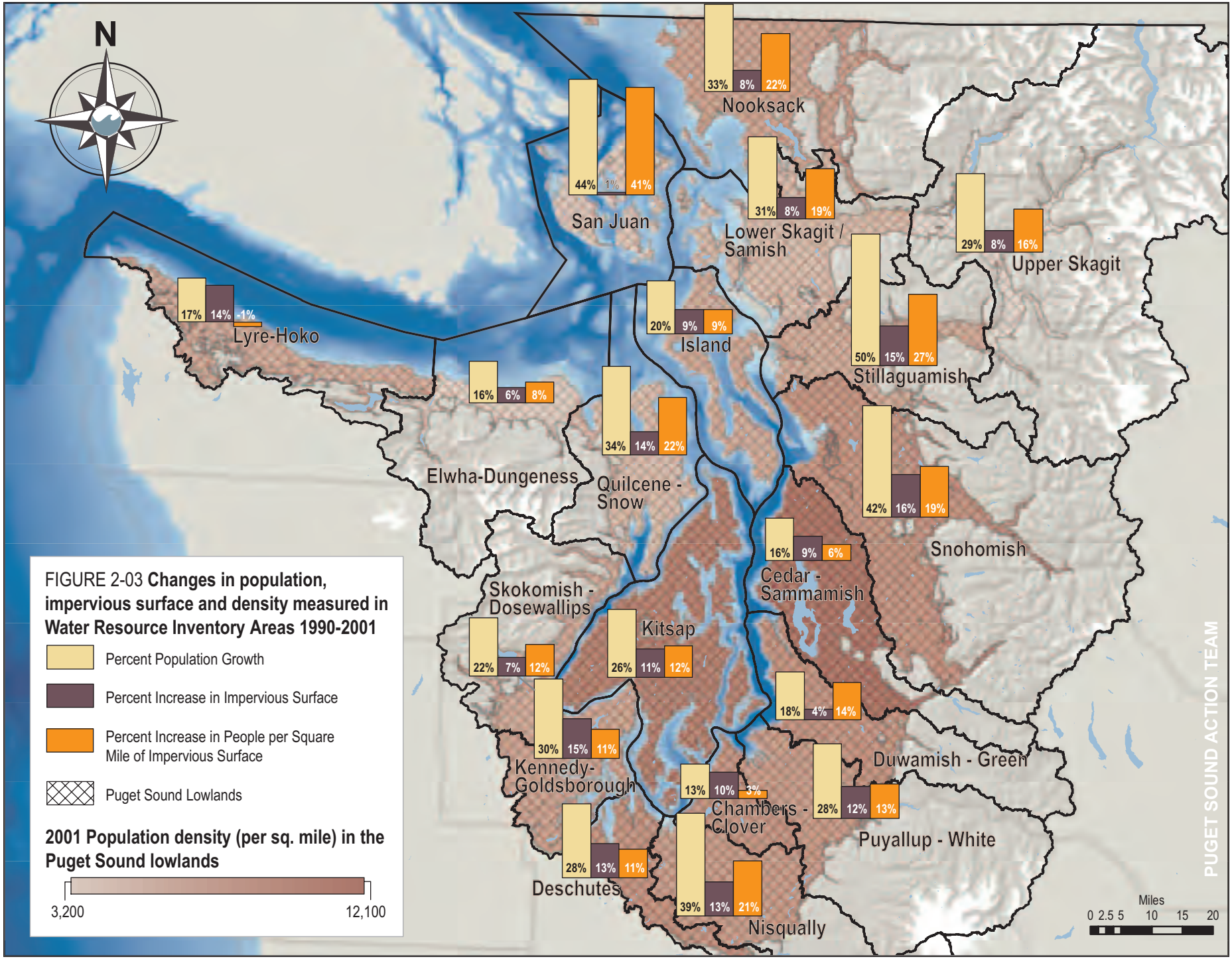
What do the numbers mean?

- If the orange bar is larger than either of the other bars, then new growth occurred primarily within the desired already-developed areas.
- If the gold bar is larger than either of the other bars, then new growth occurred primarily outside already-developed areas. *Source: Action Team.*

WANT TO KNOW MORE?

For more information about the Partnership visit www.pugetsoundpartnership.org.

PHOTO: Sunset from Anacortes. | Shutterstock.com/Natalia Bratslavsky.


N
Nooksack
33% 8% 22%
San Juan
44% 1% 41%
Lower Skagit / Samish
31% 8% 19%
Upper Skagit
29% 8% 16%
Lyre-Hoko
17% 14% -1%
Island
20% 9% 9%
Stillaguamish
50% 15% 27%
16% 6% 8%
Elwha-Dungeness
34% 14% 22%
Quilcene - Snow
Snohomish
42% 16% 19%
16% 9% 6%
Cedar - Sammamish
Skokomish - Dosewallips
22% 7% 12%
Kitsap
26% 11% 12%
18% 4% 14%
Kennedy-Goldsborough
30% 15% 11%
Duwamish - Green
13% 10% 3%
Chambers - Clover
28% 12% 13%
Puyallup - White
28% 13% 11%
Deschutes
39% 13% 21%
Nisqually
FIGURE 2-03 Changes in population, impervious surface and density measured in Water Resource Inventory Areas 1990-2001
Percent Population Growth
Percent Increase in Impervious Surface
Percent Increase in People per Square Mile of Impervious Surface
Puget Sound Lowlands
2001 Population density (per sq. mile) in the Puget Sound lowlands
3,200
12,100
Miles
0 2.5 5 10 15 20
PUGET SOUND ACTION TEAM

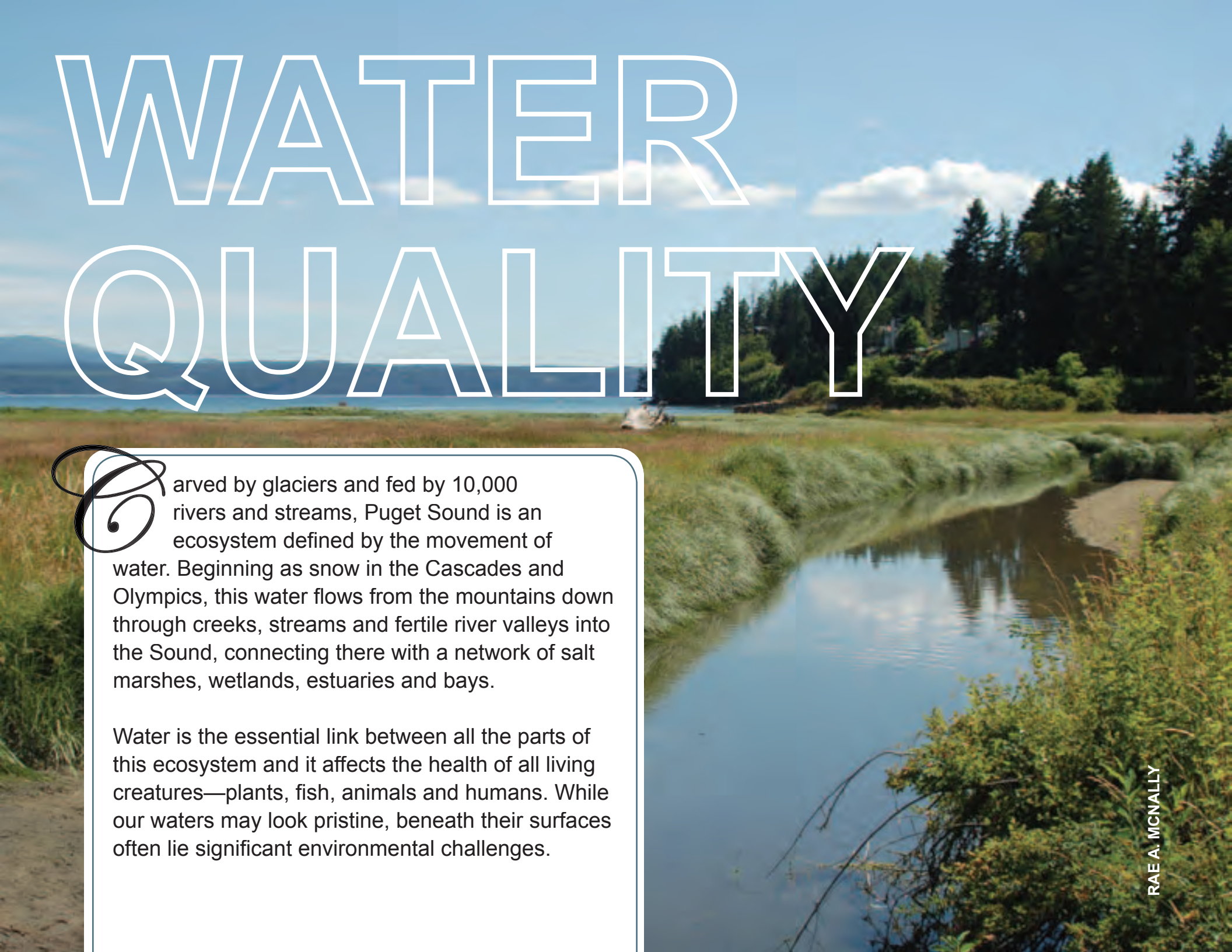
STATE OF THE SOUND:

WATER QUALITY

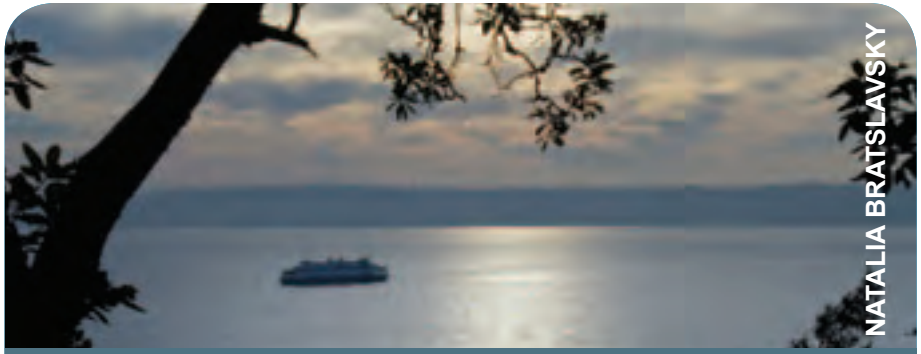
WATER QUALITY

Carved by glaciers and fed by 10,000 rivers and streams, Puget Sound is an ecosystem defined by the movement of water. Beginning as snow in the Cascades and Olympics, this water flows from the mountains down through creeks, streams and fertile river valleys into the Sound, connecting there with a network of salt marshes, wetlands, estuaries and bays.

Water is the essential link between all the parts of this ecosystem and it affects the health of all living creatures—plants, fish, animals and humans. While our waters may look pristine, beneath their surfaces often lie significant environmental challenges.



RAE A. MCNALLY


NATALIA BRATSLAVSKY

INDICATOR: MARINE WATER QUALITY

The Department of Ecology has been monitoring marine water quality at 39 stations since 1967. Monitoring measures fecal coliform, nitrogen, ammonium, dissolved oxygen and stratification. All 39 sites showed some level of concern for at least one of these parameters in 2005, with eight areas classified as "highest concern" because they exceed standards for several or all of the parameters. Ten additional areas are rated "high concern" because they exceed standards for dissolved oxygen and fecal coliform. Two new sites were added in 2005 to the highest concern category.

STATUS

Ecology is monitoring data from 39 sites throughout Puget Sound. Of these, the eight sites rated of highest concern are Budd Inlet, South Hood Canal, Saratoga Passage, Possession Sound, Penn Cove, Commencement Bay, Elliott Bay and Sinclair Inlet. Locations of high concern include Bellingham Bay, Oakland Bay, Case Inlet, Discovery Bay, Strait of Georgia, Carr Inlet, Port Orchard, West Point, Skagit Bay and Port Susan.

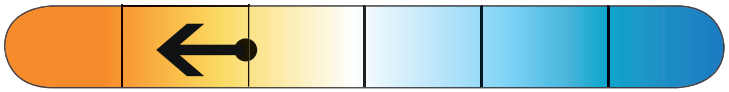
TRENDS

Since 1994, Hood Canal, Budd Inlet and Penn Cove have been locations of highest concern in Puget Sound, due to low dissolved oxygen. In 2002, Budd Inlet was showing signs of improvement, but the area continues to be a concern because of strong stratification, very low DO, high fecal coliform levels and moderate nitrogen. Saratoga Passage and Possession Sound were moved from high to very high concern for the period 2001-2005.


JENNIFER VANDERHOOF

PHOTOS: Brittle star. | Jennifer Vanderhoof; (indicator) A north Puget Sound passage. | Shutterstock.com/Natalia Bratslavsky; (opposite page) Dosewallips River connecting with Hood Canal. | Rae A. McNally; (next page 22) Deschutes River. | Rae A. McNally.

INDICATOR: MARINE AND FRESH WATER HEALTH



Every two years, the Department of Ecology assesses the quality of the surface waters of Washington State. Water bodies that do not meet the state's water quality standards because of human-caused problems are identified as "impaired" and assigned a category for further study and clean up.

STATUS

In 2004, there were approximately 1,474 listings of impaired waters in Puget Sound's fresh and marine waters. Most of the impairments are the result of toxic contamination, pathogens, low dissolved oxygen and high temperatures.

TRENDS

A trend in water quality is difficult to determine since the number of areas monitored and the parameters measured can change. However, a negative trend can be extrapolated from the data, particularly in the areas of temperature, dissolved oxygen, pathogens, and the low number of approved cleanup processes.

FIGURE 3-04: (right) Every two years, the Department of Ecology assesses the quality of the surface waters of Washington State. Water bodies that do not meet the state's water quality standards because of human-caused problems are identified as impaired and assigned a category for further study and clean up. In 2004, there were approximately 1,474 listings of impaired waters in Puget Sound's fresh and marine waters. Most of the impairments are the result of toxic contamination, pathogens, low dissolved oxygen and high temperatures. *Source: Action Team; Ecology.*

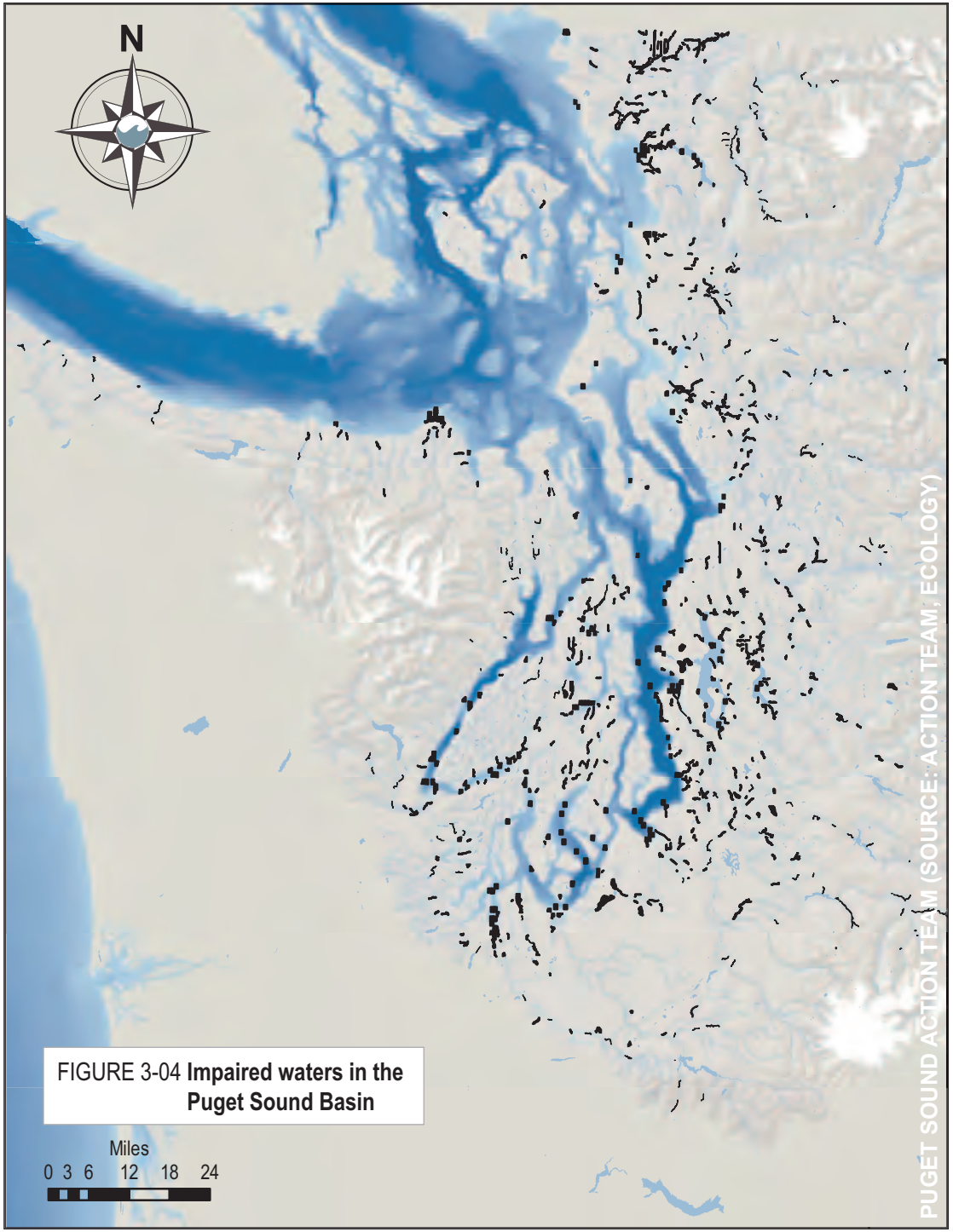
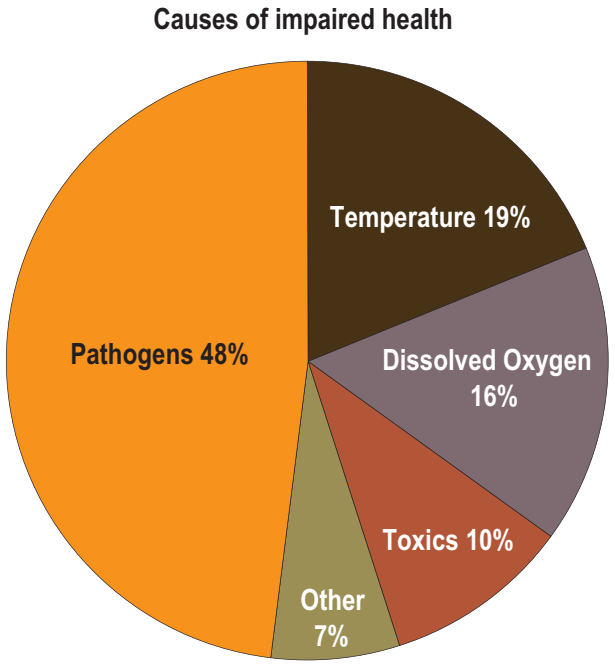
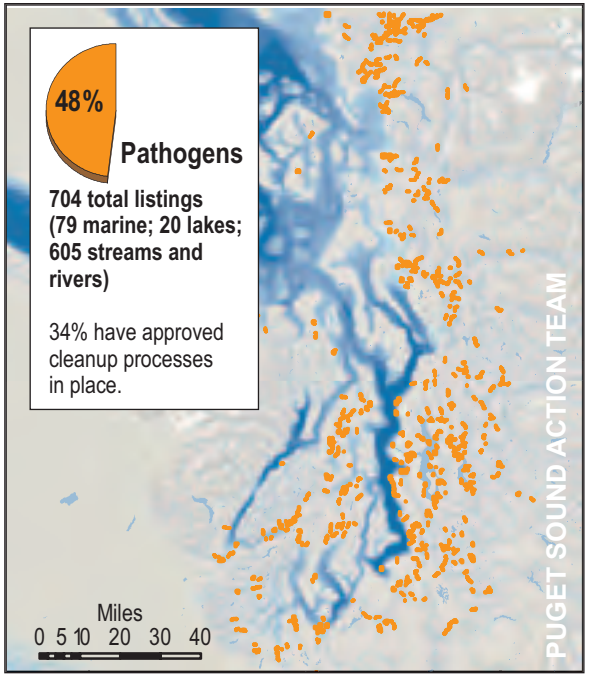
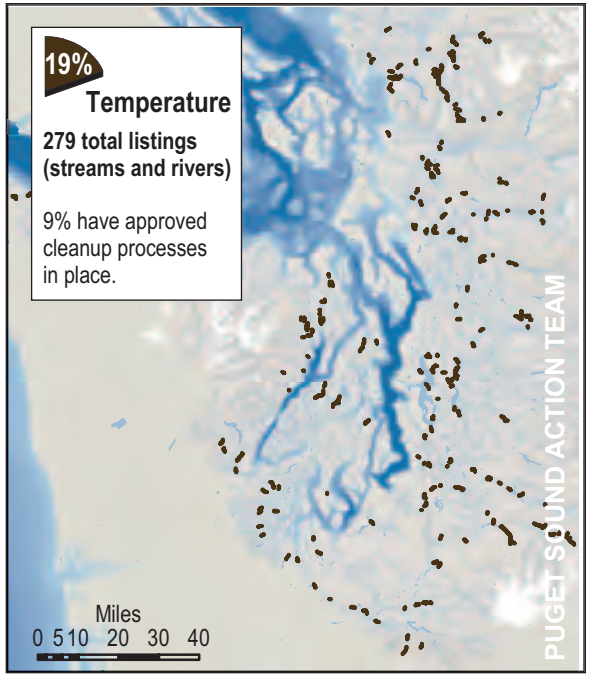
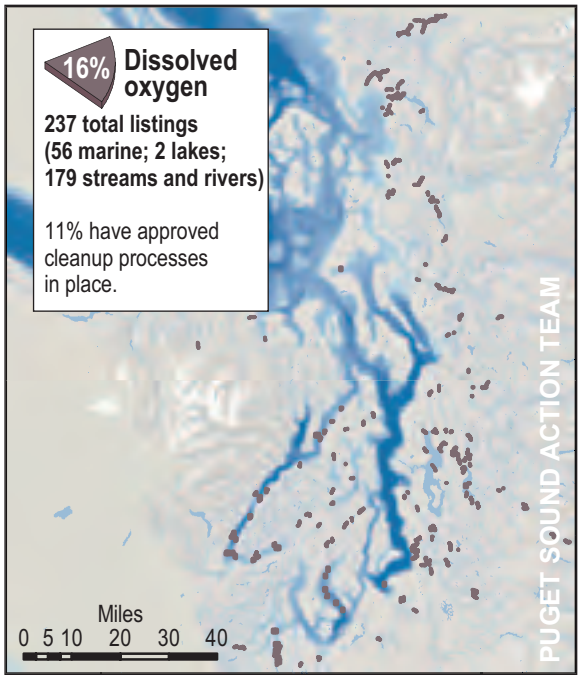


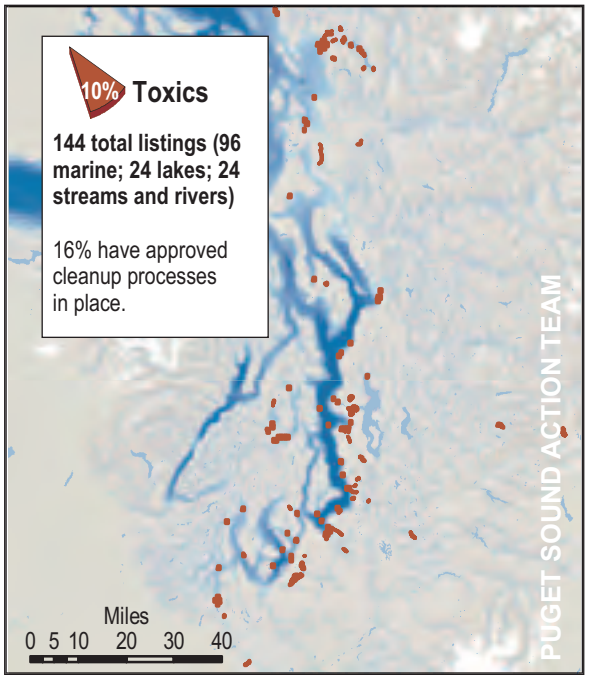
FIGURE 3-04 **Impaired waters in the Puget Sound Basin**

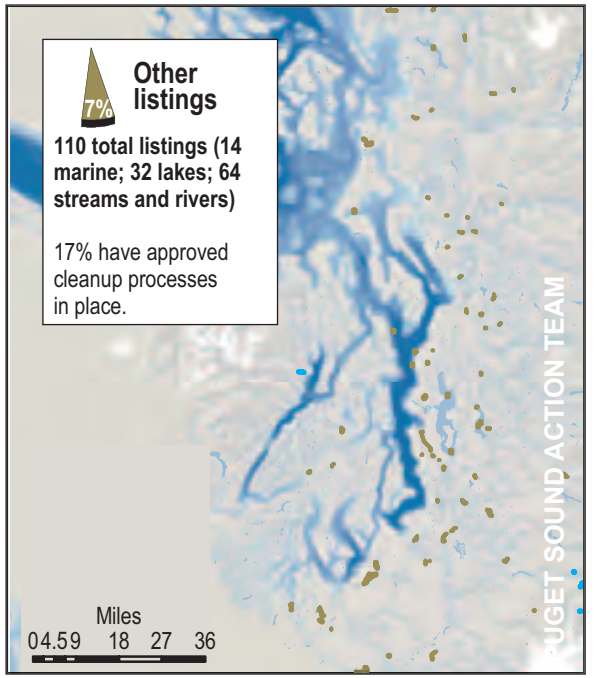

Causes of impaired health
Temperature 19%
Dissolved Oxygen 16%
Toxics 10%
Other 7%
Pathogens 48%


48%
Pathogens
704 total listings (79 marine; 20 lakes; 605 streams and rivers)
34% have approved cleanup processes in place.
Miles
0 5 10 20 30 40
PUGET SOUND ACTION TEAM


19%
Temperature
279 total listings (streams and rivers)
9% have approved cleanup processes in place.
Miles
0 5 10 20 30 40
PUGET SOUND ACTION TEAM


16%
Dissolved oxygen
237 total listings (56 marine; 2 lakes; 179 streams and rivers)
11% have approved cleanup processes in place.
Miles
0 5 10 20 30 40
PUGET SOUND ACTION TEAM


10%
Toxics
144 total listings (96 marine; 24 lakes; 24 streams and rivers)
16% have approved cleanup processes in place.
Miles
0 5 10 20 30 40
PUGET SOUND ACTION TEAM

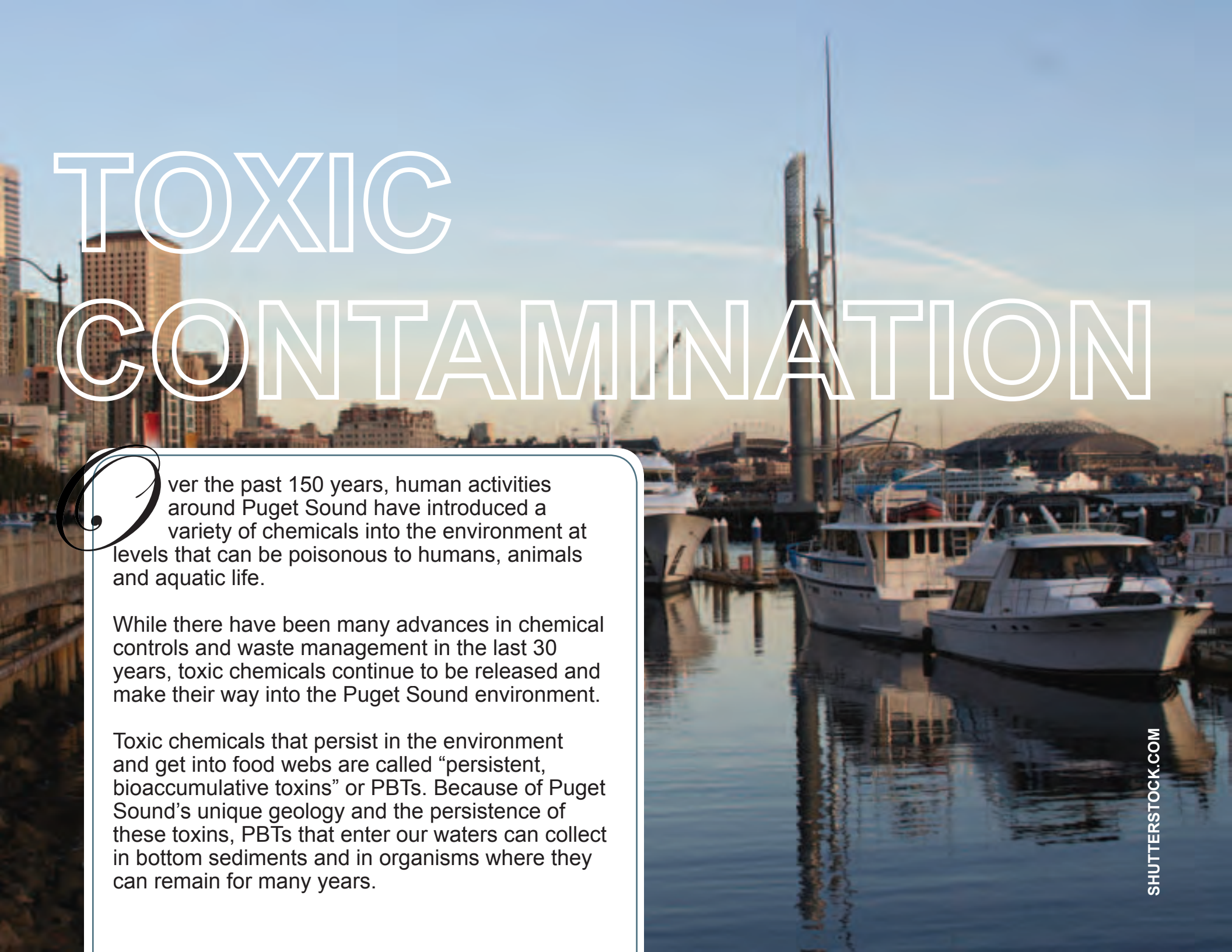

7%
Other listings
110 total listings (14 marine; 32 lakes; 64 streams and rivers)
17% have approved cleanup processes in place.
Miles
0 4.5 9 18 27 36
PUGET SOUND ACTION TEAM

TOXIC CONTAMINATION

Over the past 150 years, human activities around Puget Sound have introduced a variety of chemicals into the environment at levels that can be poisonous to humans, animals and aquatic life.

While there have been many advances in chemical controls and waste management in the last 30 years, toxic chemicals continue to be released and make their way into the Puget Sound environment.

Toxic chemicals that persist in the environment and get into food webs are called “persistent, bioaccumulative toxins” or PBTs. Because of Puget Sound’s unique geology and the persistence of these toxins, PBTs that enter our waters can collect in bottom sediments and in organisms where they can remain for many years.



SHUTTERSTOCK.COM

PHOTOS: (top to bottom) Assorted cosmetics. | Shutterstock.com/Tom McNemar; Contractors clean up waters near Point Defiance ferry docks after an oil spill. | Kathy Taylor; (opposite page) Marina, downtown Seattle. | Shutterstock.com.

WANT TO KNOW MORE?

about toxics in Puget Sound?

In April 2006, Action Team staff wrote a report called *Toxics in Puget Sound* that can be found at www.psat.wa.gov/toxicsreport.

TOXICS IN OUR BODIES

In 2005, 10 Washington residents agreed to have their hair, blood and urine tested for the presence of toxic chemicals as part of an investigative study by the Toxic-Free Legacy Coalition. The study revealed that the same toxic chemicals we find in Puget Sound are also showing up in our bodies.

Each person tested positive for at least 26—and as many as 39—of the toxic chemicals tested for, including common pesticides such as carbaryl; plasticizers and fragrances found in vinyl, toys and personal care products; perfluorinated chemicals such as those used to make Teflon™, toxic flame retardants found in electronics, mattresses and furniture; heavy metals such as lead, mercury and arsenic; and both DDT and PCBs, which have been banned for decades. These toxics in people come from everyday activities and products such as food, cosmetics, home electronics, furniture made of vinyl, packaging, cookware and even clothing. The presence of these toxic chemicals is generally not noted on labels, and the companies that sell them may not even know their products contain the chemicals.

In 2004, Sightline Institute conducted a study that tested for PBDEs in breast milk. Sightline, a Seattle-based not-for-profit research and communication center, found that the 40 Puget Sound area mothers in the study had levels of PBDEs 20-to-40 times higher than levels found in individuals from Europe and Japan.

Pollutants of concern in Puget Sound

POLLUTANT	SOURCES	HARM
HEAVY METALS		
Lead, mercury, copper and others	Vehicles, batteries, paints, dyes, stormwater runoff, spills, pipes.	Can cause neurological, developmental and reproductive problems in people and animals.
ORGANIC COMPOUNDS		
Polycyclic aromatic hydrocarbons (PAHs)	Burning wood and fossil fuels as well as oil spills, leaking underground fuel tanks, creosote, asphalt and coal.	Can increase the risk of cancer and harm immune systems, reproduction and development. Associated with liver disease in English sole.
Polychlorinated biphenyls (PCBs)	Banned in the U.S. in 1976, it can still be found in the environment. Hydraulic fluids, solvents, electrical coolants, lubricants.	Can harm immune systems, reproduction and development; retard growth; increase the risk of cancer; and disrupt hormone systems.
Dioxins, furans	Byproducts of combustion and industrial processes.	Can harm immune systems, reproduction and development; retard growth; increase the risk of cancer; and disrupt hormone systems.
Dichloro-diphenyl-trichloroethane (DDT)	Banned in the U.S. in 1972, it can still be found in the environment. Used in the U.S. as a pesticide, it is still used in many countries in agricultural practices and disease control.	Thins bird eggshells and causes reproductive and developmental problems. Linked to cancer, liver disease and hormone disruption in laboratory-test animals.
Phthalates	Plastic materials, including food packaging, garden hoses, medical equipment and toys; and personal care products such as soap and shampoo, deodorant and lotion.	Can produce lowered testosterone levels, testicular atrophy and other abnormalities in animals if high doses are present in the fetal period.
Polybrominated diphenyl ethers (PBDEs)	Added to electronics, textiles and plastics as a flame retardant.	Accumulates in the environment, harming mammals' reproduction and development. Can increase risk of cancer and disrupt hormone systems.

INDICATOR: TOXICS IN SEDIMENTS

Over the years, the more long-lasting chemicals introduced into the ecosystem have accumulated in the mud and sediments of Puget Sound and from there into the tissues of living organisms. In a study area of 584,000 acres of Puget Sound sediments, about one percent (about 5,700 acres) was found to be contaminated with high levels of toxic substances, mainly in areas around urban developments. Another 31 percent (179,000 acres) was considered moderately contaminated.

Although the number of acres of highly toxic sediments may appear small as an overall percentage of Puget Sound, these contaminated sediments can affect much larger areas of the ecosystem. When organisms live in or eat in these areas of contamination, not only are they directly harmed but they also accumulate contaminants in their tissues and transfer them throughout the food web.

STATUS

In a multi-year study completed in 2003, Ecology found 14 percent of the sediments in developed harbors and four percent of the sediments in urban bays outside of harbors were highly contaminated. These sediments had elevated concentrations of toxic chemicals, observable toxicity in laboratory tests, and impaired communities of bottom-dwelling organisms.

TRENDS

Ecology collects sediment samples every five years, most recently in 2005, but analysis had not been completed as of late 2006. Our last report, *State of the Sound 2004*, listed increasing PAHs at four of 10 stations, decreasing levels of metals at others, and no measurable change in other contaminants. The 2005 samples will allow further investigations of these patterns.

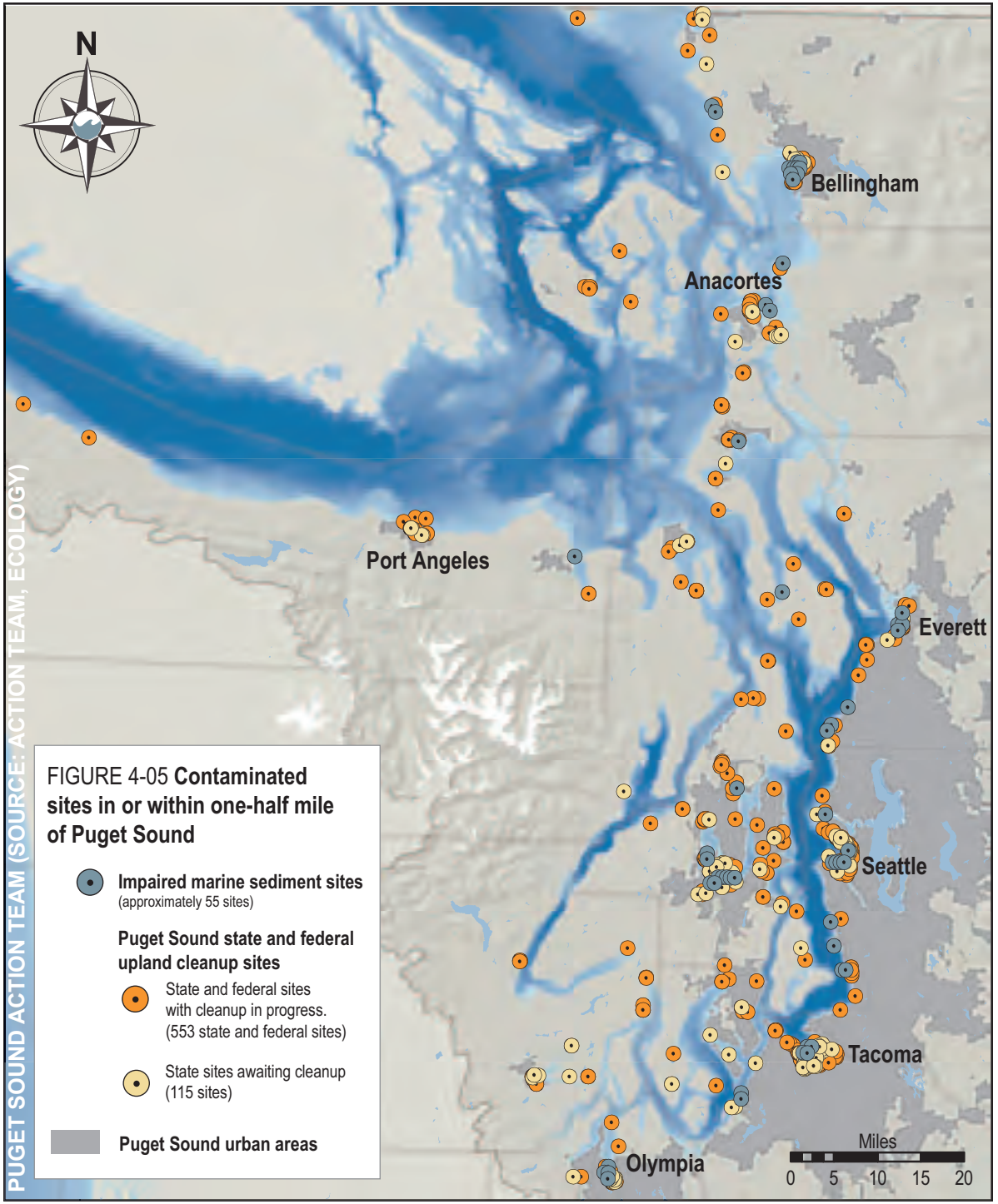
PHOTOS: A Natural Resource Damage Assessment cleanup site in Tacoma. | City of Tacoma; (indicator) Dredging. | Shutterstock.com/Steven Allen.

Emerging trend: PBDEs

Based on sampling initiated in 2004 and expanded in 2005, Ecology identified PBDEs as a new contaminant of concern turning up in the sediments of Puget Sound. Ten long-term sediment sampling stations all show detectable levels of PBDEs. A detailed study of Hood Canal, which is among the least urban areas of Puget Sound, showed PBDEs occurring in 17 percent of the sampling stations. Ecology will continue to monitor Puget Sound annually to better characterize PBDE contamination in sediments and to determine if concentrations are changing.

PHOTO: Cascade Pole sediment dredging project. | Mohsen Kourehdar/Washington State Department of Ecology.

FIGURE 4-05: Impaired marine sediment sites (the blue dots), are general locations where in-water sediments have been tested and found to have toxic pollutants that exceed state standards. Some of these sites have cleanup plans in place. Contaminated sites within one-half mile of Puget Sound include general locations either awaiting cleanup (yellow dots), or have cleanup in progress (orange dots). The cleanup sites are current as of mid-2006, however sediment cleanup is a dynamic process and site numbers change frequently. For the most current information, contact the Department of Ecology's Toxic Cleanup Program: www.ecy.wa.gov/services/disclosure/coordinators_tcp.html.
Note: Because of the map's scale, it is impossible to distinguish the precise location of individual sites.
Source: Action Team; Ecology.

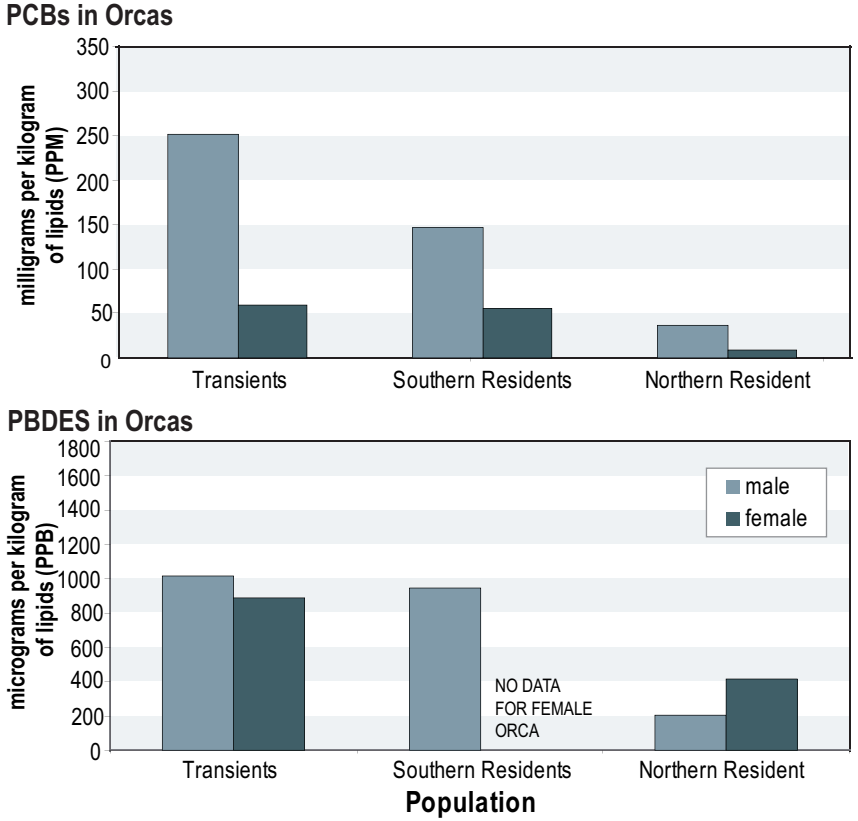


CONTAMINANTS IN MARINE SPECIES

Many species of fish and wildlife rely on marine and freshwater habitats to live, feed and reproduce. When toxic, long-lived pollutants find their way into the environment, they disturb the ecological balance and work their way into the food web. Many types of fish, as well as seals and orca, now have high levels of toxic contamination, potentially interfering with their immune, reproductive and neurological systems.

PHOTO: Juvenile coho in the Elwha River, Clallam County. | Roger Peters/U.S. Fish and Wildlife Service.

FIGURE 4-06 **Orcas at risk from toxics**



Puget Sound's orca population faces a number of stressors. Exposure to high levels of long-lived industrial chemicals, such as PCBs, PBDEs and dioxins in the food supply, is one of the most serious.

Southern resident orcas, which feed mainly on salmon returning to Puget Sound and the southern Georgia Basin, have three times the level of PCBs and four times the level of PBDEs of the northern residents, which feed primarily on salmon from further north in the Georgia Basin waters. Transient orcas, which visit Puget Sound and the Georgia Basin and feed primarily on marine mammals such as harbor seals have higher levels of both PBDEs and PCBs than the salmon-preferring resident orcas. Although DOH has recommended that humans limit their meals of Puget Sound chinook, the southern resident orca continue to consume them as a major food source.

There is no consistent trend data for contaminant levels in orca because of the risk of stressing or harming the mammals during the sampling process. Samples are usually collected from beached carcasses. *Source: DFO (Canada)*

Health advisory for Puget Sound fish

Fish are an important part of a healthy diet, but some Puget Sound salmon should be eaten in moderation, according to a 2006 assessment by the Department of Health (DOH).

Because of high PCB (polychlorinated biphenyl) and mercury levels, consumers should limit their consumption of Puget Sound chinook salmon to one meal per week and resident chinook (locally referred to as "blackmouth") to two meals per month.

DOH completed its study of toxics in Puget Sound fish using 10 years of data from the PSAMP. The department also sampled fish found in markets across the state.

For more information on meal guidelines, download The Healthy Fish Eating Guide at www.doh.wa.gov/fish/fishchart.htm.

INDICATOR: TOXICS IN CHINOOK AND COHO SALMON

Persistent pollutants such as PCBs and PBDEs can accumulate in fish. Because salmon live only three to five years and feed high on the food chain, their contaminant levels are valuable reflectors of current environmental conditions.

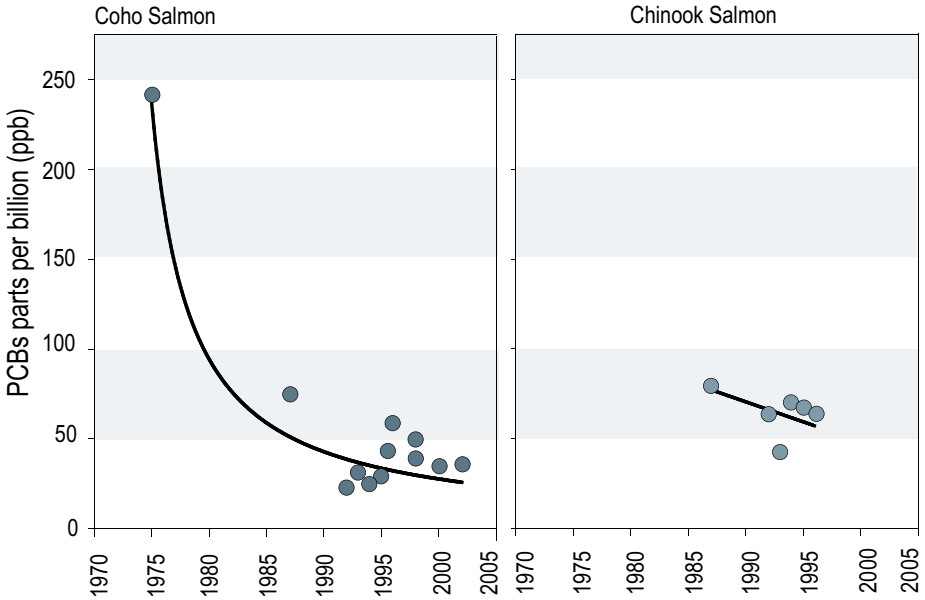
STATUS

Chinook salmon from Puget Sound have higher levels of PCBs than those measured in other West Coast populations including Alaska, British Columbia and Oregon. PCB levels in Puget Sound chinook range from 14 to 210 parts per billion (ppb), averaging 42 ppb. This is two-to-six times higher than average PCB concentrations found in other West Coast chinook.

PCB levels in coho populations within Puget Sound vary. Those from southern Puget Sound generally have higher PCB accumulations than fish from northern Puget Sound. Scientists suggest that the length of time that coho spend in Puget Sound and the distance they must migrate from their native streams to the ocean could play a role.

Researchers are also studying the extent of flame retardant contamination (PBDEs) in Puget Sound chinook and have recently documented PBDE concentrations ranging from 0 to 110 ppb, with an average of 19 ppb. These levels are five-to-17 times higher than average PBDE concentrations detected in chinook that are returning to rivers in British Columbia and coastal Washington. The highest PBDE levels are found in "blackmouth" chinook that reside in Puget Sound throughout most of their lifetime and do not migrate to the Pacific Ocean.

FIGURE 4-07 **PCB trends in Puget Sound salmon 1970-2005**



TRENDS

Limited long-term data suggest that PCBs in Puget Sound chinook and coho salmon were higher in the 1970s through the mid-1980s and leveled off to current concentrations in the late 1980s. This trend is consistent with national and global trends for PCBs in fish and is also reflected in the concentrations measured in orcas and seals.

Long-term data is not available to indicate trends for PBDEs in salmon. However, trends of PBDEs in seals from southern Puget Sound indicate a striking increase in that contaminant in the past 20 years, a trend that is likely reflected in salmon as well.

FIGURE 4-07: PCB levels in Puget Sound coho have declined since the 1970s when production of these compounds ceased. Data for chinook doesn't begin until the mid-1980s. PCB concentrations in salmon have evened out over the past 10 to 15 years, but remain at levels that may still be harmful to fish and people who consume them. *Source: WDFW*

PHOTO: (indicator) Coho swim in Jefferson County creeks. | Jefferson County Conservation Districts.

INDICATOR: TOXICS IN MUSSELS

Mussels feed by filtering large quantities of water and are valuable indicators of toxic contaminants in marine water. Every two years since 1984, scientists from the National Oceanic and Atmospheric Administration (NOAA) have tested contaminant levels in mussel tissue from Puget Sound and the outer coast of Washington. Data from the Mussel Watch program has helped scientists gauge the water quality around the monitoring sites.

STATUS

PAHs: Average concentrations of PAHs in mussel tissue from Puget Sound sites range from 200 to 4,000 parts ppb dry weight (dw). These concentrations range from one to more than 10 times the national median value of 220 ppb dw.

PCBs: Average PCB levels in Puget Sound mussel tissue—approximately 80 ppb dw—are 60 percent higher than the national median of 50 ppb dw. Two sites, Duwamish Head and Fourmile Rock, both located near Elliott Bay, have especially high PCB levels, 262 and 288 ppb dw, respectively.

Mercury: Average mercury levels in Puget Sound mussels are 20 percent higher than the national median of 0.10 ppm dw. In 2002, only Bellingham Bay had substantially higher levels of mercury (0.21 ppm dw) compared to the other sites in Puget Sound.

TRENDS

PAHs: The pattern of PAH concentrations in mussel tissue in Puget Sound has varied over the last two decades. PAH levels declined in the mid-1980s, then increased slightly in the mid-1990s. Overall, PAHs in mussel tissue appears to be in decline.

PCBs: The highest recorded levels of PCBs in mussels were from Elliott Bay where concentrations reached 1,400 ppb dw in 1986. Since then, levels at this site have dropped to about 300 ppb dw. At other sites throughout Puget Sound, levels of PCBs declined through the 1980s, increased slightly in the 1990s and then declined again.

Mercury: In the past two decades, only slight changes have occurred in mercury concentrations in Puget Sound mussels. The exception is in Bellingham Bay, where, since 1986, levels have consistently remained more than 50 percent higher than at other sites.

FIGURE 4-08 **Concentrations of PAHs, PCBs and mercury in mussels**

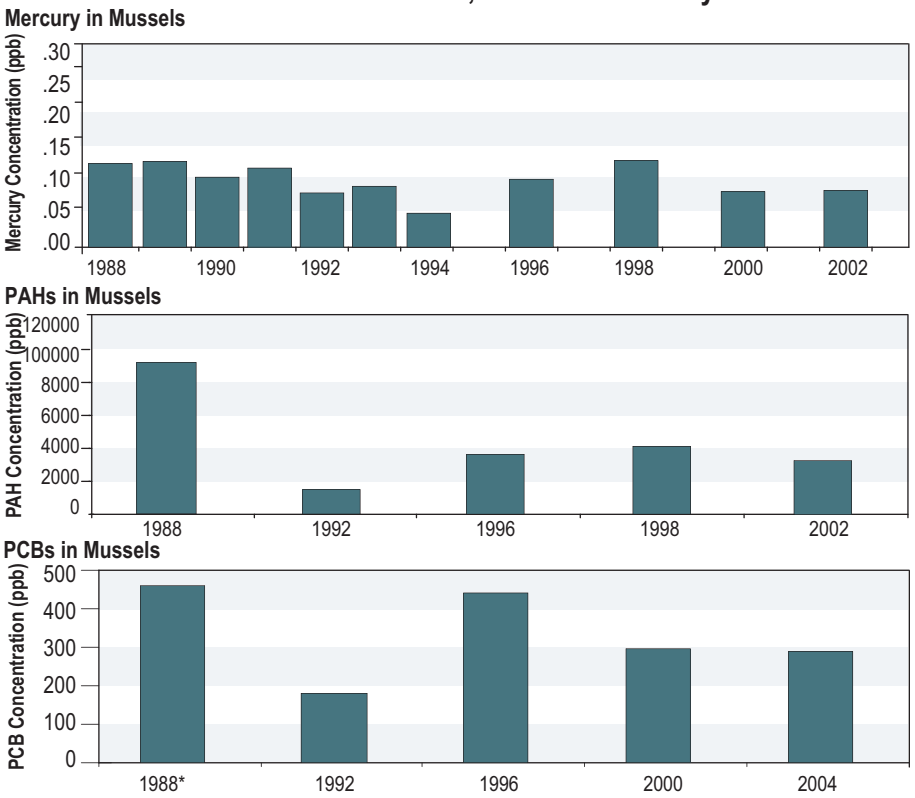


FIGURE 4-08: The National Oceanic and Atmospheric Administration's Mussel Watch program has collected data on contaminants in mussels since 1984. PCB and PAH concentrations have generally declined; mercury levels have stayed fairly stable. *Source: NOAA.*

PHOTO: (indicator) Mussels. | Shutterstock.com.

INDICATOR: TOXICS IN HARBOR SEALS

Harbor seals are the most abundant marine mammal in Puget Sound. Because they feed on a wide variety of fish and invertebrates, harbor seals serve as important sentinels of food web contamination. Their numbers are growing and today's Washington harbor seal population numbers more than 30,000.

STATUS

PCBs: *The State of the Sound 2004* and Puget Sound-Georgia Basin ecosystem indicator reports noted that harbor seal pups in south Puget Sound are seven times more contaminated with PCBs than seal pups from the Georgia Basin. Intermediate levels of contamination were found in animals from northern Puget Sound (Smith Island). These reports also show that levels of dioxins and furans present a different pattern because seals from the Georgia Basin had higher levels of these contaminants than those in Puget Sound.

PBDEs: Recent studies by Canada's Department of Fisheries and Oceans (DFO) show that blubber collected in 2005 from Puget Sound harbor seal pups contained more than twice the PBDE levels as their counterparts near Vancouver, B.C.—approximately 1,000 parts of PBDEs per billion of fatty tissue versus about 500 ppb.

TRENDS

PCBs: *The State of the Sound 2004* described a declining trend in PCB concentrations in harbor seal pups in northern Puget Sound. There was a steep decline in the 1980s that leveled off noticeably in the 1990s. No new trend data is available.

PBDEs: Unlike PCBs, PBDE levels in seals increased dramatically in recent years. Analysis by DFO of samples collected between 1984 and 2003 showed that PBDE levels in seals from south Puget Sound rose from less than 50 ppb of PBDEs in fatty tissue to more than 1,000 ppb. This trend indicates PBDE concentrations are doubling every four years. If this rate continues, contamination of harbor seals by PBDEs would surpass PCB contamination by 2020.

FIGURE 4-09 **PBDEs in harbor seals from Gertrude Island 1980-2005**

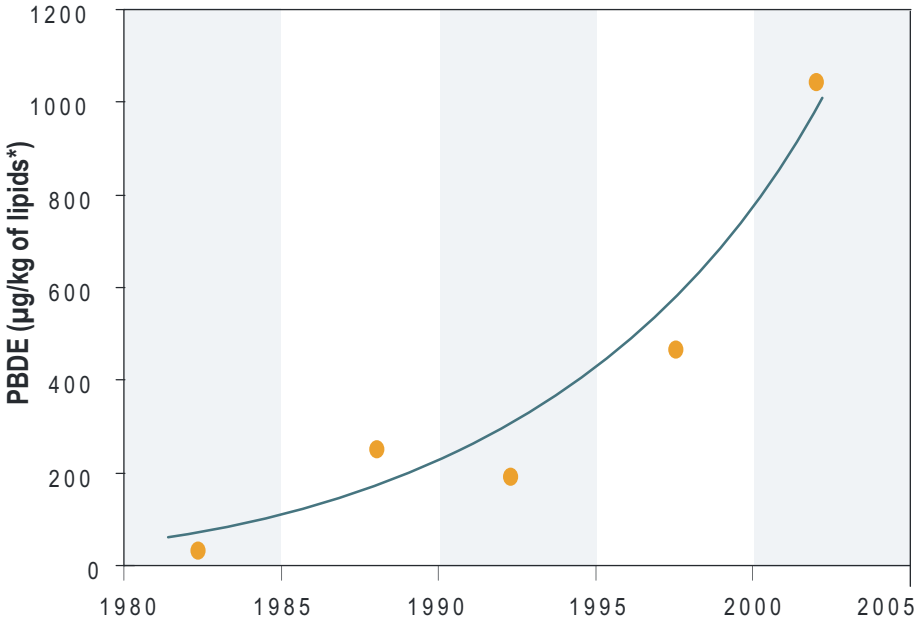


FIGURE 4-09: Seal pups from Gertrude Island in south Puget Sound have been sampled for contaminants for more than two decades. Recent analysis of archived tissue shows a rapid increase in PBDEs since the mid-1980s. *Source: DFO (Canada).*

PHOTO: (indicator) Resting harbor seal. | Rae A. McNally.

**micrograms per kilograms*

INDICATOR: LIVER DISEASE IN ENGLISH SOLE

English sole are an abundant flatfish, widely distributed throughout Puget Sound's shallow bays. Because they are bottom dwellers that consume invertebrates, shellfish and other organisms that live in the sediment, they are good indicators of sediment quality. Concentrations of PAHs, associated with a risk of liver lesions in English sole, are elevated in many of Puget Sound's urban bays which otherwise provide biologically productive, protected habitats for this species.

STATUS

Based on more than 17 years of data collected by the Department of Fish and Wildlife (WDFW) and NOAA, English sole from the shoreline of Seattle's Elliott Bay have six times the risk of developing liver lesions compared with uncontaminated baseline sites (**Figure 4-10**). English sole from the Thea Foss Waterway in Tacoma had four times the risk. Both locations have relatively high exposure to PAHs.

TRENDS

Although trends in liver disease in English sole have fluctuated throughout the years, Soundwide there has been a general decrease in the disease from 1999-2005. This decline may be attributed to sediment cleanup measures and better source controls. Despite the decline in PAHs, the risk of liver disease associated with PAH exposure is still significant in several urban bays.

FIGURE 4-10 **Risk of liver disease in English sole**

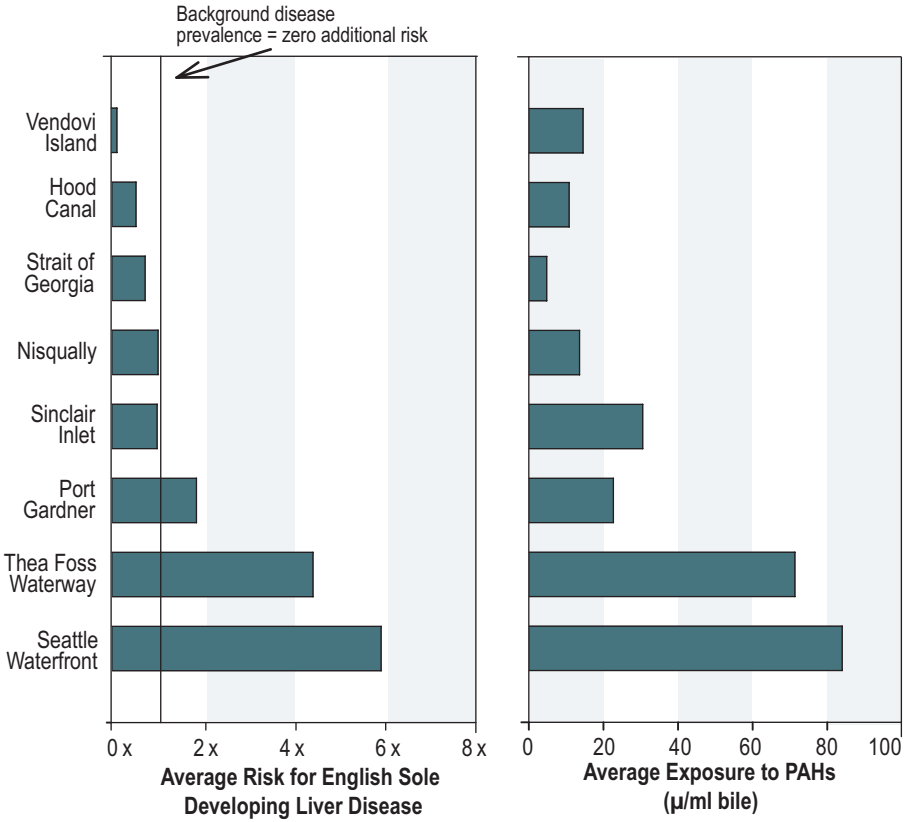


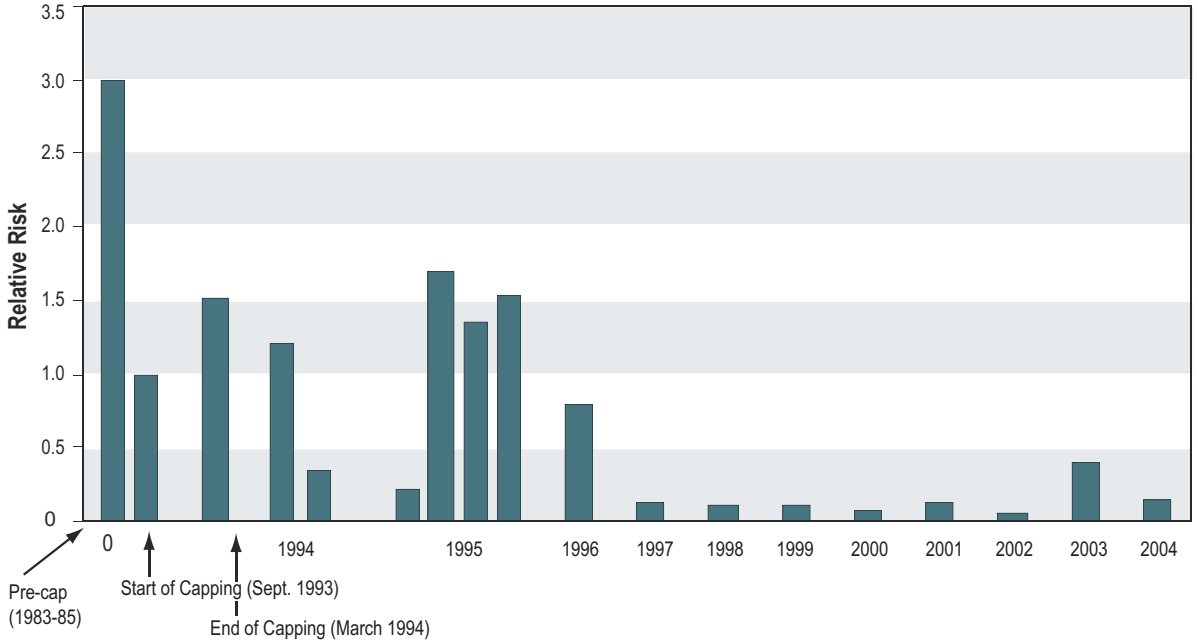
FIGURE 4-10: The risk of English sole developing liver disease was assessed at eight long-term monitoring stations. Their exposure to PAHs was determined by using a biomarker phenanthrene, which is a chemical released by the liver into bile when the fish is exposed to PAHs. This is measured as micrograms per milliliter of phenanthrene in bile (µ/ml bile). Risks were averaged over a 17-year period, and PAH exposure was averaged over an eight-year period. *Source: WDFW*

PHOTO: (indicator) Sampling English sole from Puget Sound. | Steve Quinell/WDFW.

Eagle Harbor capping project a success

PHOTOS: (top to bottom) Scooping sediment into a jar for testing, August 2002. | EPA; Sheet pile wall just offshore of the beach, January 2000. | EPA; Washing clean cap materials into the water from a barge, early 2002. | EPA.

FIGURE 4-11 **Eagle Harbor monitoring results**



In the mid-1980s, scientists found that English sole from Eagle Harbor (on the eastern shore of Bainbridge Island) showed significant liver lesions and tumors consistent with contaminant exposure.

Upon further study, scientists discovered high concentrations of PAHs in the sediment—which was released from a nearby creosote factory. The area was designated a Superfund cleanup site in 1987 by the U.S. Environmental Protection Agency (EPA).

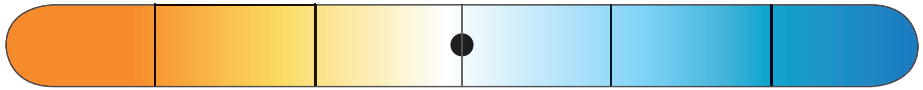
In 1993, the EPA and the Army Corps of Engineers started placing clean sediment over the most contaminated portions of Eagle Harbor to try to immobilize PAH-contaminated sediments.

To monitor data from this effort, fish were collected immediately after capping and at regular intervals for several years.

After two years, scientists saw a significant decrease in liver lesions in English sole. Capping the contaminated sediment effectively reduced PAH exposure among sole and other resident flatfish (**Figure 4-11**).

Source: NOAA Northwest Fisheries Science Center.

INDICATOR: OIL SPILLS



Each year, commercial ships transport about 15.8 billion gallons of crude oil and refined petroleum products through Puget Sound. The total number of vessels and the amount of oil that each vessel can carry have both increased, therefore increasing the risk of oil spills in Puget Sound.

For example, newer container ships can now carry up to 3.8 million gallons of fuel, while oil tankers carry upwards of 40 million gallons. Additional sources of potential oil spills are large marine oil terminals, refineries, oil pipelines, land transportation and smaller commercial or recreational boats.

A major oil spill in Puget Sound could be catastrophic for Puget Sound marine life and the area's economy.

STATUS

Since 2005, there have been no "major" spills (10,000 gallons or more). There have been 19 "serious" spills (25 gallons or more) with about 4,000 gallons reaching Puget Sound. Of this amount, commercial vessels spilled at least 3,160 gallons.

TRENDS

Since 1998, Puget Sound and its tributaries experienced one major spill and 165 serious spills, totaling at least 350,000 gallons. During each of the last nine years, the total number of oil spills reported to Ecology has stayed about the same, while the number of serious spills has decreased from 23 to about 13 spills per year.

While it is difficult to characterize trends in these low-probability high-impact events, it appears that the volume of oil released from large spills has steadily declined in the last 15 years.

FIGURE 4-12 **Volume and number of oil spills 1995-2004**

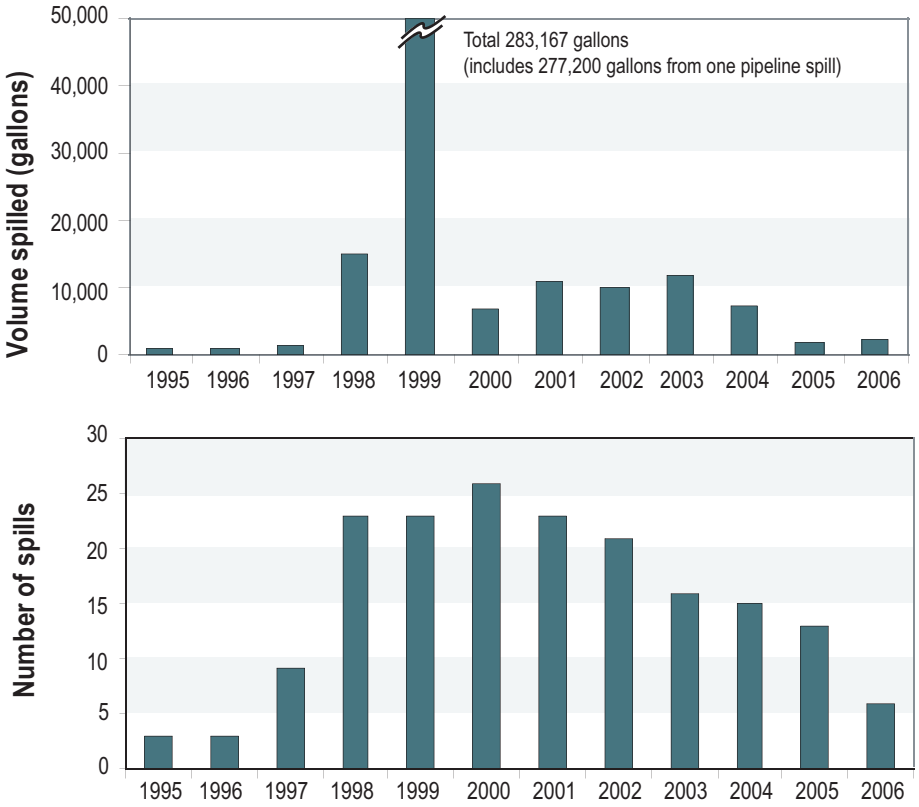


PHOTO: (indicator) Department of Ecology crews deploy oil containment booms during a November 1, 2006, training exercise. | Ecology.

Oil transfer operations

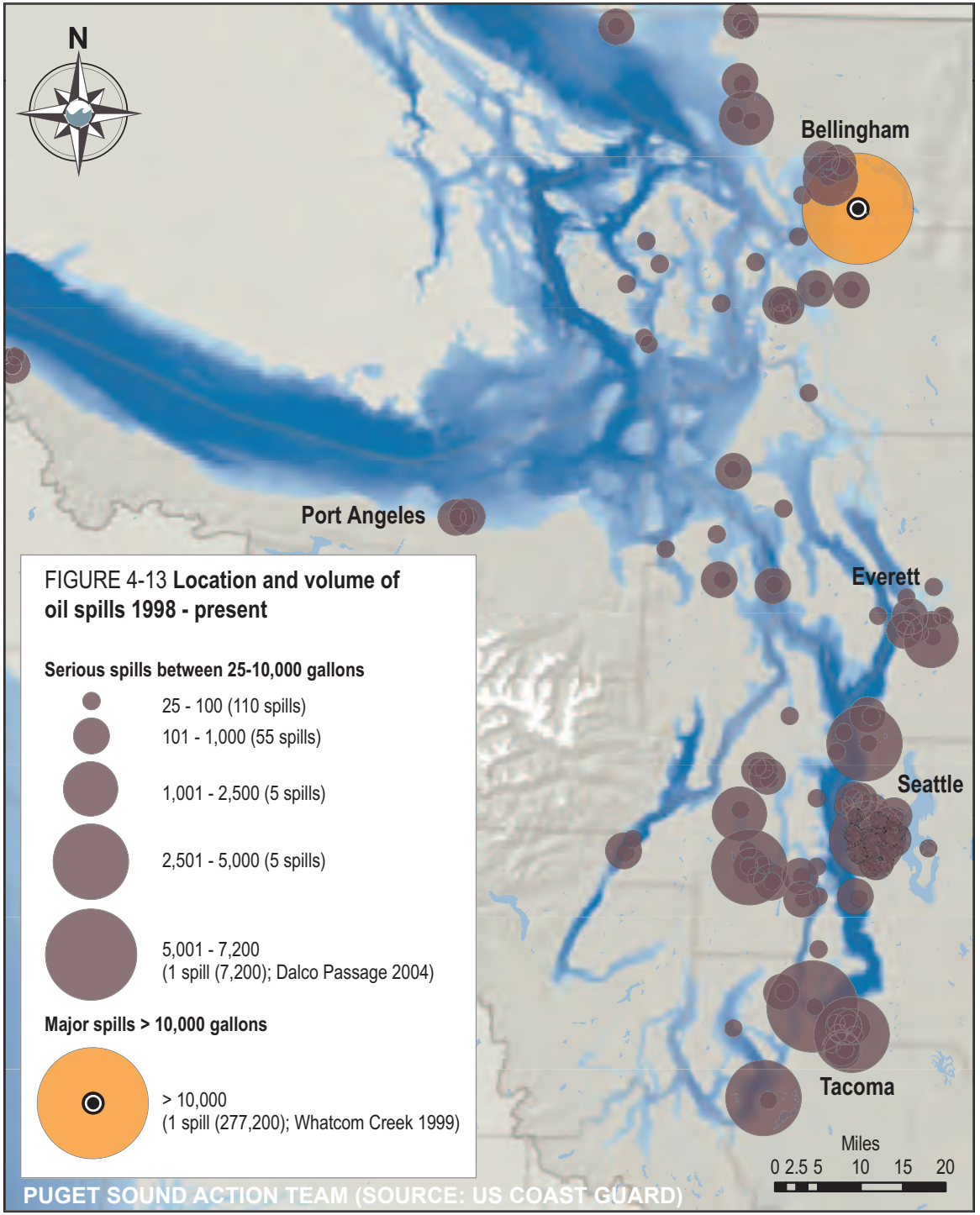
A huge volume of crude oil, diesel, gasoline and other fuels are transferred over Puget Sound waters every year. During a six-month period from December 2004 to May 2005, there were approximately 4,700 transfers in Washington State totaling 3.36 billion gallons. Marine oil terminals, including refineries, transferred 90 percent of the oil (more than 3 billion gallons). Tank barge vessels transferred nine percent (284 million gallons). Tank trucks transferred less than one percent. Although tank trucks transferred the least volume, they represented approximately 24 percent of all transfers.

Oil transfer locations and sources in Puget Sound December 2004-May 2005

CITY OR REGION	MOBILE	FIXED	VESSELS
Anacortes	38	250	7
Bainbridge Island	2	--	--
Bellingham	29	248	--
Bremerton	30	121	3
Clinton	1	1	--
Eagle Harbor	9	--	--
Edmonds	1	98	2
Everett	26	3	4
Ferndale	--	42	1
Kenmore	33	--	--
Kingston	1	--	--
Oak Harbor	1	--	--
Olympia	--	--	1
Port Angeles	33	108	10
Port Townsend	37	12	--
Seattle	645	894	271
Tacoma	45	415	250
Vashon	2	--	--
Total	933	2,192	549

Source: Oil and Fuel Transfer Over Waters of the State of Washington: A Report to the Legislature. Ecology 2005.

Mobile facilities: Primarily oil transfers from tank trucks, although they may also include railcars. **Fixed facilities:** Transfers to or from oil processing plants (such as refineries), oil and fuel storage facilities, or distribution plants. **Vessel-to-vessel transfers:** Transfers between tank vessels or when oil is passed from a tank vessel to a receiving ship.
Source: US Coast Guard.



The Action Team's work on
TOXIC CONTAMINATION

A. Cleaning up contaminated sites and sediments

What we said we would do

1. Finish cleanup at 400 contaminated sites between July 2005 and June 2007, and stay on schedule on all others.
2. Increase the pace of cleanups and funding for cleanups on state-owned aquatic lands as well as on "orphan" sites that do not have a party identified to pay for them.
3. Address sites contaminated by wood waste.
4. Support local government cleanup actions in urban bays.

What's been done

1. **Cleanups.** *Ecology's Sediment Cleanup Status Report* indicated that 23 in-water sites were cleaned up in 2005, compared to 17 sites in 2003. The number of known in-water sites where the cleanup process had not yet started was down to 17 in 2005 from 23 in 2003. Ecology also cleaned up 323 terrestrial sites within one-half mile of Puget Sound. We have no data on progress since June 2005.
2. **Additional cleanups on state-owned aquatic lands and "orphan" sites.** In July 2006, the state provided additional funds for cleanup of contaminated sites in and within one-half mile of Puget Sound, including support for cleanups on state-owned aquatic lands and "orphan" sites. At the time *State of the Sound 2007* went to press, it was too early to determine how many sites would be cleaned up with these funds.
3. **Cleaning up creosote logs and pilings.** In 2004, the Northwest Straits Commission (NWSC) began a project to remove creosote-soaked logs from Puget Sound beaches. From mid-2004 to mid-2006, the NWSC worked with federal, state and local entities to remove nearly 600 tons of creosote logs and pilings from aquatic lands.
4. **Cleaning up wood waste.** The Department of Natural Resources (DNR) is reviewing every log storage lease on state-owned aquatic lands that is ending or is up for renewal. Ecology and DNR are developing protocols for cleaning up these leased sites.

B. Reducing toxic contamination

What we said we would do

1. Secure funding for the Neah Bay rescue tug to prevent oil spills.
2. Develop chemical action plans to reduce and, where possible, eliminate persistent bioaccumulative toxins (PBTs).
3. Reissue the National Pollutant Discharge Elimination System (NPDES) permits for discharges from industrial and municipal wastewater facilities.
4. Increase the amount of water reclaimed by municipal wastewater operations.
5. Collect unused pesticides and provide training in pesticide safety.
6. Improve measures to prevent and respond to oil spills.

What's been done

1. **Support for the Neah Bay tug.** Ecology sought and received funding to locate a rescue tug at Neah Bay for the winter months at a cost of $1.4 million annually. During the 2005-2006 winter storm season, the tug responded to three requests for emergency assistance from vessels in distress.
2. **Chemical action plans.** Ecology adopted a PBT rule in January 2005 that included a list of target chemicals, ways to update the list and procedures for developing chemical action plans such as:

PHOTO: Neah Bay rescue tug. | Ecology.

Complying with environmental laws

The State Department of Ecology ensures that individuals and businesses comply with pollution laws. If people do not, Ecology first tries education and technical assistance, and then can levy fines and take enforcement actions to ensure compliance. Ecology's 2005 Enforcement Report shows that the number of enforcement actions has remained fairly constant at about 537 per year.

In the last few years, Ecology has offered violators "innovative settlements" as a way to make retribution for violations. These settlements, intended to benefit the community where the violation took place, could include pollution prevention work, environmental restoration, monitoring or public awareness projects.

For example, Glacier Bay Catamarans in Monroe used $22,200 of its $39,000 penalty to conduct projects to reduce waste. Among other things, the company sponsored a free environmental seminar for fiberglass-reinforced plastics manufacturers in 2005, which explored environmental challenges in the industry and helped generate ideas for solutions.

Read the full enforcement report at www.ecy.wa.gov/pubs/0601004.pdf.

Mercury chemical action plan

Ecology and DOH continued to implement a chemical action plan for mercury, working with a variety of partners. Selected results include:

- *Automotive sources:* To date, the state's automobile recyclers have kept 26 pounds of mercury from being released into the environment by removing 12,000 mercury switches from scrapped vehicles. Ecology expects about 450 pounds of mercury each year will be captured by this program
- *Dental sources:* A partnership with Washington Dental Association resulted in nearly a 90-percent reduction of amalgam waste discharges each year (about 400 pounds of mercury). Most state dentists installed amalgam separators by the end of 2005.

PBDE chemical action plan

- In January 2006, Ecology and DOH, using input from key stakeholders, developed a chemical action plan for PBDEs. It is too early to report on trend information.

3. **Reissue NPDES permits for industrial and municipal wastewater facilities.** Between July 2004 and June 2006, Ecology reissued 96 individual NPDES permits for discharges from industrial or municipal facilities in the Puget Sound basin. Eighty-two of these were for facilities other than public wastewater treatment plants. We do not know whether these actions reduced pollutants to the Sound.

4. **Increase the amount of reclaimed water.** In early 2006, Ecology issued a permit for a reclaimed water plant under construction by the LOTT partnership, which is the municipal wastewater utility for the cities of Lacey, Olympia, Tumwater and Thurston County. The facility will have an initial reclaimed water capacity of two million gallons per day (mgd) with a future capacity of five mgd.

5. **Waste pesticide collection and pollution prevention.** From July 2004 to June 2005, the Washington Department of Agriculture (Agriculture) collected 45,000 pounds of waste pesticides and disposed of them properly. In 2006, Washington State University Cooperative Extension (WSU Extension) trained 3,328 people in the proper use and handling of pesticides.

6. **Improve measures to prevent oil spills.** Actions taken by Ecology include:
   - Adopted two oil transfer rules with better safeguards for facilities and vessels. Ecology also adopted new contingency rules for oil spills intended to strengthen contingency planning.
   - Obtained access to infrared aerial surveillance systems for use under low-light conditions to monitor oil in the water.
   - Began an inventory of response equipment and personnel available to assist its staff in monitoring and responding to oil spills.
   - Boarded and inspected 373 ships calling in Puget Sound in 2006.
   - Responded to 247 chemical and hazardous material-related incidents and 978 petroleum-related incidents from July 2004 through June 2006.

Additional actions taken to address toxic contamination

- In 2006, the Washington State Legislature passed a law requiring manufacturers of electronic products containing PBDEs and other harmful chemicals to provide convenient recycling services throughout the state by January 1, 2009. The "e-waste" products covered are personal computers, monitors and televisions.

- In October 2006, Ecology issued and ConocoPhillips agreed to pay a $540,000 fine for the 2004 Dalco Passage oil spill. The fine was the maximum penalty possible under state law, and the largest fine ever issued by Ecology for a spill in marine waters. The penalty proceeds will help pay future state spill response costs and also support the rescue tug at Neah Bay.

Action needed on
TOXIC CONTAMINATION

Even as we continue to clean up areas contaminated by past practices, current toxics released into the Sound add a significant threat to our area's long-term health. ***Without significant changes in our policies and our actions, the cumulative effects of toxic contamination will increase*** in the years ahead, especially as our population grows and development increases.

Also, there are new contaminants of concern coming to light. These include a host of largely unstudied pharmaceuticals (Prozac, Viagra, synthetic hormones, etc.) and personal care products (deodorants, nail polish, fragrances, etc.). These new chemicals are passing through us, into our sewage treatment plants and ultimately into Puget Sound.

To address continuing toxic contamination, we need to:

- **Focus on prevention.** Through product bans, substitutions, and better handling and disposal practices, we can help remove toxics from domestic and industrial wastewater before it gets to treatment plants.
- **Get rid of the most dangerous substances first—PBTs.** We need to move beyond a chemical-by-chemical strategy. Phasing out PBTs requires new policy and regulatory tools, such as product labeling, stronger incentives and accelerated innovation.
- **Further reduce the levels of toxics.** By using advanced treatment methods and water reclamation, we can reduce the levels of toxics discharged by wastewater treatment plants and industrial outfalls. And, through a mixture of source controls and targeted retrofits, we can reduce the levels of toxics flowing through urban stormwater systems.
- **Finish clean up.** We need to clean up all highly contaminated sites.
- **Continue to improve our knowledge.** It is critical that we understand where toxics enter the system, in what quantities and with what effect, so we can continue to improve our control actions.

PHOTOS: Busy Seattle waterfront. | Shutterstock.com/Jo Ann Snover; (opposite page) Refinery near Anacortes, with a view of Mt. Baker. | Shutterstock.com/Natalia Bratslavsky.

Federal toxics control system is inadequate

According to a recent U.S. Government Accounting Office report, more than 700 new chemicals are introduced every year—flame retardants, pesticides, additives to plastics manufacturing and pharmaceuticals to name a few. The report concluded that current government practices do not adequately assess the risks of these chemicals before they enter the marketplace. The use of these chemicals and their release into the environment pose serious threats to Puget Sound and human health.

NATALIA BRATSLAVSKY

POLLUTION FROM HUMAN AND ANIMAL WASTE

Our waters are vulnerable to pollution that comes from an array of human and animal waste sources including sewage treatment plants, septic systems, agricultural and landscaping practices, ship/boater discharges and wildlife. Nutrients and pathogens are some of the pollutants coming from these sources.

Excess nutrients—and the carbon, nitrogen and phosphorus they contain—can disrupt the functions of a healthy ecosystem. For example, nitrogen-enriched marine waters can accelerate the growth of phytoplankton, which in turn reduces the concentration of dissolved oxygen, causing aquatic organisms to suffocate. Hood Canal's oxygen problems are an example of this cycle. Nutrients can come from human and animal wastes as well as from a variety of other natural and human sources such as fertilizers.

Pathogens, such as viruses, some bacteria and parasites, may make people and wildlife sick, and cause us to limit our normal contact with the environment in order to avoid exposure. Pathogen pollution can seriously affect shellfish harvest and restrict recreational activities, such as swimming. In the Puget Sound region, human and animal wastes are the source of most pathogens.

RAE A. MCNALLY


JASON OSBORNE

INDICATOR: SAFE SWIMMING BEACHES

In 2004, Ecology and DOH teamed up to collect annual data on swimming beaches around Puget Sound, allowing us to monitor the status and trend of this indicator for future reports.

STATUS

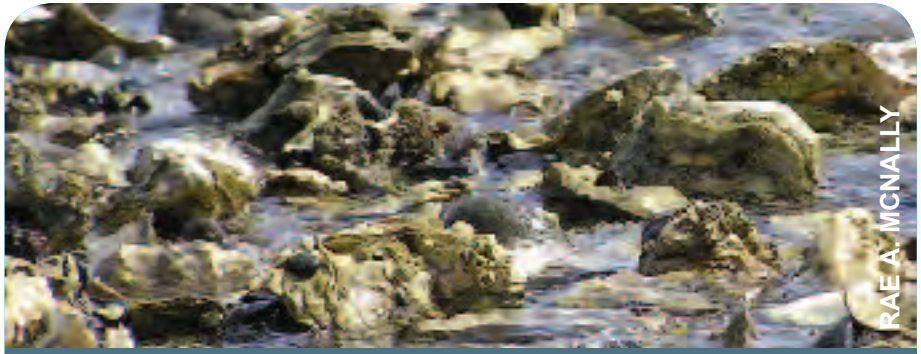
In 2005, levels of enterococci bacteria exceeded state water quality standards at 24 of the 65 recreational swimming beaches monitored under the state beach program. Seven beaches had multiple violations. This represented a 12-percent decrease over 2004 when 28 of 66 beaches exceeded the enterococci bacterial standards at least once during the summer season. In 2004, 10 beaches had multiple violations.

TRENDS

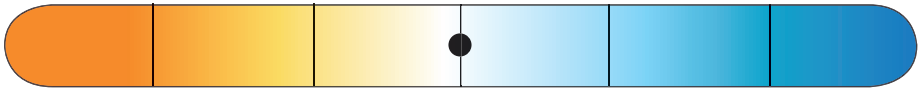
Not enough time has elapsed to establish a trend. Ongoing monitoring and reporting will show trends in the future.


VLADIMIR IVONOV

PHOTOS: Swimming lesson in open water. | Shutterstock.com/Vladimir Ivonov; (indicator) Family on beach. | Shutterstock.com/Jason Osborne; (opposite page) A man shovels pet waste while his dog plays. | Rae A. McNally.



INDICATOR: SAFE, EDIBLE SHELLFISH



Shellfish such as clams, oysters and other bivalves filter large quantities of water. For this reason, shellfish can accumulate bacteria, viruses or other harmful pathogens from the water. If contaminated shellfish are eaten, they can cause severe illness in humans. Shellfish growing areas require constant monitoring to ensure the waters are clean so these areas can remain open for harvesting.

STATUS

In 2005, nearly one-third of the Sound's shellfish growing areas had high enough levels of fecal coliform bacterial pollution to restrict harvest. Commercial growing areas with the highest percentage of polluted waters included Henderson Inlet, Filucy Bay, Dungeness Bay and Drayton Harbor.

In summer 2006, extensive areas of the Sound were temporarily closed to harvest when *Vibrio parahaemolyticus*, a naturally occurring bacterium, was found in concentrations harmful to humans. But this is not unusual. Every year, areas are closed because of harmful algal blooms that can cause serious illness and even death.

TRENDS

- Soundwide monitoring at more than 1,300 sampling stations in shellfish growing areas indicates that overall levels of fecal coliform bacterial pollution remained relatively stable between 1998 and 2005.
- Shellfish areas with at least one sampling station threatened with closure because of fecal pollution increased from nine in 1997 to a peak of 20 in 2005. A total of 36 shellfish areas were listed as threatened at least once during the 10-year period between 1997 and 2006.

FIGURE 5-15 **Commercial shellfish growing area closures**

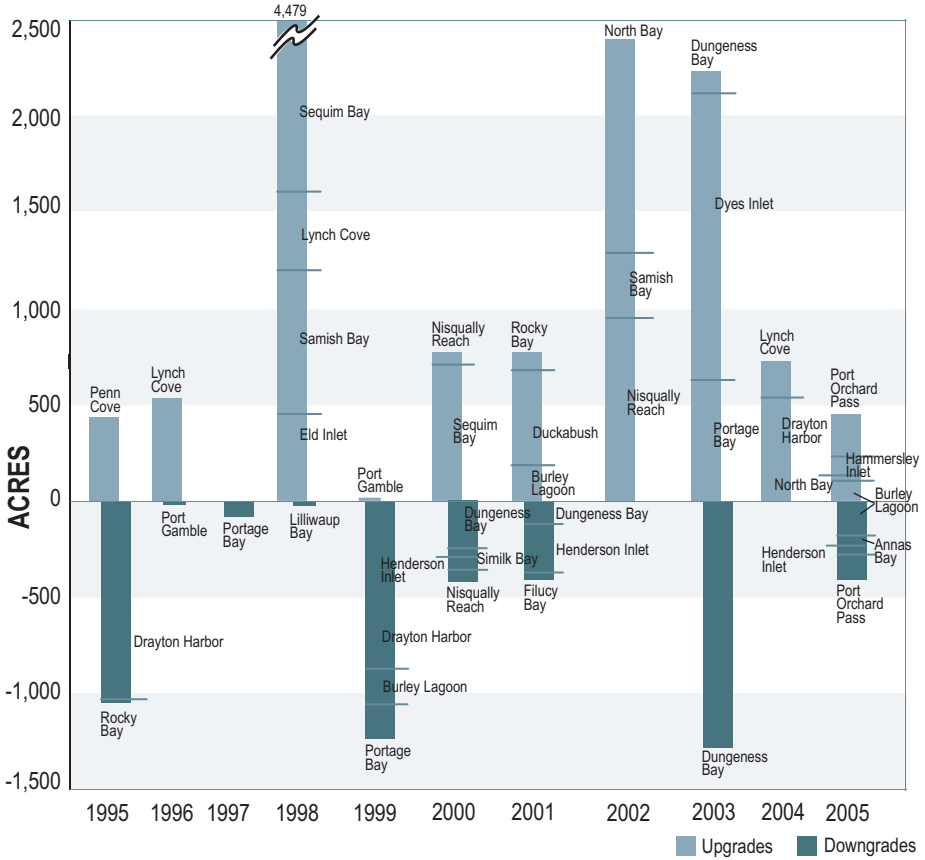


FIGURE 5-15: From 1995 to 2005, the Department of Health reclassified more than 20 commercial shellfish growing areas in Puget Sound. Improved water quality allowed 12,617 acres to be upgraded, while increasing bacterial contamination caused 5,218 acres to be downgraded.
Source: Action Team; DOH.

PHOTOS: Tubes used for growing geoducks in Samish Bay. | Taylor Shellfish Farms; (indicator) Shellfish in Hood Canal exposed by the low tide. | Rae A. McNally

FIGURE 5-16 **Commercial shellfish growing areas closed to harvest in Puget Sound since 1980**

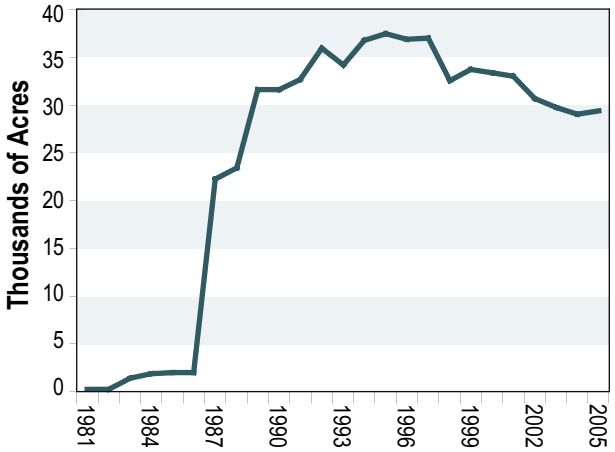
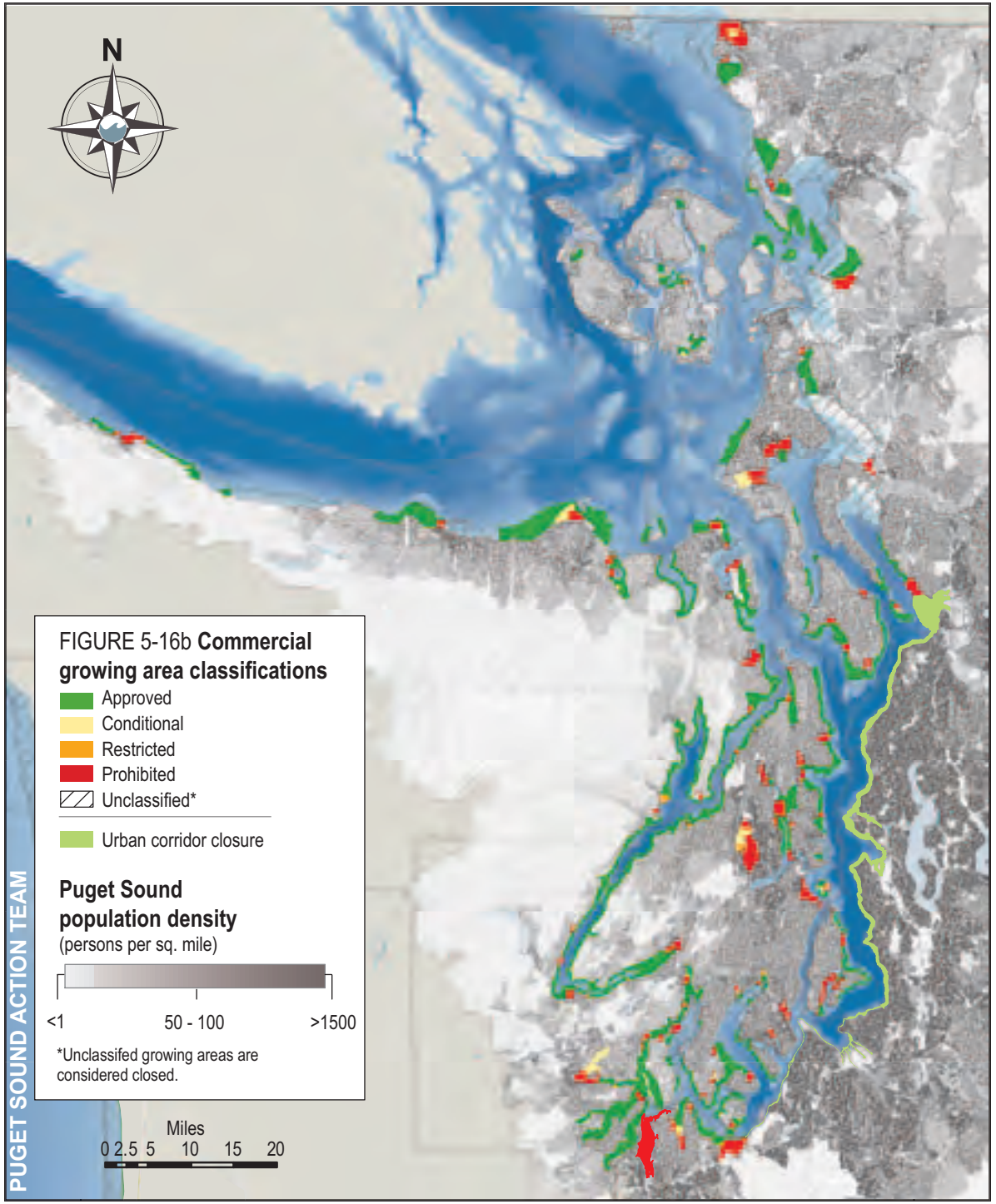


FIGURE 5-16: 30,000 acres of commercial growing areas remained closed in 2005 due to water pollution. *Source: Action Team; DOH.*

FIGURE 5-16b: Population threatens shellfish harvesting in Puget Sound. Densely populated areas are generally unsuitable for shellfish harvesting, including the urbanized corridor from Tacoma to Everett, while more rural areas tend to have better water quality for shellfish harvesting. Closures over the past 25 years have reduced the area available for commercial shellfish harvesting in Puget Sound by nearly 30,000 acres.
Source: Action Team, DOH, U.S. Census Bureau, State of Washington Office of Financial Management



The Action Team's work on

POLLUTION FROM HUMAN AND ANIMAL WASTE

What we said we would do

1. Improve water quality to restore and upgrade the classification of 1,000 acres of tidelands for shellfish growing and harvesting.

2. Submit water cleanup plans to EPA for water bodies impaired by fecal coliform bacteria pollution and nutrient and pathogen pollution, and implement those plans.

3. Improve the management of onsite sewage treatment systems.

4. Reduce animal waste pollution in the Sound.

5. Initiate corrective actions in Hood Canal to address low levels of dissolved oxygen. (**See sidebar on page 45**.)

What's been done

1. **Restoring water quality for shellfish harvesting.**
   - There was an increase of 1,195 acres of shellfish growing areas upgraded for harvest in 2004-2006. Plans to correct water quality problems inhibiting harvest were carried out in numerous shellfish growing areas including Henderson Inlet, Nisqually Reach, Filucy Bay, Burley Lagoon, Lower Hood Canal, Oakland Bay, Dyes Inlet, Dungeness Bay, Portage Bay and Drayton Harbor.
   - The nonprofit Puget Sound Restoration Fund (PSRF), the University of Washington Sea Grant Program (Sea Grant) and other organizations promoted community shellfish farming in Drayton Harbor and elsewhere, and created the Henderson Inlet community shellfish farm.
   - Using local volunteers, the Jefferson County Marine Resources Committee and WSU Extension Jefferson County seeded more than 200,000 Olympia oysters in Discovery Bay.

2. **Water quality improvement plans.**
   Ecology developed formal plans to improve water quality in cooperation with local governments, tribal governments and citizens. Plans were completed for Stillaguamish River, Portage Creek, Issaquah Creek Basin, South Prairie Creek and Dungeness Bay. Work is underway on plans for Samish Bay and Oakland Bay-Hammersley Inlet and tributaries.

   Ecology completed studies as precursors to formal plans for Stillaguamish River Watershed, Nisqually River Basin, Sinclair-Dyes Inlet Watershed, Henderson Inlet Watershed, and tributary streams of Totten, Eld and Little Skookum inlets.

3. **Improving management of septic systems.**
   - The State Board of Health adopted new rules governing septic systems (aka onsite sewage systems), requiring Puget Sound's 12 local health authorities to develop enhanced management programs. The programs will include an inventory of systems, an evaluation of areas where septic systems pose a risk to public health, and select regulatory and non-regulatory strategies to minimize impact.
   - The Legislature added to this rule by passing a law requiring health authorities to designate "marine recovery areas." Once designated, actions must be taken to find and fix malfunctioning septic systems in these areas.
   - The Legislature earmarked $7 million for loans and grants to help septic owners fix faulty systems, and $500,000 to help local health agencies administer loan and grant programs. Seven counties in the Puget Sound area have applied to Ecology to use these funds for local programs. Funds are scheduled to be disbursed in early 2007.

PHOTOS (top to bottom): Dog waste litter bin. | Shutterstock.com/Susan MacKenzie; Portable toilets. | Shutterstock.com/Tiburon Studios.

Hood Canal fish kills and the Action Team's response

In September 2006, extremely low dissolved oxygen levels caused widespread fish kills in southern Hood Canal.

Scientists, divers and citizens reported that more than 30 species of fish suffered losses, including large lingcod, rockfish, several types of perch, wolf eel, sculpins, flatfish and sand lance. The conditions were also hard on crustaceans—observers found dead spot prawns, rock crabs and Dungeness crabs.

When low dissolved oxygen levels caused fish kills in 2002 and 2003, scientists and resource managers increased their efforts to better understand and address the complex, dynamic forces at work in Hood Canal. Action Team partners and others formed the Hood Canal Dissolved Oxygen Program (HCDOP), made up of federal, state and local government agencies, tribal governments, university scientists, educators, environmental organizations and individual citizens.

HCDOP coordinates efforts to improve water quality in Hood Canal, educates the public, and conducts scientific studies, computer modeling and field monitoring to better identify the causes so that corrective actions can be taken.

In 2005, the Legislature and Governor Gregoire authorized an additional $20 million for corrective actions in the Hood Canal area. State, federal and local resources collaborated on a number of projects including:

- Improving wastewater treatment. Design of new sewage systems is underway from Hoodsport to the Skokomish Reservation and for the city of Belfair. In addition, wastewater improvement projects began in every state park on Hood Canal.
- Improving management of septic systems. Shoreline surveys to identify sources of bacterial and nitrogen contamination were conducted by health agencies in Jefferson, Mason and Kitsap counties.
- Testing new technologies to reduce nitrogen pollution in sewage systems. Demonstration units were installed and testing begun, with results expected in 2007.
- Ending chum carcass disposal in Hood Canal. The Skokomish Tribe led an effort to keep hundreds of thousands of pounds of organic fish matter out of the canal.
- New controls for animal manure. The Conservation Commission and Mason Conservation District began developing plans to construct a biogas digester to process manure into electricity.
- Improving the state of science on Hood Canal. HCDOP's Integrated Assessment and Modeling project, a three-year study, will use marine animal and plant data and computer modeling to provide needed scientific information about the causes of the low oxygen problem in the canal. The model will be completed in 2007.

WAYNE PALSSON

PHOTO: Dead lingcod washed up on Hood Canal shores in September 2006 during a period of low dissolved oxygen. | Wayne Palsson, WDFW.

- The Legislature provided nearly $21 million to improve sewage facilities at Puget Sound state parks. Some of these projects will bring substantial improvements to septic or onsite sewage systems or to connect parks to adjacent community treatment facilities.

4. **Reducing animal waste pollution into the Sound.** Puget Sound's 12 conservation districts contacted 229,974 private landowners who keep livestock or have streamside property. As a result:
   - 822 landowners initiated conservation plans and practices.
   - 81 conservation plans were completed.
   - 389 best management practices (BMPs) were implemented.
   - 3,675 acres no longer contribute to water pollution.
   - 17.5 stream miles were protected, enhanced or restored.
   - $321,491 in outside funds were leveraged by these grants.

In 2005, the Washington State Parks and Recreation Commission (State Parks) installed three new boater pumpout stations to collect boater waste, raising the total number of stations in Puget Sound to 186. In 2005, the stations prevented an estimated 2.9 million gallons of untreated waste from entering Puget Sound. In addition, all state parks on Puget Sound now offer pet waste bags to visitors, a program initiated in 2001. In 2005, 13,500 bags were handed out.

ALLEN FURMANS

PHOTOS: (top to bottom) A septic system undergoes a retrofit. | Jill Williams; A sailor pumps waste from his boat. | Toni Droscher; (opposite page) Cruise ship leaving Seattle. | Shutterstock.com/Allen Furmans.

Action needed on

POLLUTION FROM HUMAN AND ANIMAL WASTE

Municipal sewage treatment plants are key sources of nutrients and pathogens. Although plant upgrades have dramatically lowered the concentration of many conventional pollutants discharged into the Sound, higher discharge volumes generated by a growing population have offset some of these gains. In addition, nutrients are not currently controlled by most of these plants because the wastewater treatment methods were not designed for this purpose.

Septic systems continue to be a key challenge. Residents living outside urban areas are served by an estimated one-half-million onsite sewage systems that can contaminate Puget Sound and its freshwater streams if they are not maintained properly to prevent leakages and failures.

Dramatic increases in cruise ship traffic raise important questions about the impact of their wastewater discharges and treatment methods. There is also growing concern about discharges from the nearly 180,000 registered boats in the region.

Agricultural practices are an additional source of nutrients and pathogens in Puget Sound. Although great progress has been made in farm practices, more care is needed to protect water quality. Fertilizers from landscaping and forest practices can also add nutrient pollution to the Sound.

Addressing these myriad sources of nutrients and pathogens will require concerted and sustained action and focus. We need to:

- **Upgrade wastewater treatment.** We need to upgrade treatment technology and move rapidly toward wastewater reclamation and reuse in Puget Sound. This will take new policy development and increased investment.
- **Continue to improve management of septics.** New rules and laws passed in 2005-2006 should improve oversight and management of septic systems, but many local jurisdictions lack the funding and trained staff to fully implement the regulations.
- **Establish standards for nitrogen.** Until Hood Canal's problems surfaced five years ago, we did not focus on nitrogen as a pollutant of concern in Puget Sound. We need to determine safe discharge levels for nitrogen.
- **Pay greater attention to vessel discharges.** The increase in cruise ship and recreational boat traffic may lead to establishing no-discharge zones. We also need more boat sewage pumpout facilities throughout the region.
- **Continue to improve agricultural and landscaping practices.** Improvements in this area will help prevent releases of nutrients and pathogens.
- **Continue to improve our knowledge.** We need to better understand where nutrients and pathogens enter the system, in what quantities and with what effect, so we can continually improve our control actions.

STORMWATER RUNOFF

Stormwater runoff presents a high risk to the health of Puget Sound by causing two major problems. First, stormwater transports a mixture of pollutants from roads, parking lots, lawns and other developed lands to the Sound, degrading water quality and harming or even killing species.

Pollutants include petroleum products and heavy metals from vehicles and industries, fertilizers and pesticides from homes and farms, animal wastes, and sediment from construction sites. In many areas that have separate storm-sewer systems, stormwater receives minimal treatment, if any, before being discharged directly into the Sound. In areas with combined sanitary and storm sewers, a mixture of stormwater and raw sewage can be discharged into the Sound during heavy rainstorms.

Second, during the wet season, the volume, peak flow and duration of runoff increase dramatically. These high volumes undercut and erode stream banks, widen stream channels, deposit excessive sediment, and alter natural stream and wetland processes. These effects can greatly change, if not damage, fish and wildlife habitat.

Local examples of the ill effects from stormwater

The Department of Ecology identifies stormwater as the leading contributor to water pollution in our urban waterways. Local examples of the ill effects from stormwater include:

- After years of costly Superfund cleanup efforts, the Thea Foss Waterway is becoming recontaminated by phthalates (generated from plastics, some adhesives and paints) that are transported in stormwater from downtown Tacoma. Studies have shown that phthalates have hormonal effects in animals.
- Largely because of stormwater runoff, shellfish harvest is restricted at numerous shellfish growing areas including North Dyes Inlet, North Bay and lower Hood Canal.
- Stormwater runoff is a limiting factor for the recovery of two species of salmon and bull trout under the Federal Endangered Species Act.
- National Oceanic and Atmospheric Administration (NOAA Fisheries) scientists discovered that 25 to 90 percent of otherwise healthy coho salmon died within hours after entering several urban creeks in the Seattle area. The weight of evidence suggests that adult coho, which enter small urban streams following fall storm events, are acutely sensitive to nonpoint source stormwater runoff containing pollutants that typically originate from urban and residential land-use activities.

INDICATOR: IMPERVIOUS SURFACE CHANGES

When native Pacific Northwest forests and prairies are replaced by rooftops, roads and parking lots, stormwater runoff increases dramatically. Researchers estimate that runoff from a one-acre parking lot is about 16 times greater than runoff from an undeveloped meadow of the same size.

Not only is flow increased, so too is contamination. Impervious surfaces are repositories for numerous pollutants such as oil and grease, gas residue, metals, nutrients and pathogens, sediment and other toxic compounds. As impervious surfaces get larger and interconnect, they provide excellent pathways to transport pollutants and increased flows to our region's streams, rivers, bays and wetlands. Stormwater controls help remove pollutants and control storm flows, but to date, they have proven inadequate to fully protect salmon, shellfish harvesting and other water resources from the many effects caused by land-cover changes and development.

PHOTOS: (top to bottom) Thurston County "No Dumping! Drains to Bay sign." | Tim Ransom; Rain soaked Interstate 5. | Rae A. McNally; (indicator) New housing development off Yelm Highway in Thurston County. | Rae A. McNally; (opposite page) Storm drain. | Shutterstock.com.

STATUS

In 2001, impervious surfaces covered 3.3 percent of the Puget Sound region. In areas below 1,000 feet elevation, impervious surfaces measured 7.3 percent.

TRENDS

The enhanced images (**Figure 6-17–next page**) show that between 1991 and 2001, impervious surfaces increased 10.4 percent regionwide (43 square miles). Some watersheds saw even greater increases in impervious surface: a 15.7 percent increase in Snohomish, a 13.4 percent increase in Deschutes and a 12.3 percent increase in Puyallup-White. This relatively short analysis of changes in land use shows that forest cover is decreasing and impervious surface is increasing throughout the region. These landscape changes are more pronounced in some watersheds than others. The extent of forest cover and impervious surface has a significant impact on our ability to protect natural water bodies from the negative effects of stormwater runoff and land development.

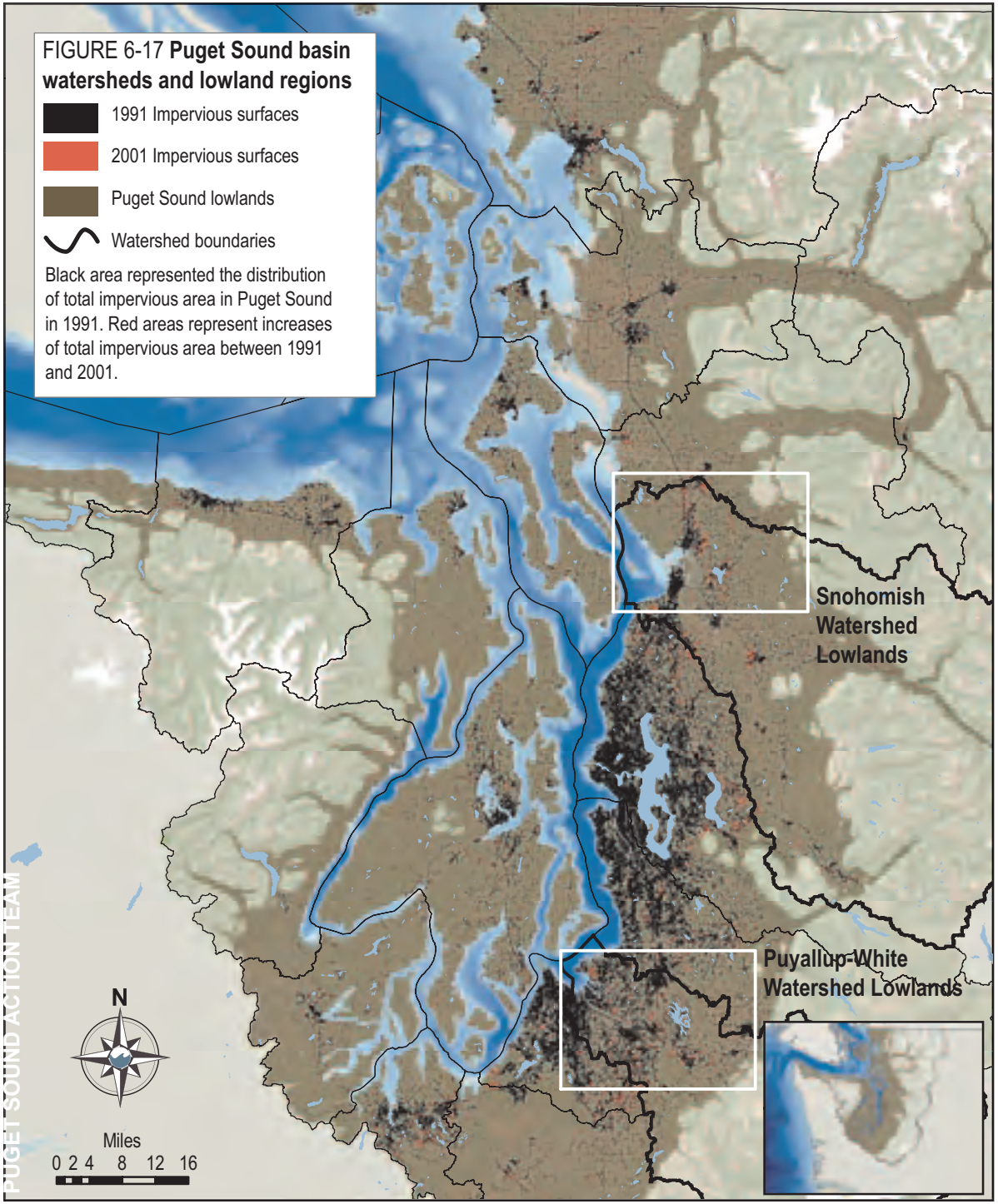
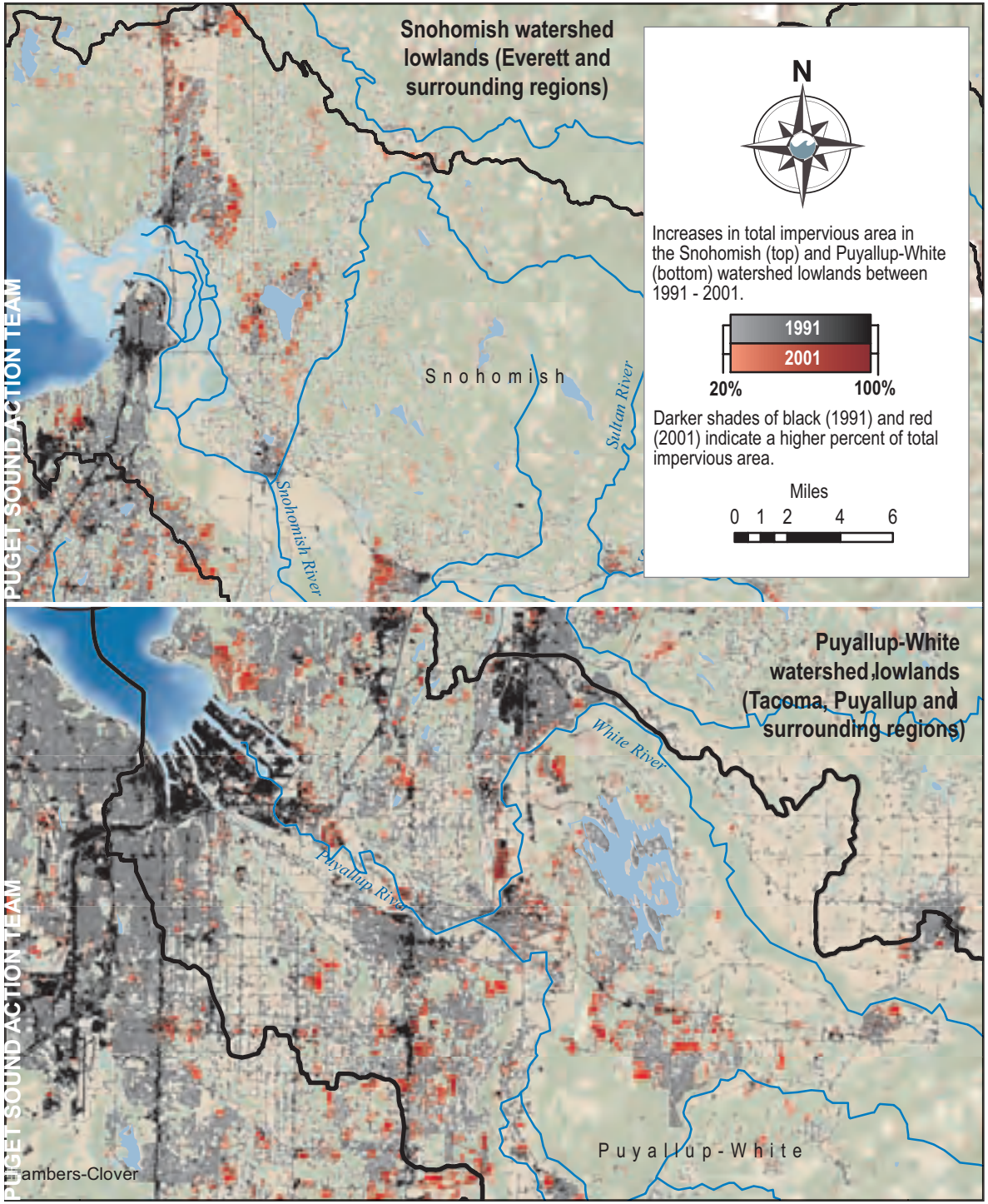


PHOTO: Congested downtown Seattle freeway. | Shutterstock.com/Natalia Bratslavsky.

FIGURE 6-17: (maps left and right) Total impervious surface in the Puget Sound basin in 1991 was an estimated 417 square miles or three percent of the basin (shown in black). By 2001 that area had increased 10.4 percent (43 square miles) shown in red. Most all of the impervious surface is found in lowland areas (elevations below 1,000 feet, shown in dark green).

The Snohomish (upper map, at right) and the Puyallup-White (lower map, at right) watersheds are two of the faster growing watersheds in the region, with impervious surface increasing 15.7 percent and 12.3 percent respectively for the years 1991 to 2001. Red areas of the inset maps show where impervious surface has increased. During this time, the Snohomish watershed grew by 42 percent, and Snohomish County (of which the Snohomish watershed is part) is projected to grow another 53 percent by 2025. The Puyallup-White watershed grew by 25 percent, and Pierce County (of which the Puyallup-White watershed is part) is projected to grow 34 percent by 2025.
Source: Action Team; Ecology; Sanborn Mapping Solutions.



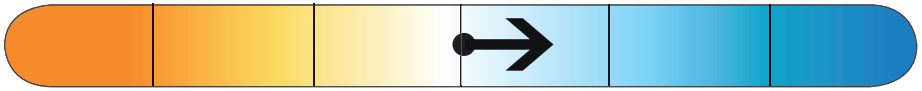
PHOTOS: (top to bottom) Development in Port Ludlow, Jefferson County. | Toni Droscher; Water over roadway. | Harriet Beale.

WANT TO KNOW MORE?

about alternatives to shoreline armoring in Puget Sound?

In September 2006, the Action Team produced the *Alternative Shoreline Stabilization Project Report*. It can be found at www.psat.wa.gov/shorelinereport.

INDICATOR: LOCAL GOVERNMENT STORMWATER MANAGEMENT PROGRAMS



PHOTOS: A homeowner in front of his home in the LID pilot project in Sumner. | Kathy Taylor; (indicator) Sign for Sumner Low Impact Development Pilot Project. | Kathy Taylor.

The majority of development within the Puget Sound basin occurs on lands over which cities, towns and counties have jurisdiction. Local municipalities review development proposals, issue permits, inspect construction sites, maintain systems, provide education and monitor resources.

Local governments are on the frontline of managing stormwater runoff in the region. Because of this, the Action Team's *Puget Sound Water Quality Management Plan* has called for local municipalities to develop and carry out stormwater management programs since 1987.

STATUS

In spring 2004, Action Team staff, in partnership with the Association of Washington Cities, surveyed 72 Puget Sound cities and towns and nine counties. Thirty-three cities and towns and five counties responded, representing a response rate of 47 percent.

Overall, 82 percent of municipalities were carrying out at least half of the elements of an effective local stormwater program. However, only 37 percent were carrying out at least 75 percent of the elements. Key findings included:

- All jurisdictions review development site plans to ensure stormwater controls are adequate and consistent with local requirements.
- 91 percent of these jurisdictions had ordinances that require construction-site BMPs.
- 53 percent use Ecology's 2001 stormwater manual for construction-site BMPs. Another 30 percent use the 1998 King County manual.
- 95 percent regularly inspect construction sites to ensure appropriate BMPs are in place.
- 47 percent use Ecology's 2001 manual or a local equivalent for permanent (post-construction) BMPs. A total of 53 percent still use the older 1992 version or a local equivalent.
- 34 percent had adopted or revised ordinances to allow for low impact development (LID).
- 71 percent had a process in place to identify and prioritize existing stormwater problems.
- 55 percent provide substantive public education and involvement to address these issues in their communities.
- 42 percent monitor stream flow and receiving waters.
- 84 percent have stormwater utilities. Most rely on more than one funding source.

Progress is substantial but there are still shortcomings. The greatest deficiencies were in adopting the 2001 Ecology manual or a local equivalent, integrating LID into local ordinances, using integrated pest management strategies and providing environmental monitoring.

TRENDS

The trend is based on analysis of the survey results, the issuance of the Phase II Municipal Stormwater Permits, and other actions taken by local governments to address stormwater.

PHOTOS: (top to bottom) An improved "fish friendly" culvert helps manage increased stream flow due to stormwater runoff. | Rae A. McNally; Clearing land for a new housing development near Mud Bay, Thurston County. | Stuart Glasoe.

The Action Team's work on
STORMWATER RUNOFF

What we said we would do

1. Improve management of stormwater at the local level.
2. Reduce combined sewer and stormwater overflows.
3. Advance the use of LID stormwater practices in Puget Sound.
4. Improve management of stormwater from highways.

What's been done

1. Improve management of stormwater at the local level.

- Ecology updated and reissued a statewide stormwater management permit for general construction efforts, but it was appealed. Despite the appeal, the permit was in effect while the Pollution Control Hearings Board heard the appeal.
- In December 2006, Ecology issued a new stormwater management permit covering 76 smaller cities, towns and portions of counties in Puget Sound and smaller construction sites. This program will bring 80 percent of the region's population under significantly improved stormwater management.
- A stormwater management permit for the five most populous local governments was re-issued in December 2006.
- An updated stormwater permit for industrial uses is scheduled to be issued in September 2007.
- Staff from Ecology, the Action Team and other state agencies increased technical support, guidance, funding and outreach efforts to help cities, towns and counties meet the new permit requirements.
- In February 2005, Ecology issued an updated *Stormwater Management Manual for Western Washington* that includes credits for LID practices and state-of-the-art stormwater management standards. Cities and counties covered by the stormwater permits will be required to adopt the new manual by late 2008.

2. Reduce combined sewer overflows. A number of jurisdictions continue to work on reducing problems from combined storm and sewer systems:

- Three jurisdictions completed systems upgrades: Bellingham, Bremerton and Everett.
- Four jurisdictions approved plans for combined sewer overflow (CSO) reduction projects: Everett, Snohomish, Port Angeles and Mount Vernon.
- Four jurisdictions were in the process of evaluating alternatives, planning and design: Anacortes, King County Metro, Bellingham and Seattle.

3. Advance the use of LID.

- See the highlight box on the following page for recent LID activities.

4. Improving management of highway runoff.

- The Washington State Department of Transportation (WSDOT) improved stormwater facilities on Puget Sound highways by constructing 18 detention ponds, two detention vaults, 11 infiltration BMPs and 31 linear treatment facilities. WSDOT also upgraded two existing stormwater outfalls in Puget Sound.
- In 2005 and 2006, WSDOT provided erosion-control training to more than 500 employees. The Association of General Contractors provided erosion-control training to certify contractors working on all WSDOT projects.

Growing smarter: Low impact development

By 2025, the Puget Sound area is expected to increase by 1.4 million people who will all need places to live, roads to drive on and buildings in which to work. This growth will further impair water quality if we do not better manage stormwater runoff.

We need to grow smarter.

Low impact development (LID) practices can help lessen the effects of development on the Sound. In 2005 and 2006, the Puget Sound Action Team helped a number of local communities increase their use of LID practices.

- The Action Team helped 19 cities and counties expand their use of LID practices by recommending changes to local codes and standards. As of press time, Snohomish County and the cities of Marysville and Redmond adopted, or made significant progress on adopting new code language. Other local jurisdictions were evaluating changes to their local codes.
- Eleven other cities and counties independently adopted some form of LID standards into their codes.
- Ecology awarded $2.5 million in grants to 10 jurisdictions for LID projects around the Sound.
- Staff from the Action Team and WSU Extension Pierce County published the *Low Impact Development Technical Guidance Manual for Puget Sound* in January 2005, and distributed more than 2,500 copies. It is available online at: www.psat.wa.gov/Publications/LID_tech_manual05/lid_index.htm.
- Professional training classes, community education and realtor classes on LID were offered by staff from the Action Team, WSU Extension and the University of Washington (UW).
- WSU staff continued to monitor a residential subdivision project to test the performance of LID techniques used there.
- Snohomish County, Olympia and a number of other jurisdictions and developers built LID projects using a variety of techniques, such as bioretention (rain gardens), pervious pavement and compost-amended soils.
- Seattle Public Utilities expanded its award-winning Natural Drainage Systems program to include the High Point project in West Seattle.

TONI DROSCHER

PHOTOS: (top to bottom) Swales and no rolled curb with permeable concrete shoulder. | Curtis Hinman; Green roof on the Seminar 2 Building at the Evergreen State College. | Tom Holz; (opposite page) Homeowners in Port Townsend do their part to help the environment by collecting rain water (tall metal cylinder) and reducing pavement. | Toni Droscher.

Action needed on
STORMWATER RUNOFF

Stormwater pollution is the most ubiquitous of Puget Sound's pollution problems. It happens whenever rainfall exceeds the capacity of the land to absorb it. The problems of stormwater will likely be magnified by population growth.

Current development practices generally lead to a significant loss of forest cover and an increase in impervious surfaces, diverting more potentially polluted runoff directly into streams, rivers and Puget Sound. Land that is already developed often has inadequate, if any, stormwater controls in place. Our stormwater management efforts have so far proven inadequate to protect our water resources and habitats from harm.

Reducing the harm caused by stormwater runoff will require concerted, sustained action and focus. We need to:

- **Bring more of the region under effective stormwater management.** Newly issued stormwater permits will cover many urban areas of the Sound, a significant step forward. However, most unincorporated counties and some shoreline cities will still not be covered by permits. To ensure adequate stormwater management, all cities and counties within the region need to carry out effective management programs. Local governments will need increased financial resources and staff to accomplish this.

- **Improve stormwater runoff controls in existing developed areas.** Developed lands, especially those developed before 1990, often have inadequate stormwater controls. Coupled with dense populations, this means runoff can be highly contaminated. We need more attention and resources focused on stormwater systems maintenance, source control, education and system retrofits.

- **Improve how we develop the land.** Because most development projects use land-clearing practices, stormwater management techniques have not reduced the effects of stormwater from these sites. We need to accelerate innovative LID practices and other cost-effective solutions for new developments and retrofits.

- **Increase education efforts.** Elected officials, business owners and the general public need to better understand the problems caused by stormwater runoff, their role in helping to solve the problems and the need for additional effort and resources.

- **Continue to improve our knowledge.** We need to know more about the negative effects of stormwater and how to identify more effective solutions through a comprehensive regional monitoring program.

WANT TO KNOW MORE?

about the cost of stormwater damage in Puget Sound?
In August 2005, Action Team produced a report called *Damages and Costs of Stormwater Runoff in the Puget Sound Region*. The summary can be found at www.psat.wa.gov/stormwater.

STATE OF THE SOUND:

HABITAT

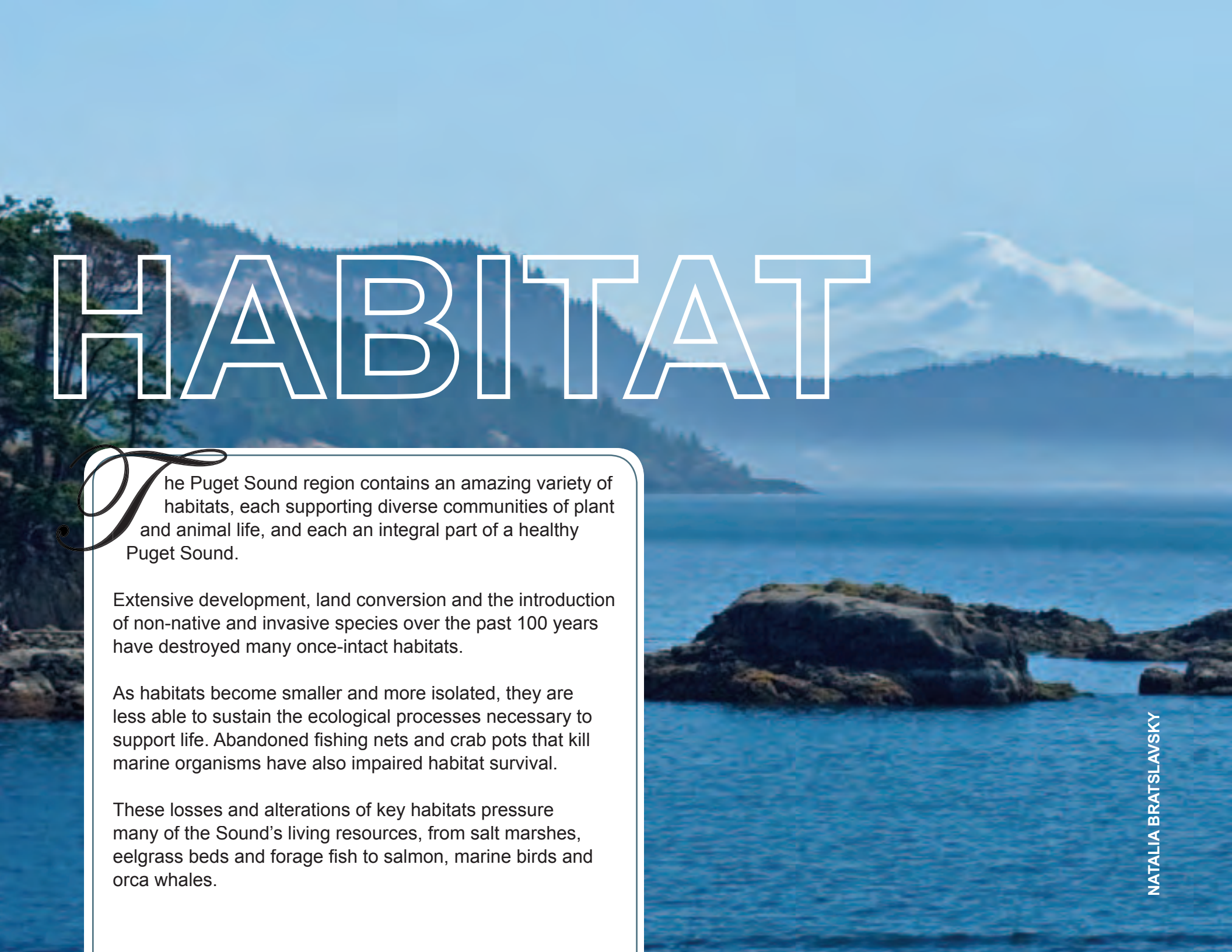
HABITAT

The Puget Sound region contains an amazing variety of habitats, each supporting diverse communities of plant and animal life, and each an integral part of a healthy Puget Sound.

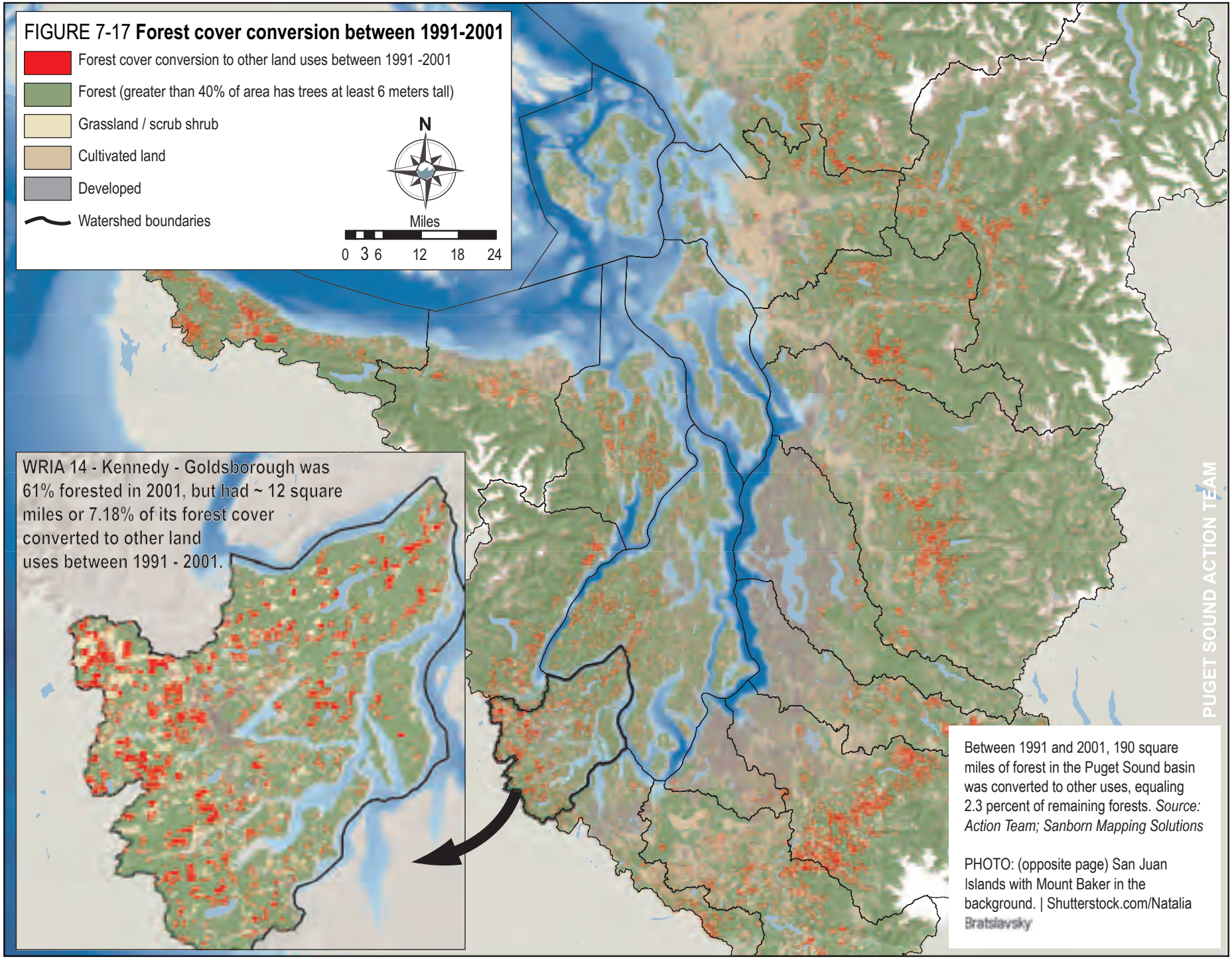
Extensive development, land conversion and the introduction of non-native and invasive species over the past 100 years have destroyed many once-intact habitats.

As habitats become smaller and more isolated, they are less able to sustain the ecological processes necessary to support life. Abandoned fishing nets and crab pots that kill marine organisms have also impaired habitat survival.

These losses and alterations of key habitats pressure many of the Sound's living resources, from salt marshes, eelgrass beds and forage fish to salmon, marine birds and orca whales.



NATALIA BRATSLAVSKY



Between 1991 and 2001, 190 square miles of forest in the Puget Sound basin was converted to other uses, equaling 2.3 percent of remaining forests. *Source: Action Team; Sanborn Mapping Solutions*

PHOTO: (opposite page) San Juan Islands with Mount Baker in the background. | Shutterstock.com/Natalia Bratslavsky

INDICATOR: LOWLAND HABITAT LOSS

The clean, cold streams and rivers flowing into Puget Sound provide critical habitat for many important freshwater and marine species. These waters depend on forests to provide shade, to keep the water cool, filter rain runoff, and provide nutrients and food sources for salmon and other aquatic species. Loss of forest habitat and forested corridors can dramatically impact river and stream systems and the species that depend on them.

STATUS

Surveys conducted in the 1930s indicate there were approximately 15.5 million acres of forest land in western Washington available for timber harvest. (This figure includes all of western Washington, not just the Puget Sound basin). By 2004, that acreage was cut nearly in half (eight million acres).

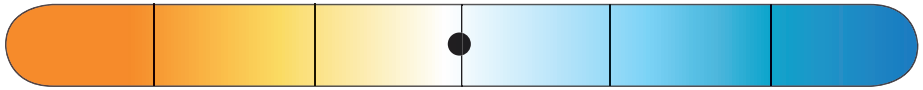
In 1991, there was an estimated 5.4 million acres of forest cover in the Puget Sound basin. In 2001, that figure had been reduced to 5.2 million acres, a loss of 200,000 acres.

TRENDS

To better understand the extent and rate of land cover changes, Ecology examined satellite images from 1991 to 2001. Scientists discovered that approximately 190 square miles of forest (about 2.3 percent of the total forested area of the Puget Sound basin) had been converted to other uses. Of the 19 watersheds mapped, five had lost half or more than half of their total forested area. Because sufficient forest cover is critical to ensuring watershed health, protecting or recovering aquatic resources in these watersheds may prove increasingly difficult.

In areas below 1,000 feet elevation, the change was more dramatic: 3.9 percent of total forest area was lost between 1991 and 2001 (see **Figure 7-17**). Some watersheds lost even more forest cover below 1,000 feet of elevation. The Nisqually watershed, for instance, lost 10 percent (19 square miles) of its forest area.

INDICATOR: EELGRASS



Eelgrass, the dominant seagrass in Washington, grows in tidelands and shallow waters along much of Puget Sound's shoreline. Despite its name, eelgrass is neither a grass nor a seaweed but a flowering plant that can live for years. It serves as a haven for many fish and wildlife species, providing them with food, breeding areas and protective nurseries. Because eelgrass habitat shelters and feeds so many species, it plays a critical role in the health of Puget Sound marine species.

The depth at which eelgrass grows in the water depends on the available light and water clarity, so its presence is a valuable indicator of estuarine health. Excess nutrients, sewage and algae in the water can reduce clarity while storms, runoff and dredging can stir up sediment, preventing light from penetrating. Boat wakes, propellers and docks can also disturb sensitive eelgrass beds.

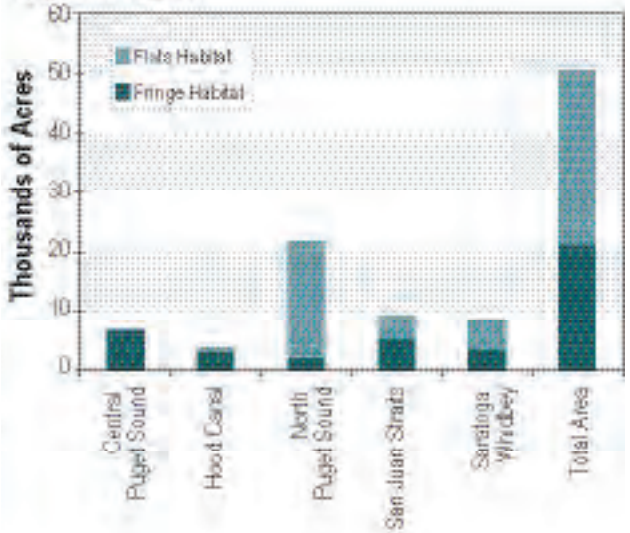
STATUS

In 2006, there were approximately 50,000 acres of eelgrass beds in Puget Sound. Nearly one third of that eelgrass grows in Padilla and Samish bays in northern Puget Sound, providing a unique habitat not found anywhere else in the Sound. Equally important are the smaller beds that support habitat diversity and provide valuable shoreline functions, especially for migrating salmon that travel to and from the ocean and their native streams.

TRENDS

DNR began monitoring the distribution of eelgrass along Puget Sound's shoreline in 2000. Between 2003 and 2004, eelgrass declined Soundwide by four percent, but since that time has remained unchanged. However, localized declines have taken place in Hood Canal, North Puget Sound, the Saratoga-Whidbey region and the San Juan archipelago. The greatest losses have been in Hood Canal between 2001 and 2004, ranging from one percent to 22 percent per year.

FIGURE 7-18 **Estimated native eelgrass by type and region**



PHOTOS: (opposite page indicators) Bellingham panoramic. | Shutterstock.com/L.Bakker; Eelgrass. | John Southard.

FIGURE 7-18b: (right) The Department of Natural Resources (DNR) conducts surveys every year to determine whether there have been any changes in the scope and extent of eelgrass. *Source: DNR*

Elwha River: The power of restoration

A century ago, the Elwha River on the Olympic Peninsula was one of the most productive salmon rivers in all of Puget Sound. But in 1913 and again in 1927, two dams were built on the river that blocked fish runs and trapped sediments and nutrients, dramatically altering the structure and composition of its delta, beaches and riparian zones.

In 2008, removal of the Elwha dams begins, opening up more than 70 miles of largely pristine salmon habitat. Once the dams are gone, scientists estimate that in 30 years salmon and steelhead populations will number about 390,000 fish—a near 100-fold increase—over the 4,000 salmon that currently spawn there. Work on removal of the Elwha dams is a joint effort of tribal, state and federal agencies.

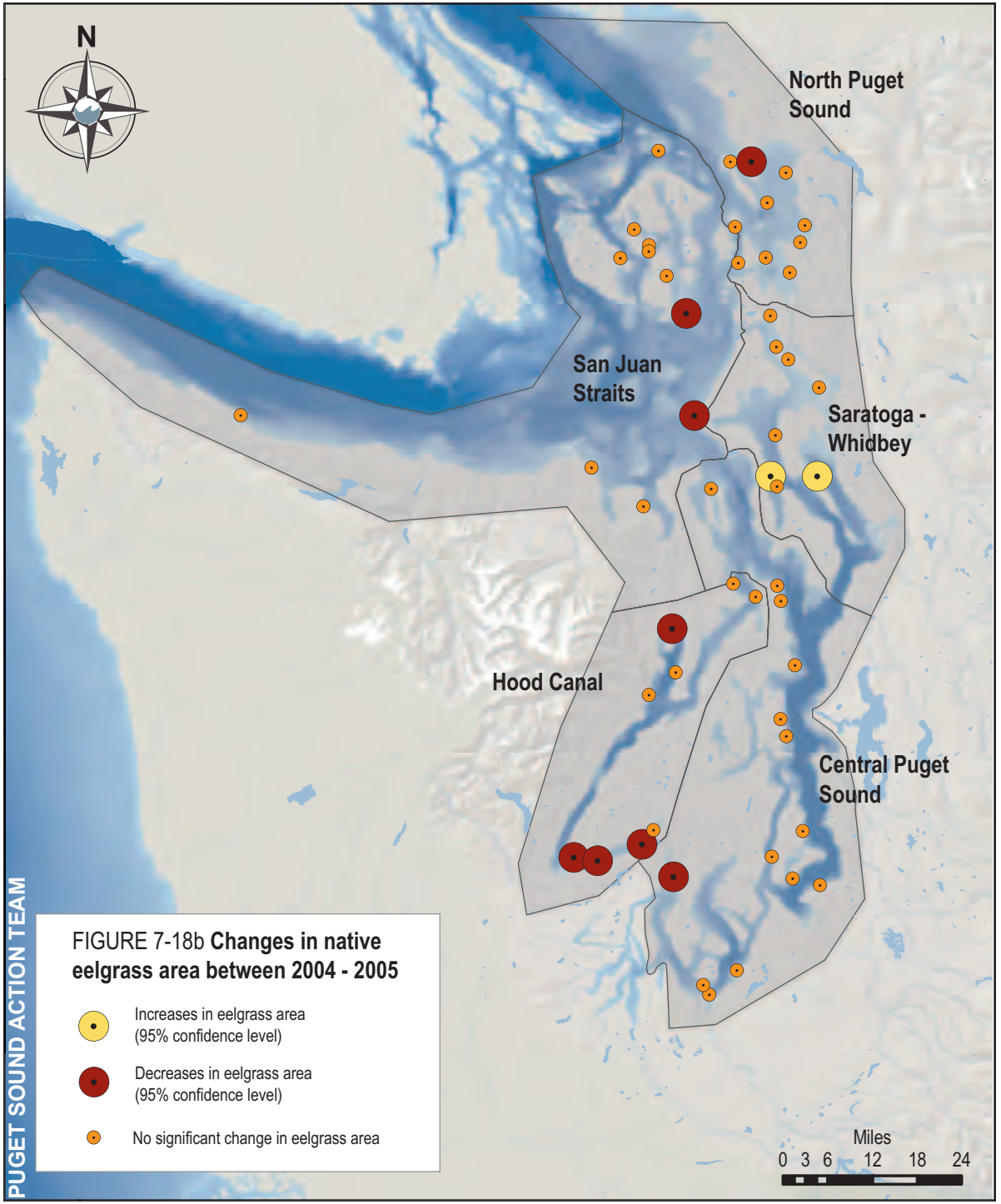
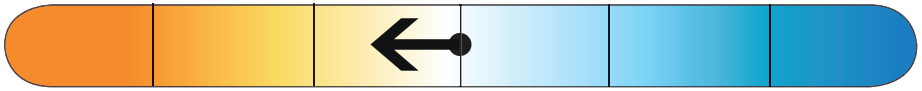


FIGURE 7-18b **Changes in native eelgrass area between 2004 - 2005**

INDICATOR: AQUATIC NUISANCE SPECIES



Puget Sound has become home to a number of non-native species. The most noxious of these are aquatic nuisance species (ANS), which can out-compete native species for habitat and food, altering the natural ecosystem. Two species of significant concern in Puget Sound are tunicates, commonly called sea squirts, and spartina, a type of salt marsh grass. Both multiply rapidly, which presents an ongoing challenge to controlling or removing them.

STATUS

Tunicates: The invasive tunicate *Didemnum* was first discovered in Puget Sound several years ago on a submerged wooden boat near Edmonds. Within months, the colony had multiplied threefold. In early 2006, divers surveyed and identified the invasive *Styela clava*, or club tunicates, on recreational vessels at four marinas: Blaine, Semiahmoo, Pleasant Harbor and Neah Bay. The divers found 156 vessels infested with tunicates.

Spartina: In 2004, spartina covered an estimated 645 acres in Puget Sound. In 2005, that figure dropped to 550 acres, and in 2006 dropped to 250 acres.

TRENDS

Tunicates: The tunicate *Ciona savignyi,* initially seen at one location in 2004, was found at eight marinas by 2006. It was also found in 19 out of 22 areas surveyed in the lower Hood Canal—a dramatic finding since this species was not found in that region a decade earlier.

Spartina: Since 2004, areas of Puget Sound covered by spartina have declined 40 percent to 440 acres. At the current rate of removal, agencies are on track to effectively eradicate spartina from Puget Sound by 2010.

FIGURE 7-19 **Spartina infestation in Puget Sound 1997-2006**

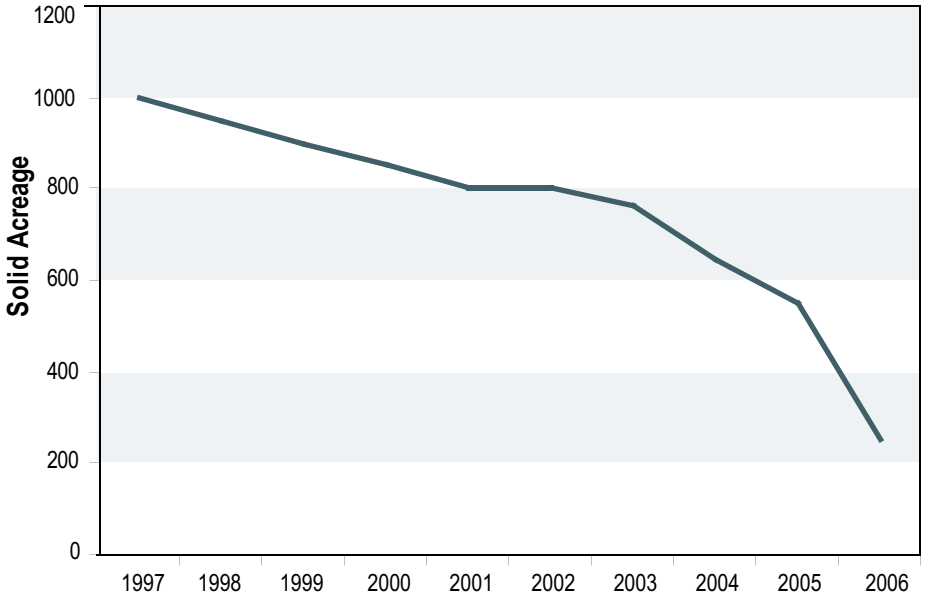


FIGURE 7-19: Since 2004, areas of Puget Sound covered by spartina have dropped from 645 acres to 250 acres. *Source: Agriculture.*

PHOTOS: Spartina at Lake Hancock (Whidbey Island). | Lisa Kaufman. (indicator) Club tunicate (*Styela clava*) discovered at Pleasant Harbor. | Simon Geerlofs.

PHOTOS: (top to bottom) Gary Chittum, King 5 News (dark coat) and crew observe volunteers as they check a salmon trap on the Dewatto River for Earth Day. The Hood Canal Salmon Enhancement group operated the traps and helped provide staff for that day. | Emily Piper; A group works on a re-vegetation planting at Dalby Creek in Union, and the Mason Conservation District and Community Nearshore Restoration Program helped out that day. | Emily Piper.

The Action Team's work on HABITAT

A. Habitat protection

What we said we would do

1. Permanently protect ecologically important habitats.
2. Protect important habitats during development through critical areas and shorelines regulations.
3. Develop and carry out watershed plans for water resources, habitats and salmon recovery.
4. Detect and respond to invasive species that can harm habitats.
5. Increase citizen stewardship.

What's been done

1. Protecting high-value habitats.

- State, federal, tribal and local partners acquired nearly 200 acres of salt marsh, beaches and flood plains for protection or eventual restoration.
- In 2004, approximately 17 miles of riparian habitat were purchased for permanent protection.
- In November 2004, DNR designated the 5,530-acre Maury Island an aquatic reserve and began outreach the following spring to create the Cypress Island reserve in the San Juan Islands by 2007. DNR also began work on two additional marine reserves at Fidalgo Bay and Cherry Point.

2. Improving regulatory protection.

- Port Townsend and Bellingham adopted updated shoreline master programs (SMPs).
- Whatcom and Snohomish counties were on track to complete their SMP updates by the end of 2006.
- Five Puget Sound counties and 23 cities received state or federal funds for SMP updates, along with technical assistance from Ecology, WDFW, DNR and Action Team staff.
- King, Whatcom and Pierce counties adopted, revised\ and updated critical areas ordinances (CAOs); Snohomish and Thurston counties' CAOs were near completion.
- Ecology completed guidance materials for wetlands and wetland mitigation to guide local governments and developers.

3. Completing watershed plans and other ecosystem-scale plans.

- During 2004-2006, watershed plans were approved in the following water resource inventory areas (WRIAs): Nooksack, San Juan, Island and Dungeness-Elwha. Watershed plans were completed in Chambers-Clover, Deschutes, Kennedy-Goldsborough and Kitsap but were not approved by all governments. In 2006, the Skokomish-Dosewallips planning group completed its plan. The Quilcene-Snow plan was close to final approval.
- Ecology provided grants to carry out actions in watershed plans to the Nooksack, San Juan, Island County and Nisqually watershed groups.
- WDFW completed a comprehensive wildlife conservation strategy which focuses on species and habitats in greatest need of conservation, while recognizing the need to maintain all species.

4. Protecting the Sound from harmful invasive species.

Ballast water: The shipping industry, the state and the U.S. Coast Guard continue to make significant progress to minimize the risks associated with ballast water discharges.

- From January to June 2005, ship operators reduced their discharge of ballast water in Puget Sound ports by 50 percent over the previous six-month period.
- Starting in January 2004, ship operators substantially reduced the volume of high-risk ballast water discharged to Puget Sound ports from an average of 155,000 cubic meters every six months to about 10,000 cubic meters.
- In 2004, WDFW staff inspected more than 200 vessels, and issued three fines and five warnings to operators who discharged high-risk ballast water into state waters.

Prevention and monitoring: In 2005, the state aquatic nuisance species committee completed the early detection rapid response plan for managing invasive aquatic species. The plan was approved by WDFW.

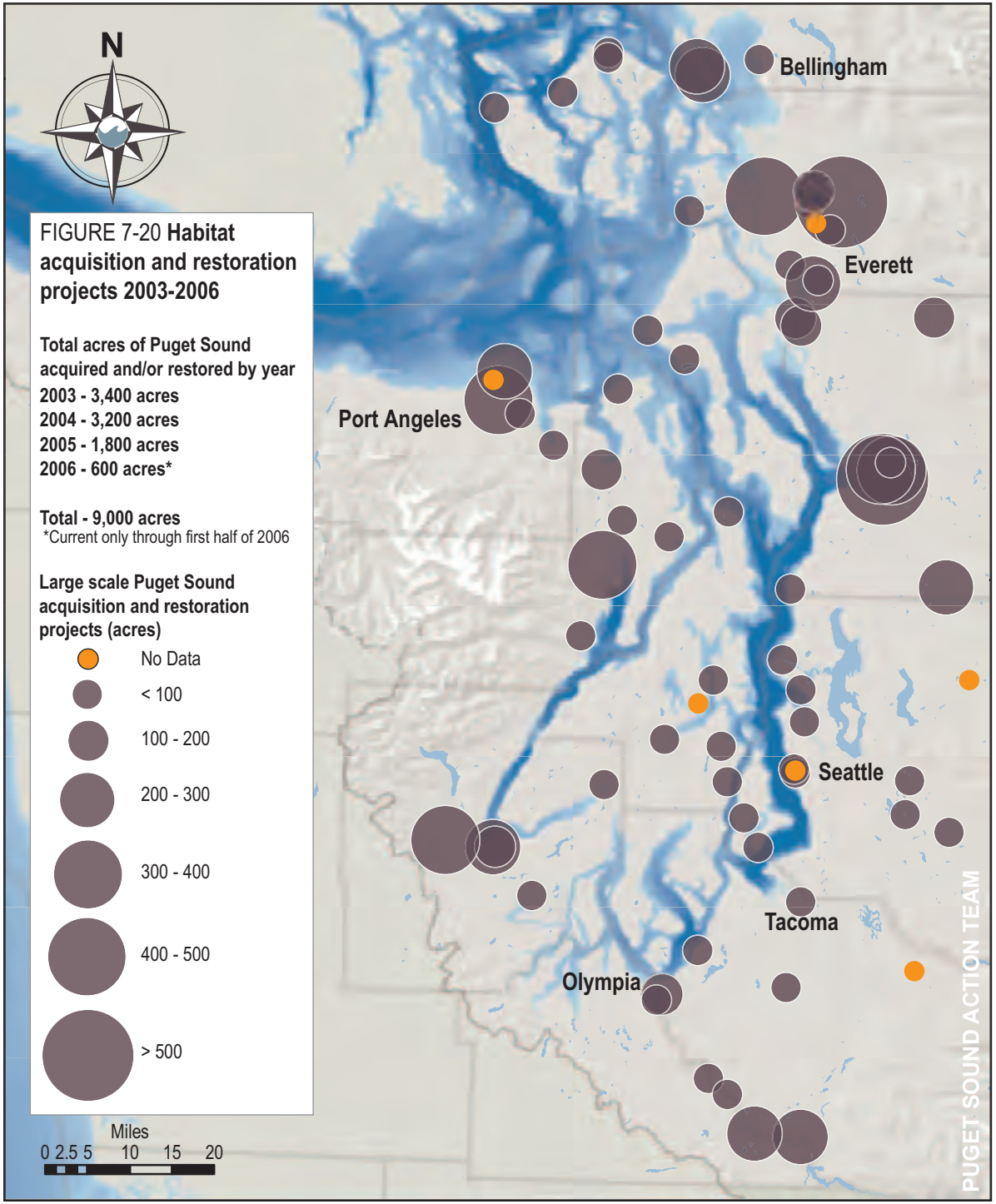


FIGURE 7-20: From 2003 through the first half of 2006, approximately 9,000 acres of critical Puget Sound habitats had been acquired or restored to preserve and enhance habitat function. Shown are acquisition and restoration activities by local, state and federal agencies, tribes, private organizations and volunteers. *Source: Action Team.*

Belfair State Park: Dike removal and estuary restoration project

State Parks, in collaboration with the Hood Canal Salmon Enhancement Group (HCSEG) and other partners, removed rip rap (a "hard" shoreline protection method) from the nearshore environment of Belfair State Park in Hood Canal and reshaped the shoreline, restoring approximately four acres of nearshore habitat. About 600 feet of dike were also removed, restoring seven acres of estuary. When the project is completed in 2007, 927 feet of dike will be removed, restoring 10 acres of estuarine habitat.

BEFORE

AFTER

PHOTOS: HCSEG.

Partnering with citizens to protect the Sound

Great things can happen when average citizens get involved in protecting Puget Sound's health. The Action Team's Public Involvement and Education (PIE) Fund supports local projects that help protect and improve Puget Sound's water quality and marine resources.

Between 2004 and 2006, the Action Team provided $525,000 for 15 local projects. Highlights include:

- Work with 12 marinas to adopt practices to keep harmful pollutants such as fuel and cleaning products out of the water.
- Train shoreline landowners in San Juan County to better manage their properties to benefit Puget Sound.
- Involve the Stillaguamish Tribe and 60 high school students in research and education on local water quality.
- Develop a pilot drug take-back program in multiple counties to keep unused pharmaceutical products out of the waste stream.

Since the program began 20 years ago, the Action Team has provided nearly $6 million for more than 350 PIE projects. Read more at www.psat.wa.gov/pie

5. Expanding citizen stewardship.
The Beach Watcher program successfully expanded from a model program started by WSU Extension Island County to six additional counties: Whatcom, San Juan, Skagit, Snohomish, Jefferson and Clallam. Beach Watchers are citizen volunteers who receive intensive training in watershed, nearshore and marine protection and restoration.

B. Habitat restoration

What we said we would do

1. Restore marine and freshwater habitats in every Puget Sound watershed.

2. Restore marine shoreline functions and habitats, including replacing "hard" armoring on shorelines with "soft" alternatives.

3. Eradicate spartina and respond to new invasive species.

What's been done

1. Habitat restoration efforts.

- Dozens of state, tribal, federal, local and private partners worked to restore more than 300 acres of marine and freshwater habitats and natural processes, restoring natural tidal hydrology at three locations in Puget Sound, and reconnecting approximately five miles of riparian and flood plain forests to mainstream channels.
- The Conservation Reserve Enhancement Program (CREP), administered by the Conservation Commission, provides technical and financial assistance through local conservation districts to install native trees and shrubs along salmon-bearing streams. Since 1999, the districts targeted 2,172 acres and 131 miles of riparian area for conservation, placing them under long-term leases. From July 2004 to June 2006, approximately 74 contracts were signed with landowners to lease additional agricultural lands along streams in Puget Sound and restore them based on U.S. Department of Agriculture (USDA) standards.

2. Restoring marine shorelines.

- In 2006, through the efforts of the Nisqually Tribe and the Nisqually Wildlife Refuge, 100 acres of farmland were restored to their historic estuarine condition.
- Restoration occurred at five Puget Sound beach locations—Seahurst Park (central King County), Close Property (Port Orchard Bay between Bainbridge Island and the Kitsap Peninsula), Piner Point (Maury Island), Crescent Beach (Orcas Island) and Hansville Beach Park (Admiralty Inlet).

3. Eradicating harmful invasive species.
Spartina: In 2004 and 2005, Agriculture treated an estimated 1,140 acres of spartina in the Puget Sound basin, which is between 82 percent and 95 percent of the existing spartina infestation. In mid-2006, remaining spartina totaled about 220 acres and the agencies treated about 200 acres of it. At current levels of funding, the agencies expect to eliminate spartina infestations by 2010.

Invasive tunicates:

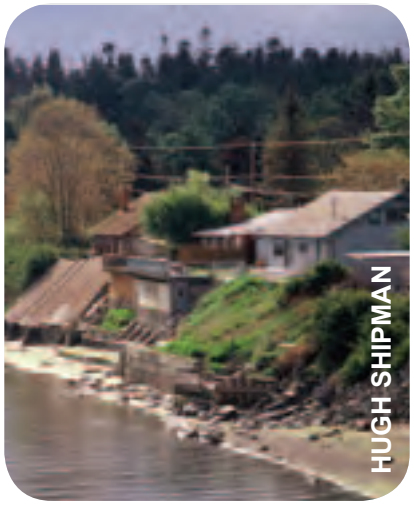
- The state, working with local citizen groups, launched an intensive effort to eradicate *styela clava*, an invasive tunicate species first detected in March 2004. More than 90 pounds of the tunicates were removed from infested boats in four marinas. In addition, divers surveyed about 30,000 square meters of docks in the infested marinas, cleaned about 33 percent of the area and removed about 2,000 pounds of invasive tunicates. More work is needed to remove the remaining tunicates in these infested marinas.
- In May 2006, DNR contracted with the Skokomish Tribe to survey the invasive tunicate *Ciona savignyi* in lower Hood Canal. *Ciona* was found throughout the area, often in dense mats that excluded other marine organisms. DNR will use this information to develop a response plan.
- State Parks posted educational materials regarding invasive tunicates at many marine recreational facilities along Puget Sound.

Action needed on
HABITAT

We are running a “habitat deficit” in the Puget Sound region. This means we do not have enough key habitats to sustain a healthy ecosystem. Although we are investing significant amounts of money on restoration projects, we are allowing vital habitats to be degraded and lost.

To have the quantity and quality of habitats needed requires concerted, sustained action and focus. We need to:

- **Protect existing habitats and connectivity.** We must prevent additional loss of habitats and the corridors that connect them. Much of this responsibility falls to local governments in their roles as land-use managers. These local agencies need additional funds, staff and public support to enact, enforce and legally defend programs and actions to protect habitats.
- **Develop new and creative tools to protect habitats.** Without unfairly burdening property owners, we need to develop innovative approaches to protect our habitats, including more favorable tax policies, increased incentives, transfer of development rights programs and innovative development techniques.
- **Improve shoreline master programs.** We need to make sure that SMPs do a better job of preventing habitat loss. Technical guidance for local governments is needed as well as financial assistance.
- **Prevent harm from invasive species.** We need dedicated funding so we can develop comprehensive approaches to better prevent the introduction of invasive species and eradicate those that have become established.
- **Target protection and restoration dollars.** We need a strategic plan to identify protection and restoration projects that provide the most value for investment dollars and that result in significant habitat gains. We need to place a higher value on strategic investments than on geographic funding equity.
- **Continue to improve our knowledge.** We need to monitor and assess our protection and restoration actions to ensure they are effective, and to test and develop new techniques to accomplish our goals.



PHOTOS: (top to bottom) Farm clearcut near Quilcene. | Toni Droscher; Puget Sound shorelines. | Hugh Shipman/Ecology; (opposite page) Late afternoon at Nisqually Delta in winter. | Shutterstock.com/Lawrence Freytag.

LAWRENCE FREYTAG

STATE OF THE SOUND:

SPECIES

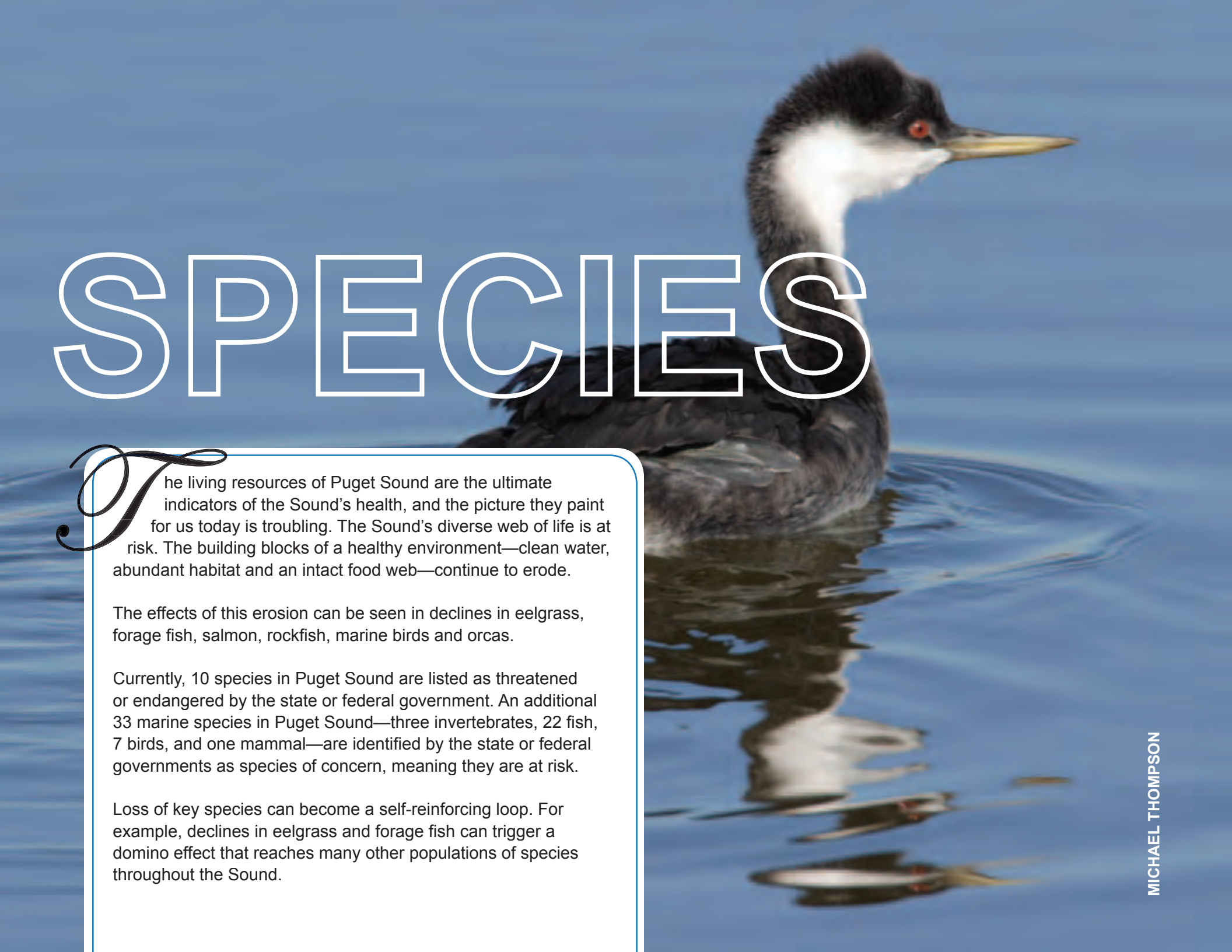
SPECIES

The living resources of Puget Sound are the ultimate indicators of the Sound's health, and the picture they paint for us today is troubling. The Sound's diverse web of life is at risk. The building blocks of a healthy environment—clean water, abundant habitat and an intact food web—continue to erode.

The effects of this erosion can be seen in declines in eelgrass, forage fish, salmon, rockfish, marine birds and orcas.

Currently, 10 species in Puget Sound are listed as threatened or endangered by the state or federal government. An additional 33 marine species in Puget Sound—three invertebrates, 22 fish, 7 birds, and one mammal—are identified by the state or federal governments as species of concern, meaning they are at risk.

Loss of key species can become a self-reinforcing loop. For example, declines in eelgrass and forage fish can trigger a domino effect that reaches many other populations of species throughout the Sound.



MICHAEL THOMPSON


JENNIFER VANDERHOOF


SHUTTERSTOCK.COM

PHOTOS: (top to bottom) Tiger rockfish | Jennifer Vanderhoof; Bald Eagle. | Shutterstock.com; (opposite page) Western grebe. | Shutterstock.com/ Michael Thompson.

State and federal listed species in Puget Sound
As of October 2006[1]

GROUP	COMMON NAME	STATE STATUS	FEDERAL STATUS
MARINE AND ANADROMOUS FISHES	Chinook Salmon (Puget Sound)	C	T
	Chum Salmon (Hood Canal/ E. Strait of Juan de Fuca)	C	T
	Coho Salmon (Puget Sound/ Strait of Georgia)		C
	Bull Trout (Coastal/Puget Sound)	C	T
	Pacific Hake	C	C
	Pacific Cod	C	
	Walleye Pollock (South Puget Sound)	C	Co
	Pacific Herring (Cherry Point/ Discovery Bay)	C	C
	Brown Rockfish	C	
	Copper Rockfish	C	
	Greenstriped Rockfish	C	
	Widow Rockfish	C	
	Yelloweye Rockfish	C	
	Quillback Rockfish	C	
	Black Rockfish	C	
	China Rockfish	C	
	Tiger Rockfish	C	
	Bocaccio Rockfish	C	
	Canary Rockfish	C	
	Redstripe Rockfish	C	
	Yellowtail Rockfish	C	
	Eulachon	C	
	River Lamprey	C	Co
	Pacific Lamprey		Co
	Coastal Cutthroat		Co
MARINE MAMMALS	**Northern Pacific Humpback Whale**	**E**	**E**
	Steller Sea Lion	T	T
	Orca	**E**	**E**
	Pacific Harbor Porpoise	C	
	Northern Sea Otter	**E**	Co
BIRDS	Bald Eagle	T	T*
	Canada Goose, Aleutian	M	Co
	Golden Eagle	C	
	Marbled Murrelet	T	T
	Tufted Puffin	C	Co
	Brandt's Cormorant	C	
	Cassin's Auklet	C	Co
	Common Murre	C	
	Western Grebe	C	
	Snowy Plover	**E**	T
INVERTEBRATES	Olympia Oysters	C	
	Newcomb's Littorine Snail	C	Co
	Pinto (Northern) Abalone	C	

State and Federal Status

E – Endangered
T – Threatened
C – Candidate
Co – Concern
M - Monitor

[1]This list includes marine–dependent species that live all or part of their life cycle in the waters of the Strait of Juan de Fuca, San Juan Islands, Hood Canal, and central and south Puget Sound. Not included are species that live in freshwater and upland of the shoreline.
**The federal government is proposing to de-list bald eagles.*

INDICATOR: ORCAS

Three main orca populations visit the waters of Puget Sound regularly but only one—southern resident whales—return each summer to Puget Sound and the waters around the San Juan Islands.

In 2005, southern resident orcas were added to the federal endangered species list after scientists determined they are a genetically distinct population that do not breed with other orca populations.

STATUS

The population of southern resident orcas was 86, at press time. The historic population of Puget Sound orcas, before European settlement, was estimated at 150-250 whales.

TRENDS

Between 1974 and 1995, southern resident orca populations increased to 98 but dropped sharply in 2001 to 81 whales, a loss of 17 percent.

Although the number of southern resident orcas has increased to 86, these animals continue to face threats to their health from a number of stresses including PBTs and other contaminants and declines in prey. The whales are also at risk from major oil spills and from increased noise from whale-watching boats and other vessels.

FIGURE 8-21 **Trends in southern resident orca population 1974-2006**

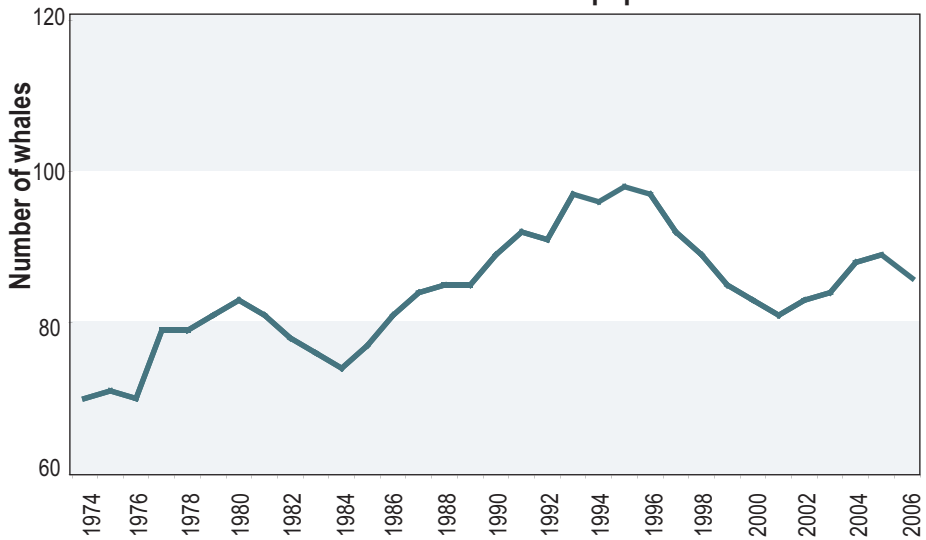


FIGURE 8-21: Between 1974 and 1995, southern resident orca populations increased to 98 but dropped sharply in 2001 to 81 whales, a loss of 17 percent. Although the number of southern resident orcas has increased to 86, these animals continue to face threats to their health. *Source: Center for Whale Research.*

PHOTOS: Orca whales breaching. | Tim Ransom; (indicator) Orca whales near San Juan Island. | Shutterstock.com/Matt Ragen.

INDICATOR: SALMON

Wild salmon are a keystone of the Puget Sound ecosystem, with numerous species returning to spawn in streams across the region. As juveniles, salmon are a food source for other fish and marine birds; later in life they are a favored prey of orca that return annually to Puget Sound.

In the last 50 years, overfishing, dams and habitat degradation have led to major declines in several of Puget Sound's approximately 200 salmon stocks. In 1999, Puget Sound chinook salmon, the largest of the Pacific salmon, were listed as threatened under the federal Endangered Species Act, as were Hood Canal summer-run chum and bull trout.

In March 2006, NOAA Fisheries announced it is considering listing all stocks of Puget Sound steelhead as threatened or endangered. A decision is expected in 2007.

STATUS

In 2002, the most recent data available, there were 207 salmonid stocks in Puget Sound, according to WDFW inventory data. Stocks include chinook, chum, coho, pink, sockeye and steelhead. Of the total number, 81 stocks are healthy, 52 are depressed and 12 are critical. The status for 62 stocks is unknown, and eight are extinct.

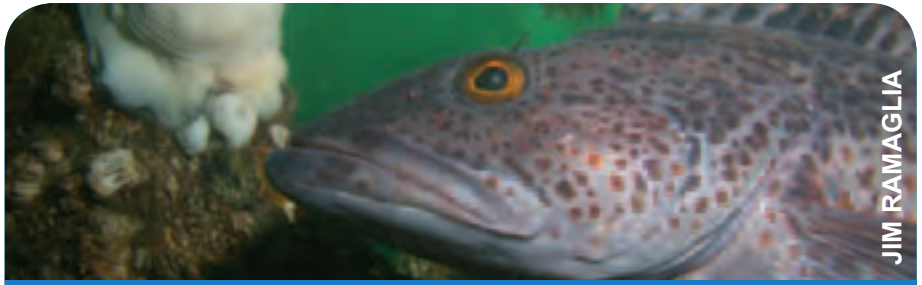
TRENDS

When 2002 data is compared to 1992 data, salmonid stocks are on a downward trend. The most significant statistics are in the area of extinct stocks. In 1992, there was one extinct stock; in 2002, that number had increased to eight. In that same period, the number of healthy stocks declined from 93 healthy stocks to 81. Although monitoring continues, the salmonid stock inventory data has not been updated since 2002.

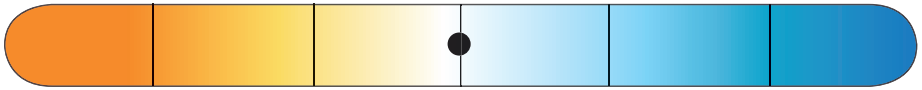
Salmon stocks in Puget Sound

	1992		2002	
PUGET SOUND TOTAL	NUMBER OF STOCKS	PERCENT OF STOCKS	NUMBER OF STOCKS	PERCENT OF STOCKS
Healthy Stocks	93	45%	81	38%
Depressed Stocks	44	21%	52	24%
Critical Stocks	11	5%	12	6%
Extinct Stocks	1	<1%	8	4%
Not Rated Stocks	N/A	N/A	2	<1%
Unknown Stocks	60	29%	60	28%
Total	209		215	

PHOTOS: Coho salmon. | USFWS; (indicator) Chum salmon make their annual return to spawn in Kennedy Creek, South Puget Sound. | Terry Hull.



INDICATOR: GROUNDFISH



Puget Sound has more than 150 species of groundfish, those fish that live near or on the bottom of the Sound for most of their adult lives. These fish play an important role in the food web, serving as a link between nearshore and midwaters and the sea floor. Many of the harvestable groundfish species are in sharp decline including Pacific cod, hake, walleye pollock and several species of rockfish.

More than 27 species of rockfish—an extremely long-lived group of fish—have been recorded in the inland marine waters of Washington State. These slow-growing species do not reproduce until fully mature, which makes them particularly vulnerable. Scientists measure rockfish health by their ability to reproduce, known as their spawning potential. Spawning potential declines when there are fewer fish of spawning age or when individual fish produce fewer eggs.

STATUS

While the majority of Puget Sound groundfish stocks are in good condition, the status for individual species is mixed. Some species are in steep decline while others are improving. Pacific cod, walleye pollock, Pacific hake, rockfish and spiny dogfish are in depressed or critical condition in Puget Sound. Lingcod, English sole, starry flounder, sand sole and Pacific halibut populations have increased.

TRENDS

Based mainly on sport-fishing surveys and harvest information, the condition of groundfish stocks improved slightly during the past four years. This improvement is most apparent in several species of flatfish including English sole, which saw increases ranging from 17 percent to 42 percent, and lingcod, which saw increases ranging from 68 percent to 104 percent since the 1980s.

Spawning potential for copper and quillback rockfish dropped by nearly 75 percent between 1970 and 1999, and more recent information confirms a continued decline. Although the overall number of groundfish has not changed significantly in the last few decades, many popular harvest species have sharply declined.

FIGURE 8-22 **Groundfish stock conditions 2002-2006**

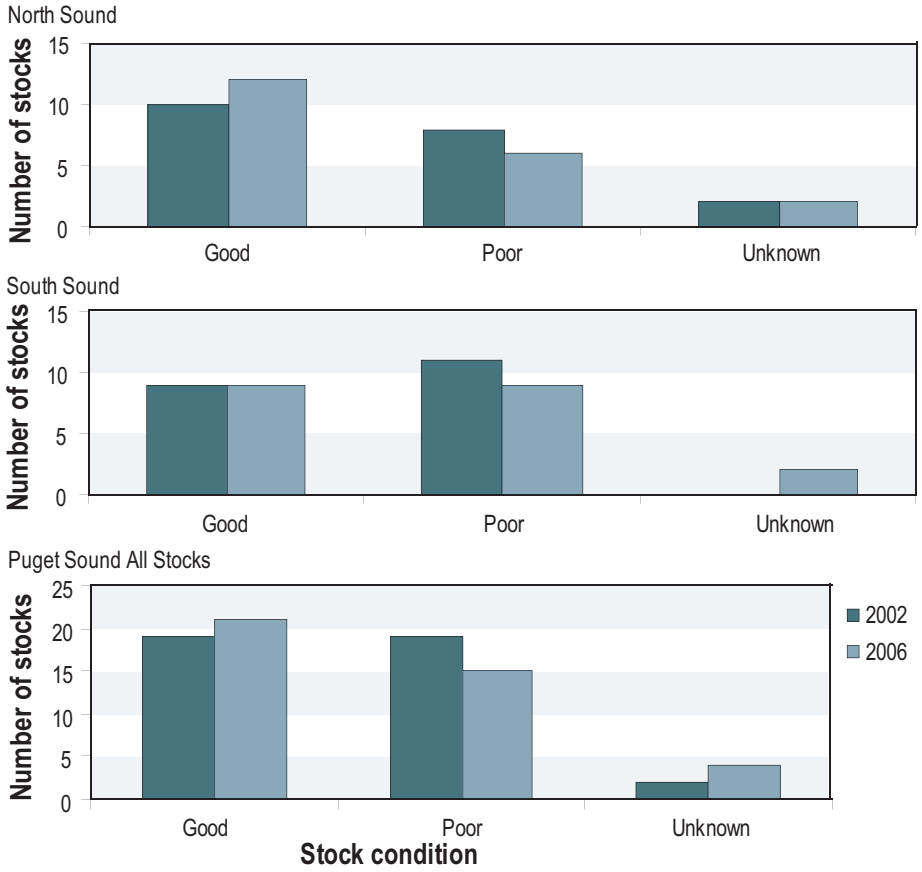


FIGURE 8-22: The condition of groundfish stocks improved slightly during the past four years. Some species are currently doing well (lingcod, English sole, starry flounder, sand sole and Pacific halibut), whereas other species are depressed or in critical condition (Pacific cod, walleye pollock, Pacific whiting, rockfish, and spiny dogfish). *Source: WDFW.*

PHOTO: (indicator) Lingcod. | Jim Ramaglia.

INDICATOR: HERRING

There are 19 designated populations of Pacific herring in Puget Sound. This small fish serves as food for a wide variety of seabirds, marine mammals and predatory fish. Estimates of herring spawning biomass are calculated annually to determine adult herring population size for Puget Sound herring stocks.

STATUS

Based on acoustic trawl surveys and spawn deposition surveys conducted by WDFW, the current estimate of spawning biomass for all Puget Sound herring stocks is approximately 12,000 tons.

TRENDS

Across Puget Sound, estimates of herring spawning biomass have varied from year to year but most stocks have declined in the last five years. In 2002, the combined biomass of Puget Sound herring stocks was estimated at 17,700 tons. In 2004, that figure dropped to about 11,000 tons—a decrease of about 40 percent. In 2006, biomass estimates increased to 17,765 tons.

Cherry Point herring, once the largest stock in Puget Sound, have declined steeply in the past 30 years, dropping from an estimated 12,000 tons of spawning herring in 1976 to approximately 2,200 tons in 2006, a decline of 82 percent.

FIGURE 8-23 **Estimated spawning biomass of Puget Sound herring by region 1976-2005**

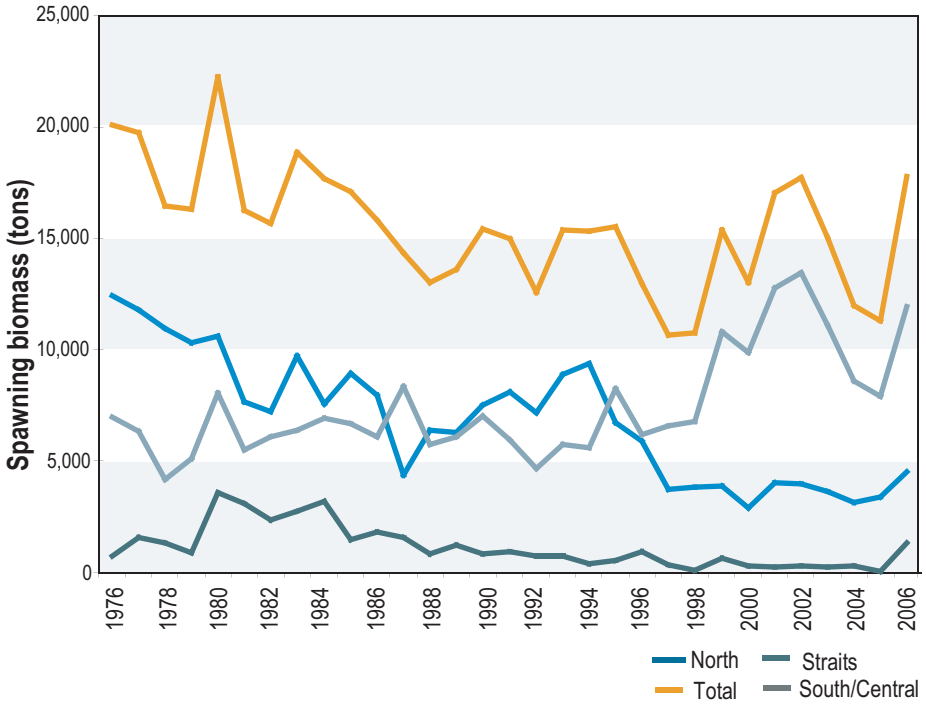
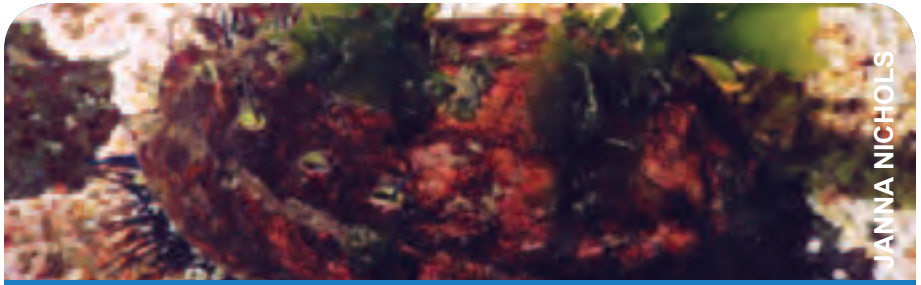


FIGURE 8-23: Across Puget Sound, estimates of herring spawning biomass have varied from year to year but most stocks have declined in the last five years. *Source: WDFW.*

PHOTO: (indicator) Herring. | Jake Gregg and Paul Hershberger, USGS.



INDICATOR: PINTO ABALONE

Pinto abalone play an important role in shaping the nearshore rocky habitat. They are one-shell mollusks that graze on algae, opening up habitat for other invertebrates to colonize. This species, one of the smallest of abalone, rarely grows to more than six inches long. The pinto abalone habitat range includes northern Puget Sound and the San Juan Archipelago, and they have not historically been found in centeral or southern Puget Sound.

STATUS

Once fairly abundant in the Strait of Juan de Fuca and the San Juan Archipelago, the pinto abalone population continues to decline, despite the fact that commercial harvest has never been permitted and statewide recreational harvest was closed in 1994. In 2004, the federal government listed pinto abalone as a species of concern. Species estimate information is available from 10 study sites in the San Juan Archipelago.

TRENDS

Abalone abundance in 10 sites in the San Juan Archipelago has steadily decreased from a peak of 351 animals in 1992 to 103 animals in 2005. Changes have also been noted in shell size. Scientists are recording a shift from smaller to larger shells, reflecting a change in population from younger to older animals. Abalone smaller than 2.5 inches are nearly non-existent. The shell length data suggest that continued population declines may be the result of a lack of reproductive success.

FIGURE 8-24 **Pinto abalone abundance in the San Juan Archipelago 1992-2005**

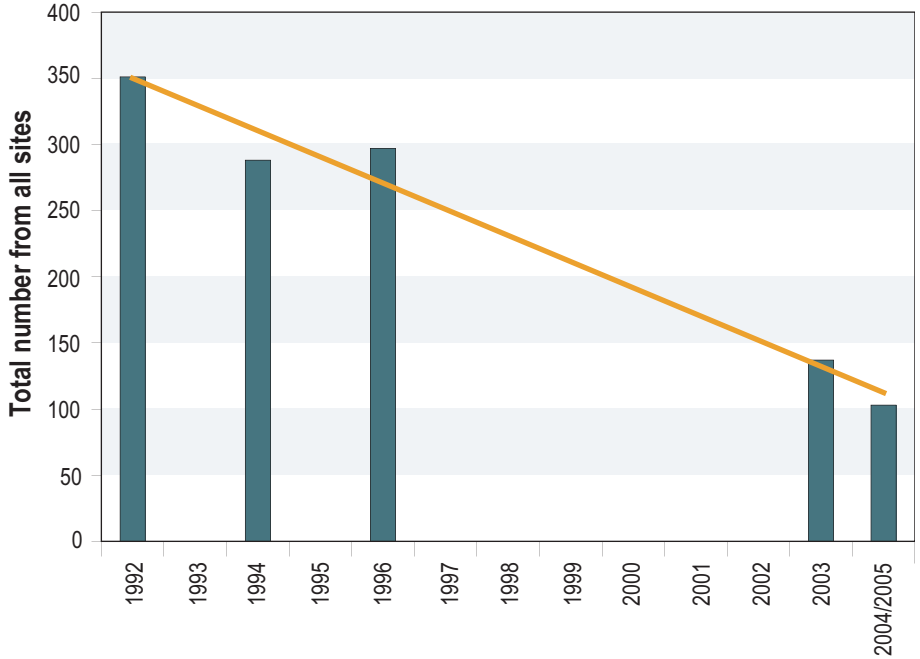
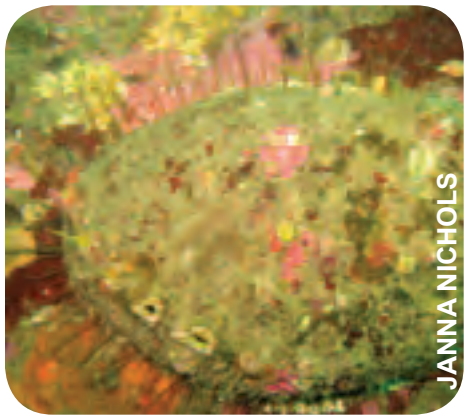
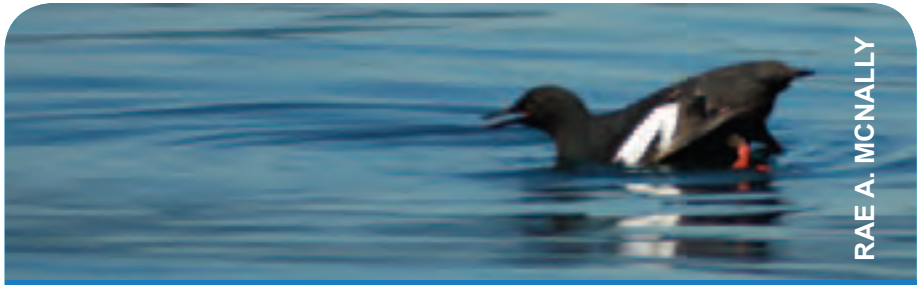


FIGURE 8-24: Pinto abalone abundance at 10 monitoring sites in the San Juan Archipelago indicates a steady decline in the total number of animals between 1992 and 2005. Despite the elimination of recreational harvest in 1994, pinto abalone continues to decline. *Source: WDFW.*



PHOTOS: Pinto (a.k.a. Northern) abalone. | Janna Nichols; (indicator) Pinto abalone. | Janna Nichols.



INDICATOR: MARINE BIRDS

More than 100 species of marine birds, including seabirds, sea ducks and shorebirds, are either part-time or full-time residents of Puget Sound. Many of these species are at or near the top of the food chain and thus are important indicators of overall ecosystem health.

STATUS

A total of 19 of the 30 most common marine bird species in northern Puget Sound decreased by 20 percent or more between 1978 and 2004, according to Western Washington University (WWU). Overall, the total population of wintering marine birds in this northern area decreased by 27 percent during this period. It is not entirely known what is driving this decline but some likely factors include decreases in forage fish populations, including herring spawn at Cherry Point and Discovery Bay, changing migrations patterns, predation, habitat loss, hunting, by-catch from fishing operations (including derelict fishing gear), and harm to breeding grounds in the Arctic. Data for surf scoters and western grebes indicate a dramatic decrease in populations of both species over the past 25 years.

Pigeon guillemots remain abundant in Puget Sound. They are an important indicator of overall ecological health because, as generalists, they forage on a wide range of food across a variety of habitats.

TRENDS

Scoters: Puget Sound once attracted some of the largest wintering scoter populations on the West Coast. But since 1995, scoter populations have declined by more than half, from about 70 birds per square kilometer to a low of 35 birds per square kilometer in 2003.

Grebes: Western grebes have steadily declined in Washington the past 15 years. The Christmas bird counts conducted by Audubon Washington tracked more than 40,000 western grebes in western Washington in 1992. Recent tallies show only 7,500 grebes—a decline of 81 percent.

Pigeon guillemots: These are the second most abundant seabird found in Puget Sound. They do not appear to have declined as severly as surf scoters and western grebes, although only limited trend data exists on this species. Some reports by WWU indicate that pigeon guillemot populations increased by 20 percent since the 1970s, but more recent data from PSAMP suggest a stable or even modest decline. Repeating the 1999-2004 breeding surveys will give us more insight into the health of this bird population.

FIGURE 8-25 **Densities of marine birds in north Puget Sound 1997-2006**

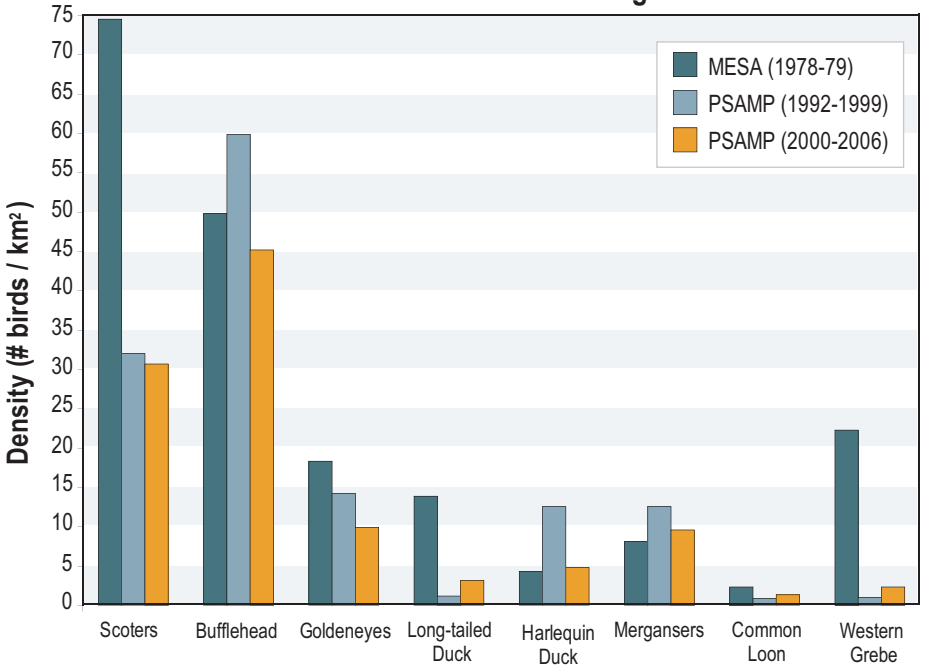


FIGURE 8-25: Three separate surveys of several marine birds in Puget Sound since the late 1970s indicate major declines in many of the species, most notably scoters, goldeneyes, long-tailed ducks and western grebes. Because many of Puget Sound's marine birds frequent the region for only part of the year, the causes of the decline are not understood. *Source: WDFW.*

PHOTO: (indicator) Pigeon guillemot. | Rae A. McNally.

The Action Team's work on
SPECIES

What we said we would do

1. Complete and begin implementing recovery plans for listed salmon species.

2. Establish marine reserves and protect declining rockfish.

3. Conduct forage fish inventories along Puget Sound shorelines.

4. Implement orca recovery actions.

What's been done

1. Salmon and bull trout recovery plans.

- In June 2005, a draft of the Puget Sound chinook salmon recovery plan was submitted to NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) for review and approval. The plan sets goals for achieving self-sustaining populations of Puget Sound chinook. Action Team agencies contributed to the effort through funding and staff support, WDFW Watershed Stewards helped developed local plans, and Action Team staff wrote the regional chapter on nearshore habitat. Implementation on the local and regional levels has begun.
- The Hood Canal Coordinating Council submitted the *Hood Canal/Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan* to NOAA Fisheries in October 2005; it is currently under review.
- USFWS issued the *Recovery Plan for the Coastal-Puget Sound Bull Trout* in 2006.
- Ecology developed a plan to monitor and assess statewide watershed health and salmon recovery, which will provide information on the physical, chemical and biological conditions of Washington's rivers and streams.
- Ecology continued its intensively monitored watershed (IMW) program to better understand the complex relationships between salmon health and habitat restoration efforts.

2. Making progress on forage fish inventories. The NWSC reported that forage fish inventories were completed for the seven northern counties: Clallam, Jefferson, Snohomish, Island, Skagit, San Juan and Whatcom. State, tribal and salmon restoration Regional Fisheries Enhancement Groups conducted inventories in parts of Kitsap, Mason, Pierce, King and Thurston counties and in Hood Canal.

3. Protecting groundfish.

- In 2004, San Juan County officials declared the county a marine stewardship area and began to develop a community-based effort to address threats to marine resources. San Juan County has extensive rocky shoreline habitat used by groundfish.
- The Washington Fish and Wildlife Commission (WFWC) increased restrictions on groundfish harvest, including closing all harvest in Hood Canal until dissolved oxygen conditions improve. In the broader Sound, WDFW limited the rockfish season, prohibited the taking of canary and yelloweye rockfish, and in most areas required fishers to keep the first rockfish caught.

4. Conserving and recovering orca.

- In November 2005, NOAA Fisheries Service listed the southern resident killer whale as endangered under the federal Endangered Species Act. In June 2006, the agency announced its proposed critical habitat for this important species.
- NOAA Fisheries issued a draft Orca Conservation *Plan for Southern Resident Killer Whales* in 2005.

5. Habitat conservation plan for state-owned aquatic lands. DNR continued development of a habitat conservation plan for 2.4 million acres of state-owned aquatic lands, including all the bedland areas of Puget Sound and many of the tidelands, covering 21 endangered, at-risk or sensitive species.

PHOTOS: (top to bottom) Seals on buoy in Colvos Passage. | Linda Farmer; Salmon fry. | Corps of Engineers.

PHOTOS: (top to bottom) Common murre. | NOAA; Pygmy rock crab. | Jennifer Vanderhoof.

Action needed on
SPECIES

Puget Sound species are the ultimate indicators of the overall health and vitality of the Sound, and the declines we see reflect the declining health of the Sound itself. The status of species that are fished and hunted is also directly related to our stewardship and harvest choices.

Protecting the Sound's species requires that we understand and protect the integrity of the overall food web. This means we must effectively address pollution and habitat loss. We cannot save the species without saving Puget Sound.

Ensuring that we have balanced populations of indigenous plants and animals requires concerted, sustained action and focus. We need to:

- **Take actions already identified.** The most important thing we can do is to take the actions identified in existing recovery plans to protect the species that are at greatest risk.

- **Be more proactive.** Waiting until species are listed under the federal ESA as threatened or endangered can be detrimental. We need to develop management strategies when species begin to show serious declines but before they have reached the point where they are threatened or endangered.

- **Go beyond the species-by-species approach to conservation and recovery.** This approach can fail to address broader ecosystem needs. We must supplement species-by-species recovery planning with an ecosystem approach that addresses the stressors for many species. This approach will likely be more effective and long-lasting as well as more relevant and useful for resource managers, landowners, regulators and others working to protect and recover species.

- **Complete and implement habitat management and conservation plans.** We need to develop and implement these plans on a regional scale for all key habitat types, such as eelgrass.

- **Continue to improve our knowledge.** More information is needed about the life histories and environmental requirements of species in decline, especially those that are migratory or spend a portion of each year outside the region. To be more strategic in our recovery actions, we also need to improve our understanding of the interconnectedness of the food web and the ecosystem.

STATE OF THE SOUND:

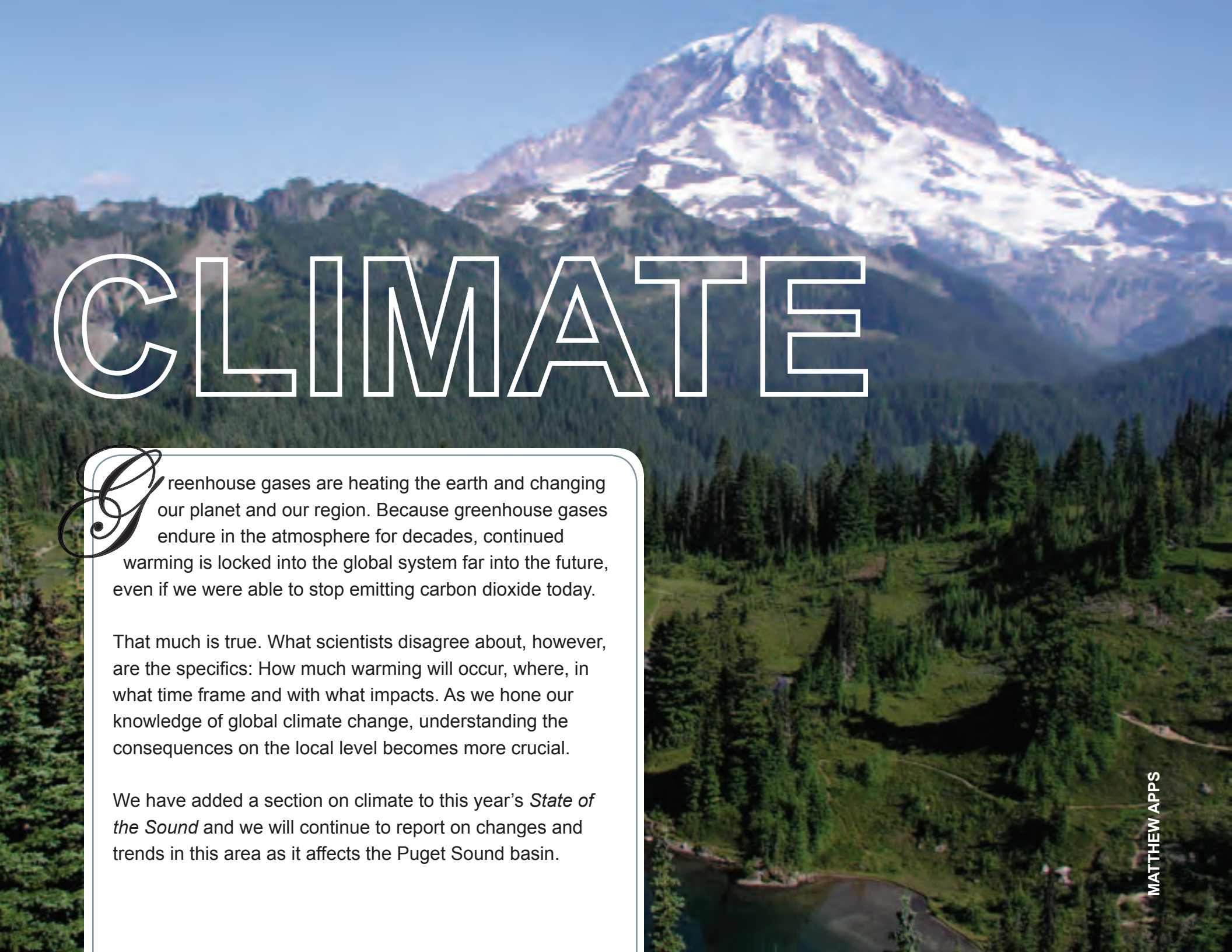
CLIMATE

CLIMATE

Greenhouse gases are heating the earth and changing our planet and our region. Because greenhouse gases endure in the atmosphere for decades, continued warming is locked into the global system far into the future, even if we were able to stop emitting carbon dioxide today.

That much is true. What scientists disagree about, however, are the specifics: How much warming will occur, where, in what time frame and with what impacts. As we hone our knowledge of global climate change, understanding the consequences on the local level becomes more crucial.

We have added a section on climate to this year's *State of the Sound* and we will continue to report on changes and trends in this area as it affects the Puget Sound basin.



MATTHEW APPS

INDICATOR: TEMPERATURE

AIR TEMPERATURE

STATUS

During the past century, the Puget Sound region warmed at a rate substantially greater than the global warming trend. The average annual temperature increased by 2.3 degrees Fahrenheit (degrees are all noted in F), more than double the rise seen in global average air temperature, which is 1.1 degrees. Every climate record in the Puget Sound area showed a warming trend. Rural climate stations have warmed just as much as urban stations. Puget Sound winters warmed at an even greater rate, increasing 2.7 degrees since 1950.

TRENDS

Climate models project a continued warming trend in the Pacific Northwest between 0.2 and 1.0 degrees per decade until 2050, with average warming of 1.8 degrees by the 2020s and 3.0 degrees by the 2040s (relative to the average temperature between 1970 and 1999.) Even the lowest estimated warming will change the Northwest's climate significantly, causing smaller snow packs, warmer rivers and more intense dry spells.

SEA SURFACE TEMPERATURE

Water temperature affects whether habitats are suitable for marine organisms. It also affects the physical, biological and chemical processes important to maintain a healthy food web. Many Puget Sound species, such as salmon, oysters and groundfish, depend on cold water. Rising water temperatures will carry considerable consequences to the ecosystem, including likely declines in cold-water species and an increased abundance of species that thrive in warmer waters.

STATUS

Of the water quality problems identified in the Puget Sound basin in 2004, 20 percent were related to river temperatures that exceeded critical threshold values. The extent to which these changes are related to global climate change is unknown, but future warming as predicted will continue to increase the number of rivers exceeding critical thresholds.

TRENDS

While we do not have much information on trends in water temperature for fresh and marine waters in the Puget Sound basin, there is evidence of warming during the 20th century.

FIGURE 9-25 **Air temperature projections for the Puget Sound basin 2000-2100**

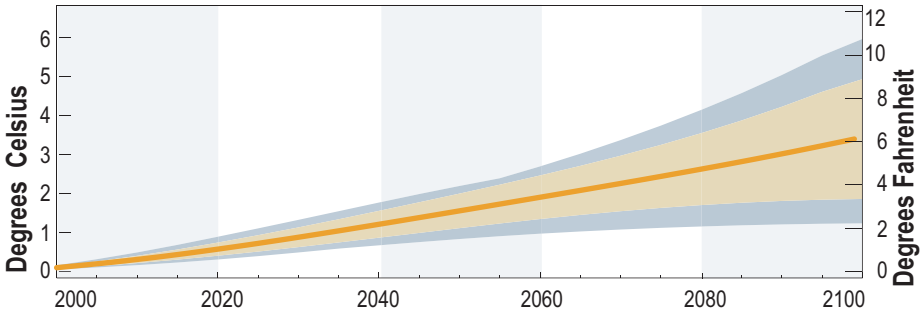


FIGURE 9-25: Projected changes in annually averaged temperature for the Pacific Northwest, compiled by considering climate scenarios from 10 global climate models. The orange line shows the average of all the models. The blue shading indicates the range from highest to lowest, and the yellow shading indicates the range in which about two-thirds of the scenarios fall. *Source: Uncertain Future: Climate Change and Its Effects on Puget Sound. Action Team, 2005.*

FIGURE 9-26 **Sea surface temperature at Race Rocks 1915-2005**

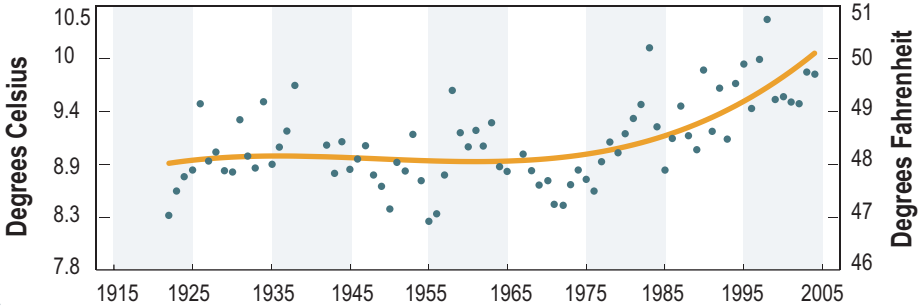
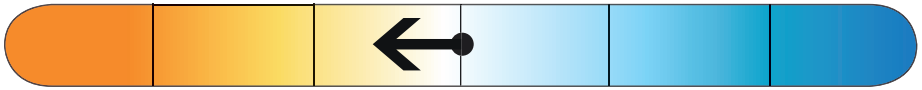


FIGURE 9-26: Average annual sea surface temperature at Race Rocks near Victoria BC. Each year's temperature is shown as a circle, and the smooth curve indicates a long-term warming trend of 1.7 degrees F since 1921 and 1.8 degrees F since 1950. *Source: Uncertain Future: Climate Change and Its Effects on Puget Sound. Action Team, 2005.*

PHOTOS: (indicator) Sunrise. | Shutterstock.com; (opposite page) Mount Rainier. | Shutterstock.com/Matthew Apps.

INDICATOR: SEA LEVELS



The melting of polar ice sheets, glaciers and ice fields, along with the warming of the ocean's waters and the resulting thermal expansion, are causing global sea levels to rise, which can have a profound impact on Puget Sound.

STATUS

Global sea levels increased an estimated four-to-eight inches during the 20th century. Geological factors that cause the rising of the earth's crust in the northwest region of the Sound and sinking in the southeast region produced different rates of sea level rise. This net local sea level rise in north Puget Sound was close to the global average while sea level rise in south Puget Sound was nearly double the global average.

TRENDS

Future global sea level rise is likely to accelerate as a result of global warming, with changes projected anywhere from four to 35 inches during this century. Some climate models suggest we may see an additional eight inches in sea level rise in coastal waters because of changes in wind patterns.

WANT TO KNOW MORE?

about climate in Puget Sound?

In November 2005, Action Team produced a report called *Uncertain Future: Climate Change and Its Effects on Puget Sound* that can be found at www.psat.wa.gov/climatechange.

FIGURE 9-27 **Predicted sea level rise for various Puget Sound locations**

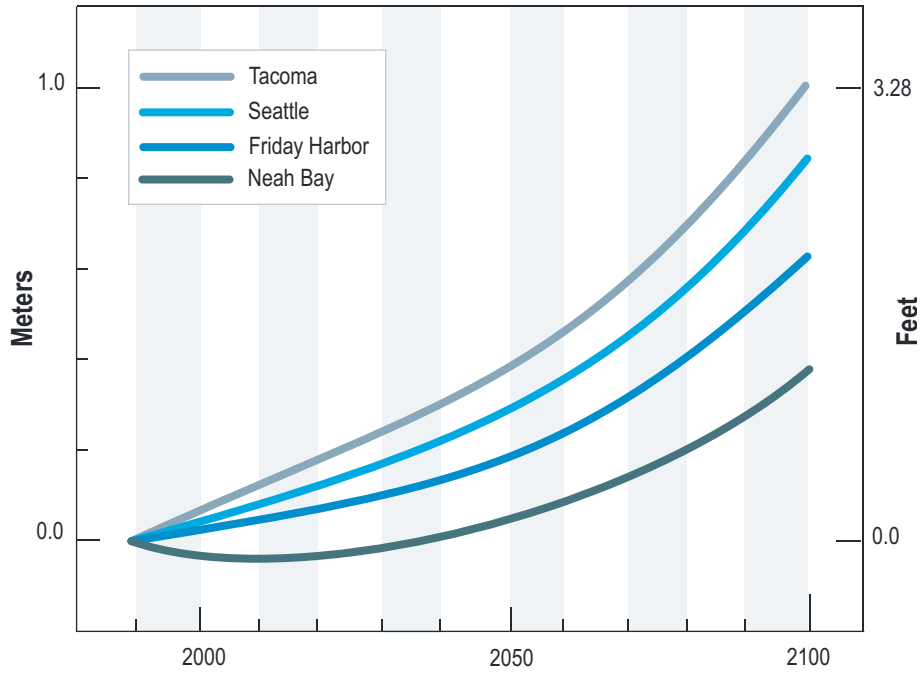


FIGURE 9-27: Future sea level rise scenarios for various locations in Puget Sound are shown. These sea level rise curves take into account projected global sea level rise, the increased rate projected for the NE Pacific and the sinking of local land. The degree of sea level rise projected at Tacoma for 2050 (about 1.2 feet or 0.4 m) would not occur at Seattle until around 2060 and at Friday Harbor until around 2080. Given continued uncertainty, the sea level rise scenarios could be 20 percent to nearly 200 percent of the mid-range scenarios depicted. *Source: Uncertain Future: Climate Change and Its Effects on Puget Sound. Action Team, 2005.*

PHOTO: A storm near the San Juan Islands. | Shutterstock.com

INDICATOR: STREAM FLOW

Freshwater inflow to Puget Sound—the total flow of all of the major rivers—is an important element of the Sound's marine environment. The timing of regular yearly rainfall, and the timing and magnitude of winter and spring high-flow rain events influence water temperature, salinity, circulation patterns, habitat characteristics and marine life.

STATUS

Across much of the western United States as well as in the Puget Sound region, scientists have observed hydrologic changes in the past 50 years that are consistent with the observed atmospheric warming, including reduced spring snow pack, earlier spring snow melt, increased winter flow and decreased summer flow.

These changes, most of which have been linked to rising temperatures, can lead to altered habitats for fish and other species. The observed changes also have implications for municipal and agricultural water needs that are dependent on surface water.

TRENDS

From 1948 to 2003, freshwater inflow in Puget Sound changed in the following ways:

- Total annual inflow declined 13 percent because of changes in precipitation.
- Average snow melt is 12 days earlier, shifting 2.1 days per decade.
- The fraction of annual flow entering Puget Sound from June to September decreased by 18 percent.
- The likelihood of unusually high daily inflow increased, despite the decline in annual inflow.
- The likelihood of unusually low daily inflow increased.

FIGURE 9-28 **Average daily freshwater flow into Puget Sound 1948-2003**

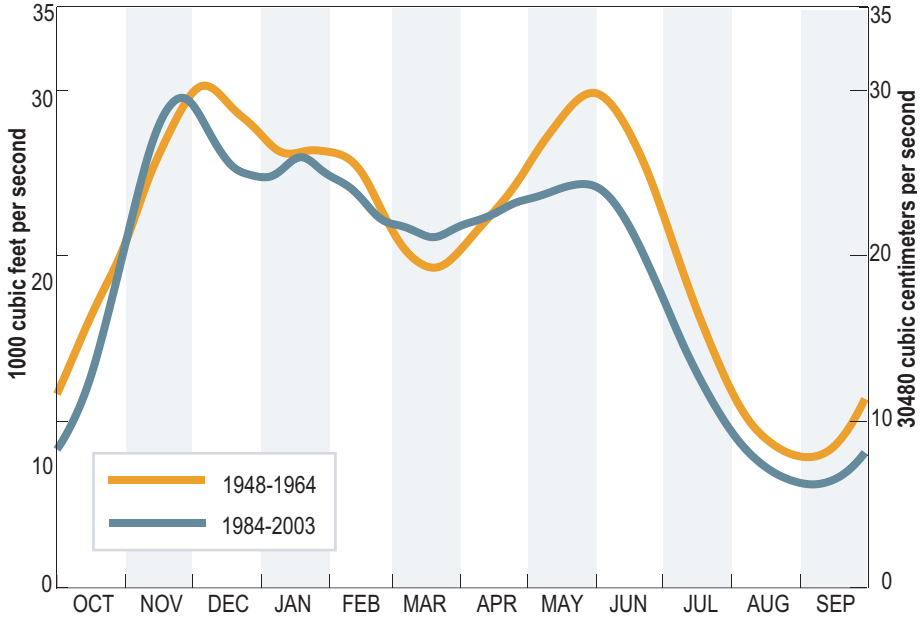


FIGURE 9-28: Average daily freshwater flow into Puget Sound (calculated by adding the flow of nine of the largest rivers) for 1948-1964 (orange) and 1984-2003 (blue). Note the decline in May-October flows and increase in March-April flows. *Source: Uncertain Future: Climate Change and Its Effects on Puget Sound. Action Team, 2005.*

PHOTO: (indicator) Northwest stream. | Shutterstock.com/Aaron Whitney.

INDICATOR: SNOW PACK

Both the Puget Sound ecosystem and its cities depend on snow melt. Snow melt sustains flows in rivers and streams over long periods and it replenishes water reservoirs in the spring before the heat of summer sets in. Because temperatures are rising, climate models predict more precipitation falling as rain instead of snow. This means winter flooding will increase and our natural water stores will be reduced.

STATUS

Snow pack measurements—the depth of water from melted snow, also known as the snow water equivalent, (or SWE)—taken on April 1 (roughly the date of peak snow pack) show a marked decline since 1950 almost everywhere in the Cascades. This decline exceeded 25 percent at most locations and tended to be greatest at the lower elevations.

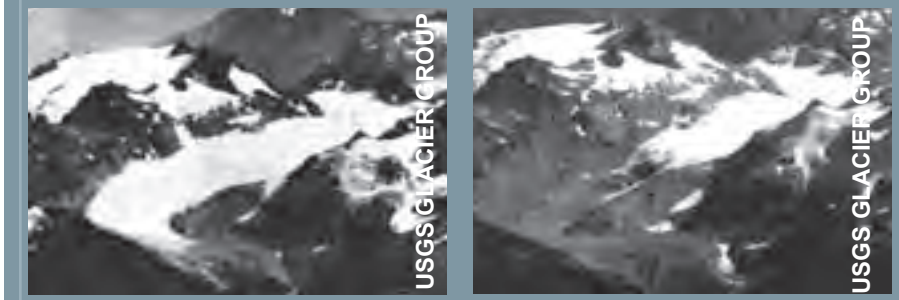
TRENDS

If average temperatures rise approximately 4.1 degrees by as early as 2040 (but more likely later in the century), runoff from October through March might increase by about 25 percent, and runoff from April through September might decrease by 21 percent. These changes would increase the risk of flooding, change the circulation in the Sound and create higher water temperatures in streams, rivers and estuaries.

PHOTOS: Mount Rainier at Myrtle Falls. | Shutterstock.com/Micheal Thompson. (indicator) Ski lift. | Shutterstock.com/David Gaylor.

Glaciers in retreat

Because of global warming, nearly every glacier in the Cascades and Olympics has retreated during the past 50 to 150 years. Small glaciers are disappearing rapidly, and glacial mass on the larger ones has been reduced. In the higher reaches of certain river basins, such as the Nooksack, and on some tributaries of the Skagit, melting glaciers provide a substantial portion of stream flow in late summer. This is also true for the Nisqually River, which is fed by receding glaciers on Mt. Rainier. Glaciers have significant local effects on stream temperature and water supply for aquatic plants and animals.



The South Cascade Glacier from the same viewpoint in 1928 and 2000. Not only has the glacier retreated substantially, leaving behind a meltwater lake, it has also thinned at higher elevations. *Courtesy of Dr. Ed Josberger, USGS Glacier Group, Tacoma, WA.*

Local governments lead the way

Local governments have stepped up to the growing challenge of climate change.

In February 2005, Seattle Mayor Greg Nickels challenged fellow mayors across the country to join with his city in pledging to meet or exceed the Kyoto Protocol's emissions-reduction goals. So far, more than 300 mayors representing 51 million Americans in 46 states have signed the U.S. Mayors Climate Protection Agreement.

Seattle completed a climate action plan that aims, by 2012, to reduce greenhouse gas emissions to seven percent below 1990 levels, a goal equivalent to the Kyoto Protocol, which was not signed by the United States.

King County has also taken a leadership role on this issue, setting up a climate response action team, compiling an inventory of King County air emissions, preparing the county to enter into a carbon-trading market, accelerating the use of biodiesel fuel in buses, and producing electricity from methane at the Cedar Hills Landfill.

The county is also co-authoring a guidebook to help local and regional governments plan for the changes resulting from global warming. The guidebook will be published by Local Governments for Sustainability and distributed to its 193 U.S. member cities, towns and counties.

The Action Team's work on CLIMATE

What we said we would do

Climate change will have significant impact on the Puget Sound ecosystem and food web as well as on those of us who live here. To plan for this growing threat, the Action Team recently began work on some projects to better understand the implications for Puget Sound.

What's been done

1. In October 2005, the Action Team released the first climate change report focused solely on the Puget Sound area: *Uncertain Future: Climate Change and Its Effects on Puget Sound*. The report, which can be found at www.psat.wa.gov/climatechange, was developed by UW's Climate Impacts Group. It presents existing and predicted changes in Puget Sound's climate and sea level, and outlines a wide range of possible impacts to the Sound's ecosystem.

2. The state formed an interagency climate change group to coordinate a statewide response to climate change and the reduction of greenhouse gas emissions. Agencies will also work with the public and local governments to help them prepare.

Action needed on CLIMATE

The consequences of a warmer world will make sustaining Puget Sound ecosystems increasingly difficult.

Climate change cannot be fixed within a short period of time even if we had the necessary commitment and funding. Because of lags in the climate system, warming and sea level rise will continue for centuries, regardless of whether we can stabilize and reduce concentrations of greenhouse gases in the atmosphere today. And we are nowhere near achieving stabilization, much less reduction.

The ultimate impacts of climate change in Puget Sound depend on future levels of greenhouse gases, but also to some degree on the choices we make to prepare for those impacts. Because it is likely that climate change will severely disrupt the physical and biological environment of Puget Sound, we need to be prepared. We must:

- **Treat climate change as a serious threat.** We cannot ignore or deny this threat to our region. Climate change is already here and will create significant challenges far into the future.

- **Develop the local and regional capacity to manage risks.** We need to greatly enhance our institutional capacity to manage climate change. Government agencies at all levels need continually updated information on the projected impacts of climate change so they can adequately prepare for the future, ensuring that key investments and management activities can cope with projected changes.

- **Continue to improve our knowledge.** Although we do not know the exact scope and impact of the risks, we need to expand and sustain our regional expertise on the emerging climate change science and information, and create systems to adopt emerging science into management as rapidly as possible.

- **Monitor regional climate and ecosystems for ongoing change.** To understand these changes as they occur, and to improve our predictive capacity, we need to regularly monitor the key indicators of climate change.

CONCLUSION

The past two years have seen some good news and positive trends. Yet the future of Puget Sound remains at risk. The Sound's overall trajectory, as charted in this report, continutes to be one of decline, with continuing harms to the clean water, abundant habitat and intact natural processes that are the foundations of a healthy environment.

The pace of growth in the region, coupled with associated increases in impervious surfaces, alteration and loss of habitat, and pollutants in the air and water, continue to drive a silent crisis. While the Sound appears beautiful, its web of life is at risk.

To continue our current path will mean further losses in the Sound's wildlife such as the orca, rockfish and marine birds as well as the loss of opportunities to enjoy the Sound through harvesting of oysters and clams, swimming at its beaches and watching the salmon swim upstream to spawn.

CANDICE CUSACK

PHOTOS: (top to bottom) Gravel shoreline at Fort Worden State Park. | Rae A. McNally; Paddling a kayak across a Puget Sound bay. | Shutterstock.com/Alan Heartfield; (opposite page) Winter dawn, Seattle. | Shutterstock.com/Candice Cusack.

But a healthy Puget Sound is within our reach if we make significant changes in the way we develop the land, use resources and dispose of our wastes. We must manage our own behaviors and activities in ways that protect public resources and our natural heritage. The choices are ours, but they are not easy ones to make.

There are, however, reasons to be optimistic. The past two years have seen many important improvements. The achievements are the result of the work of thousands of people throughout the region who dedicate their time and energies to the protection and restoration of Puget Sound. We greatly appreciate their contributions. Their work has been essential to the preservation of a functioning ecosystem.

As we continue to make strides in reducing our impact on the environment, the playing field is always changing. As known threats are reduced or eliminated, new threats and challenges emerge. For example, flame retardants in fish, mammals and people was a compound we did not even track a decade ago.

Protecting and restoring a complex and dynamic ecosystem like Puget Sound, with an equally complex and dynamic human civilization threaded throughout, is a permanent challenge. We will never reach the point where the Sound is “recovered” and we can turn our attentions to something else. Sustaining a healthy Puget Sound requires perpetual effort and vigilance.

In the final analysis, saving Puget Sound is not just about Puget Sound. What affects Puget Sound affects our lives and our future as well. Taking care of Puget Sound is taking care of our homes and our economy. It is taking care of the place that gives us shelter, provides food, maintains our health and makes our lives richer.

Taking care of Puget Sound is also taking care of the most important legacy we have to give to our children and grandchildren. We do not own Puget Sound, we have only borrowed it from our children and grandchildren. We owe it to them to pass on the Sound in a healthy and thriving condition.

PHOTOS: (top to bottom) Passengers on a ferry in Central Puget Sound. | Shutterstock.com/Cliff Deputy; Barge on Thea Foss Waterway, Tacoma. | Rae A. McNally.

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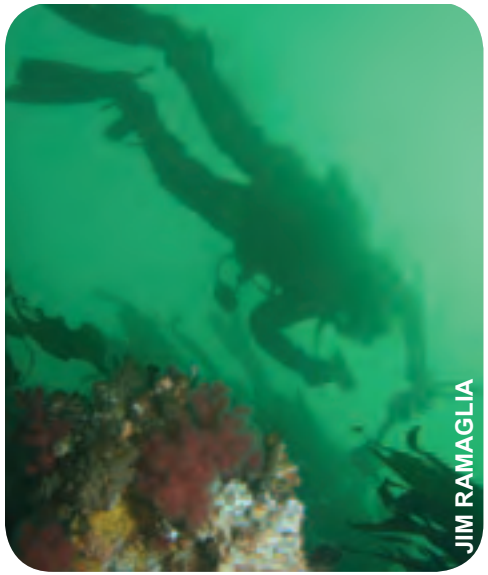
PHOTOS: (top to bottom) Lighthouse in Port Townsend, Washington. | Shutterstock.com/Natalia Bratslavsky; Anenomes. | Jennifer Vanderhoof.



PHOTOS: (top to bottom) Tacoma waterfront. | Shutterstock.com/Lawrence Freytag; Diver. | Jim Ramaglia.

GUIDE TO TERMS

PUGET SOUND ACTION TEAM

Action Team staff	Puget Sound Action Team staff
Action Team Members	Puget Sound Action Team Partner Members
PIE Fund	Public Education and Involvement Fund
PSAMP	Puget Sound Assessment and Monitoring Program

WASHINGTON STATE AGENCIES

Agriculture	Department of Agriculture
CTED	Department of Community, Trade and Economic Development
DOH	Department of Health
DNR	Department of Natural Resources
Ecology	Department of Ecology
IAC	Interagency Committee
OFM	Office of Financial Management
State Parks	Washington State Parks and Recreation Commission
WDFW	Department of Fish and Wildlife
WSDOT	Department of Transportation

FEDERAL AGENCIES

DFO	Department of Fisheries and Oceans (Canada)
EPA	Environmental Protection Agency
NOAA	National Oceanic and Atmospheric Administration
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service

LOCAL AGENCIES AND ORGANIZATIONS

AGC	Association of General Contractors
CD	Conservation District
CREP	Conservation Reserve Enhancement Program
HCDOP	Hood Canal Dissolved Oxygen Program
NWSC	Northwest Straits Commission
PSRF	Puget Sound Restoration Fund
WFWC	Washington Fish and Wildlife Commission

ACADEMIC INSTITUTIONS AND PROGRAMS

Sea Grant	University of Washington Sea Grant Program
UW	University of Washington
WWU	Western Washington University
WSU Extension	Washington State University Cooperative Extension

OTHER ACRONYMS

ANS	Aquatic nuisance species
BMP	Best management practices
CAO	Critical Areas Ordinance
CSO	Combined sewer overflow
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved oxygen
dw	dry weight
ESA	Endangered Species Act
GMA	Growth Management Act
IMW	Intensively Monitored Watershed
LID	Low impact development
LOTT	Municipal wastewater utility for Lacey, Olympia, Tumwater and Thurston County
Mgd	Million gallons per day
PAHs	Polycyclic aromatic hydrocarbons
PBDEs	Polybrominated diphenyl ethers
PBTs	Persistent, bioaccumulative toxins
PCBs	Polychlorinated biphenyls
ppm	Parts per million
ppb	Parts per billion
NPDES	National Pollutant Discharge Elimination System
SMA	Shoreline Management Act
SMP	Shoreline Master Programs
SWE	Snow water equivalent
TMDL	Total maximum daily load
WQI	Water quality index
WRIA	Water resource inventory areas

PUGET SOUND ACTION TEAM MEMBERS

The Puget Sound Action Team has 17 members: a city and a county representative; a representative of federally recognized tribes; ex-officio representatives of three federal agencies; the heads of 10 state agencies involved in carrying out the *Puget Sound Water Quality Management Plan* and a chair appointed by the Governor. The Action Team:

- Develops a biennial work plan and budget.
- Periodically amends the *Puget Sound Water Quality Management Plan*.
- Coordinates the monitoring and research programs.
- Coordinates implementation of the *Puget Sound Water Quality Management Plan*.

Brad Ack, Director, Puget Sound Action Team

Ken Berg, Manager, U.S. Fish and Wildlife Service *

Mark Clark, Executive Director, Washington State Conservation Commission

Rex Derr, Director, State Parks & Recreation Commission

Laura E. Johnson, Director, Interagency Committee for Outdoor Recreation

Jeffrey Koenings, Director, Department of Fish & Wildlife

Elin D. Miller, Regional Administrator, U.S. Environmental Protection Agency

Bob Lohn, Regional Administrator, NOAA Fisheries

Valoria Loveland, Director, Department of Agriculture

Doug MacDonald, Secretary, Department of Transportation

Jay Manning, Director, Department of Ecology

Joan McGilton, Mayor of Burien, Representing City Government

Francea McNair, Aquatics Steward, Department of Natural Resources

Dan McShane, Whatcom County Council, Representing County Government

Mary Selecky, Secretary, Department of Health

Juli Wilkerson, Director, Department of Community, Trade and Economic Development

Daryl Williams, Director, Department of the Environment, Tulalip Tribes, Representing Tribal Government

PUGET SOUND COUNCIL

The Puget Sound Council has 12 members: seven appointed by the Governor and four legislators. The director of the Action Team also chairs the Council. The Council:

- Advises the Action Team on work plan projects and activities, and on coordination with other state and local activities.
- Reviews progress on implementation of the *Puget Sound Conservation and Recovery Plan*.
- Recommends changes to the *Puget Sound Water Quality Management Plan*, as needed.
- Tracks the progress of state agencies and local governments in implementing the work plan.

Brad Ack, Director, Puget Sound Action Team

Kenneth A. Dahlsted, Skagit County Commissioner, Representing County Government

Bill Dewey, Taylor Shellfish Co., Inc., Representing the Shellfish Industry

Sen. Karen Fraser, (D-Olympia), Representing the State Senate *

David Herrera, Skokomish Tribe, Representing Tribal Government

Doug Mah, City of Olympia council member, Representing City Government

Vacant Position, Representing the State House

Scott McCreery, Representing Business

Sen. Dan Swecker, (R-Rochester), Representing the State Senate

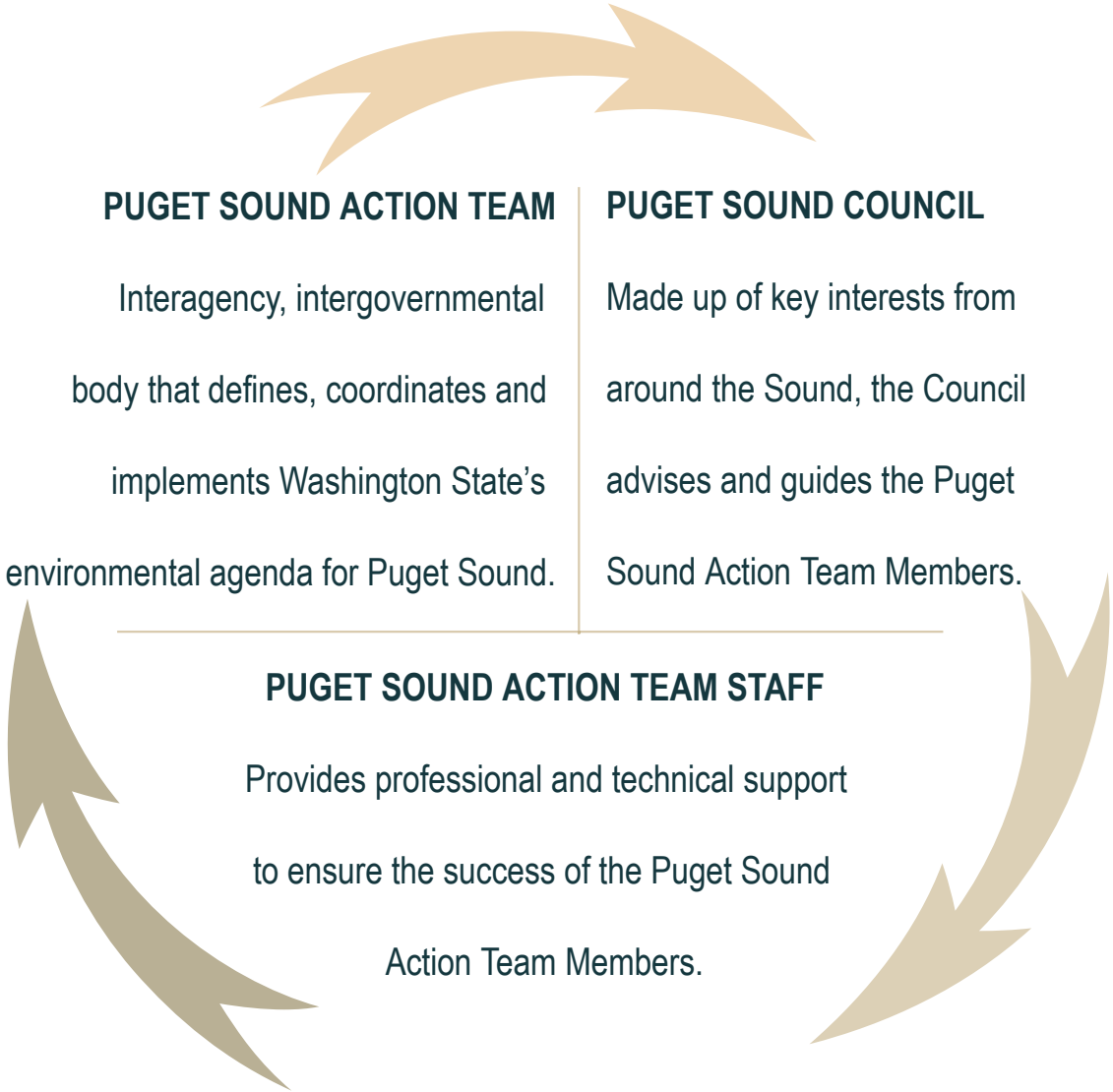
Naki Stevens, People for Puget Sound, Representing the Environmental Community

Jerry VanderVeen, Representing Agriculture

Christine Rolfes, Representing the State House *

** non-voting members*

PHOTOS (top to bottom): Kamilche, south Puget Sound. | Duane Fagergren; Central Puget Sound shoreline. | Toni Droscher.



PUGET SOUND ACTION TEAM

Interagency, intergovernmental body that defines, coordinates and implements Washington State's environmental agenda for Puget Sound.

PUGET SOUND COUNCIL

Made up of key interests from around the Sound, the Council advises and guides the Puget Sound Action Team Members.

PUGET SOUND ACTION TEAM STAFF

Provides professional and technical support to ensure the success of the Puget Sound Action Team Members.

PUGET SOUND ACTION TEAM

Office of the Governor | State of Washington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