# Condition of Fresh Waters in Washington State for the Year 2002

WASHINGTON STATE DEPARTMENT OF ECOLOGY

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# Monitoring the Quality of our Fresh Waters

In 2001, Governor Locke signed into law the Watershed Health and Salmon Recovery Monitoring Act. The law requires state agencies to develop a comprehensive monitoring strategy and action plan for monitoring watershed health statewide, with a focus on salmon recovery. The strategy and action plan were submitted to the governor and the legislature in 2002. The action plan recommends that information collected under the strategy be evaluated and reported every two years. This report was produced to comply with this recommendation.

The Freshwater Monitoring Unit of the Environmental Assessment Program at the Washington State Department of Ecology (Ecology) routinely collects information on the aquatic resources of Washington State. Monitoring is conducted to collect data on water quality and biological health of our fresh waters. The freshwater monitoring program is designed to provide guidance for management decisions faced by the state.

The comprehensive monitoring strategy identifies four questions for which monitoring information is needed to manage the quality of our fresh waters:

1. What is the quality of surface waters?

2. How are surface-water-quality conditions changing over time?

3. Where do water-quality conditions not support aquatic life and recreational uses?

4. How effective are clean-waters programs at meeting water-quality criteria?

The monitoring activities conducted by the Freshwater Monitoring Unit are designed to answer these four questions. This report presents results from these activities.

# What is the quality of surface waters?

One of the most often asked questions is: *What is the overall status of water quality in Washington State?* This is the same question the state is required to address for the report to Congress under the federal Clean Water Act (Section 305(b)). It is impossible to conduct a full census of conditions by monitoring every water body in the state to answer this question. The approach instead is to randomly sample water bodies to infer conditions statewide. This approach, known as sample survey monitoring design, provides a statistically representative view of surface water over a broad spatial scale.

Ecology is conducting statewide sampling of wade-able streams as part of the U.S. Environmental Protection Agency (EPA) Western Environmental Monitoring and Assessment Project. This project uses a sample-survey monitoring approach and is part of an assessment of 12 western states. Field sampling is conducted to assess the ecological status of streams based on water chemistry, physical habitat, and biological assemblages. Sampling will be conducted through 2003, after which the results will be used to infer freshwater conditions statewide.

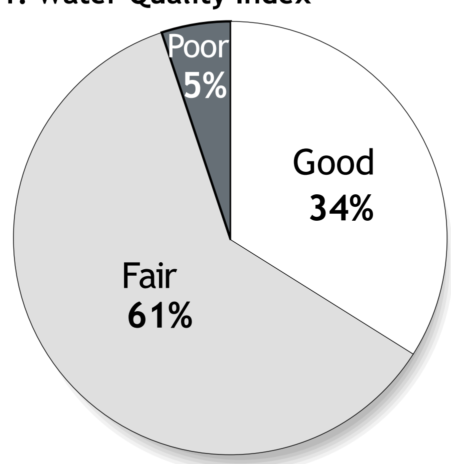
Ecology has operated a long-term river and stream monitoring program since 1970. The current program conducts monthly monitoring of 12 water-quality constituents and flow at 62 stations across the state. The program collects water-quality information at stations, generally near the mouths of major rivers and below major cities. These stations are assumed to represent the cumulative effect of human disturbances within the watershed.

The comprehensive monitoring strategy mandates that Ecology use the stream Water Quality Index (WQI) to evaluate the status of water quality to guide management decisions. The WQI also is used as a performance measure in the Salmon Scorecard report to the governor and the legislature.

The WQI is represented by numbers ranging from 1 to 100, indicating the general water quality at each station. The higher index numbers are indicative of better water quality. Multiple constituents of the water quality measured are combined, and the results are aggregated to produce a single score for each sample station.

The WQI was calculated for each of the long-term monitoring locations in 2002. Results show the distribution of index scores statewide. Waters of highest concern are labeled as "poor," those of moderate concern are "fair," and those of lowest concern are considered "good."

**Figure 1: Water Quality Index**



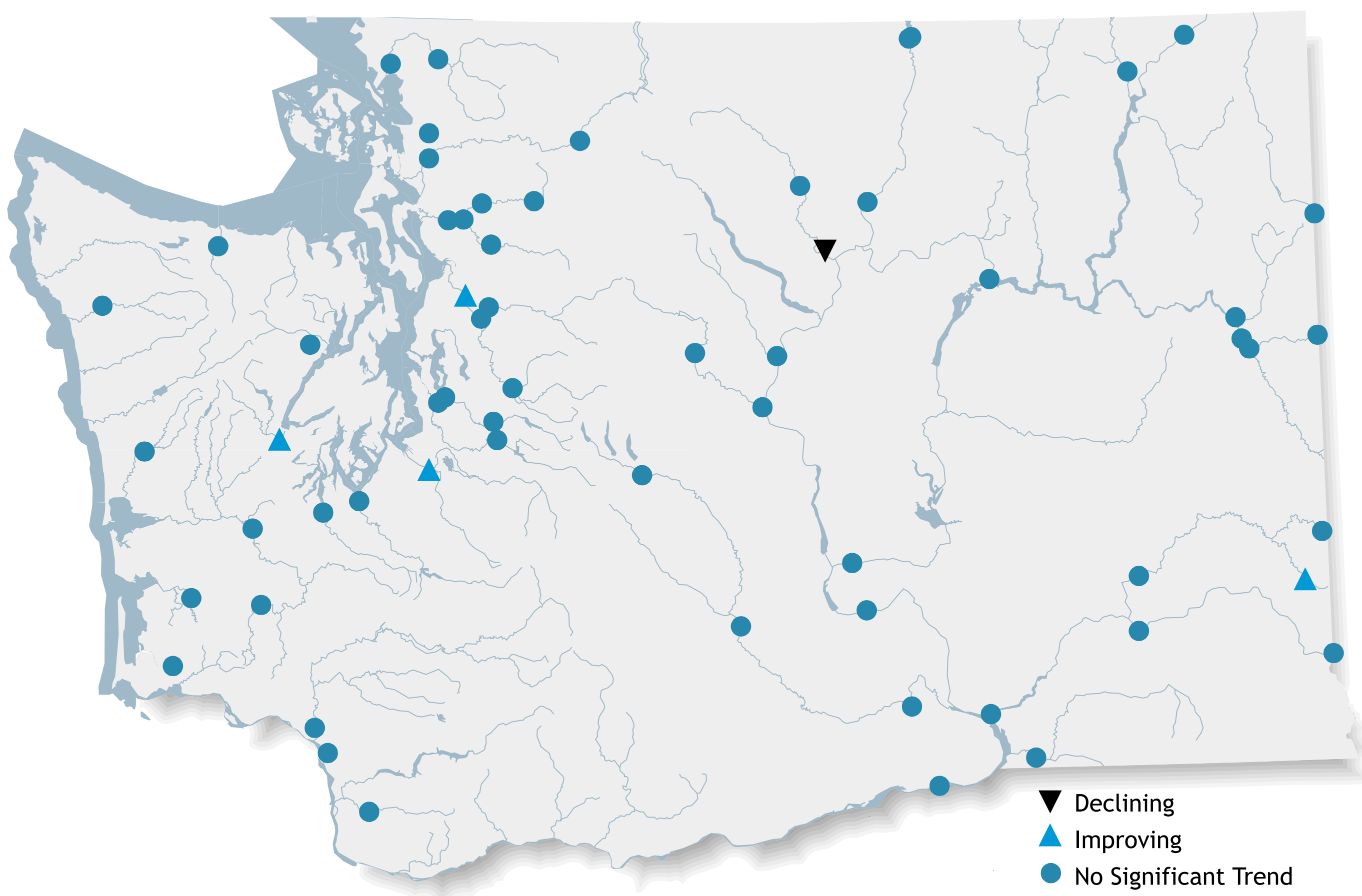
# How are surface water-quality conditions changing over time?

To identify trends, water-quality data must be collected routinely over long periods of time. The presence or absence of trends is a good indication of the degree to which water quality is responding to changes in the watershed. Formal statistical trend analysis provides a rational, scientific basis for addressing issues that can be confused by natural variations in water quality.

WQI scores derived from data collected by the river and stream monitoring program from 1991 through 2000 were used to assess the trends in water quality. Monthly WQI scores were evaluated for trend by using a statistical analysis called the Seasonal Kendall's Tau test. The test tells whether there is a trend in water quality at a prescribed level of certainty. Trends in individual constituents were not evaluated.

Trends of multiple stations can be evaluated together using a statistical method called meta-analysis. Stations can be grouped from various geographic regions or watershed land uses to draw a collective assessment of trend for each group. Stations were grouped according to their location in each ecological region as defined by EPA. Results of the station trend test were used in meta-analysis to evaluate trends in indicators for each ecoregion and also on a statewide basis. A slight improvement in water-quality conditions was observed statewide, with the greatest improvement in the Columbia Basin ecoregion. However, overall water-quality conditions remain of moderate concern in Columbia Basin rivers and streams.

**Figure 2: Water Quality Trends**



# Where do water-quality conditions not support aquatic life and recreational uses?

Washington State is required under the federal Clean Water Act (Section 303(d)) to periodically assess water quality and prepare a list of waters whose beneficial uses are impaired. Waters with impairment caused by pollutants from human sources require further pollution controls. Water-quality data collected by Ecology and others are evaluated to determine compliance with the state water-quality standards.

Ecology's Freshwater Monitoring Unit conducts five monitoring activities to assess aquatic life and recreational uses of fresh waters.

## Basin Stations

Ecology's river and stream monitoring program consists of both long-term trend and annual basin-monitoring stations. The basin stations are selected to support Ecology's basin approach to water-quality management and to address site-specific water-quality issues. Basin stations are typically monitored for one year to collect current water-quality information. The current program conducts monthly monitoring of 12 water-quality constituents and flow at approximately 20 stations across the state.

Data collected at basin monitoring stations in 2002 were assessed against the numeric criteria of Washington's water-quality standards. Impairments to aquatic life were identified at 48 percent of the basin stations for several water-quality indicators.

**Figure 3: Aquatic Life Support**

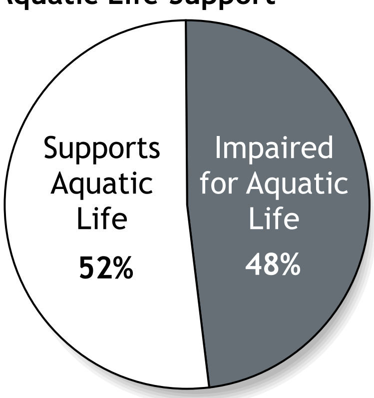



**Table 1: Basin monitoring stations showing 2002 conditions that impair aquatic life.**

| River or stream | Indicators not meeting water-quality standards established to protect aquatic life |
|---|---|
| Sumas River | Dissolved oxygen |
| South Fork Nooksack River | Temperature |
| Middle Fork Nooksack River | Mercury |
| White River | Temperature, pH |
| Chehalis River | Temperature |
| Palouse River | Dissolved oxygen, Temperature, pH |
| Pleasant Valley Creek | Temperature, pH |
| Asotin Creek | Temperature, pH |
| Cowiche Creek | pH |
| Yakima River | pH |
| Pend Oreille River | Temperature, pH |

## Continuous Temperature

During the summer of 2002, Ecology recorded continuous temperature data at 30-minute intervals at 53 of the basin and long-term monitoring stations. The purpose of monitoring temperature was to determine compliance with current and proposed water-quality standards. The proposed standard requires measuring temperature on consecutive days to apply the criterion. Temperature measurements collected in 2002 at the long-term stations were assessed using Ecology's policy for identifying impairments under the federal Clean Water Act (Section 303(d)). The proposed standard was exceeded (violated) at 77 percent of the monitored stations.

**Figure 5: Temperature Conditions**

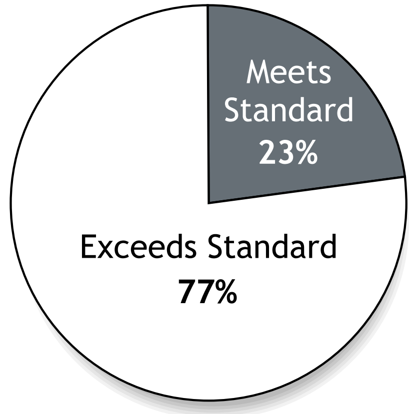
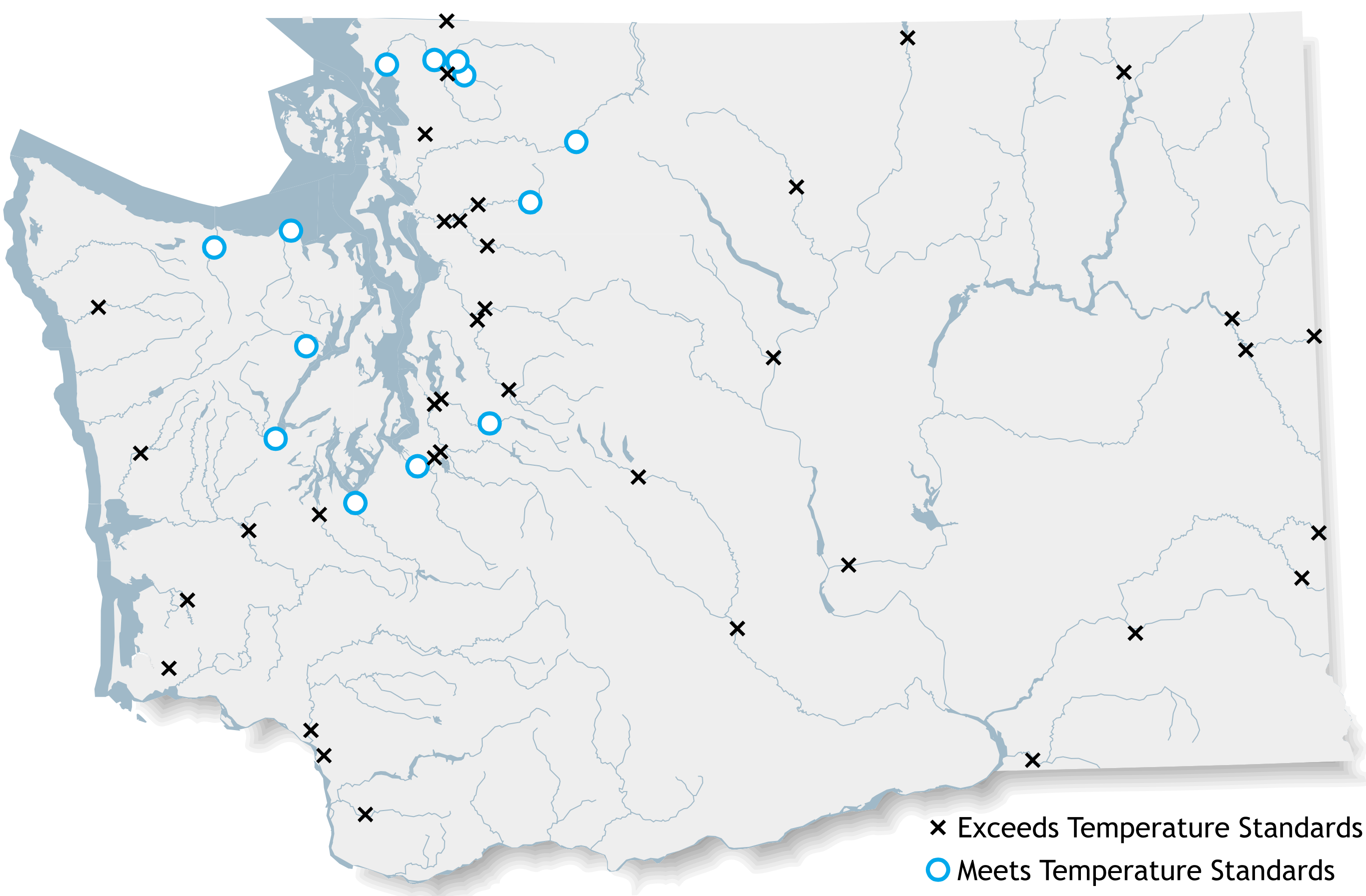



**Figure 4: Temperature Conditions**



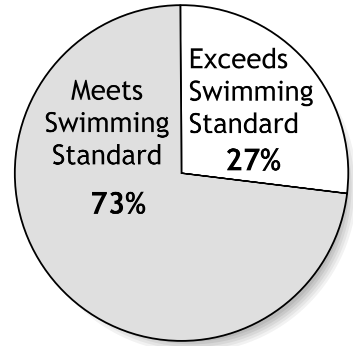
## Sanitary Conditions

Fecal coliform contamination is often evaluated to determine the sanitary conditions of fresh waters. Since it is impossible to test for all pathogenic organisms that could cause human illness, fecal coliform bacteria are used as an indicator of potential risk of contracting illnesses. These bacteria originate from the intestinal tract of warm-blooded animals, and the levels in water are relatively easy to measure. As such, water-quality standards for fecal coliform have been established to protect the use of swimming or wading in fresh waters.

**Table 2: Locations where 2002 bacteria levels were higher than recommended levels for swimming and the reduction of pollutant needed to meet expectations.**

| Location | Percent reduction required to meet swimming standards |
|---|---|
| Wide Hollow Creek at Randall Park | 29% |
| Cowiche Creek at Zimmerman Road | 29% |
| Mission Creek near Cashmere | 25% |
| Samish River near Burlington | 23% |
| Campen Creek near Washougal | 22% |
| Gibbons Creek near Washougal | 21% |
| White River at 'R' Street | 20% |
| South Fork Palouse River at Pullman | 18% |
| Willapa River near Willapa | 15% |
| Pataha Creek at Rosy Grade | 15% |
| Sumas River at Jones Road | 14% |
| Ahtanum Creek at 62nd Ave | 12% |
| Cedar River at Logan Street in Renton | 9% |
| Pleasant Valley Creek below St John | 9% |
| Chehalis River at Dryad | 8% |
| East Fork Lewis River near Dollar Corner | 8% |
| Palouse River at Colfax | 8% |
| Tucannon River at Powers | 5% |
| Green River at Tukwila | 4% |
| Puyallup River at Puyallup | 3% |
| Stillaguamish River near Silvana | 2% |
| Chumstick Creek near Leavenworth | 1% |
| Puyallup River at Meridian Street | 1% |

**Figure 6: Sanitary Conditions**




Water samples collected in 2002 at the basin and long-term monitoring stations were assessed using Ecology's policy for identifying swimming use impairments under the federal Clean Water Act (Section 303(d)). Twenty-seven percent of the stations exceeded (violated) water-quality standards established to protect swimming.

In addition, a statistical approach was applied to these data to determine the level of reduction in pollution needed to meet water-quality standards. This information is being used by Ecology to help decide where pollution-control efforts should be targeted to protect the health of swimmers.

## Biological Monitoring

Traditional measurements of chemical and physical components for rivers and streams do not provide sufficient information to detect or resolve all surface-water problems. Biological evaluation of surface waters provides a broader approach because degradation of sensitive ecosystem processes is more frequently identified.

Biological assessments supplement chemical evaluation by:

- Directly measuring the most sensitive resources at risk.
- Measuring a stream component that integrates and reflects human influence over time.
- Providing a diagnostic tool that synthesizes chemical, physical, and biological perturbations.

Ecology collects biological information from rivers and streams throughout the state. The long-term monitoring program was established in 1993 to explore spatial patterns and identify temporal trends in stream insect communities (i.e., benthic macroinvertebrates). The program has developed a large base of information that describes biological characteristics of reference and degraded conditions. Reference conditions are found in streams with no or little human impact.

The use of ecoregions is a useful way to help evaluate the observed aquatic conditions. Washington State has eight ecoregions defined by EPA. These ecoregions have different landforms and biological characteristics.

A biological model was developed that predicts expected aquatic macroinvertebrate community composition for streams in Western Washington. The model (River Invertebrate Prediction and Classification System, or RIVPACS) is constructed from biological, physical, and chemical information collected at more than 100 reference sites throughout Western Washington. These physical and chemical variables that describe stream-setting and that are highly correlated with the assortment of species located in that setting are the basis for evaluating sites suspected to have suffered some level of degradation. The direct comparison of a site score with that expected from model predictions describes the probability that the site belongs to the reference condition. The model built for Western Washington streams considers 86 percent similarity and greater to be identical to "reference" conditions, with no apparent signs of degradation. The site scores are records from streams that have been evaluated based on this RIVPACS model.

A similar model for Eastern Washington streams is currently under development. When this model is complete, it will be used to evaluate biological condition of streams throughout Eastern Washington.

**Figure 7: Biological Health of Streams in Western Washington**

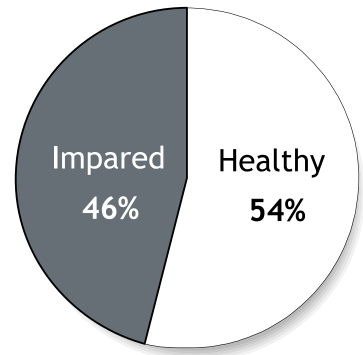
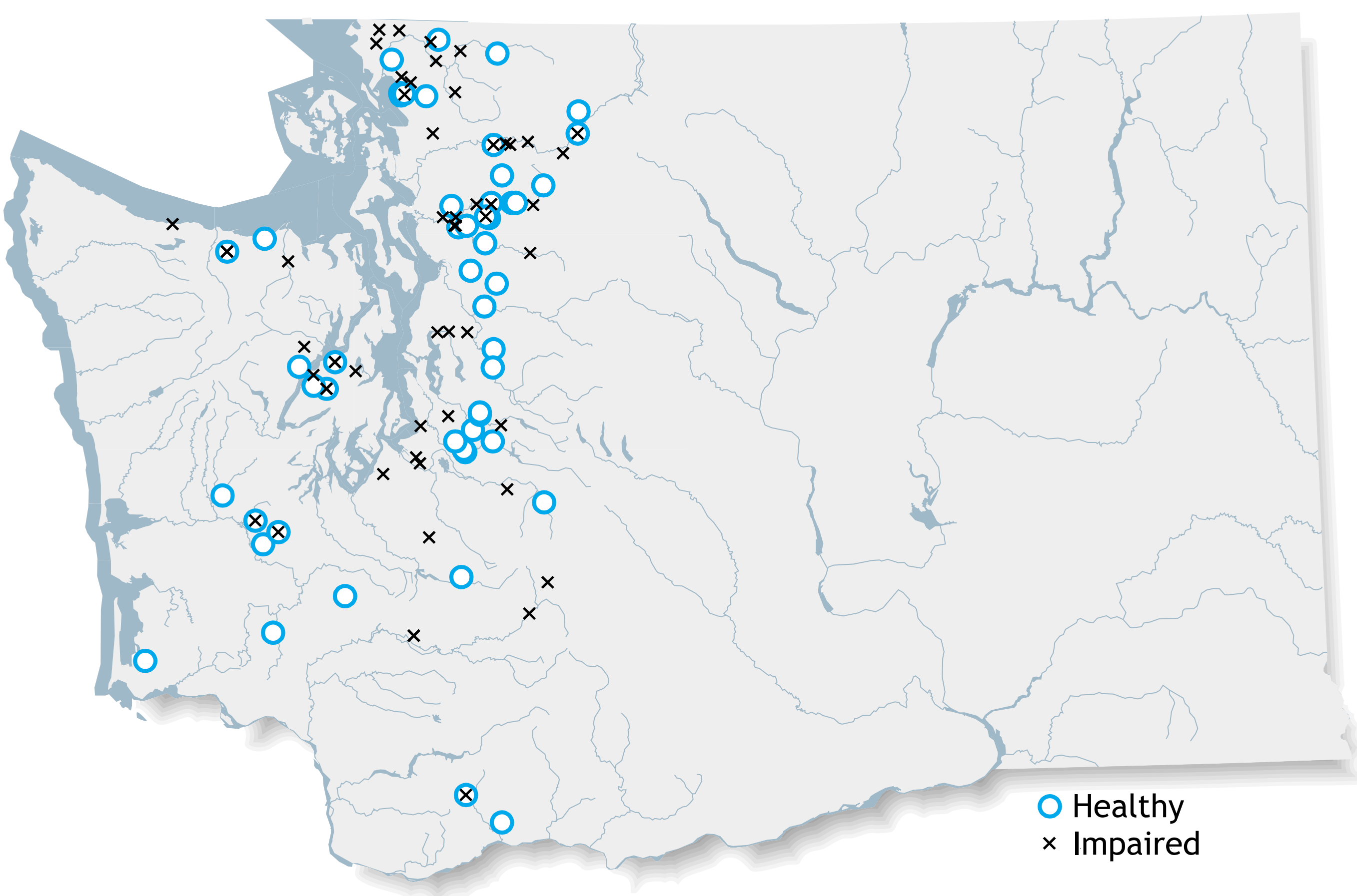



**Figure 8: Biological Conditions**



## Aquatic Plants

Ecology has been collecting information on aquatic plants from lakes and rivers throughout the state since 1994. The main objective of this program is to inventory and monitor the spread of invasive non-native aquatic plant species. Other objectives are to provide technical assistance on identifying aquatic plants and controlling invasive species, and to conduct special projects evaluating the effects of invasive non-native species and their control.

For most lakes, the method used is to circumnavigate the littoral zone in a small boat. When a different plant or type of habitat is observed, samples are collected for identification. Notes on species distribution, abundance, and maximum depth of growth are made. In addition, secchi depth and alkalinity data are collected.

**Figure 9:** Proportion of Waterbodies Sampled in which Invasive Exotic Aquatic Weeds were found

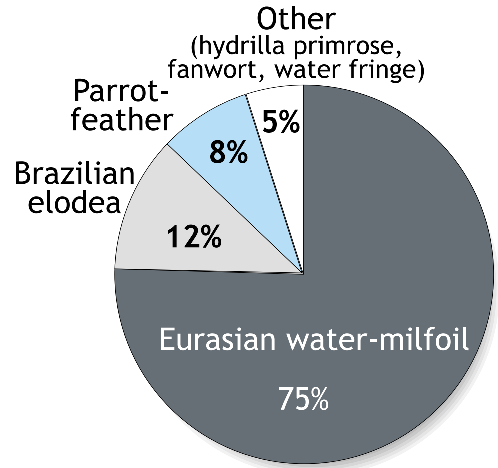
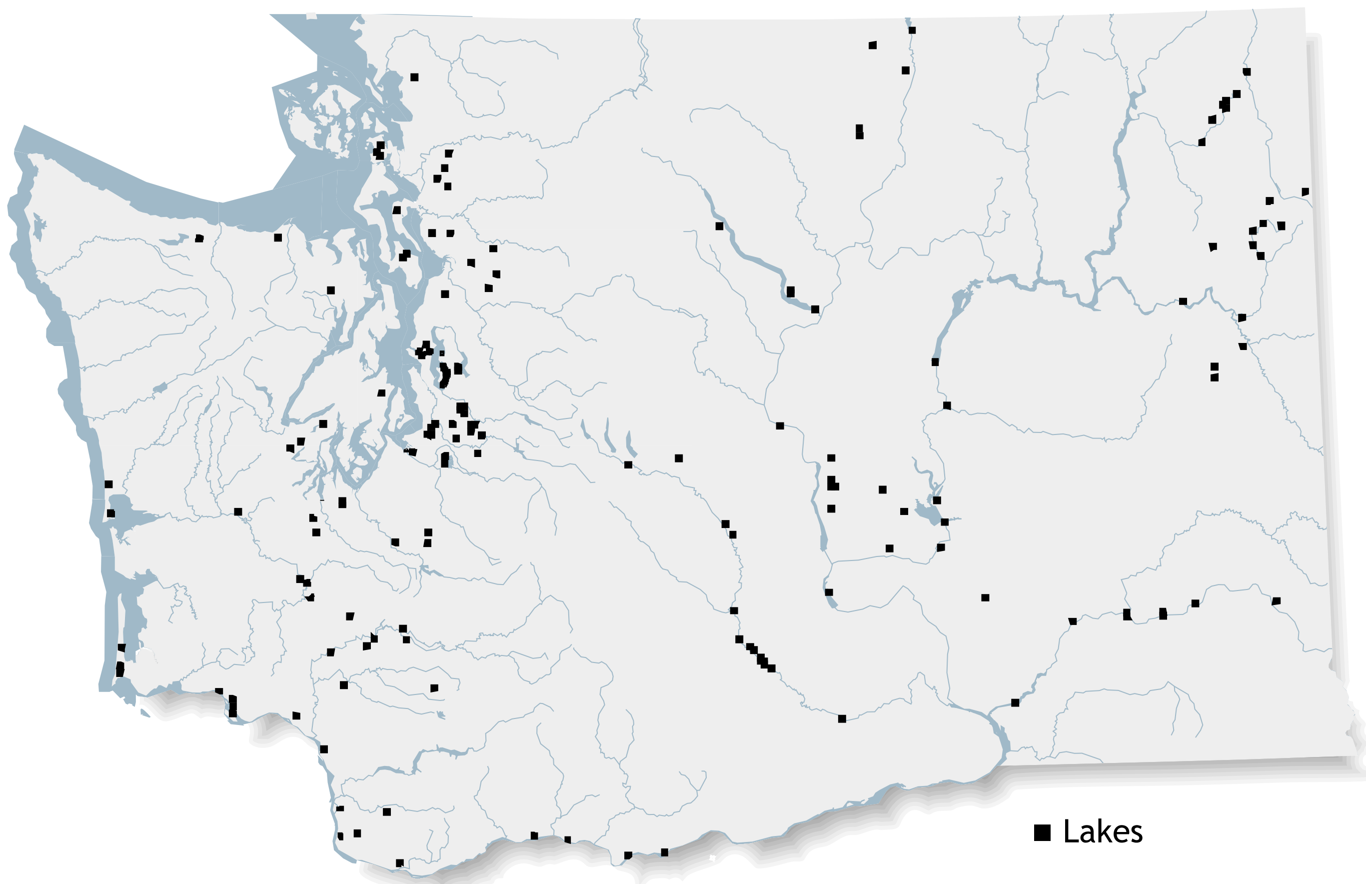



**Figure 10:** Locations with Invasive Exotic Aquatic Weeds



# How effective are clean-waters programs at meeting water-quality criteria?

Under the federal Clean Water Act and EPA implementing regulations, Ecology is required to develop cleanup plans called total maximum daily loads (TMDLs) for impaired waters. Ecology also is required to implement and evaluate the effectiveness of these cleanup plans to achieve the needed improvements in water quality.

Effectiveness monitoring is a fundamental component of any TMDL implementation activity. It measures to what extent the work performed has attained the improvement recommended in the TMDL in order to comply with state water-quality standards.

The benefits of TMDL effectiveness evaluation include:

- A measure of progress toward water-quality improvements (i.e., how much watershed restoration has been achieved and how much more effort is required).
- More-efficient allocation of funding and optimization in planning/decision-making.
- Technical feedback to refine the initial TMDL model, best management practices, nonpoint-source pollution plans, and permits.

To date, very little has been done with TMDL effectiveness monitoring to evaluate the efficiency of the cleanup plans. Consequently, Ecology is formulating a strategy that involves the TMDL modelers, agency planners, and local partnerships in developing plans prior to the need for monitoring.

Limited data exist to evaluate water-quality conditions and trends for TMDL effectiveness monitoring. Besides the limited Ecology data, only a few data collected by cities, counties, tribes, and other local agencies were available to assess progress with EPA-approved TMDLs.

As discussed in the following three sections, the Freshwater Monitoring Unit has compiled monitoring data to assess the effectiveness in meeting water-quality goals from these TMDLs.

## Fenwick and Sawyer Lakes

Total phosphorus TMDLs were developed for Fenwick and Sawyer lakes, based on the state water-quality standard for aesthetics. Maximum in-lake mean summer total phosphorus concentration limits of 19 and 16 µg/L were set for Fenwick and Sawyer lakes, respectively, in their TMDLs (cleanup plans) to deter progression of eutrophication.

Available monitoring data indicate that both lakes have periods when total phosphorus concentrations are above their target limits for a short period, especially at Lake Fenwick. Consequently, the state water-quality standard for aesthetics may be violated, and further eutrophication may occur. Although Lake Sawyer appears to meet the TMDL target limit as a long-term average, more data are required to validate this improvement.

## Paper Mills

Ecology developed dioxin TMDLs for four mills in Washington State that produce bleached pulp and/or paper products: Weyerhaeuser, Everett; Rayonier, Port Angeles; Simpson, Tacoma; and Weyerhaeuser, Cosmopolis.

The TMDLs were based on the state water-quality criterion of 0.014 parts per quadrillion (ppq) at the edge of the mixing or dilution zone. Maximum dioxin target limits of 10 ppq and 5 ppt (parts per trillion) were set for effluent discharge and sludge, respectively, in the NPDES permits to provide protection for human and aquatic organisms, as recommended by EPA.

Evaluation of discharge-monitoring-report data and dioxin tissue-bioaccumulation results indicates that both effluent and sludge NPDES-permit target limits for dioxin are generally being met. These facilities did not appear to pose a problem to public health at the time of data collection. However, future recommendations are to:

- Conduct a dioxin tissue-bioaccumulation study for these mills to verify improvement in water quality.
- Monitor these mills on a five-year cycle.
- Make dioxin receiving-water monitoring part of the permit requirement for these mills during future permit renewal.

## Yakima River

The cleanup plan (TMDL) for suspended sediments and DDT in the lower Yakima River was submitted to and approved by EPA in 1998. This TMDL targeted sediment eroded from agricultural fields as the cause for high turbidity in the mainstem Yakima River and several agricultural return drains. It also was determined that the sediment carries with it residual amounts of the organochloride pesticide DDT that was archived in the soils since before DDT was banned for agricultural use in 1972.

Primary implementation activities focus on reducing field erosion by installing irrigation best management practices. The 2003 irrigation season will mark a fifth-year milestone requiring compliance with state turbidity standards in the Yakima River and a turbidity of 25 NTU (nephelometric turbidity units) at the mouths of the major drains.

Ecology and the Yakama Nation are performing TMDL effectiveness monitoring during the irrigation seasons of 2002 and 2003 to determine if compliance goals for turbidity are being met. Ongoing monitoring by local irrigation and conservation districts are showing marked improvements in water quality in the lower Yakima River. There is great optimism that the TMDL will be a success.

# Fresh Water Monitoring Needs

Ecology is initiating a new program focused on beaches at freshwater lakes. The purpose of this program is to collect and report data that relate to waterborne bacteria that can sicken swimmers. This monitoring program complements and supplements existing beach monitoring programs operated by some of the larger counties in Washington. It is modeled after a similar effort endorsed by the EPA called the *Beaches Environmental Assessment, Closure, and Health (BEACH) program*.

Lake monitoring has been absent for several years and is an important contribution to knowledge about their conditions. We are attempting to acquire means to implement a monitoring program that provides chemical and physical characterizations of lakes throughout the state. Lakes are attractive for summer recreational activities and are important habitat for wildlife. Lake monitoring provides valuable information for prioritizing and implementing water-quality restoration and protection efforts.

The need for more complete characterization of water quality of Washington's rivers, streams, and lakes has always been an issue. A new monitoring design that uses a randomized (probabilistic) site-selection process provides adequate representation of water-quality conditions throughout the state. This monitoring strategy was developed by the EPA and has been tested in Washington under a variety of projects.

By using the probabilistic site-selection and sampling process, we would be able to estimate water-quality conditions across broader portions of the landscape, which is prohibitive if using sites selected in a non-random fashion. We need to expand the sample size to achieve statistical reliability before the inception of this program. We have found this to be a promising approach for generating information to build a strategy for improving water quality.

The randomized sampling design has been adopted as part of the action plan for Washington's comprehensive monitoring strategy. Further development of monitoring partnerships with other state and federal agencies will be one of the means by which we can attempt to accomplish this important work.

Establishing a Water Quality Monitoring Council was proposed as one of the elements in the state's comprehensive monitoring strategy, but has not yet been established. This council would be an important decision-making body for identifying water-quality problems and prioritizing efforts to protect and restore water quality. The council would represent governmental and business leaders as well as general citizenry. We hope to eventually see a council established for Washington State.

New monitoring technology emerges and can help us better understand how complex changes occur in chemical and physical characteristics of our waterways. We have begun to establish continuous temperature and dissolved-oxygen monitoring programs using new electronic technology. These water-quality characteristics change over the course of a day and can be difficult to use for regulatory decision-making if not monitored continuously. For this reason, we are attempting to expand the use of this technology so we may be able to promote more-sophisticated evaluations of our environment.

Evaluating the biological condition of rivers, streams, and lakes is one of our most important monitoring programs. Condition of aquatic life is a key indicator for evaluating effects from human activities near water. We have a small biological monitoring program at this time and have been developing tools for detecting and diagnosing impairments to water quality. Assessing biological conditions helps determine overall effectiveness of our water cleanup efforts. This type of characterization in aquatic systems is a primary component of the comprehensive monitoring strategy.

The development of new monitoring strategies and programs is a challenge. By evaluating and implementing current monitoring techniques, we will increase our ability to adequately characterize the state's water quality. Ecology is continuously exploring and developing evaluation tools and monitoring designs for making sound management decisions that protect our natural resources.

# Related Publications

*Washington Comprehensive Monitoring Strategy for Watershed Health and Salmon Recovery*
Interagency Committee on Outdoor Recreation, December 2002

*Environmental Monitoring and Assessment Program: West – Research Strategy*
U.S. Environmental Protection Agency, February 2001

*Freshwater Conditions for Washington State in the Year 2002 - Technical Appendix*
Ecology Publication No. 03-03-031

*River and Stream Ambient Monitoring Report for Water Year 2002* (in progress)
Ecology Publication No. 03-03-032

*A Water Quality Index for Ecology's Stream Monitoring Program*
Ecology Publication No. 02-03-052

*Assessment of Water Quality for the Section 303(d) List, Ecology Water Quality Program Policy No. 1-11*
*Using Invertebrates to Assess the Quality of Washington Streams and to Describe Biological Expectations*
Ecology Publication No. 97-332

*Aquatic Plants Technical Assistance Program – 2002 Activity Report* (in progress)
Ecology Publication No. 03-03-033

*Effectiveness Monitoring for Total Phosphorus Total Maximum Daily Loads in Fenwick and Sawyer Lakes*
Ecology Publication No. 02-03-054

*Effectiveness Monitoring for Dioxin Total Maximum Daily Loads in Western Washington*
Ecology Publication No. 03-03-002