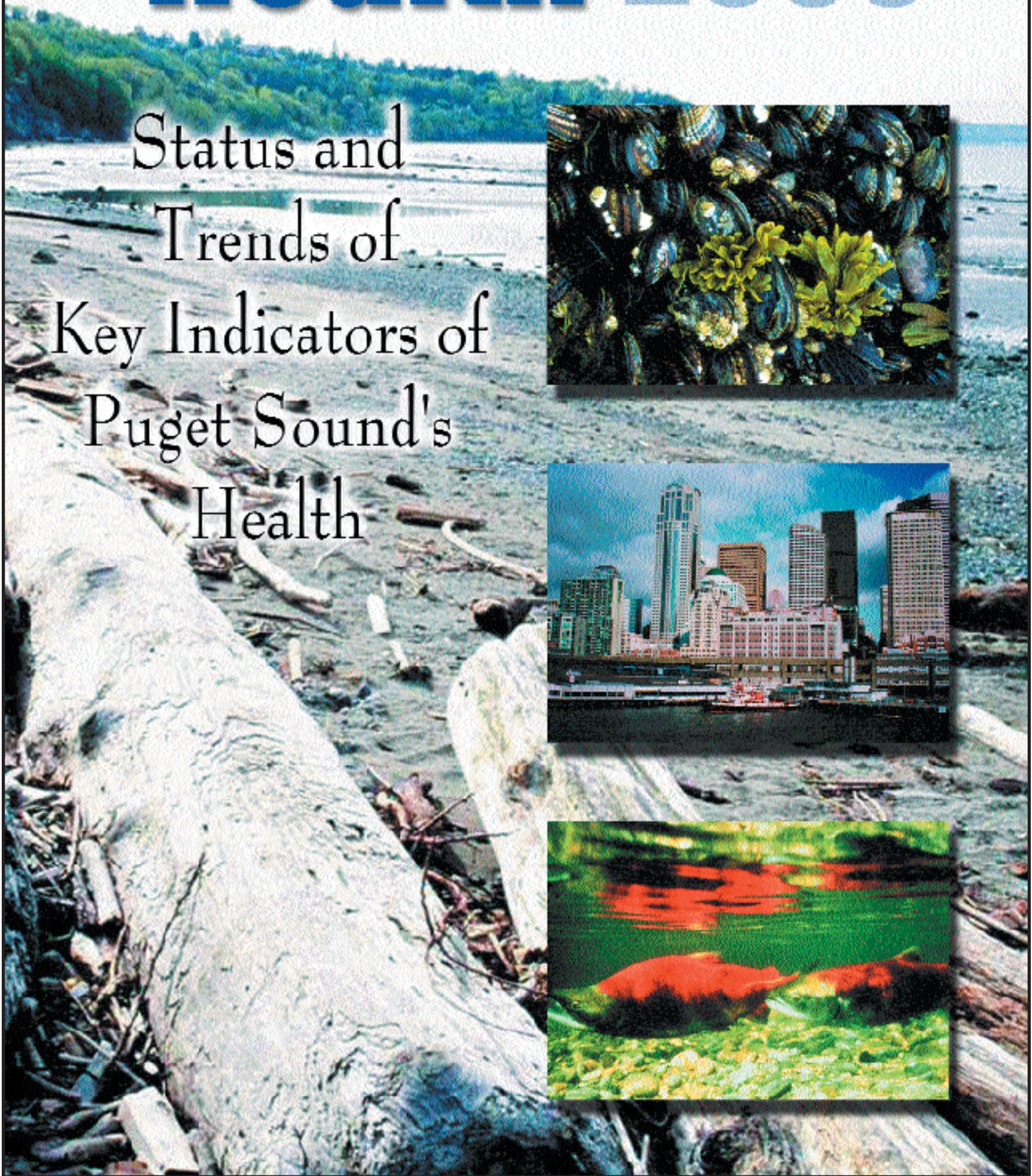
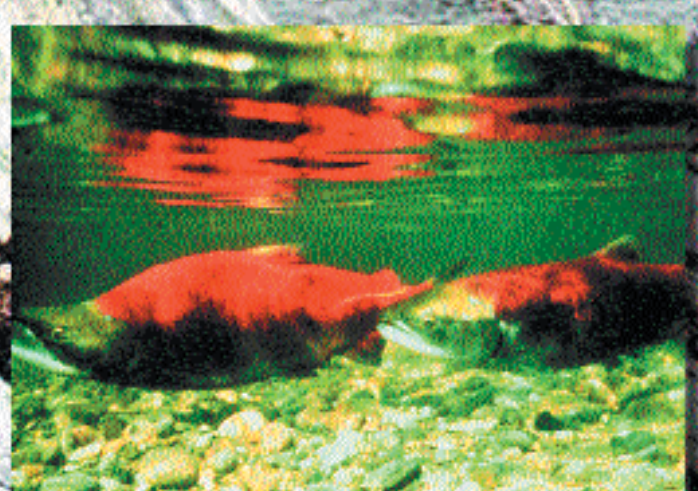


PUGET SOUND WATER QUALITY ACTION TEAM

Puget Sound's Health 2000

Status and
Trends of
Key Indicators of
Puget Sound's
Health





Puget Sound's Health 2000

This is the Puget Sound Water Quality Action Team's second report on key indicators of Puget Sound's health. This report has been prepared in response to the Washington State Legislature's request to evaluate efforts to protect Puget Sound. This second report includes updated information on the 12 indicators originally presented in 1998 as well as information on five new indicators.

The ultimate measures of the successes and shortcomings of our efforts to protect and restore Puget Sound are seen in the condition of the Sound and its biological resources. Environmental indicators serve as one measure of our performance.

Consider an analogy to medicine where Puget Sound is the patient and our efforts to protect and restore Puget Sound are the course of treatment. Environmental indicators are the "vital signs" that we use to measure the health of Puget Sound. We use these signs to tell us how the patient, Puget Sound, is doing, and whether our treatments—programs and actions—are working.

There are some difficulties and risks in presenting a small set of environmental indicators as measures of the performance of Puget Sound protection:

- The environment is continually changing. It is often difficult to determine whether changes observed in environmental indicators reflect natural factors (such as varying ocean conditions) or relate to human actions.
- Our actions and programs to protect and restore Puget Sound do not always have a simple relationship to environmental results. Multiple programs may interact to bring about changes observed in the environment. Actions taken today may not result in an environmental response for a number of years.
- The environmental indicators that we track and present in this document offer a simplified view of some of the many aspects of Puget Sound's health. Selection of a limited number of indicators necessarily limits the breadth and diversity of information that is presented. Converting data to simple indicators can sacrifice some of the richness of the underlying information. For more information on conditions in Puget Sound, visit the Action Team's web site or call us (contact information is presented on the inside of the back page) to obtain other publications about the condition of Puget Sound, including the *2000 Puget Sound Update*.

Despite these difficulties, we are committed to checking Puget Sound's "vital signs" and using this information to adapt and improve the "treatments" that we offer. An exact diagnosis and prescription is not always possible, but monitoring results often suggest management responses. For example, Puget Sound resource managers might change the requirements of wastewater or stormwater discharge permits based on information about patterns of contamination; fish and wildlife managers might identify selected areas as "no take" zones to protect species in poor condition; or public health agencies might issue advice on consumption of Puget Sound fish and shellfish based on detected levels of contamination.

We hope that the environmental indicators presented on the following pages will help you understand Puget Sound's condition and draw some conclusions about the programs and actions being implemented to protect the Sound.



STATE OF WASHINGTON
 PUGET SOUND WATER QUALITY ACTION TEAM
 OFFICE OF THE GOVERNOR

Dear Puget Sound Resident,

Signs of environmental degradation from around Puget Sound suggest that continuing development in the basin is taking its toll on the Sound. Growth in the basin has changed the Puget Sound landscape. The amount of urban land in the four most populous counties of central Puget Sound (King, Kitsap, Pierce and Snohomish) doubled between 1970 and 1995.

Environmental degradation in Puget Sound has been documented for many years, including high levels of toxic contaminants in urban bays and waterways and widespread alteration of Puget Sound's estuaries and shorelines. Environmental indicators provide some signs that conditions may be worsening as the Puget Sound basin becomes increasingly developed:

- Levels of fecal contamination increased in Drayton Harbor and Burley Lagoon, both Puget Sound shellfish growing areas (in north and south Sound, respectively) where nearby lands were being developed for residential and commercial uses.
- Incidence of liver lesions in English sole in Elliott Bay (Seattle) increased, which may reflect increased levels of contamination, especially by PAHs (polycyclic aromatic hydrocarbons), from the Sound's most highly developed urban and industrial lands.

Numerous species that live in Puget Sound also appear to be in trouble, including Pacific herring, rockfish, coho salmon, scoters, Western grebes, great blue herons and orca whales. While some species (notably harbor seals) have fared relatively well in recent years, the number and diversity of species in poor or declining condition suggest widespread effects of habitat loss and degradation, harvest pressures cascading through the food web, or natural variations in the productivity of the marine system.

Our environmental indicators show that people's actions are damaging the Sound's land, water and marine life. This must change. Collectively, we must make wiser choices about how and where growth occurs in the basin. Individually, we must live and work in ways that better protect the health of the Sound.

Sincerely,

Nancy McKay
 Nancy McKay
 Chair

Puget Sound environmental indicators are designed to answer these questions:

1. Are areas where shellfish can be safely harvested increasing or decreasing?

- Area of classified commercial shellfish harvest beds approved for direct harvest (p. 4)
- Classification of recreational shellfish beaches (p. 5)

2. Is the quality of water for recreation improving or declining?

- River and stream monitoring stations where water quality standards for fecal coliform bacteria are exceeded (p. 5)

3. Are aquatic nuisance species increasing or decreasing in Puget Sound?

- Acreage of *Spartina* infestation (p. 6) - New indicator

4. Is the area of contaminated sediments increasing or decreasing?

- Area of contaminated sediments and number of clean up sites (p. 7)

5. Is toxic contamination of the marine environment increasing or decreasing?

- Contaminants in mussels (p. 8)
- PCB contamination in harbor seals (p. 8) - New indicator
- Occurrence of liver lesions in English sole (p. 9)

6. Are the size and frequency of oil spills increasing or decreasing?

- Volume and frequency of "major" and "serious" spills (p. 9)

7. Is fish and wildlife habitat increasing or decreasing?

- Freshwater habitat available to coho (p. 10)
- River and stream monitoring stations where water quality standards for temperature are exceeded (p. 11) - New indicator
- Marine waters sensitive to eutrophication (p. 11) - New indicator

8. Are fish and wildlife populations increasing or decreasing?

- Harbor seals (p. 12)
- Scoters (p. 12)
- Herring (p. 13)
- Rockfish (p. 13) - New indicator
- Salmon (p. 13)

Are you on our mailing list?

The Puget Sound Water Quality Action Team produces a number of informative publications about Puget Sound. Many of these publications can be accessed online.



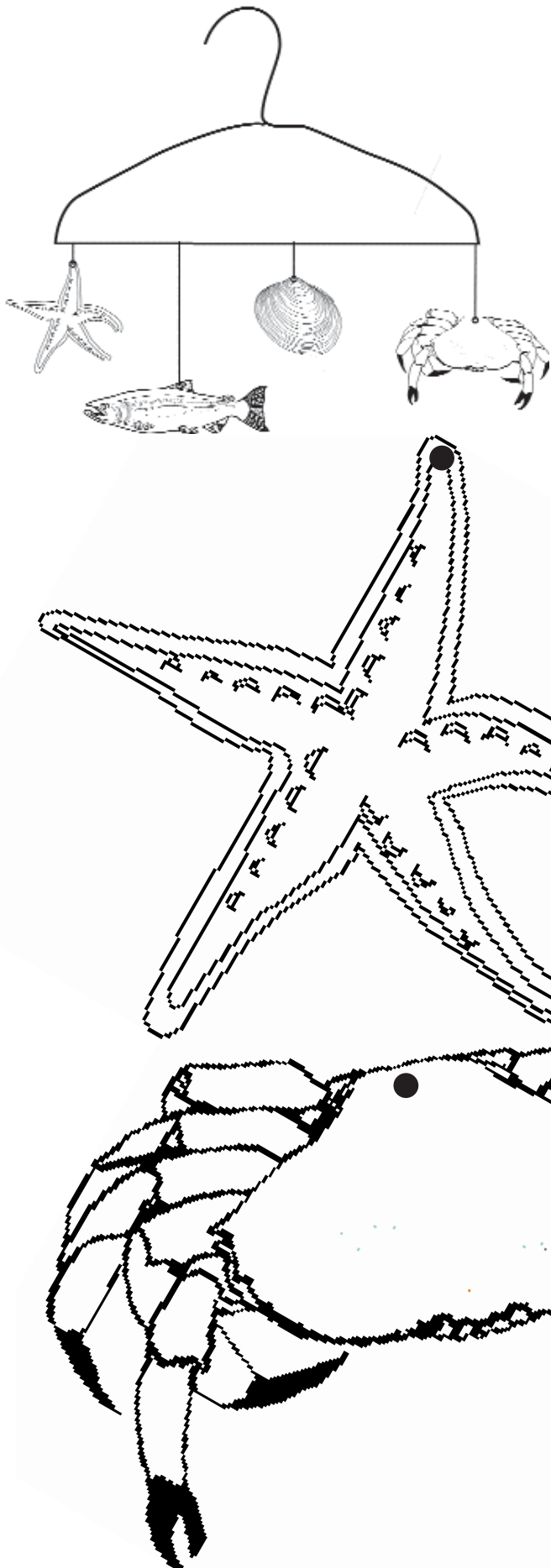
Waves is a quarterly publication featuring news from the Sound. Sign up and we'll send you an e-mail notification each time a new issue is posted online: http://www.wa.gov/puget_sound/feedback.html.

Puget Sound Notes is the Action Team's biannual newsletter on scientific research in Puget Sound. You can download the latest copy at: http://www.wa.gov/puget_sound/psnews/newsletters.html.

The Action Team also publishes fact sheets covering a variety of topics such as stormwater management, shellfish protection districts and scientific monitoring.

If you are interested in being placed on our mailing list, please contact Gigi Williams at 1 (800) 54-SOUND. You can also request fact sheets and other publications by pointing your browser to: http://www.wa.gov/puget_sound/pslibrary/requests.html.

Critters Under-the-Sea Mobile



Materials:

- Clothes hanger
- String
- Poster board
- One-hole punch
- Tape
- Glue or glue stick
- Crayons

Instructions:

- Cut out the sea life pictures on pages 14 and 15 (for best results, photocopy pictures onto heavier paper stock)
- If desired, color each picture
- Trace the outline of picture onto posterboard and cut out
- Glue picture to posterboard cutout
- Use a hole punch to make a hole where indicated on each picture
- Cut string to desired length and attach one end to the coat hanger; tie the end through the hole in the picture



Puget Sound Water Quality Action Team

Telephone:
1(800) 54-SOUND
or (360) 407-7300

http://www.wa.gov/puget_sound

For additional information contact the Puget Sound Water Quality Action Team member agencies:

Department of Agriculture
Telephone: (360) 902-1801
Home page: <http://www.wa.gov/agr/>

Department of Community, Trade and Economic Development
Telephone: (360) 753-2222
Home page: <http://www.cted.wa.gov/>

Department of Ecology
Telephone: (360) 407-6300
Home page: <http://www.wa.gov/ecology/>

Department of Fish and Wildlife
Telephone: (360) 902-2200
Home page: <http://www.wa.gov/wdfw/>

Department of Health
Telephone: (360) 236-4501
Home page: <http://www.doh.wa.gov/>

Department of Transportation
Telephone: (360) 705-7481
Home page: www.wsdot.wa.gov/eesc/environmental/

Department of Natural Resources
Telephone: (360) 902-1100
Home page: <http://www.wa.gov/dnr/>

Interagency Committee for Outdoor Recreation
Telephone: (360) 902-3000
Home page: <http://www.wa.gov/iac/>

National Marine Fisheries Service
Telephone: (206) 526-6150
Home page: <http://www.nwr.noaa.gov/>

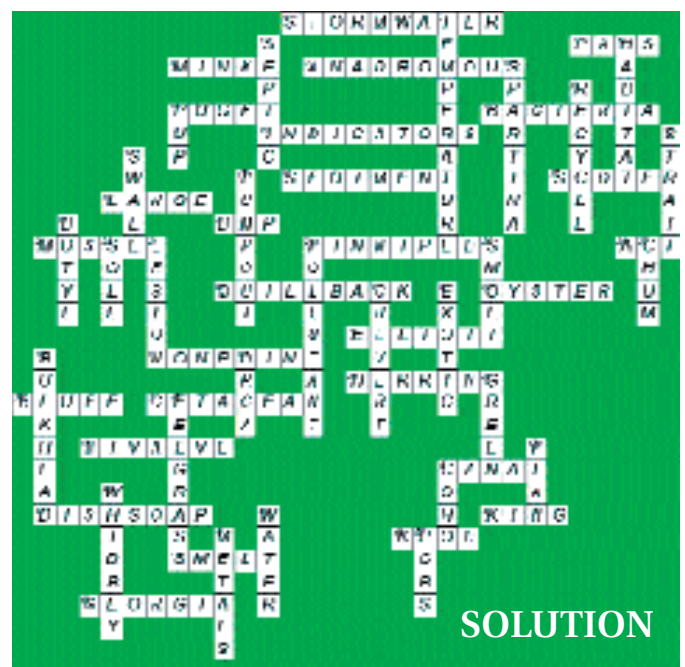
Northwest Indian Fisheries Commission
Telephone: (360) 438-1181
Home page: <http://www.nwifc.wa.gov/>

State Parks and Recreation Commission
Telephone: (360) 902-8511
Home page: <http://www.parks.wa.gov/>

U.S. Environmental Protection Agency, Region 10
Telephone: (206) 553-4423
Home page: <http://www.epa.gov/r10earth>

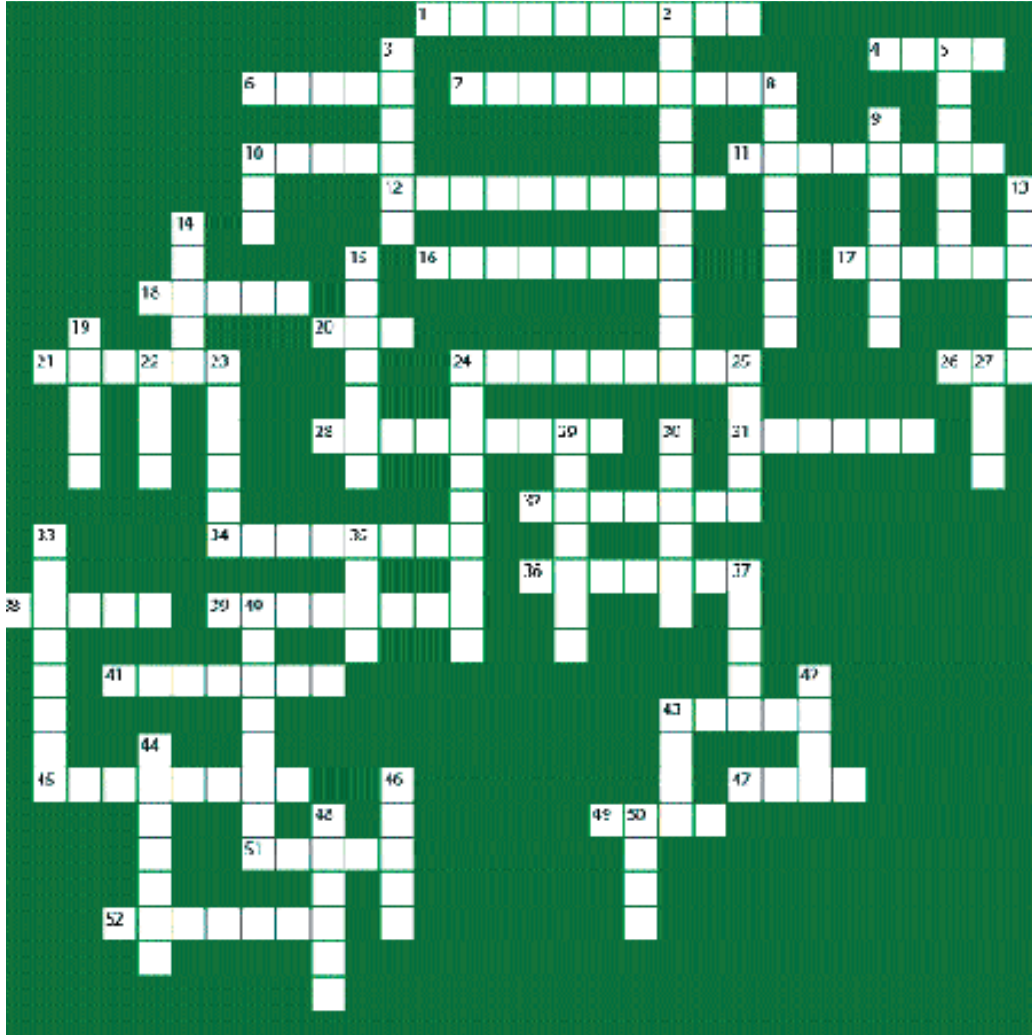
U.S. Fish and Wildlife Service
Telephone: (360) 753-9440
Home page: <http://www.r1.fws.gov/>

Washington State Conservation Commission
Telephone: (360) 407-6200
Home page: <http://www.conserver.org>



Puget Sound's Health 2000 Crossword Puzzle

(Some of the answers can be found in this publication. Others may need further investigating....)



Across:

1. Urban runoff
4. Polycyclic aromatic hydrocarbons
6. Smallest baleen whale
7. These types of fish migrate up rivers from the sea
10. Capt. Vancouver's friend Peter
11. Fecal coliform _____; indicator of human or animal waste
12. Key _____ are environmental "vital signs"
16. Bottom goo; mud
17. Abundant Puget Sound wintering web-footed bird
18. Sand _____; favorite food for big fish
20. Best Management Practice
21. Bivalve; fresh or saltwater
24. Seals and sea lions
26. Endangered Species ____; legislation to protect fish and wildlife
28. Declining rockfish
31. Edible bivalve
32. Seattle's bay
34. Diffuse pollution source
36. Forage fish
38. Feeds sediment to beaches; poker strategy
39. A whale, by any other name
41. Mollusk with a hinged shell
43. Hood _____
45. What you don't want to pour on an oil spill
47. Regal county
49. Puget Sound cetacean family
51. Surf _____; favorite salmon food
52. Basin or strait north of Puget Sound

Down:

2. Stream _____; thermal measure
3. _____ tank (sewage container)
5. Where things live
8. An invasive salt marsh grass
9. What you should do with used motor oil
10. Baby seal
13. Narrow passage connecting two large bodies of water
14. Grassy best management practice
15. Machine that removes boat waste
19. _____ tins; used in some paints
22. English _____; floundery flatfish
23. Abnormal growth on the liver
24. Waste material that contaminates
25. Young salmon
27. Dog salmon, by any other name; good buddy
29. Sometimes a barrier to fish passage; drain
30. _____ species; an aquatic nuisance
33. Shoreline armoring structure
35. Member of the dolphin family
37. _____ crab; predator from Europe
40. Underwater pasture; herring nursery
42. Management _____: a long-term strategy for protecting Puget Sound
43. Kind of salmon
44. Largest island in Puget Sound
46. Essential to all life
48. Weighty elements
50. Polychlorinated biphenyls

See SOLUTION on page 15.

Puget Sound Recipes

Steamed Clams or Mussels

(serves 2-3)

- 3-5 lbs. shell- (manila clams de-beard-mussels), washed
- 1/2 medium red onion, sliced
- 1 green onion, chopped
- Fresh thyme leaves or branches
- 4 cloves garlic, minced or pressed
- 2 cups good white wine
- 1/2 stick butter, unsalted
- Black peppercorns

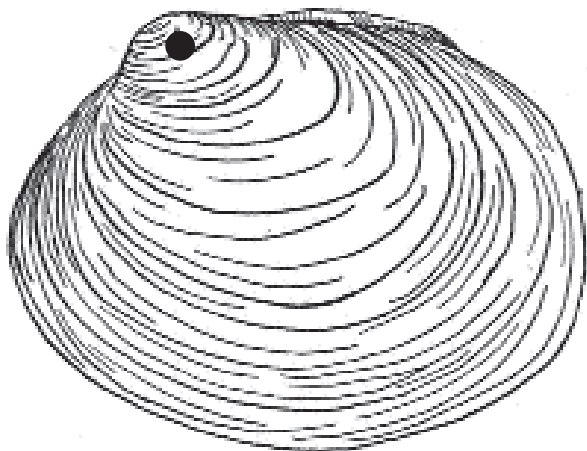
- a. Bring wine, peppercorns, green and red onions, butter and garlic to a boil in a large steaming kettle. Add shellfish and fresh thyme and bring to a boil again. Reduce heat slightly and cover kettle with a lid. Occasionally "shake" the pot, as if it were popcorn, and watch carefully (the lid could cause the kettle to boil over).
- b. Check the shellfish to make sure they have just steamed open. Do not overcook.
- c. Transfer mixture to a large serving dish or directly into individual serving bowls, making certain to transfer clam broth as well.
- d. Serve hot, with plenty of garlic bread to "sop up" the broth. White wine and fresh tossed salad should accompany.

Oyster Stew

(serves 2)

- 1 tbsp. olive oil
- 1 onion, diced
- 2 celery sticks, cut into small pieces
- 1 pint half-and-half cream
- White or black p e p - per pint small shucked Pacific Oysters (rinse in colander retaining oyster liquor, cut oysters into 3/4" cubes)
- Fresh parsley, finely chopped

- a. Saute onion and celery in medium-hot pan in 1 tablespoon of olive oil until transparent; season liberally with freshly ground pepper.
- b. In a separate pan, parboil oysters in their own liquor until the edges curl. Add onion and celery mixture to the oysters.
- c. Slowly add half-and-half to the oysters, stirring frequently so cream doesn't "break." Just before removing from heat, add fresh parsley to garnish.
- d. Serve hot with French bread or crackers.



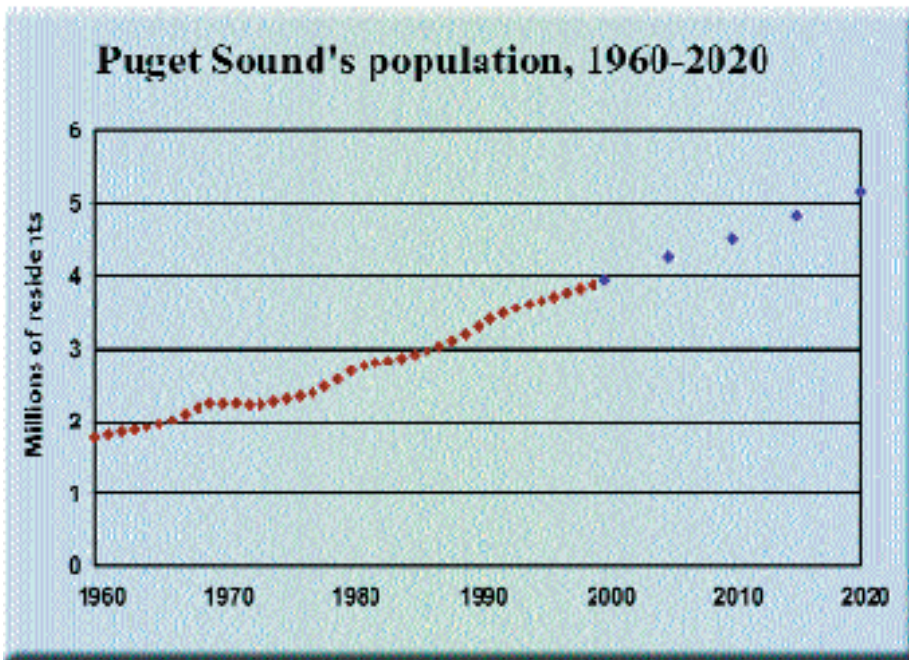
Puget Sound/ Georgia Basin



The shoreline of Puget Sound and the Georgia Basin is some of the most rugged and beautiful in the world. The protected marine waters of Puget Sound and the Georgia Basin provide invaluable habitat for fish and wildlife, including the region's renowned Pacific salmon and orca whales. The region supports one of the leading trade centers on the West Coast of North America and is a gateway to some of the continent's busiest ports.

Much of the promise and potential of this region is based on natural resources and the industries, tourism and recreation that these resources support. The region's potential has led to booming economic growth, resulting in ever-increasing numbers of people who live and work here. In 1999, the Puget Sound portion of the basin was home to nearly 3.9 million people—double the population of the mid-1960s. Puget Sound's population is now growing by about 50,000 people per year (1.5 percent per year) and is expected to reach 5 million people before 2020.

A growing population means increasing stress on Puget Sound. For instance, the number of miles driven around and through the central Puget Sound region has been growing at about the same pace as the population. The more miles driven on Puget Sound's highways and roads, the greater the possibility of spills of oil and petroleum products and the greater potential for contamination of runoff from highways, roads and parking lots.



Source: Office of Financial Management, 1999

The Puget Sound Water Quality Action Team and the Puget Sound Council

The Puget Sound Water Quality Action Team works with federal, state, tribal and local governments, citizens and businesses to develop and carry out two-year work plans that guide protection of water quality and biological resources. The biennial work plans are based on the *Puget Sound Water Quality Management Plan*, which outlines the state of Washington's long-term strategy for protecting Puget Sound.

Members of the Action Team include a chair appointed by the governor; representatives of a federally-recognized tribe, a city and a county, each appointed by the governor; the heads of ten state agencies; and the regional heads of the U.S. Environmental Protection Agency, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service.

The Puget Sound Council advises the Action Team on work plan projects and activities, and on coordination with other state and local activities. Council members are responsible for tracking the progress of state agencies and local governments in carrying out the biennial work plan. They also recommend changes to the *Puget Sound Water Quality Management Plan* as needed.

Eight of the Council's members are appointed by the governor. They include the chair of the Action Team, who also serves as chair of the Council, and representatives of agriculture, business, cities, counties, the environmental community, the shellfish industry and tribes. Four additional members of the Council are legislators selected by the leadership of the state Senate and House of Representatives.



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If you need this report in alternative format—large Braille or cassette tape—contact the Action Team's representative at 360-407-



soy-Jill

a n print, please A D A 7306.



Are areas where shellfish can be safely harvested increasing or decreasing?

Shellfish are prized symbols of the health and heritage of Puget Sound. Clams, oysters and other bivalve shellfish have long sustained the region's human population while also serving critical functions in the marine ecosystem.

Puget Sound has some of the most productive bivalve shellfish-growing areas in the entire nation. In 1998, the Puget Sound shellfish industry produced nearly 50 million pounds (live weight) of bivalve shellfish with a wholesale value of nearly \$50 million.

Why are shellfish harvest areas a good indicator of Puget Sound's health?

Bivalve shellfish, which feed by filtering large quantities of water, can accumulate bacteria, viruses and other contaminants from the water in which they live. The accumulated contaminants can harm any animals, including humans, that eat shellfish. The state Department of Health classifies shellfish-growing areas in an effort to ensure the safety of any Puget Sound shellfish that reaches seafood markets, restaurants or our kitchens. The classification of shellfish-growing areas provides information about the extent to which contamination restricts our ability to harvest some of the bounty of the Sound's natural resources.

commercial

status

Historically, shellfish have been harvested throughout Puget Sound, but the region's growing population and changing land uses have dramatically reduced the number of areas suitable for safe shellfish harvesting. Pollution has made shellfish harvesting impractical or unsafe at scattered sites across the region and along the Sound's heavily populated east shore from Everett to Tacoma.

Commercial shellfish acreage in Puget Sound, as measured over the past 20 years, totals approximately 140,000 acres. Since 1980, nearly one quarter of the area available for direct commercial shellfish harvesting has been downgraded in classification because of bacterial contamination.

The loss of significant growing areas in the late 1980s reflected both water quality conditions as well as downgrades resulting from the collection of additional monitoring information under the *Puget Sound Water Quality Management Plan*.

Commercial shellfish growing area classifications.

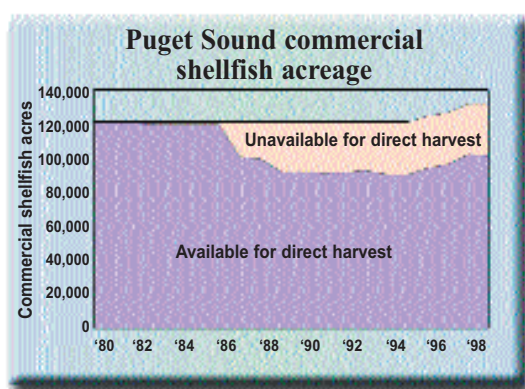
The state Department of Health classifies all commercial growing areas using National Shellfish Sanitation Program standards. State law prescribes a similar classification for recreational shellfish areas.

- **Approved** - harvested shellfish can be marketed directly with no restrictions placed on harvest due to contamination or sanitary conditions.
- **Conditionally Approved** - harvested shellfish can be directly marketed only during prescribed periods. Predictable pollution events, such as storms, close harvest for a specified period based on local conditions.
- **Restricted** - harvested shellfish cannot be marketed directly due to contamination. Shellfish must be moved to clean waters for a period of time prior to market distribution.
- **Prohibited** - shellfish cannot be harvested due to contamination or unsanitary

trends

During the 1990s, the area available for direct commercial shellfish harvest remained fairly constant. In recent years, the total acreage available for direct harvest has increased,

but much of this increase was achieved by the addition of previously unclassified areas.



Source: Department of Health, 1999

Improvements in water quality have contributed to growing area upgrades at several locations over past two years, including Eld Inlet (south Puget Sound), Port Gamble Bay (central Puget Sound), Bay (northern Puget Sound) and Sequim Bay (north Puget Sound). However, these gains were offset in grades in Burley Lagoon (south Puget Sound) and Drayton Harbor (north Puget Sound).

What affects contamination of shellfish growing areas?

Contamination of shellfish growing areas is assessed by examining potential pollution sources and measuring levels of fecal coliform bacteria in marine waters. The bacterial indicator reflects the presence of human or animal waste, which potentially carries disease-causing bacteria and viruses. Human and animal wastes can enter Puget Sound from many sources, including improperly treated sewage, poorly managed farms, stormwater runoff, failing or poorly operating on-site sewage systems and discharges from boats. In some cases, wastes from wild animals—birds and terrestrial and marine mammals— can degrade water quality and threaten areas where shellfish are grown.

Harvest of shellfish is also restricted when levels of naturally occurring toxins, such as the toxin that causes paralytic shellfish poisoning, are high. High levels of naturally occurring toxins don't appear to be related to contamination, but this relationship is not well understood.



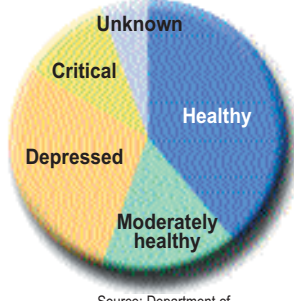
Harvest of shellfish in Puget Sound has increased since 1999, but much of this increase was achieved by the addition of previously unclassified areas.

status

There are 18 known stocks of herring in Puget Sound; seven are not faring well, ten are at least moderately healthy and one is in unknown condition.

The status of herring stocks in Puget Sound is worse than previously reported. The number of stocks in the depressed and critical categories more than tripled between 1994 and 1998. Herring stocks in the north Sound and the Strait of Juan de Fuca have fared worse than stocks that spawn in central and south Puget Sound.

Following a status review begun in 1999, the National Marine Fisheries Service may propose to list Puget Sound Pacific herring as threatened or endangered under the



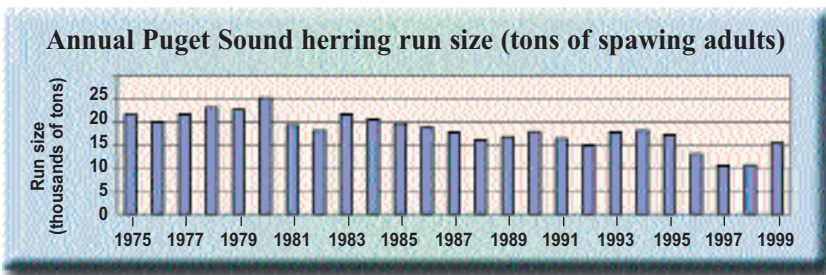
Source: Department of Fish and Wildlife, 1999

Forage fish

Pacific herring are important prey for a number of fish, birds and mammals in Puget Sound. Herring, and other small marine fish such as sand lance and surf smelt, are called "forage fish" because they are the food of many other organisms. Pacific herring are among the most common Puget Sound prey for spiny dogfish, coho and chinook salmon, western and red-necked grebes, red-breasted mergansers, common and arctic terns, rhinoceros auklets, Dall's porpoises and harbor seals.

trends

The total herring population in Puget Sound has declined considerably since 1975. This overall decline is largely attributed to the poor condition of the Cherry Point stock, which declined from a high of 15,000 tons to a low of 1,200 tons between 1973 and 1999—a 92 percent decrease in the stock during that time period.



Source: Department of Fish and Wildlife, 1999

What affects herring?

Herring stocks may be affected by a number of stressors. Low numbers of spawning herring may be related to:

- Changing predation by species such as harbor seals and Pacific hake
- Changing water conditions, such as varying temperature, salinity and dissolved oxygen
- Changing food supplies
- Alteration of critical nearshore habitat, especially eelgrass beds
- Harvest levels



Pacific herring

rockfish

status

Most rockfish stocks throughout Puget Sound are characterized as depressed based on declining success of recreational fishers in catching rockfish and declines in the spawning potential of rockfish.

In response to a petition from a local fisheries scientist, the National Marine Fisheries Service is conducting a status review of Puget Sound marine fish including copper, quillback and brown rockfish. This review will allow the Service to make decisions about listing these species as threatened or endangered under the federal Endangered Species Act.



trends

Rockfish spawning potential has declined approximately 75 percent from levels seen in the 1970s. Fisheries managers consider a decline in spawning potential of more than 60 percent a serious sign of population stress.

What affects rockfish spawning potential?

The condition of a stock can be measured by its potential to produce offspring, or its "spawning potential."

Spawning potential declines when there are fewer fish of spawning age or when the reproductive output of individual fish is lower. Larger rockfish produce many more offspring than do younger fish. Spawning potential for rockfish in Puget Sound has declined, in part because of the loss of larger, highly productive fish from the population.

Scientists have suggested that overharvesting by commercial and recreational fishers is the most likely cause of the loss of larger rockfish. Other factors that may affect larger fish include contamination of the food web and disturbance of habitat.

status

Year-to-year variations in the production of young salmon (smolts) in any Puget Sound coho salmon stock can be very large depending on flow conditions throughout the year, numbers of returning (adult) spawners, habitat damage and interactions with other species. Recent smolt production around Puget Sound has ranged from record low levels (e.g., Deschutes River) to near average levels (e.g., Big Beef Creek) to record high levels (e.g., Skagit River).

Historically, about 24 percent of the coho that entered Puget Sound survived the marine portion of their life cycle to return to their spawning stream. Recent survival rates are much lower, reaching as low as one percent for coho returning to the Deschutes River in 1998.

Puget Sound coho smolt production - examples from three streams				
Stream	Low Production	High Production	Average Production	1998 Production
Big Beef Creek (Head Canal)	11,500	45,600	24,600	22,000
Deschutes River (south Puget Sound)	6,000	133,000	66,000	6,000
Skagit River	618,000	1,760,000	1,000,000	1,760,000

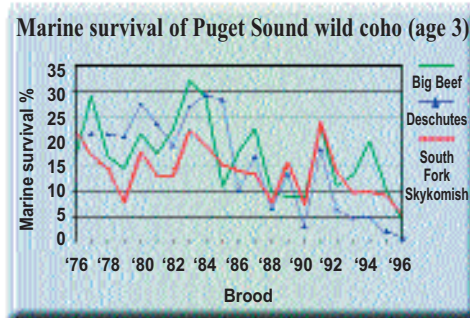
Source: Department of Fish and Wildlife, 1999

trends

Large year-to-year differences and stream-specific conditions make it difficult to discern trends in smolt production for Puget Sound coho. Slightly below average coho smolt production in Big Beef Creek in 1998 was probably due to disruption of eggs by extremely high water flows during the winter of 1996-1997. On the other hand, the record high production of the Skagit River coho stock in 1998 was probably supported by favorable year-round flows from a heavy snowpack in the winter of 1996-1997.

In recent years, marine survival of coho has been low for many Puget Sound stocks. For the eight broods produced from 1988 through 1995 (adults returning in 1991 through 1998, respectively), marine survival has declined to an average of around 10 percent.

Recent coho spawner returns to the Deschutes River are extremely low, reflecting low smolt production and the lowest marine survival rates ever measured. Concern over the poor condition of this and other south Sound salmon stocks has prompted a study of ecosystem relationships in south Puget Sound that will help to increase our understanding of the factors that are contributing to the high mortality of Puget Sound salmon in the marine environment.



Source: Department of Fish and Wildlife, 1999

salmon wild coho

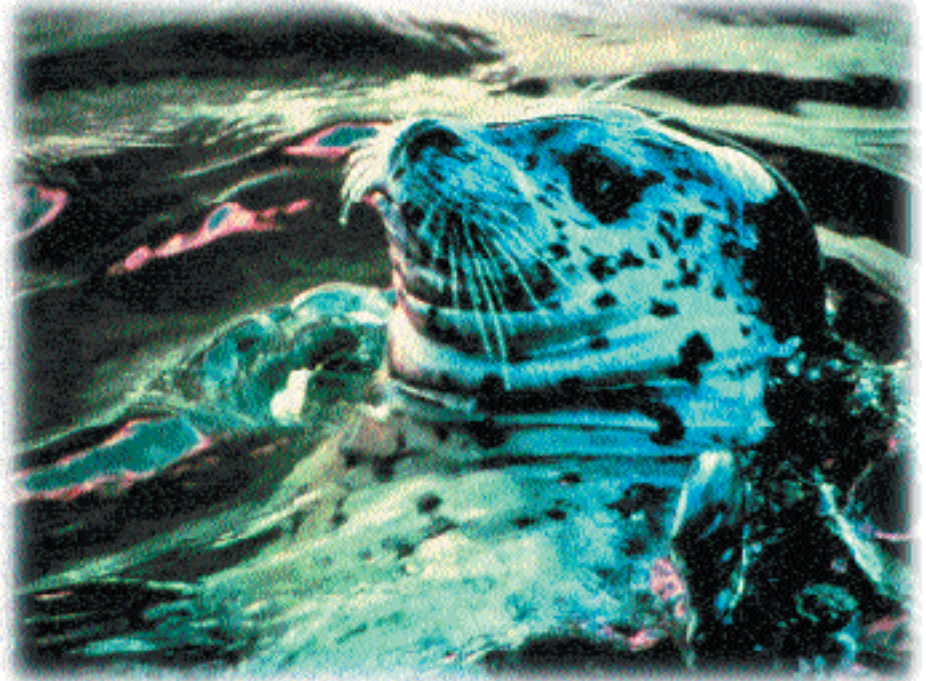


Are fish and wildlife **populations** increasing or decreasing?

Puget Sound is home to over 220 species of fish, 26 different kinds of marine mammals, 100 species of sea birds and thousands of species of marine invertebrates. Some species are migratory, while others remain in the Sound year-round. Some fish and wildlife populations are increasing, while others are decreasing. Species selected as indicators of Puget Sound's health include fish and wildlife that represent some of this diversity:

- Harbor seals
- Scoters (ducks)
- Pacific herring
- Rockfish
- Coho salmon

Pacific salmon and a number of marine fish species in Puget Sound are in peril. In 1999, chinook salmon in Puget Sound and summer chum salmon in Hood Canal were listed as "threatened" species under the federal Endangered Species Act. In early 2000, the National Marine Fisheries Service (NMFS) is expected to complete a review of the status of seven Puget Sound marine fish: Pacific herring, Pacific cod, Pacific hake, walleye pollock and three species of rockfish. Based on this review, the NMFS may propose listing these species under the federal Endangered Species Act.



harbor seals

status

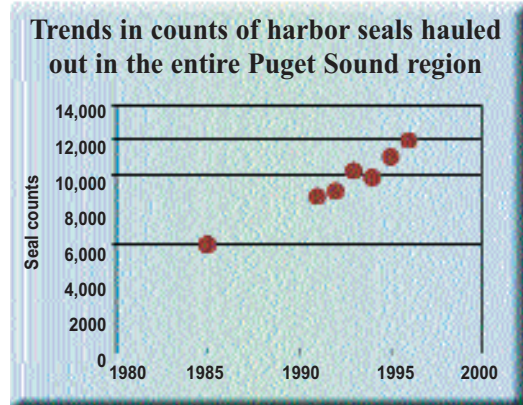
As of 1997, there were approximately 16,000 harbor seals living in the inland marine waters of Washington State. This estimate is based on counts of approximately 12,000 seals observed hauled out on the beach during surveys.



Source: Peter Haley/The News Tribune

trends

The population of harbor seals in Puget Sound has been growing since the 1970s. There is some evidence that harbor seal numbers in many areas have begun to level off in recent years. Nearly one-half of the harbor seals that live in Washington's inland marine waters are found in the San Juan Islands. Numbers there continue to increase.



Source: Department of Fish and Wildlife, 1999

What affects harbor seals?

Increasing harbor seal populations may be the result of:

- Protection from bounties or harvest by the Marine Mammal Protection Act of 1972
- Variable abundance of food resources like hake and herring
- Protection of pupping sites
- Decreasing levels of contamination

Harbor seals may be able to tolerate human disturbance better than other marine mammals in Puget Sound such as the harbor porpoise, which has disappeared from central and south Puget Sound in recent decades.

What affects scoters?

Scoters that spend the winter in the Puget Sound region migrate in the spring to nesting areas in Alaska and Canada. These ducks, which live fairly long lives and have moderate reproductive success in any given year, can be affected by:

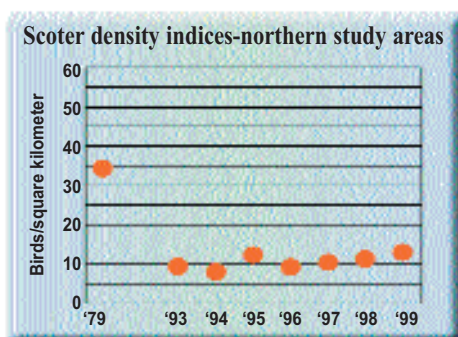
- High mortality among adults, possibly caused by lack of nutritious prey at critical times (e.g., scarcity of herring eggs prior to migration) or by hunting.
- Reproductive failure, possibly related to inadequate fat reserves caused by lack of nutritious prey;
- Natural environmental cycles, such as weather and ocean conditions related to shifts of the Pacific Decadal Oscillation; or

status

Scoters are the most abundant diving duck in Puget Sound during the winter. Winter densities of scoters in north Puget Sound are about 10 birds per square kilometer and about four times that number in south Puget Sound.

trends

Numbers of scoters wintering in Puget Sound through the 1990s were 40 to 70 percent lower than numbers observed 20 years ago.



Source: Department of Fish and Wildlife, 1999

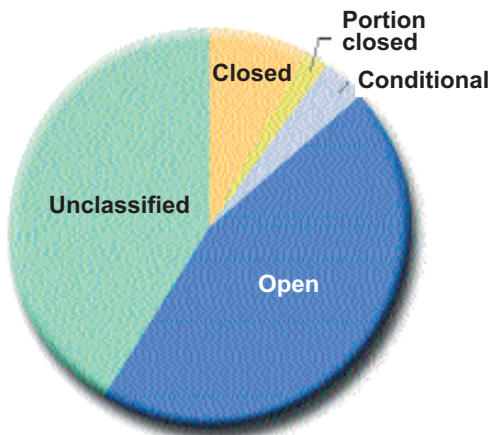


SCOTERS

Source: Jeff Skrlitz, Department of Fish and Wildlife

recreational

Most of Puget Sound's 1998 recreational shellfish harvest was taken from areas with good or unknown water quality



Source: Department of Health, 1999

status

Over 1,000 public recreational shellfish harvest areas line the shores of Puget Sound. In 1998, nearly 250,000 harvesters were observed collecting shellfish from these areas.

State and local health authorities are still working to assess water quality at recreational shellfish beaches. A number of beaches have not yet been assessed (they are "unclassified"). In 1998, about 100,000 people collected Puget Sound shellfish from "unclassified" areas. Consumption of shellfish from these beaches may or may not be safe. Another 20,000 Puget Sound harvesters were observed at areas classified as closed, which means harvesters were either unaware of, or disregarded, the closure advice.



Is the quality of water for recreation improving or declining?

Each year about 39 million acre-feet of water from more than 10,000 rivers and streams flows into Puget Sound. These rivers and streams provide recreational opportunities including paddling, fishing and swimming. River and stream water is considered safe for recreation when levels of fecal coliform bacteria remain below state standards.

Why measure bacterial contamination of rivers and streams?

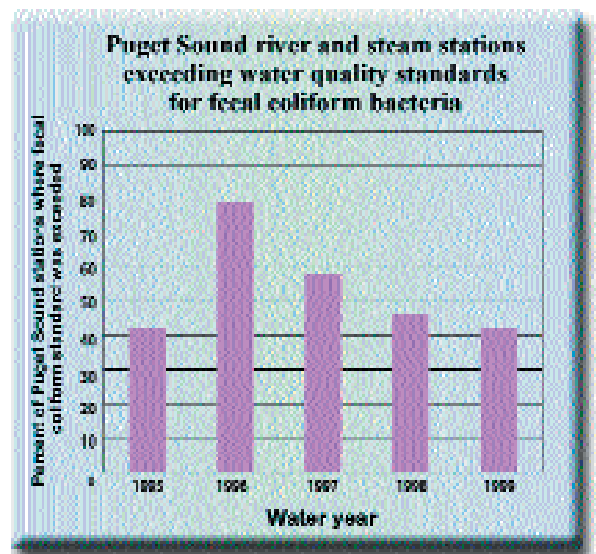
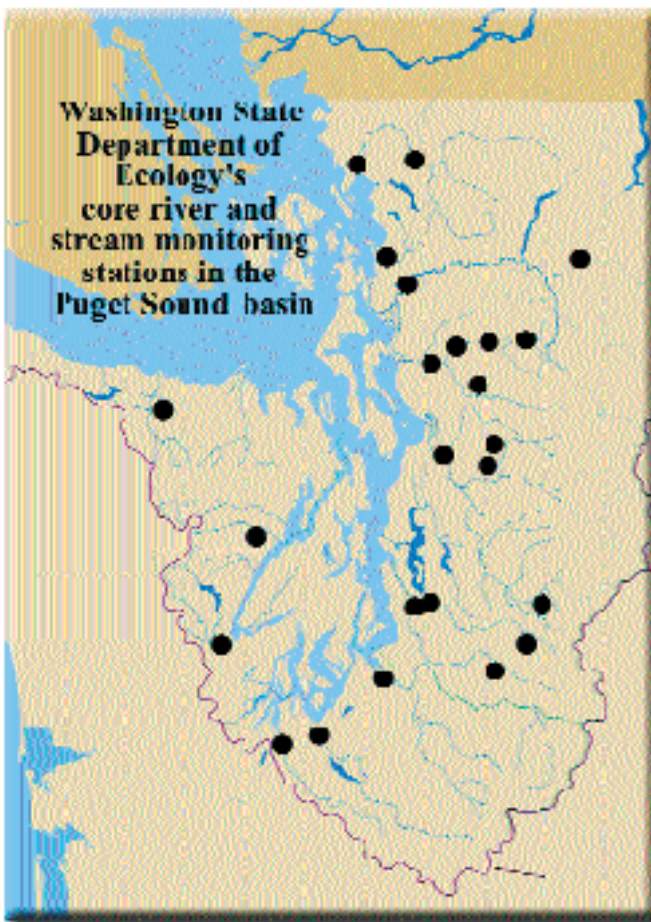
When recreational activities bring people into direct contact with contaminated water, people risk contracting water-borne diseases associated with human and animal wastes. Fecal coliform bacteria in the water indicate the presence of human or animal wastes and the possible presence of disease-causing organisms.

status

More than one half of the Puget Sound river stations monitored routinely for fecal coliform bacteria violate state standards. Monitoring is conducted monthly at 24 stations in major rivers around the Puget Sound basin. Using data from beyond these 24 long-term monitoring stations, the state Department of Ecology has identified 235 bodies of fresh water in the Puget Sound basin that are contaminated with fecal coliform bacteria. Ecology staff are developing cleanup plans (also called TMDLs or Total Maximum Daily Loads) to address these problems.

trends

Bacterial contamination in Puget Sound rivers varies considerably from year to year. No consistent trend over time has been observed. Each year from the mid-1980s to mid-1990s, between 40 and 100 percent of the routinely monitored stations on Puget Sound rivers exceeded the state standard for fecal contamination. Fecal contamination levels in Puget Sound rivers in 1995, 1998 and 1999 were at or near the lowest levels observed in the previous ten years. High levels of runoff in 1996 and 1997 may have carried more animal and human wastes into Puget Sound streams and caused the more widespread fecal contamination problems observed in those two years.



Source: Department of Ecology, 1999

Are aquatic nuisance species increasing or decreasing in Puget Sound?



The marine species that live in Puget Sound are continually changing as organisms expand their range around the globe and as ocean conditions in this area become favorable for them. A variety of human activities accelerate this process by providing pathways for the introduction of new species to the region. Pathways include discharge of ballast water, importation of species for agriculture and aquaculture, trade in live seafood, improper disposal of unwanted exotic organisms and transport of larvae in coastal ocean currents.

Some introduced species threaten native Puget Sound species and habitats and are considered nuisances. Aquatic nuisance species can cause extensive ecological and economic damage.

We have selected one invasive plant species—*Spartina*—as an indicator of the problem of aquatic nuisance species in Puget Sound. Other species of concern include the green crab and mitten crab, which have not yet been observed in Puget Sound but have damaged other West Coast areas, including San Francisco Bay.

1998 Puget Sound Expedition

In 1998, a group of scientists working with the state Department of Natural Resources completed the first survey of exotic species in Puget Sound. This effort identified 10 species not previously known to have invaded Puget Sound. These discoveries bring the number of exotic species in Puget Sound to 52. (See the 2000 Puget Sound Update for the list of species.)

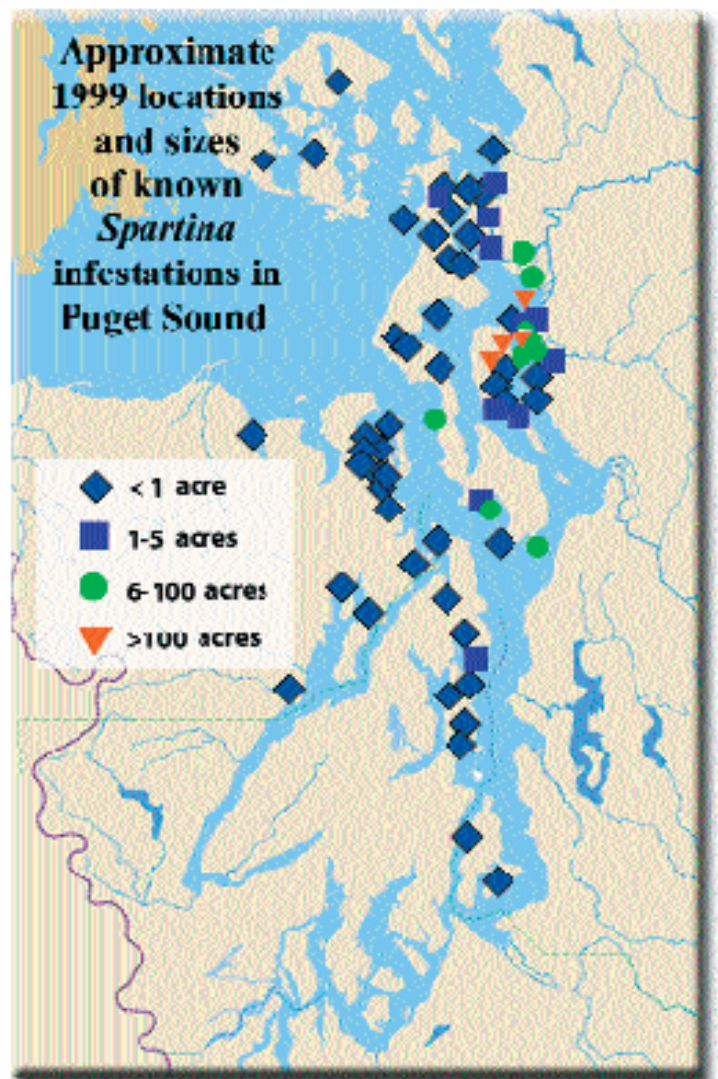
spartina

status

An invasive salt marsh grass, *Spartina* (commonly known as cordgrass) occurs throughout the north central part of the Puget Sound basin, centered on the area between Everett and Anacortes. *Spartina*'s invasion of Puget Sound is being actively controlled by state and local agencies, volunteer groups and private landowners.

trends

As of the beginning of 1999, the state Department of Agriculture and its partners had made significant progress in reducing the size of Puget Sound *Spartina* infestations (and in some cases, eliminating them). Control measures have resulted in substantial decreases in *Spartina* acreage in Skagit, Island, San Juan, Clallam, Jefferson, Kitsap and King counties. Estimated *Spartina* acreage in Snohomish County declined substantially at seven of eight sites between 1997 and 1999. However, because *Spartina* populations in south Skagit Bay (treated for the first time in 1999) have increased, there was only one percent decline in total *Spartina* acreage in Snohomish County during this period. As the state Department of Agriculture and collaborators control or eliminate smaller, outlying *Spartina* populations, which have the potential to greatly increase in area, larger areas of infestation such as south Skagit Bay will become more of a priority for control measures.



Source: Department of Agriculture, 1999



Source: Department of Agriculture

Counties	Acres of <i>Spartina</i> in 1997	Acres of <i>Spartina</i> in 1999	Percent change from 1997 to 1999
Skagit County	98	57	-42%
Snohomish County	486	480	-1%
Island County	410	350	-13%
San Juan, Clallam, Jefferson, Kitsap and King counties	9	4.6	-49%

Source: Department of Agriculture, 1999

fresh water temperature



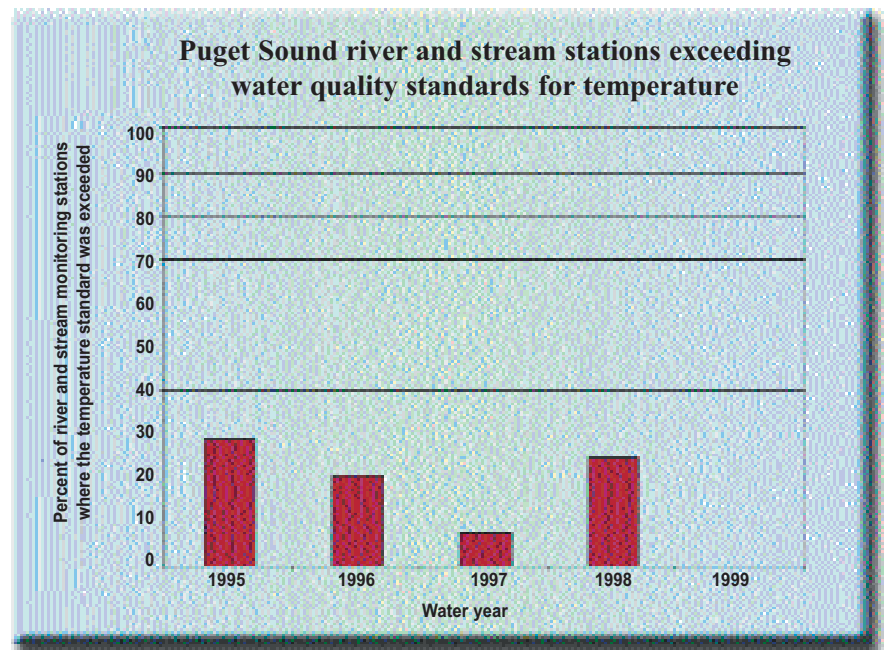
River and stream temperature

Water temperatures in Puget Sound's rivers can rise high enough over time to make the water inhospitable to salmon and other cold water fish. In 1999, no temperature measurements at the state Department of Ecology's 24 long-term monitoring stations exceeded the standards. In other recent years, 10 to 30 percent of the stations had temperatures too high (above the standards) at least once per year. The available data do not suggest any trends in river temperatures.

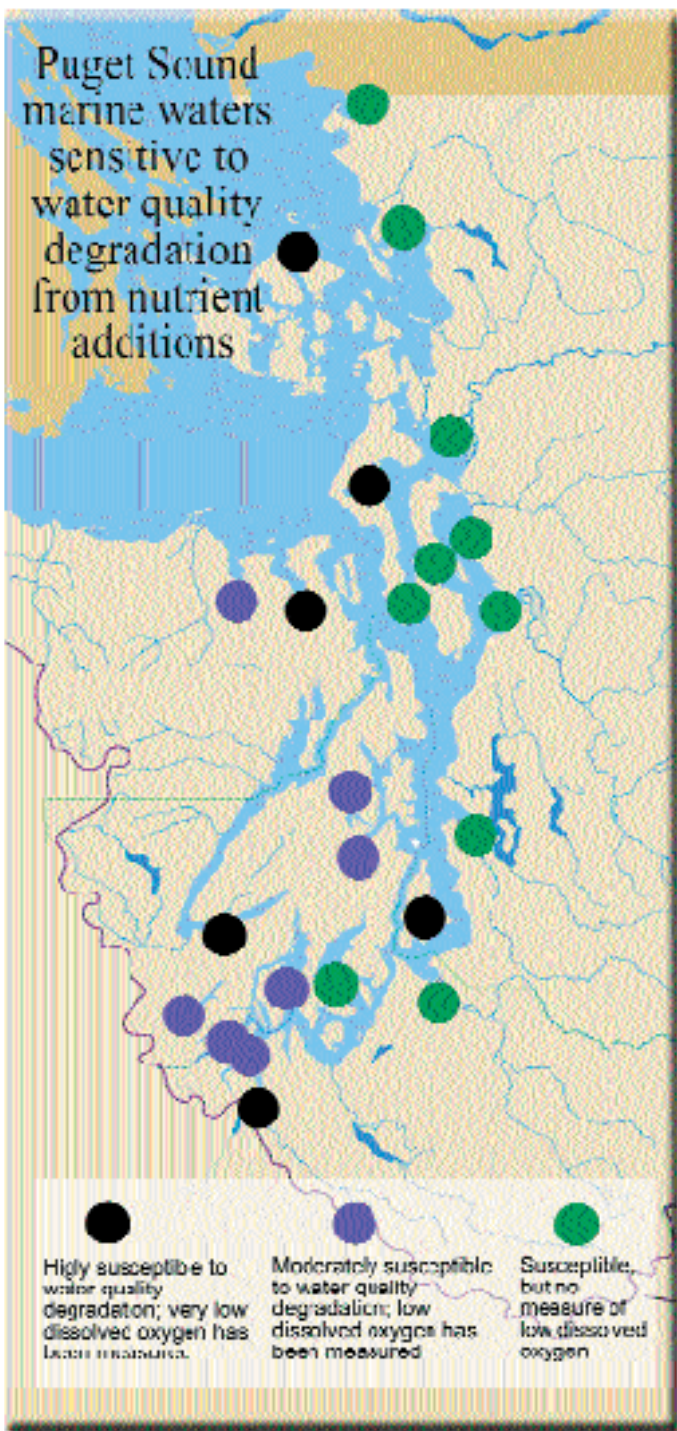
What affects stream temperature?

Stream temperature varies from year to year depending on weather conditions, the amount of snowpack and the seasonal pattern of snowmelt.

Stream temperatures can also be affected by clearing of trees and other cover along stream banks and by the impoundment of water in reservoirs behind dams.



Source: Department of Ecology, 1999



Source: Department of Ecology, 1999

Marine water habitat

Puget Sound's marine waters provide essential habitat for organisms ranging from plankton to marine fish and salmon to marine mammals. In some circumstances, nutrient additions can spur extra production by algae and plants. As algae and plant matter decomposes, dissolved oxygen can be depleted. When dissolved oxygen is depleted, habitat for bottom-dwelling species is degraded and biological communities are altered. These changes cascade through the ecosystem; other species throughout the food web, including fish, birds and mammals, are affected by changes in the availability of food and the presence of predators and competitors.

status

Because of physical mixing characteristics, marine waters in some areas of Puget Sound appear to be sensitive to water quality problems that might be caused by the excess addition of nutrients. Controlling sources of nutrients to these areas will help ensure that the condition of the water in the bottom of the Sound continues to support diverse communities of marine organisms.



marine water quality

Is fish and wildlife habitat increasing or decreasing?

Human development significantly alters the Puget Sound environment, often causing changes that reduce the quantity and quality of the diverse habitats used by the Sound's fish and wildlife. Habitat loss and degradation are major threats to the health and well-being of Puget Sound's fish and wildlife. Protecting and restoring habitat is a key element of the state's strategy to recover wild salmon and is a priority of the Puget Sound Water Quality Action Team.

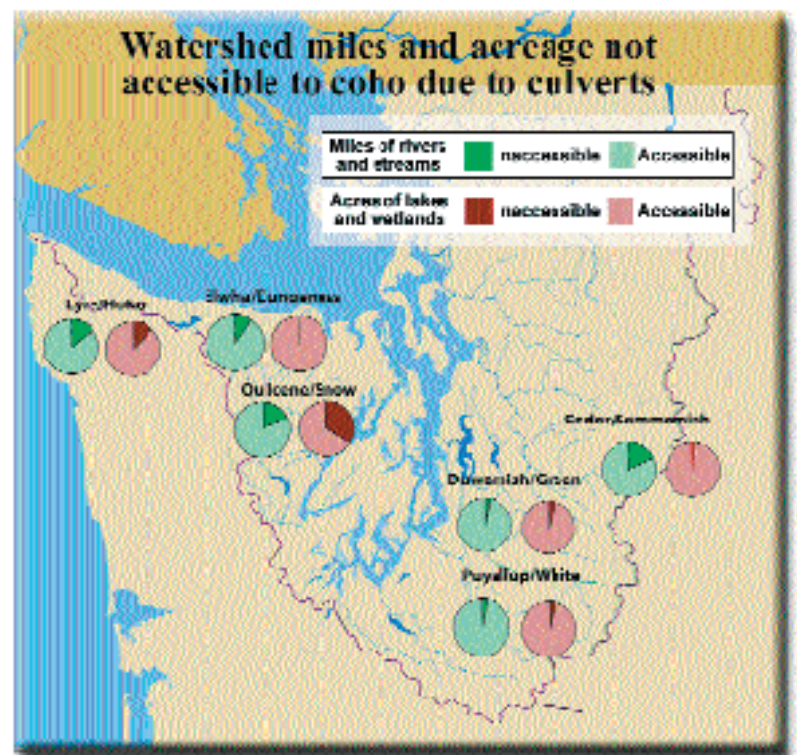
Habitats at risk from direct human alteration include freshwater habitat for salmon and other fish, and Puget Sound's fringe of shallow subtidal, intertidal and shoreline habitats known as the marine "nearshore." The Sound's marine water habitats are also threatened by water quality degradation. Though they are important habitat features in the Puget Sound basin, we are not yet able to report on:

- **Freshwater wetlands:** Advisors who helped the Action Team develop the set of indicators described in this document also suggested that we report on the quantity and quality of freshwater wetlands in the Puget Sound basin. No data are currently available to report on such an indicator, though we hope to respond to this question in the near future.
- **Puget Sound's nearshore:** More than 50 percent of the estuarine wetland habitat in the major embayments of Puget Sound has been dredged or filled since 1850. Approximately one-third of Puget Sound's shoreline has been altered by human development of port facilities, piers, bulkheads and other shoreline armoring structures. These findings indicate that people have dramatically changed the nearshore environment, eliminating or degrading many habitats. The Department of Natural Resources is completing an inventory of nearshore features, including habitat types and alterations. This inventory should be available in 2000 and may provide the basis for an indicator of the condition of nearshore habitats.

Freshwater habitat for salmon

Rivers, streams, lakes and wetlands are all critical to the survival of salmon and steelhead species. They provide food, shelter, spawning and rearing habitat. People physically alter watersheds and limit access to these habitats by creating barriers to fish passage.

The analysis of freshwater habitat is based on coho salmon because this species of salmon relies heavily on freshwater habitat (where fry reside for a year or more) and uses of a variety of freshwater habitats prior to migration to marine waters. Thus, analysis of coho habitat provides a good indicator of freshwater habitat availability and condition for all salmon. Improperly designed or maintained culverts are one type of alteration that threatens salmon habitat.



Source: Northwest Indian Fisheries Commission, 1999

What blocks fish passage?

Culverts are only one of the many types of human alterations that block fish passage and prevent access to freshwater habitat in the Puget Sound basin. This indicator does not report on the extent of habitat affected by dams, water diversions, tide gates or other alterations.

freshwater
habitat

status

An evaluation of known culvert blockages in six Puget Sound watersheds shows that about 11 percent of river and stream habitat and two percent of lake and wetland habitat potentially available to coho salmon are blocked by culverts. For this indicator, freshwater habitat is divided into two types: length of stream habitat and area of lake and wetland habitat. This distinction recognizes that salmon use lakes and wetlands differently than they use streams.



Is the area of contaminated sediments increasing or decreasing?



Puget Sound contains 1.8 million acres of submerged marine beds and tidelands. The bottom sediments of the Sound provide a record of historical and ongoing pollution in the estuary. These sediments are classified according to state standards for sediment quality developed under the *Puget Sound Water Quality Management Plan*.

Why measure the acreage of contaminated sediments?

Many pollutants have an affinity for sediment particles. Whether they enter Puget Sound through spills, wastewater discharges or stormwater runoff, toxic contaminants tend to bind to sediment particles. Therefore, as sediments settle out on the sea floor they can cause accumulations of contamination. Areas of contaminated sediment can harm marine life that lives or feeds in sediments. Fish and shellfish harvested from contaminated areas can, in turn, threaten human health.

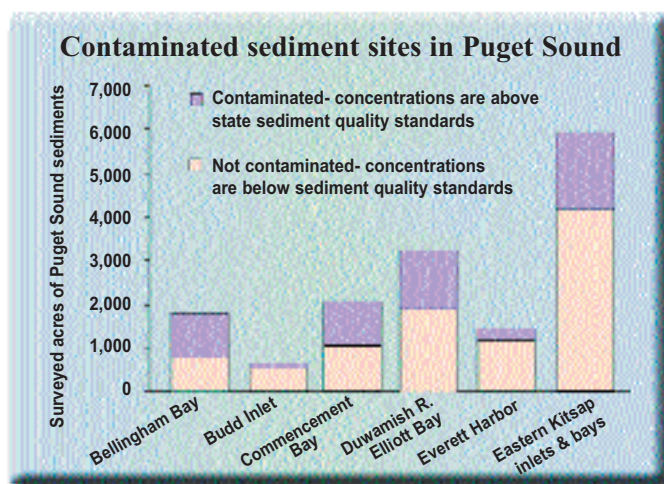
status

Of 15,300 surveyed acres of tidelands and submerged marine beds in urban portions of Puget Sound, 5,750 acres (38 percent) have been identified as contaminated above state standards.

As of 1999, the state has identified 86 contaminated sediment sites in Puget Sound. Fifteen sites, totaling 150 acres, have been cleaned up since 1996. Most of the remaining sites are undergoing an investigation and cleanup process involving federal, state and local agencies and private parties.

trends

It is too soon to determine whether the total contaminated area of Puget Sound is increasing or decreasing. As the state Department of Ecology continued to evaluate sediment quality information through the late 1990s, the number of acres identified as contaminated and the number of sites requiring cleanup grew. This increase in the area of contaminated sediments reflects improved information from additional surveys and assessments rather than a growing environmental problem in recent years.



Source: Department of Ecology, 1999



What affects the extent of contaminated sediments in Puget Sound?

Areas of contaminated sediment have developed over the past century as human activities on the water, along the shoreline and in the watersheds of Puget Sound have released toxic contaminants to the environment. Many sediment contaminants do not break down very quickly.

Decreases in the acreage of contaminated sediments will occur only by eliminating sources of pollution and cleaning up contaminated sites. Cleaning up sediments can involve dredging or removing contaminated material and properly disposing of it in designated facilities. Cleanup can also entail "capping" the contaminated sediments with cleaner material to ensure that the contaminants remain buried so they cannot harm Puget Sound organisms.

Pollutants of concern

Heavy metals:

Low levels of many elements occur naturally in Puget Sound. Human activities can cause concentrations to increase. Elevated concentrations of metals can cause reproductive failure in humans and other animals. Excess amounts of metals can be introduced to the Puget Sound environment from discarded batteries, spills of hazardous materials, car emissions, paints, dyes, polluted runoff and industrial and municipal wastewater discharges.

Polycyclic aromatic hydrocarbons (PAHs):

Some of these chemicals are present in fossil fuels and others are formed when fossil fuels and other organic materials are burned. Exposure to these chemicals increases risks of cancer and impairs immune function, reproduction and development. These chemicals enter Puget Sound in stormwater runoff, industrial and municipal discharges, and spills of petroleum and petroleum products.

Chlorinated organic compounds:

These chemicals do not occur naturally. They are some of the most toxic compounds known and can retard growth, reduce fertility and cause birth defects, liver damage and skin lesions in animals. Sources include solvents, electrical coolants and lubricants, pesticides, herbicides and treated wood. These compounds and their breakdown products persist in the environment because bacteria and chemical reactions break them down slowly. Examples of these compounds include polychlorinated biphenyls (PCBs), industrial chemicals that have been banned from many uses, and DDT, a pesticide whose use is banned in the United States.



Is **toxic** contamination of the marine environment increasing or decreasing?

Some chemicals that people introduce into Puget Sound are highly toxic to various forms of life. Many persist in the environment and accumulate easily in living organisms. Contaminants that accumulate in organisms can be evaluated by the levels of contaminants found in the muscle and organ tissue of marine organisms. Many such chemicals have been found in shellfish, fish and marine mammals. The levels of pollutants vary regionally, with higher levels found in marine life near urban areas.

Other contaminants do not accumulate—these are broken down during metabolism in some types of organisms. Evidence of the presence and effects of these types of contaminants can be obtained by looking for metabolic products of the contaminant or measuring harmful effects of the contaminant.

status

mussels

Mussels filter large quantities of water and can accumulate toxic contaminants that are present in that water. Federal monitoring of mussels from 14 stations in Puget Sound has shown that concentrations of PAHs (polycyclic aromatic hydrocarbons) in the Sound are often quite high compared to concentrations measured elsewhere around the United States. Other contaminants, especially zinc, nickel, lead and butyl tins (used in some paints), occur at relatively high concentrations at a few Puget Sound locations.

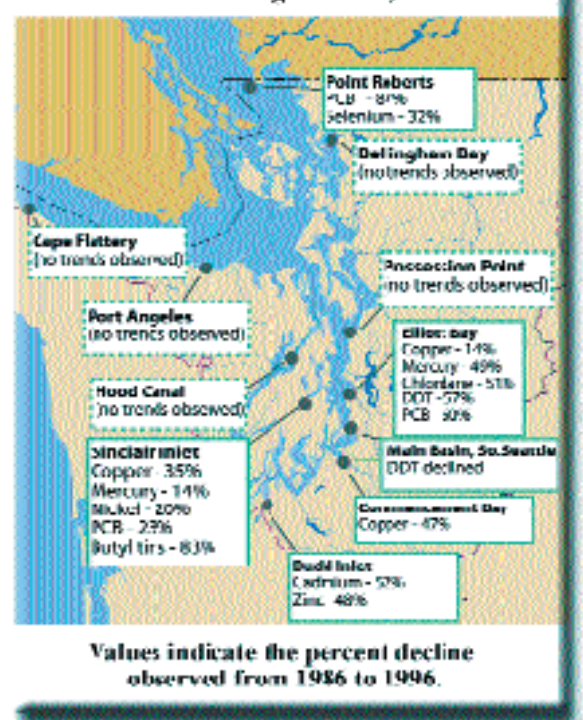


trends

Of the federal government's 14 mussel monitoring stations in Puget Sound, sufficient data are available from 11 stations to allow evaluation of trends since 1986. Decreasing trends in concentrations of one or more contaminants were observed at six stations. No increasing trends were observed for any contaminant at any of these stations.

Concentrations of PCBs (polychlorinated biphenyls), copper, DDT (a chlorinated pesticide) and mercury declined at multiple locations. Concentrations of six other contaminants declined at one location each.

Declining contaminant concentration in mussel tissue in Puget Sound, 1986-1996



Source: National Oceanic and Atmospheric Administration, 1998

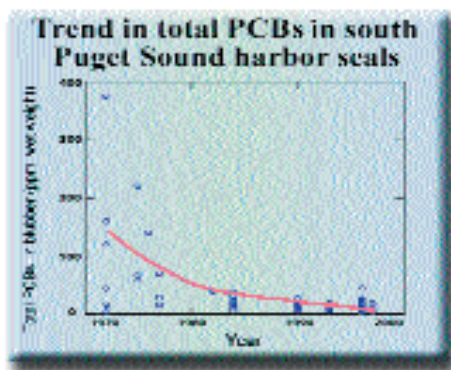
status

Harbor seals in south Puget Sound are about three times as contaminated by PCBs and dioxins as seals in Canada's Strait of Georgia. The level of PCB and dioxin contamination in south Puget Sound appears to be high enough to threaten the function of seals' immune systems. The level of chemical contamination in harbor seals is measured in samples of blubber (shown below) taken from seal pups captured from beaches where they are hauled out. These young seals are released after blubber and blood samples have been collected and the animals have been examined and tagged (shown at right).



trends

PCB concentrations in harbor seals residing in south Puget Sound, have declined considerably from the very high levels seen in the 1970s. However, this decline seems to have leveled off. Concentrations measured through 1996 appear similar to levels seen in the 1980s.



Source: Peter Haley/The News Tribune

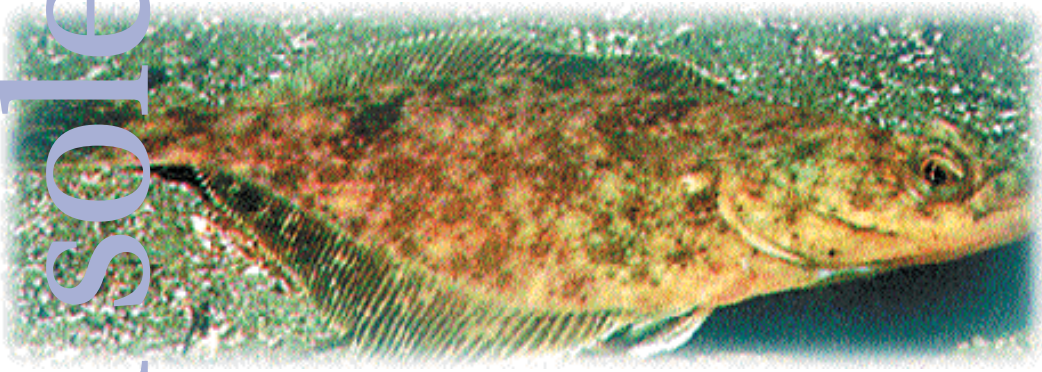
Source: Calambokidis et al, 1999



Source: Peter Haley/The News Tribune

harbor seals

English sole



Why measure liver lesions?

PAHs and other contaminants that English sole encounter in the bottom sediments of Puget Sound can cause a variety of harmful effects. Development of liver lesions, which are growths of abnormal tissue in the liver, may be one of these effects. Other indicators of toxic contaminants focus on the presence of contaminants in the environment or in the tissue of marine organisms. This indicator provides one measure of the *effect* of contaminants on fish health in Puget Sound.

status

Liver lesions occur more frequently in fish from urban locations than in fish from rural areas. Often more than 30 percent of fish from urban areas have liver lesions; typically up to 10 percent of fish from non-urban areas have liver lesions.

What might cause the incidence of liver lesions in English sole to increase?

Puget Sound scientists have shown that the incidence of liver lesions in English sole is associated with the degree of PAH contamination in the sediments in the area where the fish were collected. Although no cause-effect relationship has been demonstrated, this suggests that the increasing incidence of liver lesions in English sole from Elliott Bay might reflect increasing PAH contamination in the environment.

Studies should be conducted to determine if stormwater, industrial discharges, or spills are increasing the amount of PAHs delivered to Elliott Bay, thereby harming marine resources in the bay.

trends

English sole have been collected and analyzed annually since 1989 from six locations in Puget Sound. Fish from most of these locations do not show any trend in the occurrence of liver lesions. However, the occurrence of liver lesions in English sole from Elliott Bay appears to be increasing.

Are the size and frequency of oil spills increasing or decreasing?

Washington is one of the country's leading petroleum refining centers. Large amounts of crude oil and petroleum products enter and leave the basin via tankers, barges and pipelines. In addition, about 28 ocean-going commercial cargo vessels transit the Strait of Juan de Fuca daily. These vessels can each carry up to two million gallons of heavy fuel oil.

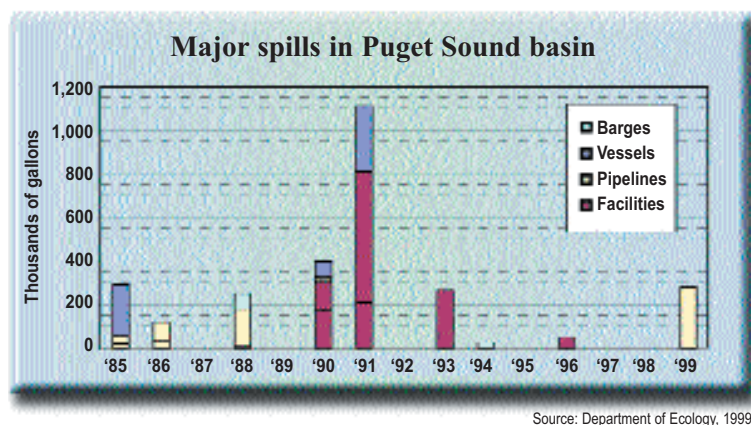


Source: Department of Ecology

Major spills (over 10,000 gallons)

trends

The volume and number of major spills has remained relatively low since 1992, with the exception of the 277,000-gallon Olympic Pipeline spill in Bellingham in June 1999 that killed three people and caused extensive environmental damage. Between 1985 and 1999, 18 major spills from facilities, pipelines, vessels and barges released over 2.8 million gallons of oil to the waters and land of the Puget Sound basin. More than one-half of this volume was released in eight spills that occurred in 1990 and 1991. Only four spills of 10,000 gallons or more occurred from 1992 to 1999.



Source: Department of Ecology, 1999

Since 1985, shore-based facilities accounted for 52 percent of the oil spilled in major incidents (10,000 or more gallons). The remaining 48 percent of oil released in major spills was relatively evenly split between spills from pipelines (26 percent) and vessels and barges (23 percent). Heavy fuel oil and crude oil are the materials most commonly spilled in major incidents.

What affects the amount and volume of oil spilled?

Human error, equipment failure and poor operating practices are responsible for the release of approximately 80 percent of spilled oil. Spills from vessels and barges are also affected by storms, marine traffic, fog, other adverse marine conditions and the Sound's numerous navigation hazards.

Washington State's spill prevention program emphasizes proper training, equipment and procedures to prevent spills from vessels and facilities. Because most spills are from vessels, and because large oil spills from vessels can have catastrophic impacts on Puget Sound, the state screens and inspects vessels to identify possible problems before they result in a spill. Several companies, in a variety of industries, have implemented voluntary measures (beyond state and federal requirements) that further reduce the likelihood of oil spills.

Serious spills (25 to 10,000 gallons)

trends

In the Puget Sound basin, 120 oil spills of 25 to 10,000 gallons to surface waters were reported to the state Department of Ecology from 1993 to 1998. No trend in the annual numbers or volume of serious spills was seen during this period.

In contrast to major spills, vessels were by far the greatest source of spills of 25 to 10,000 gallons.

Between 1993 and 1998, 53,000 gallons of oil entered Puget Sound waters from the 120 serious spills. Sixty-five percent of this total volume was due to 11 spills of over 1,000 gallons. Eight of these 11 spills were from vessels. Therefore, a relatively small proportion of the spills, many from vessels, contributed most of the oil spilled in releases of 25 to 10,000 gallons.

Not all spills are reported

This discussion of "serious" spills is based on incidents reported to the state Department of Ecology. Not all spills are reported.

Spills during fueling and from pumping bilges of small commercial and recreational boats occur fairly commonly. Washington Sea Grant estimates that the great majority of spills from these small vessels are not reported. Though individual spill events of this type may be small, repeated releases to sensitive and productive nearshore areas can be very damaging to the Puget Sound environment.

Puget Sound's Health 2000

Status and Trends
of Key Indicators of
Puget Sound's Health

- Are areas where shellfish can be safely harvested increasing or decreasing?
- Is the quality of water for recreation improving or declining?
- Is the area of contaminated sediments increasing or decreasing?
- Are aquatic nuisance species increasing or decreasing in Puget Sound?
- Is toxic contamination of the marine environment increasing or decreasing?
- Are the size and frequency of oil spills increasing or decreasing?
- Is fish and wildlife habitat increasing or decreasing?
- Are fish and wildlife populations increasing or decreasing?

What you'll find inside...



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PUGET SOUND
WATER QUALITY
ACTION TEAM
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