Washington State Water Quality Conditions in 2005 based on data from the Freshwater Monitoring Unit

WASHINGTON STATE DEPARTMENT OF ECOLOGY

November 2006
Publication No. 06-03-030

Author: *Dave Hallock*
Freshwater Monitoring Unit
Environmental Monitoring and Trends Section
Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington

The following Freshwater Monitoring Unit staff contributed to this report:
Maggie Bell-McKinnon
Chris Coffin
Dave Hallock
Glenn Merritt
George Onwumere
Jenifer Parsons
Jim Ross
Bill Ward

This publication is available on the Department of Ecology web site at *www.ecy.wa.gov/biblio/0603030.html*

For more information contact:
Publications Coordinator
Environmental Assessment Program
P.O. Box 47600
Olympia, WA 98504-7600
E-mail: *jlet461@ecy.wa.gov*
Phone: (360) 407-6764

The Technical Appendix to this publication is available at *www.ecy.wa.gov/biblio/0603031.html*

Funding for this document is provided by the U.S. Environmental Protection Agency.

If you need this publication in an alternate format, call Joan LeTourneau at (360) 407-6764. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Cover photo: The Sauk River at Backman County Park.

Table of Contents

Introduction

Data collected by Ecology's Freshwater Monitoring Unit

The purpose of the Freshwater Monitoring Unit (FMU) is to routinely collect information to characterize aquatic resources of Washington State. Data are used to assess the water quality and biological health of our fresh waters.

FMU is part of the Environmental Assessment Program at the Washington State Department of Ecology (Ecology).

Within Ecology, data generated by FMU are used to:

- Determine if designated uses are supported.
- Refine and verify Total Maximum Daily Load (water cleanup) models.
- Develop water quality based permits.
- Prepare 305(b), 303(d), and other management reports.
- Provide water quality information to prioritize grant awards.
- Conduct miscellaneous site-specific evaluations.

Our data are provided free to the public and are widely used by academics, consultants, local governments, schools, and others interested in the quality of Washington's fresh waters.

A strategy and action plan for Washington State fresh waters

As required by the state Watershed Health and Salmon Recovery Monitoring Act, a strategy and action plan was submitted to the Governor and the Legislature in 2002. The plan identifies four key questions:

- What is the quality of surface waters?
- Where do water quality conditions not support aquatic life and recreational uses?
- How are surface water quality conditions changing over time?
- How effective are clean water programs at meeting water quality criteria?

There are a number of monitoring activities conducted by FMU that address these questions. *The purpose of this report is to document those activities and summarize 2005 results for a non-technical audience.*

Station-specific analyses and assessment procedures are presented in a technical appendix (published separately).

Below
The Stevens County Conservation District is working in the Colville River near Chewelah with help from a Centennial Clean Water Fund grant.

The quality of surface waters monitored by FMU

FMU monitoring activities assess the water quality of Washington's fresh waters. However, results cannot necessarily be used to infer statewide conditions. Monitoring is often focused on areas where there are known problems, while other monitoring may apply only to specific types of streams.

For example, Ecology's Environmental Monitoring and Assessment Program (EMAP) stations are randomly located to be statistically representative but include mostly wadeable streams. FMU's long-term water quality monitoring stations are typically located in the lower end of watersheds in most of Washington's major streams. Smaller streams are not assessed using this targeted site-selection strategy. These programs and others are discussed later in this report.

Monthly monitoring for water quality

Ecology's long-term river and stream monitoring program predates the agency's inception in 1970. The current program conducts monthly monitoring for 12 water quality indicators at 62 long-term stations and at least 20 basin stations across the state.

The 12 indicators are ammonia, nitrate+nitrite, total nitrogen, total phosphorus, orthophosphorus, temperature, pH, conductivity, oxygen, turbidity, suspended sediment, and fecal coliform bacteria.

Long-term stations are generally located near the mouths of major rivers and below major cities. These stations represent the cumulative effect of human disturbances within the watershed.

Basin stations are selected to support Ecology's basin approach to water quality management and to address site-specific water quality issues. They are typically monitored for only one year. Basin stations are often located in known problem areas; consequently, results are not representative of water quality conditions statewide.

Water Quality Index

Water quality indexes have been developed to compile large quantities of water quality data into a single value in much the same way that the Dow-Jones summarizes conditions in financial markets. Although details are lost in summarizing information in this way, indexes make water quality information accessible to a much wider audience, including elected officials, administrators, and the public.

The legislatively-mandated Monitoring Oversight Committee's *Comprehensive Monitoring Strategy* requires that Ecology use the Stream Water Quality Index (WQI). The WQI is also used as a performance measure in the Salmon Scorecard report to the governor and the Legislature.

An index is useful for comparative purposes (what stations have poor water quality?) and for general questions (what is the general water quality in my stream?). Indexes are less suited for answering specific questions. Site-specific decisions should be based on an analysis of the original water quality data.

Besides being general in nature, there are at least two reasons that an index may fail to accurately communicate water quality information. Most indexes are based on a pre-identified set of water quality indicators. A particular station may receive a good WQI score, but its water quality might be impaired by indicators not included in the index. Also, combining data may mask short-term water quality problems. A satisfactory WQI at a particular station does not necessarily mean that water quality was always satisfactory. A good score should, however, indicate that poor water quality was not chronic.

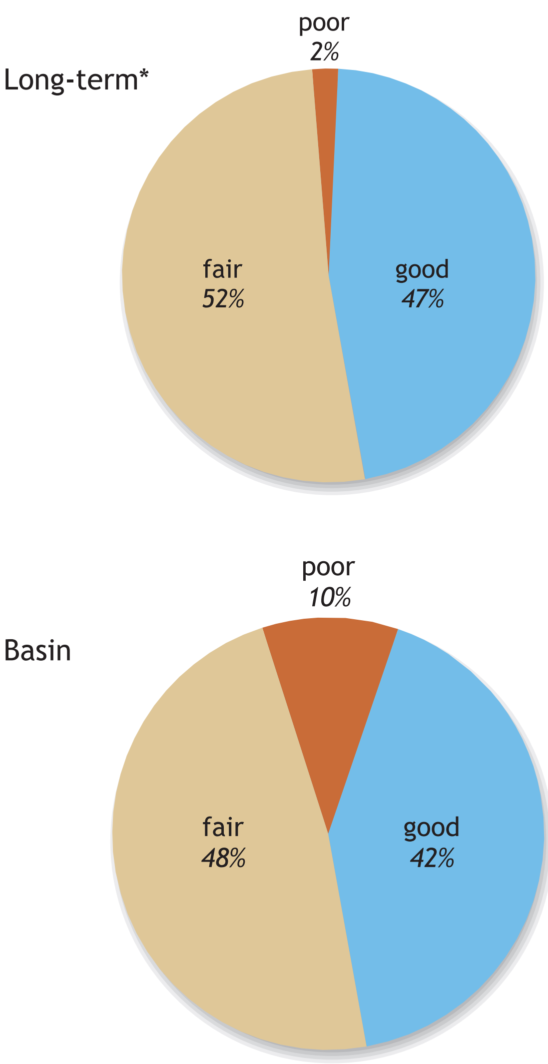
The WQI is a unitless number ranging from 1 to 100 that represents general water quality. A higher number indicates better water quality. Multiple water quality indicators are converted to an index score for each sampling visit; scores are then combined to produce a single annual score for each station.

For indicators with established water quality standards (based on criteria in Washington State's water quality standards, Chapter 173-201A WAC), the index expresses results relative to levels required to meet these standards. For example, scores below 80 indicate results did not meet the water quality standard.

For indicators without specific standards, results are expressed relative to expected conditions in the appropriate region. Multiple indicators are combined, and results over time are combined to produce a single score for each sampling station.

During 2005, the WQI was calculated for each of the long-term and basin monitoring locations. *Figure 1* shows the distribution of index scores. Waters of highest concern are labeled as *poor*, those of moderate concern *fair*, and those of lowest concern *good*.

Figure 1: In 2005, Water Quality Index scores were mostly fair or good. (*Basin stations are not necessarily representative of statewide water quality conditions.*)

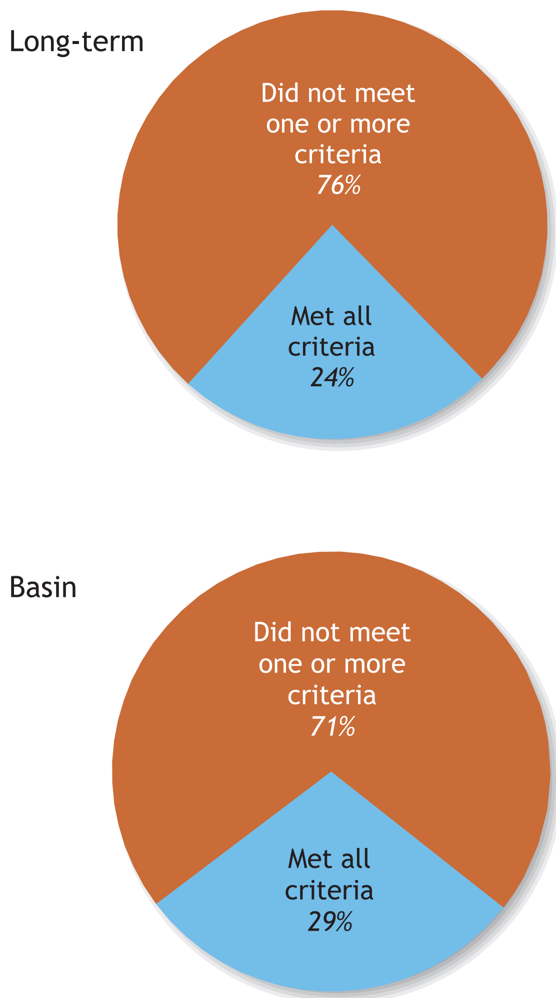


** Percentages do not total 100 due to numerical rounding.*

Aquatic life and recreation use support

Data collected at long-term and basin monitoring stations in 2005 were assessed against the numeric criteria of Washington's water quality standards (not, in this case, against the listing policy discussed in the sidebar *Washington State's water quality assessment* on page 13). These criteria are designed to protect aquatic life and recreational uses. *Figure 2* shows that for 76 percent of long-term stations and 71 percent of basin stations at least one result did not meet criteria for one of four water quality indicators (temperature, fecal coliform bacteria, pH, and oxygen).

Figure 2: Most long-term and basin monitoring stations did not meet at least one water quality criterion specified in Chapter 173-201A WAC. (*Basin stations are not necessarily representative of statewide water quality conditions.*)



Stream temperature

In the summer of 2005, the FMU recorded the temperature at 30-minute intervals at 41 long-term and 35 basin stations. The purpose of the 30-minute interval monitoring was to collect season-long, diel (24-hour) temperature data that may be used for trend analyses and to determine compliance with state water quality standards. More basin stations were monitored in 2005 than in previous years because of a projected drought.

Daily maximum temperatures were evaluated against criteria in the 1997 water quality standards. Eighty-seven percent (66 of 76 monitored stations) had at least one result that failed to meet its criterion (*Figure 3*). When evaluating temperature against Ecology's 303(d) listing policy, which requires that the seven-day average of daily maximums fail to meet the criterion, 63 stations exceeded criteria.

Bacteria conditions

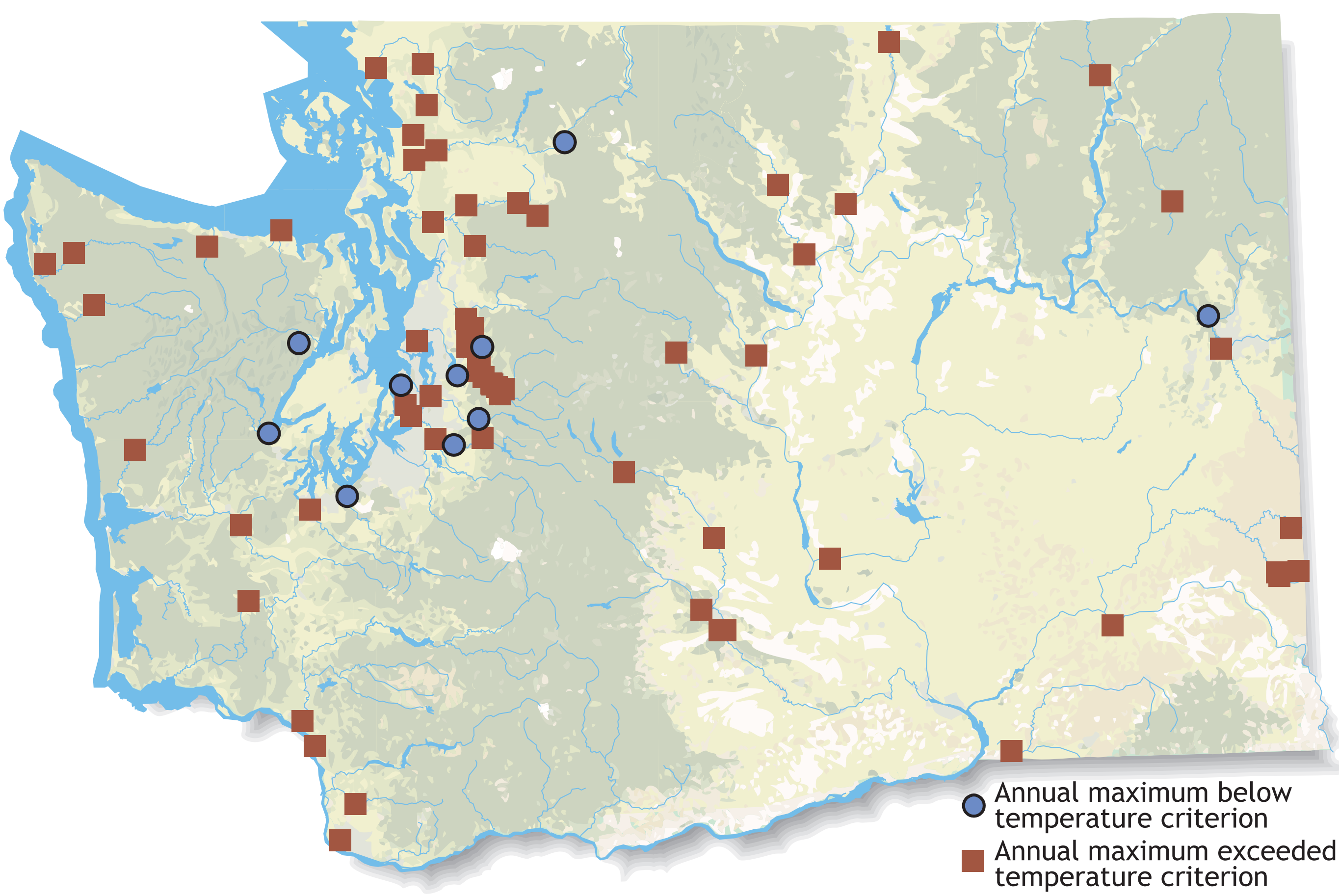
To protect human health, bacteria contamination is evaluated to determine the sanitary condition of waters where people might swim. Since it is impossible to test for all human disease-causing organisms, fecal coliform bacteria and *Escherichia coli* are used as indicators of potential risk. These bacteria originate from the intestinal tracts of warm-blooded animals, and the levels in water are relatively easy to measure.

Washington State has established water quality standards for fecal coliform bacteria in order to protect beneficial uses including swimming and other forms of recreation in fresh water.

Swimming beaches

In 2003 Ecology began an ongoing monitoring project that sampled lake swimming beaches for bacteria. Which beaches to be sampled changed every year. To date, lake swimming beaches have been sampled in the following counties: King and Pierce in 2003;

Figure 3. Seasonal maximum temperatures at long-term (n=41) and basin (n=35) continuous temperature monitoring stations were higher than water quality criteria at all but a few stations. (Basin stations are not necessarily representative of statewide water quality conditions.)



Snohomish and Whatcom in 2004; and Thurston, Lewis, and Clark in 2005. This project is not scheduled to sample any lakes in 2006.

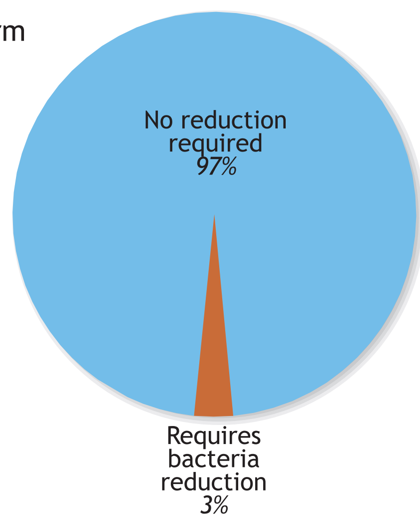
The reason for initiating this monitoring project was twofold:

- Provide additional bacteria data to local health and parks departments that have lake swimming beach monitoring programs.
- Where no lake swimming beach monitoring program exists, provide current bacteria data to local jurisdictions to assist in making decisions about public safety.

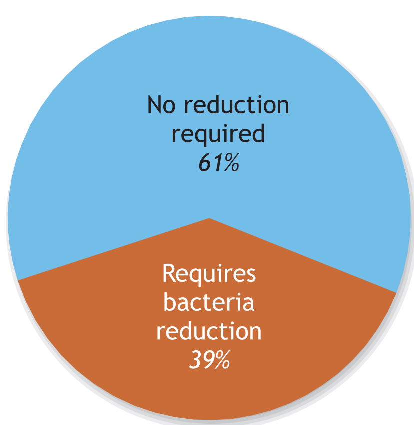
In 2005 a total of five lakes and seven swimming beaches were monitored: three lakes in Clark County, one lake (two swimming beaches) in Lewis County, and one lake (two swimming beaches) in Thurston County.

Figure 4: Although only a few long-term stations require reductions in bacteria levels based on 2005 results, nearly 40 percent of basin stations require reductions. (*Basin stations are not necessarily representative of statewide water quality conditions.*)

Long-term



Basin



At least once between June and September, three of the five lakes had bacteria levels higher than the water quality standard: Battle Ground Lake in Clark County, Mayfield Lake (Ike Kinswa State Park) in Lewis County, and Deep Lake (west beach at Millersylvania State Park) in Thurston County. Criteria were not exceeded at Vancouver and Klineline Lakes in Clark County.

Because of funding considerations, the lake swimming beach monitoring program will not be continued in 2006.

Rivers and streams

Water samples collected in 2005 at FMU's 93 river and stream monitoring stations (long-term and basin) were assessed using a statistical approach (the "roll-back" method) to determine the reduction of fecal coliform bacteria pollution required to meet both parts of the bacteria water quality standard.

Bacteria counts at 3 percent of the long-term stations and 39 percent of the basin stations require some pollution reduction to meet limits established to protect health (*Figure 4* and *Table 1*).

Table 1: List of monitoring locations where 2005 bacteria levels were higher than recommended for human health and the pollution reduction needed to meet water quality standards.

Station ID	Location	Percent Reduction Required
Long-term Stations		
09A080	Green R @ Tukwila	34%
34B110	SF Palouse R @ Pullman	91%
Basin Stations*		
01T050	Anderson Cr @ South Bay Rd	37%
09K070	Fauntleroy Cr near mouth	68%
25F060	Mill Cr nr mouth	3%
28C070	Burnt Br Cr @ mouth	59%
34C060	Paradise Cr @ mouth	50%
34C100	Paradise Cr @ Border	69%
37E050	Wide Hollow Cr @ Main St	69%
37I070	Moxee Drain @ Birchfield Rd	62%
38G070	Cowiche Cr @ Powerhouse Rd	31%
39C070	Wilson Cr @ Highway 821	53%
45D080	Brender Cr above Noname Cr	47%
45R070	Noname Cr on Mill Rd.	83%

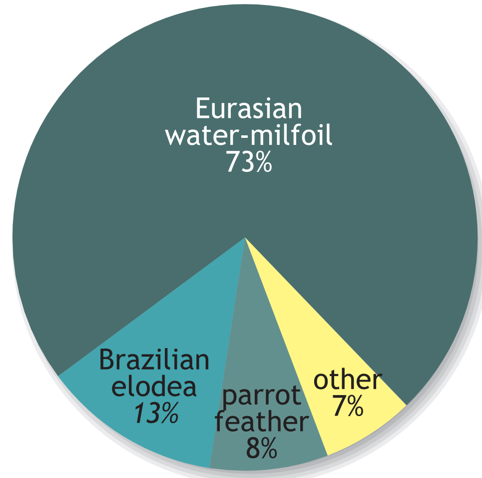
** Basin stations are not necessarily representative of statewide water quality conditions.*

Aquatic plants

Ecology has been characterizing aquatic plant communities 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 (exotic) aquatic weed species. Other objectives of the program are to provide technical assistance in identifying aquatic plants, suggest control measures for invasive species, and conduct special projects that evaluate the effects of invasive, non-native species and experimental controls (see the *Special Projects* section).

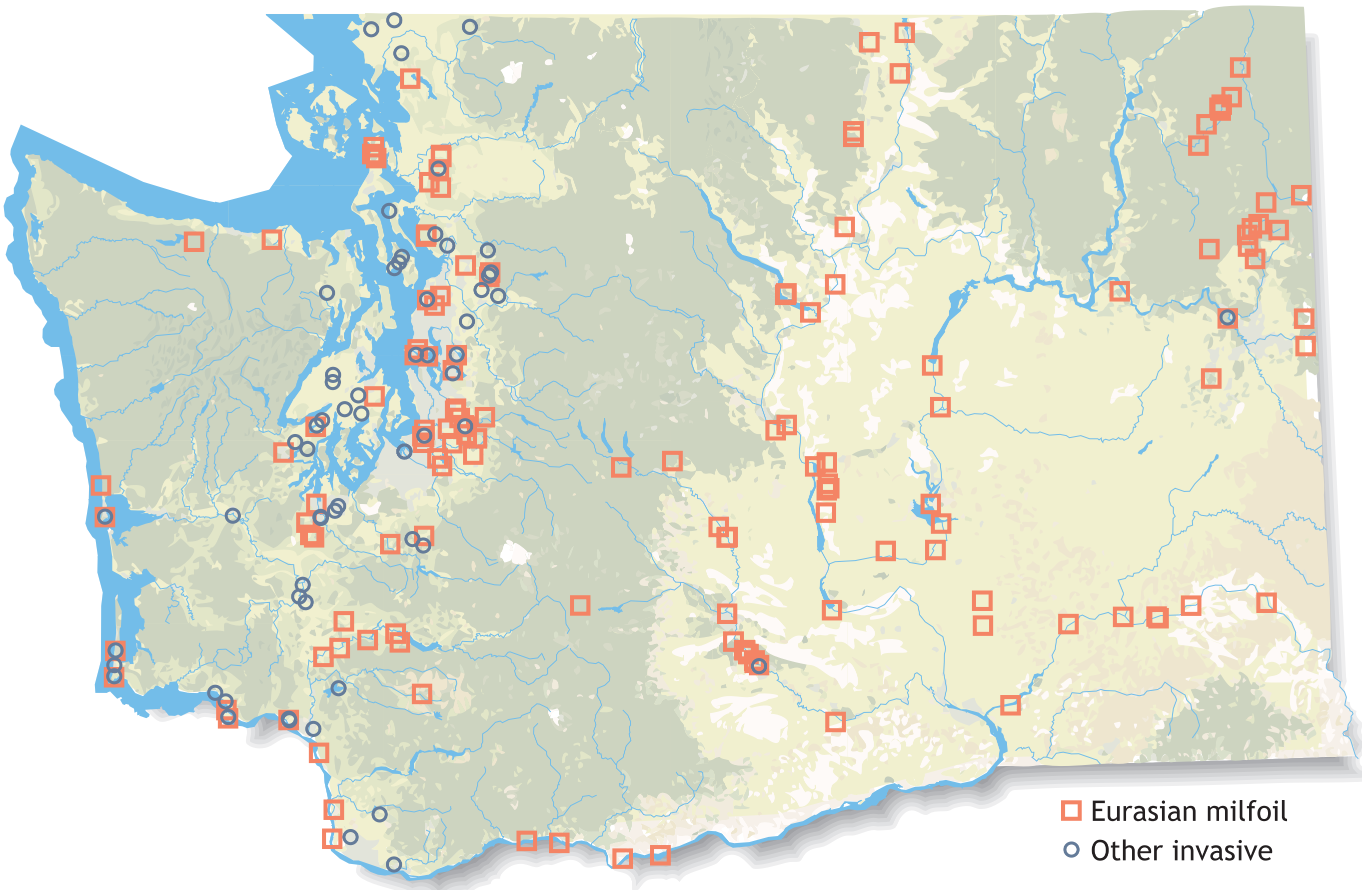
The field collection method for most lakes is to circumnavigate the littoral zone (shallow area where light penetrates to the bottom) in a small boat. When a different plant or type of habitat is observed, plant samples are collected for identification. Notes are made on species distribution, abundance, and maximum depth where the plant grows. In addition, Secchi depth and alkalinity data are collected. The most commonly occurring non-native species are shown in *Figure 5*.

Figure 5: Eurasian water-milfoil is the most frequently encountered invasive, non-native weed species.*



** Percentages do not total 100 due to numerical rounding.*

Figure 6: Since surveys began in 1994, invasive aquatic weeds have been documented at 194 sites.



To date, about 445 lakes and rivers have been surveyed statewide; 194 of these have Class A, Class B, or quarantined aquatic noxious weeds (see *www.nwcb.wa.gov* for a definition of weed classes) (*Figure 6*). Surveyed sites are often chosen based on weed problems or other indications of a potential infestation, so results are not representative of general statewide conditions.

Aquatic weeds are an increasing problem in Washington State. Additional sites with listed noxious weeds are found each year. Another complication is escapement of ornamental pond plants not yet on the noxious weed list. Populations of species never before reported from the wild have been increasingly found; often these species exhibit invasive tendencies.

We report new invasive species to the state Department of Agriculture and recommend that they add the species to the quarantine list so future import is illegal. However, attempting to control non-native species only after they have become invasive is an inefficient and cumbersome process that leaves waterways vulnerable to invasion by new non-native plant species.

We are also seeing an increase in density of native plant growth in some lakes and rivers, most likely brought on by cultural eutrophication (an increase in nutrients resulting from human activities such as fertilizer runoff and leaky septic systems). While moderate growth of aquatic plants is generally a benefit to aquatic systems, too much can cause detrimental impacts. In some cases, such as the lower Yakima River, the exceptionally dense growth of native plants is likely to adversely impact fish and other native wildlife.

Below:
Jenifer Parsons and Grace Marx set up an experiment to investigate the relationship among the milfoil weevil, fish and eurasian milfoil.

Randomized design monitoring

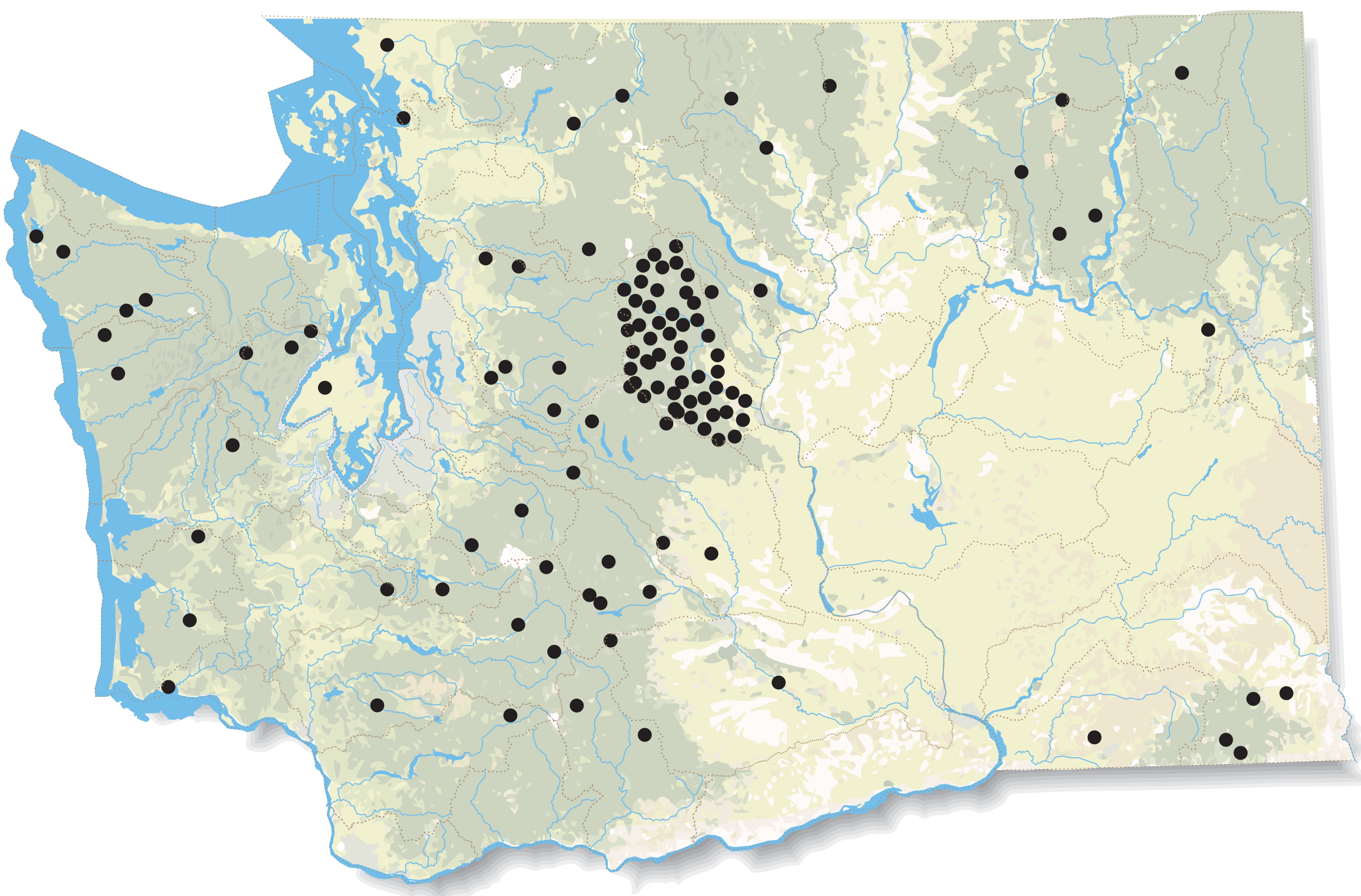
One of the most often-asked questions is: *What is the overall status of water quality in Washington State?* The state is required to answer this question in a report to Congress under the federal Clean Water Act Section 305(b). It is impossible to directly answer this question by monitoring every waterbody (a complete census). The approach recommended by the U.S. Environmental Protection Agency (EPA) is to randomly sample waterbodies and to infer conditions statewide. This approach, known as *sample survey monitoring design*, can provide a statistically representative view of surface water over a broad spatial scale.

The EMAP Western pilot project

Ecology has been conducting research in collaboration with EPA's Environmental Monitoring and Assessment Program (EMAP). EMAP uses a randomized site-selection design to describe the status of regional resources. Randomly locating sites and then characterizing them allows us to describe general conditions over broad landscape areas as well as to forecast the type and intensity of pollution problems.

Our work is part of an assessment that includes 12 western states and tribal lands.

Figure 7: Between 2000 and 2004, the EMAP Western pilot project sampled 117 stream sites throughout Washington, including 55 sites focused in the Wenatchee River basin.



Brian Engeness collects insects from French Creek. Species and abundance of insects can be used to assess ecosystem health.

As part of the EMAP Western pilot project, we conducted a large-scale, long-term (2000-2004) field study of mostly wadeable streams in Washington State (*Figure 7*). Field sampling was conducted to assess the ecological status of streams based on water chemistry, physical habitat, and biological assemblages.

During 2005, we selected more sites within the Wenatchee River basin to help test EMAP techniques on a smaller scale.

During 2005 and 2006 we have been evaluating the data. In 2006 we will report a statewide assessment of wadeable stream conditions. We intend to identify the primary causes that degrade water quality and affect habitat for aquatic life.

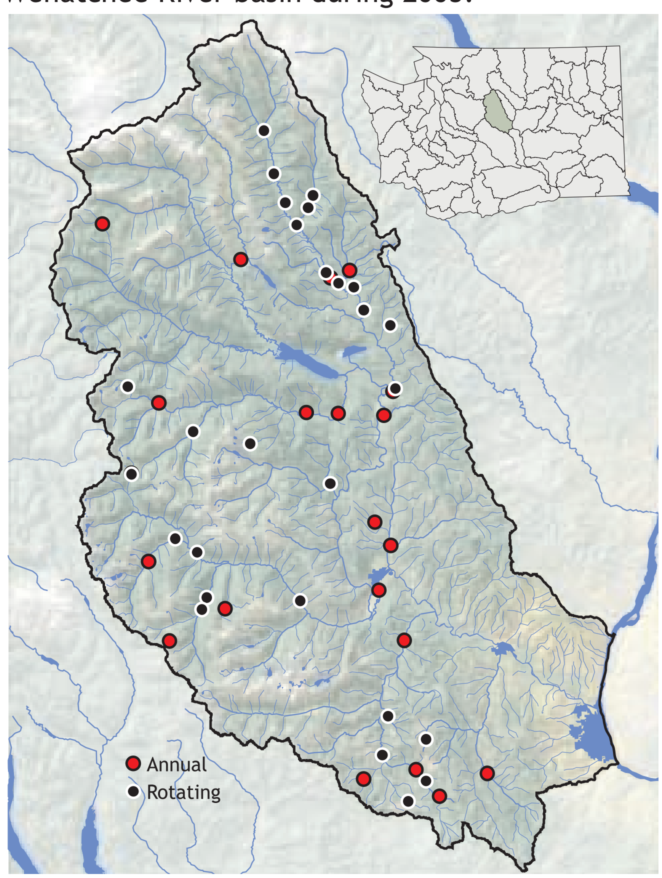
The Integrated Status and Effectiveness Monitoring Program (ISEMP)

Ecology is also conducting research funded through the Bonneville Power Administration under the guidance of the Upper Columbia Regional Technical Team and the National Marine Fisheries Service. Stream sites throughout the Wenatchee River basin were randomly chosen (independently from the EMAP Western pilot project discussed in the previous section) using EMAP protocols (*Figure 8*).

ISEMP is a long-term (2004-2008) field study of fish populations and habitat in the Wenatchee River basin. This work is intended to serve as a pilot for assessing the entire Upper Columbia River basin. Ecology is assessing stream and riparian habitat, as well as macroinvertebrate communities. Ecology is also a key contributor to the development of databases and data metrics.

ISEMP will sample approximately 50 sites annually: 25 new sites and 25 "core" sites (visited every year). There will be about 150 sites sampled over the five-year period.

Figure 8: The ISEMP project sampled 50 randomly-selected wadeable stream sites in the Wenatchee River basin during 2005.



Changes in surface water quality conditions

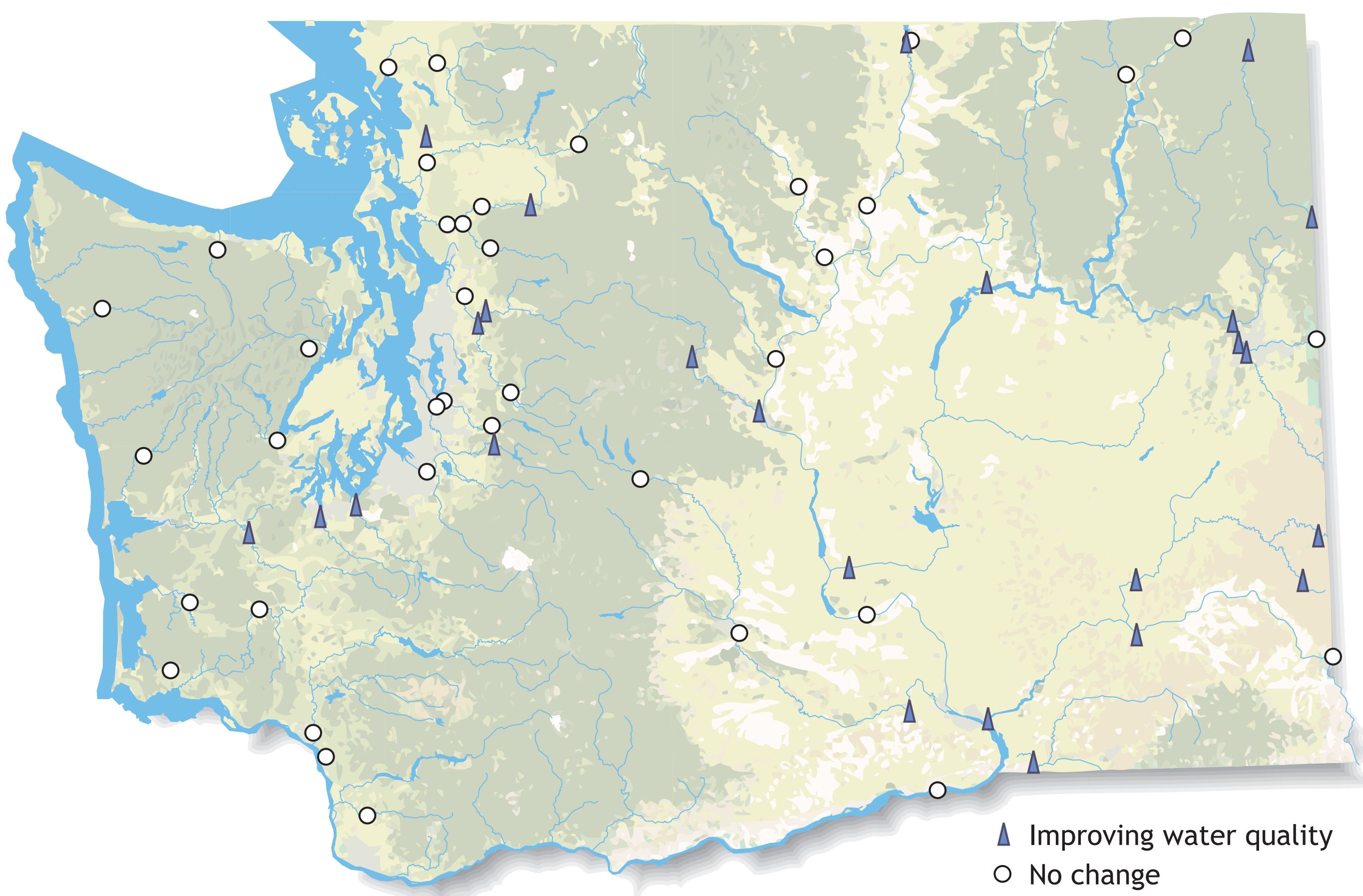
To identify trends, water quality data must be collected routinely over long periods of time. The presence or absence of trends is a good indicator of the degree to which water quality is responding to changes in the watershed. A formal statistical trend analysis provides a rational, scientific basis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

Water Quality Index (WQI) scores derived from data collected by our river and stream monitoring program from 1995 through 2004 were used to assess the trends in water quality. Monthly WQI scores were evaluated for trends 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 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. Meta-analysis was used to evaluate trends for each ecoregion and also statewide

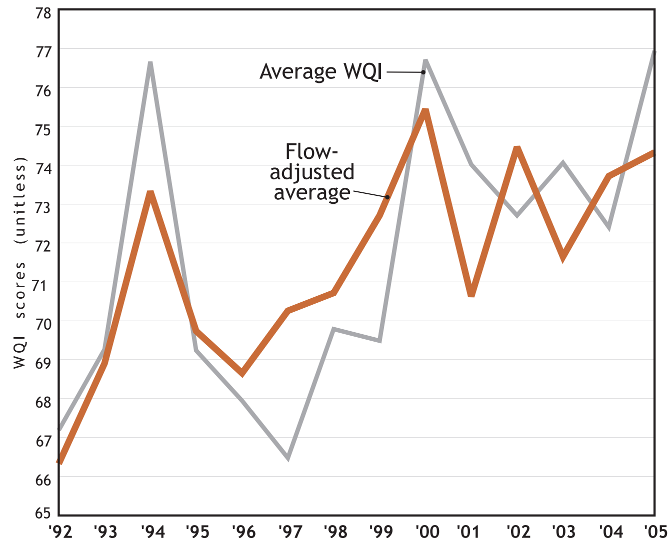
During the last ten years, 25 stations exhibited improving conditions, and no stations exhibited declining conditions; no statistically significant trend was present at 38 stations (*Figure 9*). However, trends in streamflow are responsible for some of the improving conditions. Accounting for flow, improving trends were detected at 15 stations, and declining trends were detected at four stations.

Figure 9: Water Quality Index scores improved at 25 stations statewide over the last ten years, though some of the improvement is related to changes in streamflow.



Statewide, there was statistically significant improvement in water quality conditions (0.5 WQI units per year; *Figure 10*). The greatest improvement was in the Columbia Basin Ecoregion (0.8 WQI units per year), though water quality conditions are still of moderate concern in Columbia basin streams.

Figure 10: Water quality, based on average WQIs at 62 long-term stations, has been improving over the last ten years, though some of the improvement is related to changes in streamflow.



Below:
Jill Lemmon collects a bacteria sample from the Willapa River near Raymond to assess the effectiveness of cleanup efforts.

Effectiveness of clean water programs

Ecology is required under Section 303(d) of the federal Clean Water Act to periodically prepare a list of waterbodies that do not meet Washington State water quality standards. After EPA approves the list, we at Ecology are required to prepare and implement Total Maximum Daily Load (TMDL) water cleanup plans on these waterbodies.

TMDLs are based on the relationship between pollution sources and waterbody conditions. They quantify current and allowable load allocations from discrete (point) and diffuse (nonpoint) sources of pollution. From the TMDL study, decisions are made as to which activities should be implemented to bring river or stream reaches into compliance with the state's water quality standards.

Once corrective actions, such as best management practices, have been implemented to bring a waterbody back into compliance with water quality standards, an evaluation of the effectiveness of these activities is required. This evaluation is called TMDL effectiveness monitoring. TMDL effectiveness monitoring has the following purposes:

- Provide feedback on TMDL recommendations.
- Guide implementation efforts.
- Provide data for refinement of modeling used in the initial TMDL study.

This section discusses five of Ecology's ongoing effectiveness monitoring studies:

Dave Hallock uses a "Kemmerer" sampler at Lake Ballinger to collect water from a specific depth.

Washington State's Water Quality Assessment

Section 303(d) of the federal Clean Water Act requires Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are estuaries, lakes, and streams that fall short of Washington State surface water quality standards and are not expected to improve within the next two years.

Waters placed on the 303(d) list require the preparation of Total Maximum Daily Load (TMDL) studies. A TMDL identifies the maximum amount of a pollutant allowed to be released into a waterbody so as not to impair uses of the water, and allocates that amount among various sources.

The state's 303(d) policy describes how the standards are applied, what the requirements for the data are, and how to prioritize TMDLs. The goal is to make the best possible decisions on whether each body of water is impaired by pollutants, as well as to ensure that all impaired waters are identified and no waters are mistakenly identified. (*www.ecy.wa.gov/programs/wq/303d/introduction.html*)

The analyses in this report are independent of, and may differ from, Ecology's formal Water Quality Assessment. Assessments in this report are limited to FMU data; formal Water Quality Assessments includes data from multiple sources.

While both assessments use state water quality standards (Chapter 173-201A WAC) as a key benchmark, assessment techniques differ. For example, Ecology's 303(d) listing policy (*www.ecy.wa.gov/programs/wq/303d/2002/303d_policy_final.pdf*) requires that for some indicators a minimum number of results must fail to meet a criterion, while assessments in this report are often based on direct comparisons to criteria specified in the standards.

Lake Ballinger TMDL Effectiveness Monitoring

Lake Ballinger lies just north of the King County/Snohomish County border within the cities of Mountlake Terrace and Edmonds between Interstate-5 and Highway 99. A 1972 study by METRO/ King County listed excessive nutrient loading, algal blooms, sediment loading, and bacterial contamination as water quality problems. Subsequent sewer system improvements within the watershed removed most of the human-generated bacterial problems.

Restoration efforts beginning in 1980 included the construction of two regional sedimentation facilities on the lake inlet, Hall Creek, and the rehabilitation of the lower creek. In addition, stormwater control ordinances concerning construction on and development of the lake watershed were established. In 1982, hypolimnetic systems were installed in the lake for injection of dissolved oxygen and withdrawal of nutrient-laden water.

A 1986 Phase III report concluded that after the installation of the hypolimnetic withdrawal system, internal phosphorus loading by release from anoxic sediments was no longer significant. However, external loading increases have replaced the reduced internal loading.

In 1990 the City of Mountlake Terrace treated Lake Ballinger with alum to reduce the excessive phosphorus concentration in the lake. Within 48 hours of the treatment, the clarity of the lake increased by 40% and the phosphorus levels decreased by 70%. Although the short-term result of the alum treatment was impressive, the longevity of the treatment is limited by continuing external phosphorus loading.

A TMDL plan for Lake Ballinger was submitted by Ecology and approved by EPA in 1993. The current TMDL effectiveness monitoring project began in November 2005 and continued through October 2006. Once the data are analyzed, the project will determine whether past lake treatments continue to be effective in restoring and maintaining designated uses in Lake Ballinger and whether current phosphorus concentrations are consistent with the load allocations set in the TMDL.

Contact: *Maggie Bell-McKinnon*;
360-407-6124; *mbel461@ecy.wa.gov*

Skokomish River TMDL Effectiveness Monitoring

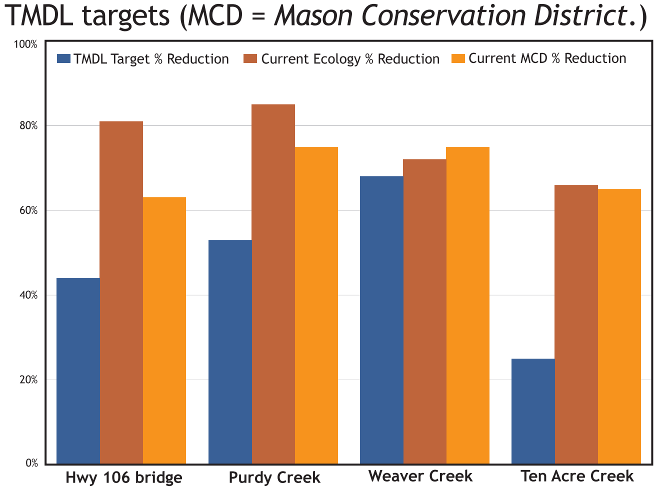
The Skokomish River drains an area of about 247 square miles before discharging into Annas Bay in southern Hood Canal near Potlatch, Washington. Bacterial contamination was found in the lower Skokomish River and its marine receiving water. This contamination threatens beneficial uses such as freshwater and marine recreation, domestic water supply, and shellfish harvest. The state Department of Health has listed the Annas Bay commercial shellfish harvest area as threatened by bacterial contamination for 9 of the last ten years. To support these designated uses, the TMDL recommended that most streams in the lower Skokomish River basin need to have fecal coliform levels well below Class AA freshwater criteria (50 colony-forming units per 100 milliliters of water) to protect the marine waters and their beneficial uses.

Cleanup efforts included decommissioning of high-risk septic systems, installation of riparian fencing, tree plantings, installation of port-a-potties, land enrollment and acquisition, posting of no trespassing signs, distribution of waste management flyers, and on-going educational outreach.

The objectives of the study are to (1) evaluate attainment of bacteria target concentrations and percent reductions, and (2) determine if Class AA water standards are being met at the four compliance stations identified in the TMDL study. Preliminary results indicate improvement in water quality and bacterial reductions greater than the TMDL targets (*Figure 11*).

Contact: *George Onwumere*;
360-407-6730; *ogeo461@ecy.wa.gov*

Figure 11: Fecal coliform bacteria reductions in the Skokomish River in 2005 were better than TMDL targets (MCD = *Mason Conservation District*.)

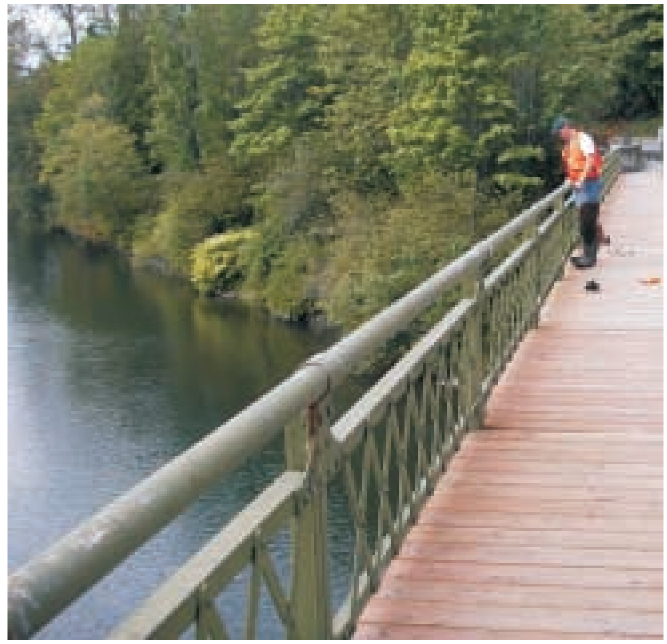


Snoqualmie River TMDL Effectiveness Monitoring

The Snoqualmie River system drains 700 square miles (1,813 square kilometers) in King and Snohomish Counties before meeting the Skykomish River at Monroe to create the Snohomish River. Most of the Snoqualmie River basin is in King County. The study area includes the lower 44.5 miles (71.6 km) of the river from the South Fork Snoqualmie River and confluence of the two other main forks near North Bend (elevation 430 ft/131 m), to the confluence with the Skykomish River.

The river system is highly valued for its recreational, aesthetics, aquatic habitat, and domestic water supply uses. However, the Snoqualmie River Valley has been undergoing rapid changes in land use with additional wasteload discharges proposed for the river. As a result, Ecology developed a TMDL for ammonia, biochemical oxygen demand (BOD), and fecal coliform for the basin that was approved by EPA in 1996. Several cleanup efforts were initiated which prompted this TMDL study.

Two years of TMDL effectiveness monitoring has been completed to characterize (1) water quality conditions in both low-flow and high-flow periods and (2) several transects around the Falls City area for pollution tracing. We are currently analyzing the data.



Chad Wiseman collects a grab sample from the Snoqualmie River as part of a TMDL effectiveness monitoring project.

Contact: *George Onwumere*; 360-407-6730; *ogeo461@ecy.wa.gov*

Below: Snoqualmie River above Carnation.

Willapa River TMDL Effectiveness Monitoring

The Willapa River drains a basin of about 260 square miles before discharging into northeastern Willapa Bay in Pacific County. The river and several of its tributaries are on the 1998 303(d) list of impaired waterbodies due to violations of fecal coliform bacteria and dissolved oxygen water quality criteria.

Since 1997, bacteria studies have been conducted by the state Department of Health Shellfish Protection Program, Pacific County, and Ecology. Fecal coliform concentrations during a 1997-98 study by Ecology found that only five of 30 sites sampled met water quality standards for fecal coliform bacteria. Data from 2004 show that conditions have improved significantly in many parts of the basin, especially in the lower stretch of the river.

Results from this current study will verify where the Willapa River meets standards and help guide local efforts to areas where bacteria problems continue to exist. The project objectives are to (1) clarify pollution sources and compare current conditions to Washington State water quality criteria for fecal coliform bacteria, (2) compare current and previous monitoring data, and (3) provide data for decisions on local TMDL implementation planning/responses. Sampling started January 2006 and ends December 2006.

Contact: *George Onwumere*;
360-407-6730; *ogeo461@ecy.wa.gov*

Willapa River near Menlo.

Pataha Creek TMDL Effectiveness Monitoring

Pataha Creek is a Class A tributary of the Tucannon River and a major salmonid habitat river in southeastern Washington. Portions of Pataha Creek were listed as impaired due to dissolved oxygen, ammonia nitrogen, and chlorine. A TMDL was developed for those parameters and approved in September 1994.

Since 1994, there has been a major effort to control both point (discrete) source discharges and nonpoint (diffuse) pollution to Pataha Creek. In 1998, a model watershed plan was developed to control erosion, restore riparian areas, and increase streamflow by reducing irrigation withdrawal. In 2002, the City of Pomeroy completed the addition of a bio-filter with second stage aeration, UV disinfection, and effluent reaeration to its wastewater treatment plant.

From June through October 2005, monitoring was performed to assess the impact of the TMDL on Pataha Creek. All results were above the state water quality criterion for dissolved oxygen and below the criterion for ammonia. In addition, the conversion to UV disinfection has eliminated chlorine toxicity.

The TMDL implemented through the National Pollutant Discharge Elimination System (NPDES) permit for Pomeroy's wastewater treatment plant has been effective in allowing Pataha Creek to meet Washington State water quality standards for dissolved oxygen, ammonia, and chlorine. Non-point-related impairments (temperature and fecal coliform) remain.

As progress continues on riparian habitat improvements under the model watershed plan, we expect water quality to continue to improve.

Contact: *Jim Ross*;
509-329-3425; *jros461@ecy.wa.gov*

Special projects

In addition to the routine monitoring reported above, Ecology's FMU occasionally conduct special projects to address particular water quality problems in our areas of expertise. Two examples of projects conducted in 2005 are summarized below.

Herbicidal control methods for aquatic weeds

FMU conducted projects to assess various herbicidal control methods for invasive, non-native aquatic weeds in 2005. Additional projects were completed prior to 2005 on other herbicides and biological control agents. Information on those projects and the three projects listed below is available at *http://www.ecy.wa.gov/programs/eap/lakes/aquaticplants/index.html.*

Impact of diquat on the aquatic plant community of Battle Ground Lake, Clark County

This project was initiated in 2003, and the final year of data collection was 2005. We found that the herbicide significantly reduced both the frequency and biomass of the target weed, Brazilian elodea, although the plant did not disappear entirely. Two native submersed plants, water moss (*Fontinalis antipyretica* L.) and stonewort (*Nitella* sp Agardh.), increased significantly after treatment. However, they did not increase enough to offset the Brazilian elodea die off, as total plant abundance was significantly reduced after treatment. The results were combined with herbicide dissipation and water quality data collected by other agencies and submitted for publication to the Journal of Aquatic Plant Management.

Impact of fluridone on Brazilian elodea, Eurasian water-milfoil, and the native aquatic plant community of Loomis Lake, Pacific County

An additional year of post-herbicide treatment data collection took place in 2005. This project will be completed in 2006.

Jenifer Parsons uses a modified lawn rake to collect aquatic plants

Impact of triclopyr on Eurasian water-milfoil and the native aquatic plant community of Capitol Lake, Thurston County

The final year of data collection took place in 2005 by Thurston County staff. We found that both the frequency of occurrence and biomass of the target plant, Eurasian water-milfoil, were reduced significantly both three months and one year after treatment with the herbicide triclopyr. However, small patches of this weed persisted in the lake, so continued control will be required to prevent additional spread and increased dominance.

Contact: *Jenifer Parsons*;
509-457-7136; *jenp461@ecy.wa.gov*

A comparison of grab and integrated sampling methods

Ecology's monitoring program collects samples by submerging a container just below the water surface. This "grab" sampling technique is relatively quick and inexpensive, but there is a risk that results may not be representative of a stream's cross-section. "Integrated" sampling, which collects volume-weighted samples throughout the water column at various points across the stream, is more representative but also more expensive. We wanted to know how results from these two methods compare.

Data collected by integrated sampling (by the U.S. Geological Survey) and by single grab sampling (by Ecology) were compared at two stations, the Palouse River at Hooper and the Yakima River at Kiona. About ten years of matching (same year and month) data exist at each station for each monitoring program. Sampling strategies and timing sample collection were not coordinated.

In general, single point grab samples provided results similar to the more intensive and expensive integrated sampling method for the Palouse and Yakima Rivers with respect to central tendency and dispersion. However, loads (concentration times discharge) of stratified indicators (total phosphorus and sediment) calculated from grab sample results were much lower than loads calculated from integrated sampling.

We expect the differences between grab and integrated sampling to be less pronounced when mixing is greater, such as in smaller streams and at sample locations that are not depositional. Unless the analyst knows that a sample site is well mixed, data collected by grab sampling should not be used to determine loads for stratified indicators. *www.ecy.wa.gov/biblio/0503009.html*;
Contact: *Dave Hallock*;
360-407-6681; *daha461@ecy.wa.gov*

Palouse River at Hooper (top) and Yakima River at Kiona (bottom.)

Freshwater resources not being monitored by FMU

This report focuses on our Freshwater Monitoring Unit's (FMU) statewide water quality and biological monitoring programs, and what we have learned from them in 2005. However, there are important environmental areas that FMU does not monitor and cannot assess. Five of these areas are listed below.

Randomized design monitoring

The action plan outlined by the legislatively-mandated Monitoring Oversight Committee's *Comprehensive Monitoring Strategy* identifies the highest monitoring need as the inclusion of a sample-survey design. We have completed several projects that were supported by EPA over the past decade. However, permanent funding should be secured for sample-survey design monitoring of lake and stream water quality, habitat, biology, and invasive aquatic plants. In the short-term, we have proposed this monitoring be implemented at the Water Resource Inventory Area (WRIA) or the Salmon Recovery Region level to be rotated throughout the state in a systematic way.

Lake monitoring

We at Ecology have monitored rivers and streams since 1959 and, with federal grants, were able to monitor lakes from 1989 through 1999. During that period, we collected data from more than 180 lakes, with help from about 250 volunteers. In 2000 Ecology discontinued the program.

Sections 305(b) and 314(a) of the federal Clean Water Act require lake monitoring. In addition, Washington State water quality standards require lake monitoring to establish lake-specific nutrient criteria. At present, there is no statewide monitoring or assessment of lake water quality.

EPA is currently designing a one-time National Lakes Assessment program with sampling scheduled for 2007. This program would provide funds to states to conduct lake monitoring for one year using a randomized sampling design. Although the national program would collect insufficient data to allow conclusions about Washington's lakes, the program could be expanded to provide a Washington State assessment.

Trout Lake in the Alpine Lakes Wilderness Area.

Lake sediment monitoring

Lake sediment cores provide qualitative and quantitative information on air, water quality, and land-use changes over long periods. New techniques examining sediment cores can estimate historical concentrations of total phosphorus in lakes by using information from fossil diatoms or insect mandibles.

Long-term changes in phosphorus loading can be quantified from lake sediment cores. Cores are dated using ^{210}lead, ^{137}cesium, or ^{14}carbon.

Estimates of lake total phosphorus concentration prior to European settlement can help determine natural conditions that form the basis of water quality standards for lakes. This information would be particularly useful for TMDL development.

Biological monitoring

For more than ten years, Ecology collected biological information from rivers and streams throughout the state. This monitoring program was designed to explore spatial patterns and impairment, and to identify temporal trends in benthic macroinvertebrates. (Benthic communities can reflect short-term impacts that can be missed by routine water quality monitoring.) At present, there is no statewide biological monitoring program for Washington State.

Lake swimming beach bacteria contamination

In 2003, Ecology began a pilot project that collected bacteria data at selected lake swimming beaches throughout western Washington. Since most local health departments do not have the monetary and staff resources to collect this type of information, the bacteria data Ecology collected was very much appreciated by local governments. Unfortunately, due to budget constraints this pilot project ended in 2005. In order to protect human health, the sampling of lake swimming beaches should be re-established as an on-going monitoring program.

Below
These kids are enjoying one of our state's many valuable aquatic resources: Deep Lake, Thurston County.

Related information

Washington State Department of Ecology publications

Washington State Water Quality Conditions in 2005, based on Data from the Freshwater Monitoring Unit: Technical Appendix
Publication No. 06-03-031
www.ecy.wa.gov/biblio/0603031.html

Washington State Water Quality Conditions in 2004, based on Data from the Freshwater Monitoring Unit
Publication No. 05-03-036
www.ecy.wa.gov/biblio/0503036.html

Condition of Fresh Waters in Washington State for the Year 2003
Publication No. 04-03-033
www.ecy.wa.gov/biblio/0403033.html

Condition of Fresh Waters in Washington State for the Year 2002
Publication No. 03-03-030
www.ecy.wa.gov/biblio/0303030.html

River and Stream Ambient Monitoring Report for Water Year 2005
Publication No. 06-03-032
www.ecy.wa.gov/biblio/0603032.html

A Water Quality Index for Ecology's Stream Monitoring Program
Publication No. 02-03-052
www.ecy.wa.gov/biblio/0203052.html

Using Invertebrates to Assess the Quality of Washington Streams and to Describe Biological Expectations
Publication No. 97-332
www.ecy.wa.gov/biblio/97332.html

Assessment of Water Quality for the Section 303(d) List
Water Quality Program Policy No. 1-11
www.ecy.wa.gov/programs/wq/303d/2002/overview.html

Other 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

Washington State Department of Ecology web sites

River and stream water quality monitoring
www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html

Stream biological monitoring
www.ecy.wa.gov/programs/eap/fw_benth

Aquatic plant monitoring
www.ecy.wa.gov/programs/eap/lakes/aquaticplants

Effectiveness monitoring
www.ecy.wa.gov/programs/wq/tmdl/effectiveness_monit/index.html

Lake monitoring
www.ecy.wa.gov/programs/eap/fw_lakes/index.html

Additional resources on Ecology's Environmental Information page
www.ecy.wa.gov/programs/eap/env-info.html