Washington State Water Quality Conditions in 2004, based on Data from the Freshwater Monitoring Unit

WASHINGTON STATE DEPARTMENT OF ECOLOGY

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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:

David Batts
Maggie Bell-McKinnon
Chris Coffin
Dave Hallock
Glenn Merritt
George Onwumere
Jenifer Parsons
Rob Plotnikoff
Jim Ross
Bill Ward
Chad Wiseman

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Cover:
Jim Garner measuring flow in the Tolt River photo by Bill Ward

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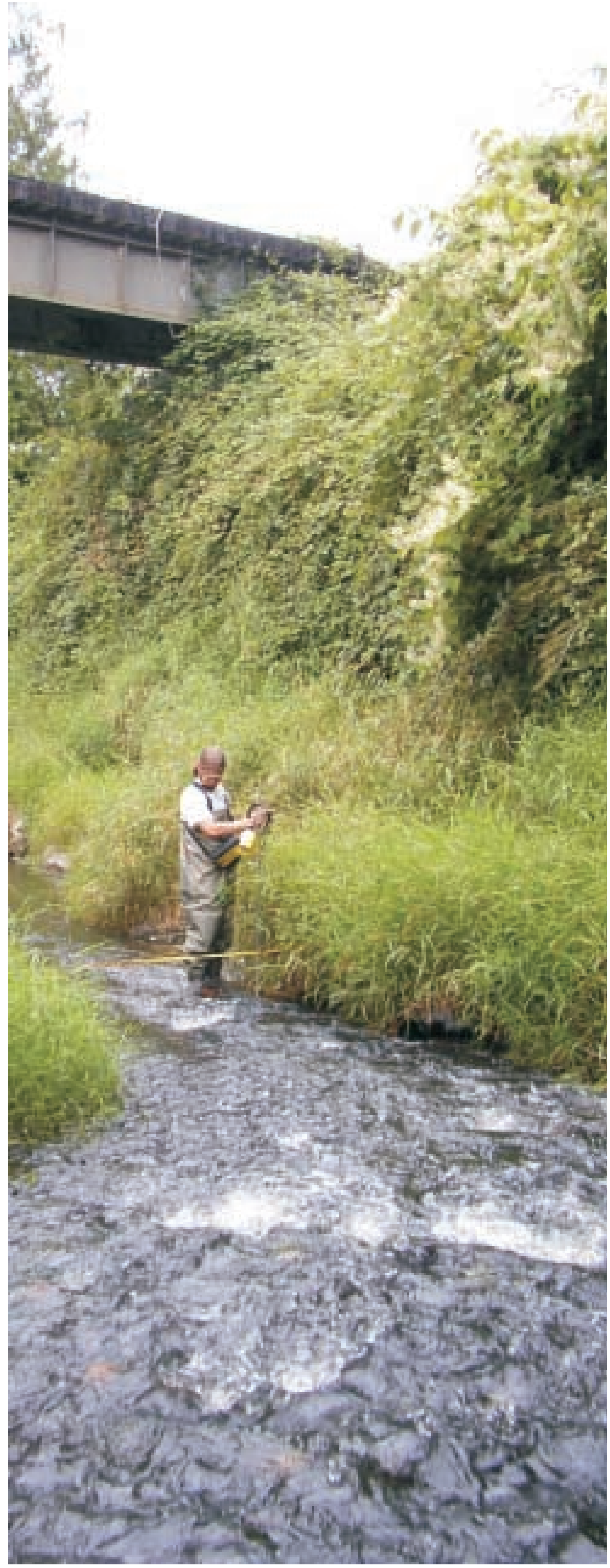


Jim Garner measuring flow

Introduction

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 (TMDL) 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 government entities, schools and others interested in the quality of Washington's 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 2004 results for a non-technical audience.

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

Washington State's water quality assessment

Section 303(d) of the federal Clean Water Act requires Washington State periodically to 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 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 TMDLs. 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, requirements for the data used, 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; the formal assessment includes data from multiple sources.

Also, 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 constituents 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.

The quality of surface waters monitored by FMU

While FMU monitoring activities assess the water quality of Washington's fresh waters, results cannot necessarily be used to infer statewide conditions. Much monitoring is 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 on 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.

Water quality: monthly stream monitoring

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

◆ *Long-term monitoring 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 one year only. Basin stations are often sited at 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 single values in much the same way that the Dow-Jones summarizes conditions in financial markets. Although much detail is 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 most 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 constituents. A particular station may receive a good WQI score but its water quality might be impaired by constituents not included in the index.

◆ 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 constituents are converted to an index score for each sampling visit; scores are then aggregated to produce a single annual score for each station.

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

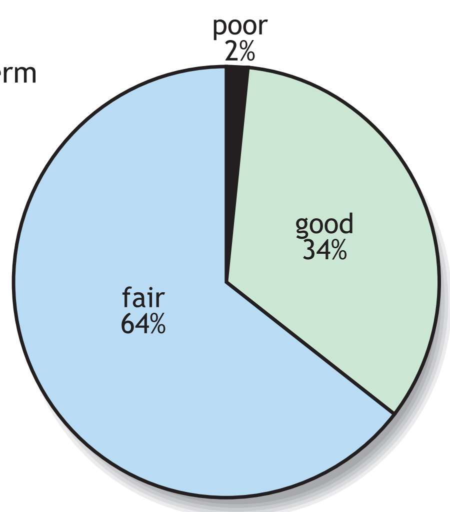
The WQI was calculated for each of the long-term and basin monitoring locations during 2004. *Figure 1* shows the distribution of index scores. Waters of highest concern are labeled as *poor*, those of moderate concern *fair*, and those of lowest concern *good*.

Aquatic life and recreation use support

Data collected at long-term and basin monitoring stations in 2004 were assessed against the numeric criteria of Washington's water quality standards (not, in this case, against the listing policy discussed in *Washing State's Water Quality Assessment* on page 3). At least one result not meeting criteria was identified at 81 percent of long-term stations and 90 percent of basin stations for one of four water quality indicators (temperature, fecal coliform bacteria, pH, and oxygen; *Figure 2*).

Figure 1: Water Quality Index Based On 62 Long-Term And 20 Basin Monitoring Stations. (*Basin stations are not necessarily representative of statewide water quality conditions.*)

Long-term



Basin

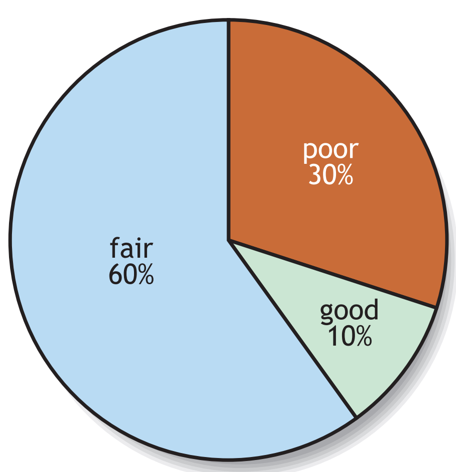
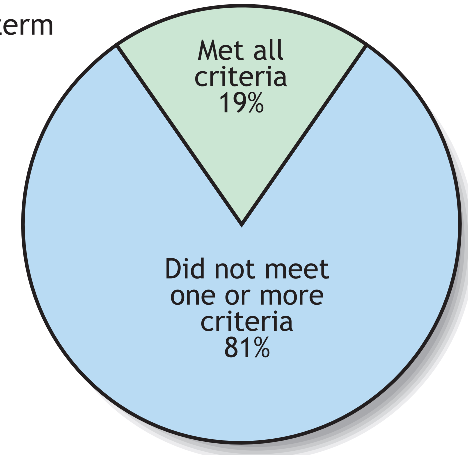
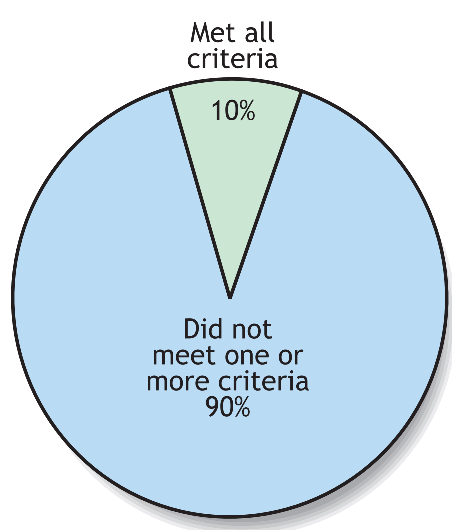


Figure 2: Long-Term (n=62) And Basin Monitoring (n=20) Stations Not Meeting Water Quality Criteria specified in Chapter 173-201A WAC. (*Basin stations are not necessarily representative of statewide water quality conditions.*)

Long-term



Basin



Temperature

In the summer of 2004, the FMU recorded the temperature at 30-minute intervals at 39 long-term and 13 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.

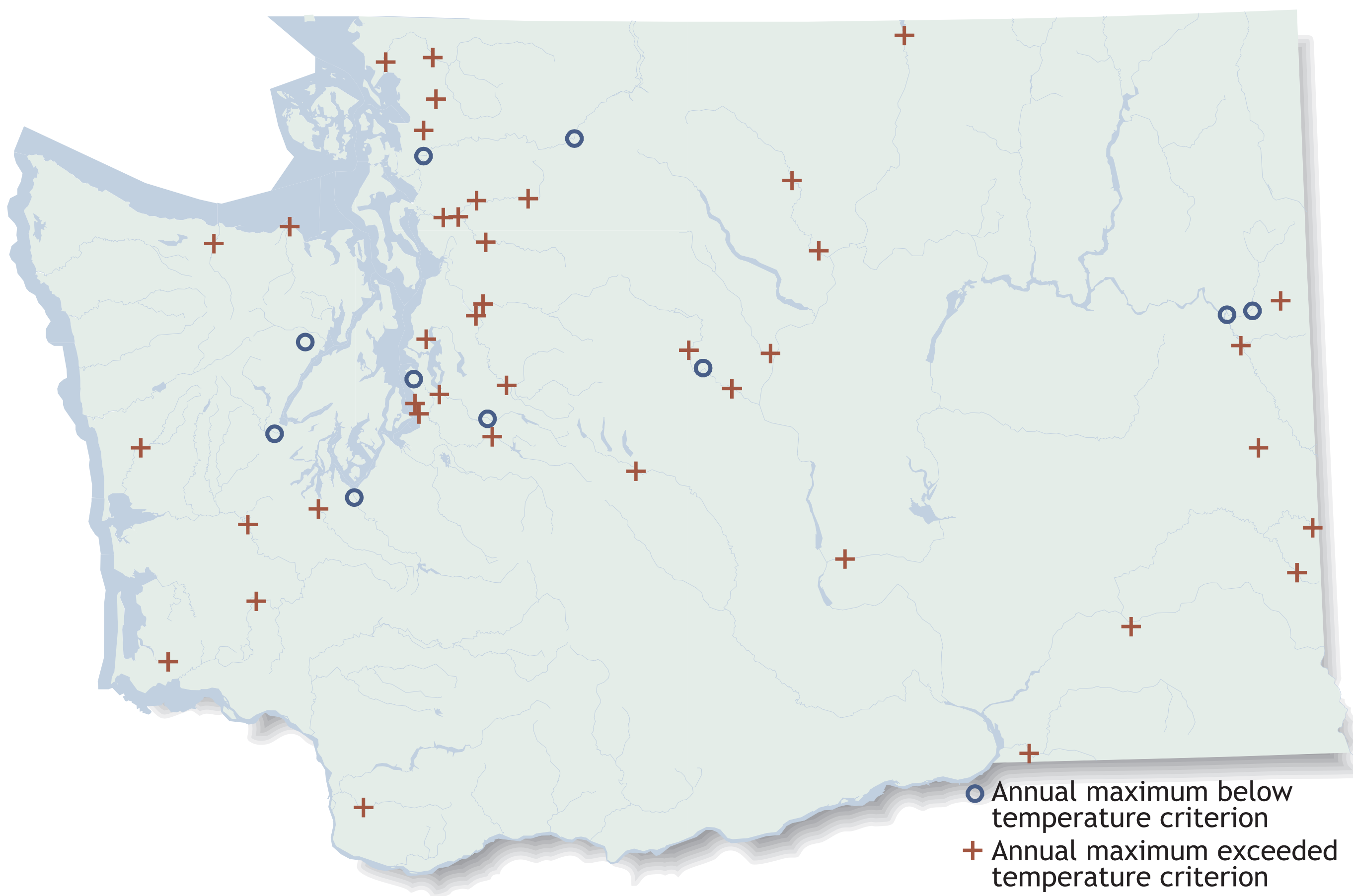
Daily maximums were evaluated against criteria in the 1997 water quality standards. Forty-six of the 52 monitored stations (88 percent) had at least one result that failed to meet its criterion (Figure 3). (Forty-three stations exceeded criteria using Ecology's 303(d) listing policy, which requires that the seven-day average of daily maximums fail to meet the criterion.)

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 pathogenic organisms that can cause human disease, 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 the use of swimming and other forms of recreation in fresh water.

Figure 3: Long-Term (n=39) And Basin Stations (n=13) Meeting And Exceeding Water Quality Criteria. (*Basin stations are not necessarily representative of statewide water quality conditions.*)



In 2003, Ecology began an ongoing monitoring project that sampled lake swimming beaches for bacteria. The reasons for initiating this monitoring project were twofold:

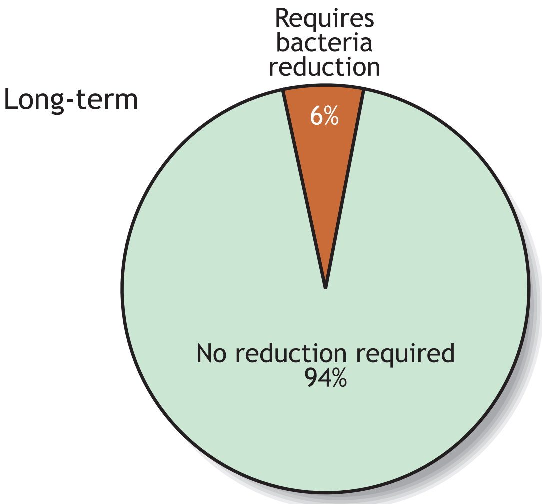
- Provide additional data to local health and parks departments that have lake swimming beach monitoring programs.
- Where no lake swimming beach program exists, provide current bacteria data to local jurisdictions to assist in making decisions about public safety.

Lake swimming beaches in two counties are chosen for sampling each year, with the assistance of the local health jurisdiction. In 2004, five lakes in Snohomish County and four lakes in Whatcom County were monitored. The 2004 results showed that of these nine lakes, swimming beaches at Silver Lake, Twin Lakes, and Lake Ballinger in Snohomish County failed to meet the water quality standard at least once between June and September. There were no lakes in Whatcom County that failed to meet water quality standards for bacteria during the 2004 season.

Water samples collected in 2004 at FMU's 82 long-term and basin river and stream monitoring stations were assessed using a statistical approach to determine the reduction of fecal coliform bacteria pollution required to meet both parts of the bacteria water quality standard.

Bacteria counts at 6 percent of the long-term stations and 60 percent of basin stations require some reduction to meet limits established to protect health (*Figure 4* and *Table 1*).

Figure 4: Bacteria Conditions At Long-Term (n=62) And Basin Stations (n=20; all months). (*Basin stations are not necessarily representative of statewide water quality conditions.*)



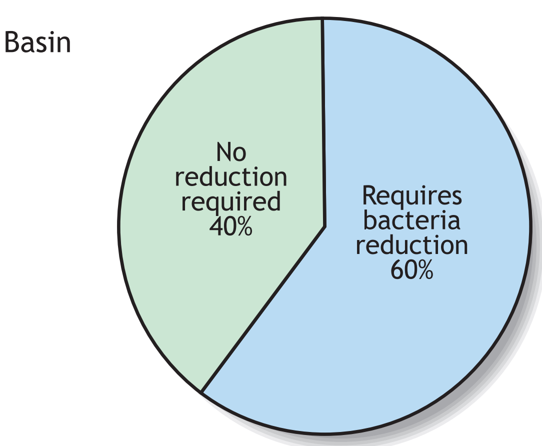


Table 1: Monitoring locations where 2004 bacteria levels were higher than recommended levels for human health, and the pollution reduction needed to meet water quality standards *(all months were included in the calculation)*.

Station	Location	Percent Reduction Required
Long-term Stations		
03B050	Samish R near Burlington	63%
08C070	Cedar R @ Logan St/Renton	27%
13A060	Deschutes R @ E St Bridge	47%
34B110	South Fork Palouse R @ Pullman	56%
Basin Stations*		
08L070	Laughing Jacobs Cr near mouth	87%
08M070	South Fork Thornton Cr @ 107th Ave	94%
09C070	Des Moines Cr near mouth	84%
09D070	Miller Cr near mouth	70%
09J090	Longfellow Cr abv 24-25th St junction	82%
28C070	Burnt Br Cr @ mouth	79%
34F090	Pine Creek at Rosalia	65%
45C060	Chumstick Cr. near mouth	26%
45D070	Brender Cr near Cashmere	63%
45E070	Mission Cr near Cashmere	19%
45R050	Noname Creek near Cashmere	81%
55C200	Deadman Cr @ Holcomb Rd	5%

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

Biological conditions

Traditional measurements of the chemical and physical characteristics of rivers and streams provide insufficient information to detect all surface water problems. Biological assessments, which measure macroinvertebrate communities, supplement chemical and physical measurements by:

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

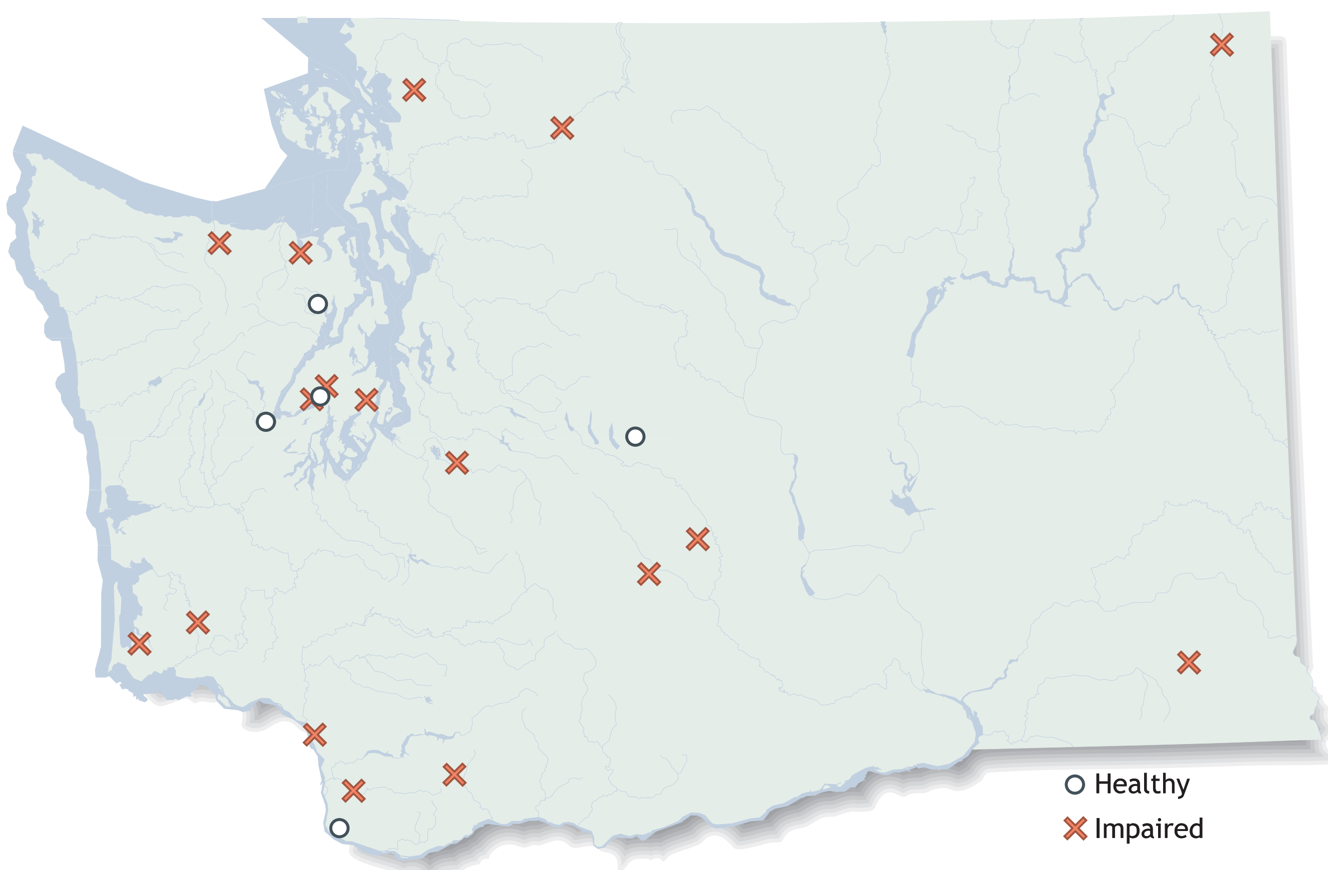
Ecology collects biological information from rivers and streams throughout the state. The long-term monitoring program was established in 1993 to explore spatial patterns and identify temporal trends in benthic macroinvertebrate communities. The program has developed a large base of information that describes biological characteristics of reference (relatively unaffected by human impacts) and degraded conditions.

Our current ambient biological monitoring strategy is to determine the biological status and trends at stream water quality monitoring sites. Sampling water quality and benthic macroinvertebrates at the same locations produces a more complete assessment than can be achieved using either approach alone. We also sample a small network of reference sites every year to obtain estimates of variability due to climatic cycles and regional conditions.

Although not included in water quality standards, we apply two types of biological criteria to measure the ability of a stream to support macroinvertebrate communities:

- The River InVertebrate Prediction and Classification System uses ecoregions as well as physical characteristics of the stream to predict macroinvertebrate community structure. The measured structure is then compared to the prediction. At this time, this model can only be applied to western Washington streams. We expect to be able to include eastern Washington streams in the near future.
- A set of multimetric indexes (quantitative expressions of the health of the invertebrate community such as number of species) for the

Figure 5: Biological condition results from summer 2004 sampling



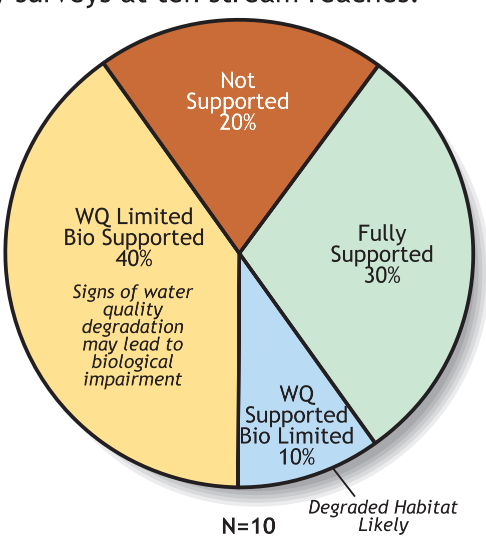
Puget Lowland and combined Cascade ecoregions have been published. Coast Range and eastern Washington indexes are currently being tested.

Twenty sites were surveyed in 2004 (*Figure 5*). These sites were not selected randomly, and results may not represent statewide conditions. The biological condition of these sites is presented in terms of their multimetric index scores. Sites were considered impaired if their index scores were lower than expected, based on conditions in their associated reference streams (below the 25th percentile of their associated reference stream distribution). Sites labeled as *healthy* indicate that they have index scores above the 25th percentile.

Ten of the biological surveys were completed at our ambient water quality sites, where Water Quality Index (WQI) scores were also available. Water quality and biological quality do not necessarily go hand in hand. One reason is that habitat modifications may affect biological quality but not water quality. Water quality and physical habitat information can be used to identify the sources of macroinvertebrate community degradation. Examination of both water quality and biological indicators provides a much more accurate assessment of aquatic life use support.

In *Figure 6*, water quality was considered supported when the WQI (excluding the fecal coliform bacteria portion of the index) resulted in a *good* assessment and limited when the WQI resulted in a *fair* or *poor* assessment. The biological assessment was based on the multimetric indexes, and considered supported when its assessment was *good* and limited when its assessment was *fair* or *poor*.

Figure 6: Results of ambient biological and water quality surveys at ten stream reaches.



Aquatic plants

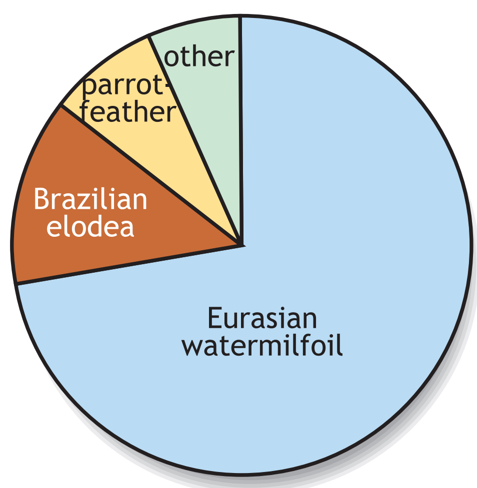
Ecology has been characterizing aquatic plant communities from lakes and rivers throughout the state since 1994. The main objective of this program is to inventory and monitor the spread of invasive, non-native aquatic plant species. Other objectives of the program are to provide technical assistance 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 on species distribution, abundance, and maximum depth where the plant grows are made. In addition, Secchi depth and alkalinity data are collected. The most commonly occurring exotic species are shown in *Figure 7*.

To date, about 430 lakes and rivers have been surveyed statewide; 195 of these have Class A or Class B aquatic noxious weeds (*Figure 8*) (see *www.nwcb.wa.gov* for a definition of weed classes). 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. Each year additional sites with listed noxious weeds are found. Another complication is escapement of ornamental pond

Figure 7: The most frequently encountered invasive exotic weed species found in waterbodies where invasive exotic weeds were present.



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 exotic 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 impacting fish and other native wildlife.

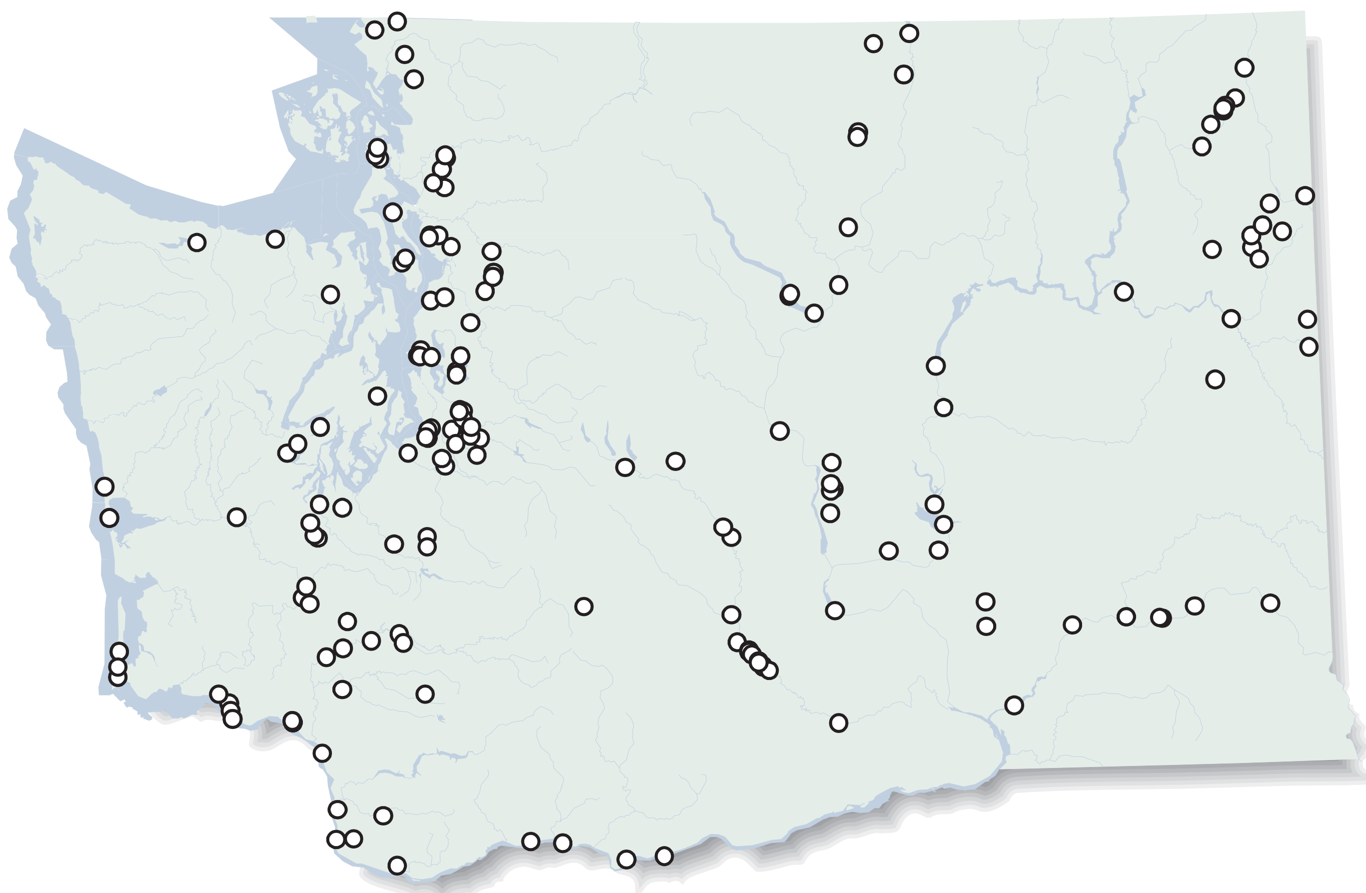
Randomized design monitoring

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 EPA is to randomly sample waterbodies and 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.

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

Figure 8: Locations where invasive aquatic weeds have been found since surveys began in 1994.



areas as well as forecast the type and intensity of pollution problems.

As part of the EMAP Western Pilot, we conducted a large-scale, long-term (2000-2004) field study of mostly wadeable streams in Washington State (*Figure 9*). Field sampling was conducted to assess the ecological status of streams based on water chemistry, physical habitat and biological assemblages.

Our work is also part of an assessment that includes 12 western states and tribal lands. Additionally, we selected more sites within the Wenatchee River basin to help test EMAP techniques on a smaller scale.

During 2005 and 2006, we plan to evaluate the data to make a statewide assessment of wadeable stream conditions. Our goal is to produce a report on condition of streams and identify the primary causes that degrade water quality and affect suitable 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 chosen (independently from the EMAP Western Pilot Project discussed in the previous section) using EMAP protocols (*Figure 10*).

Although work is contracted each year, ISEMP is a long-term (2004-2008) field study of fish populations and habitat in the 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 macro-invertebrate communities. Other cooperators assess fish populations and related information.

ISEMP will sample approximately 150 sites for habitat over the 5-year period: about 25 new sites will be sampled each year, and sampling will be repeated in these years at 25 *core* sites.

Figure 9: Stream sites sampled for the EMAP Western Pilot Project during 2000-2004

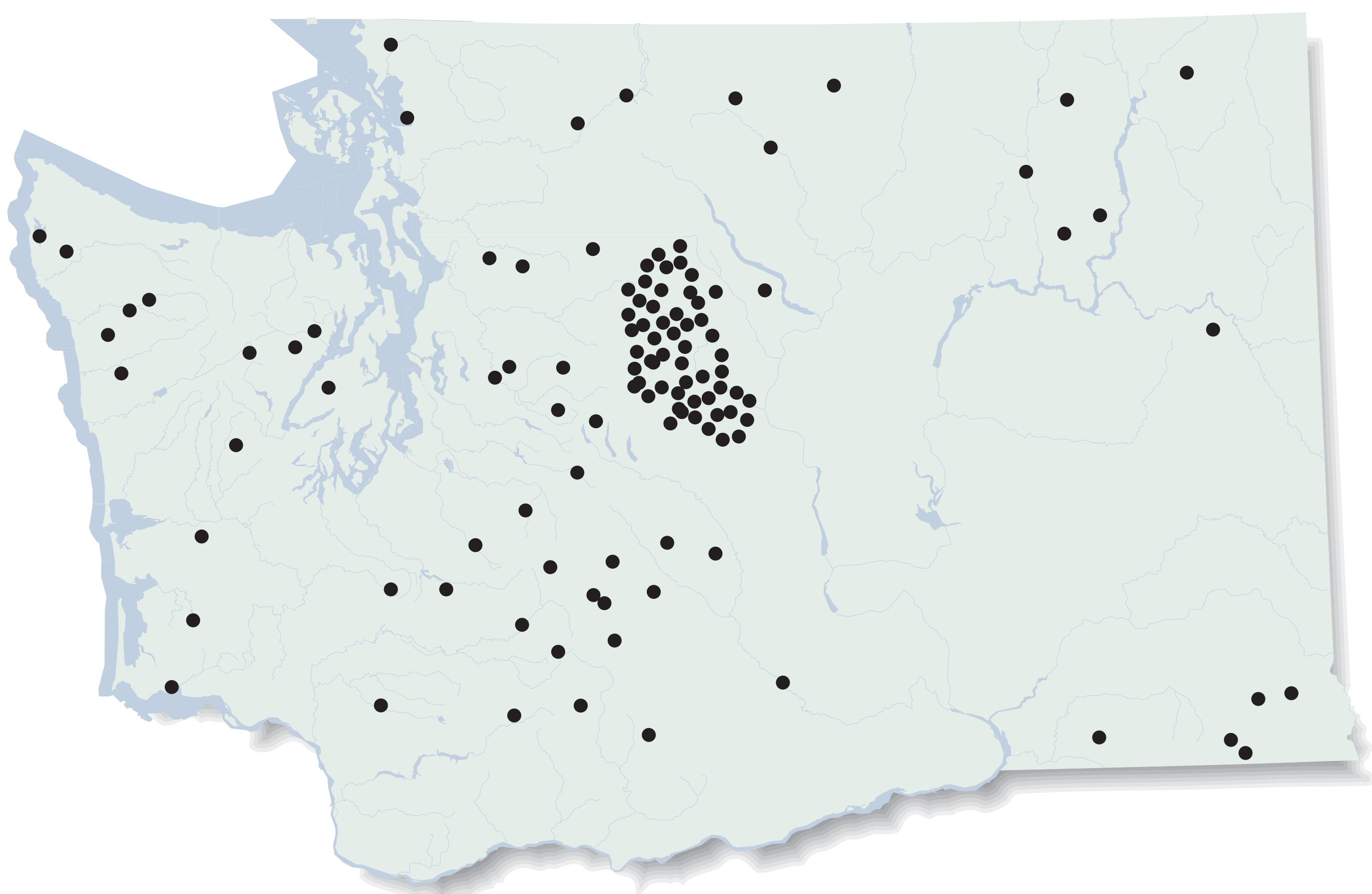
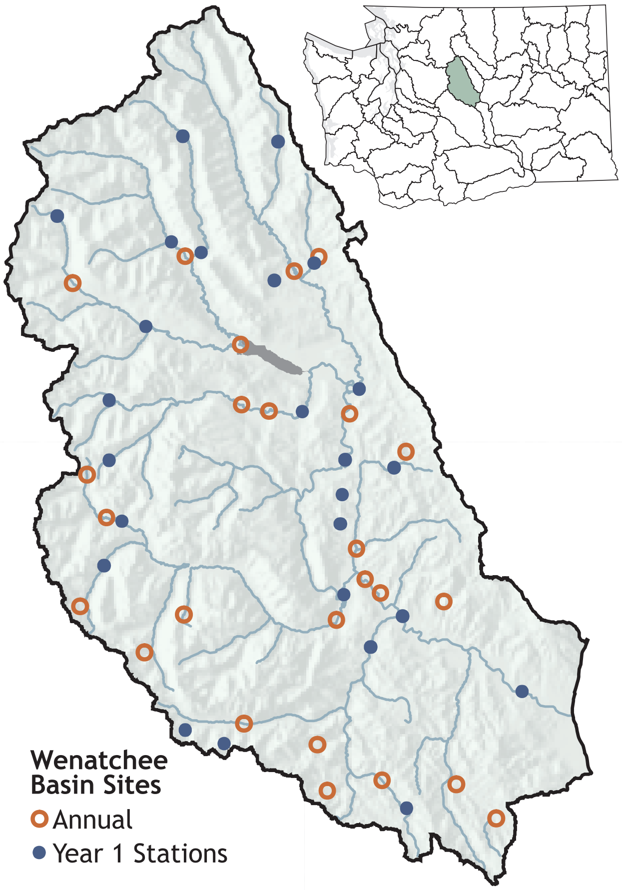


Figure 10: ISEMP Sites Sampled in 2004 in the Wenatchee River Basin.



Chad Brown collecting water samples from the South Fork of Touts Coulee Creek.

Changes in surface water quality conditions

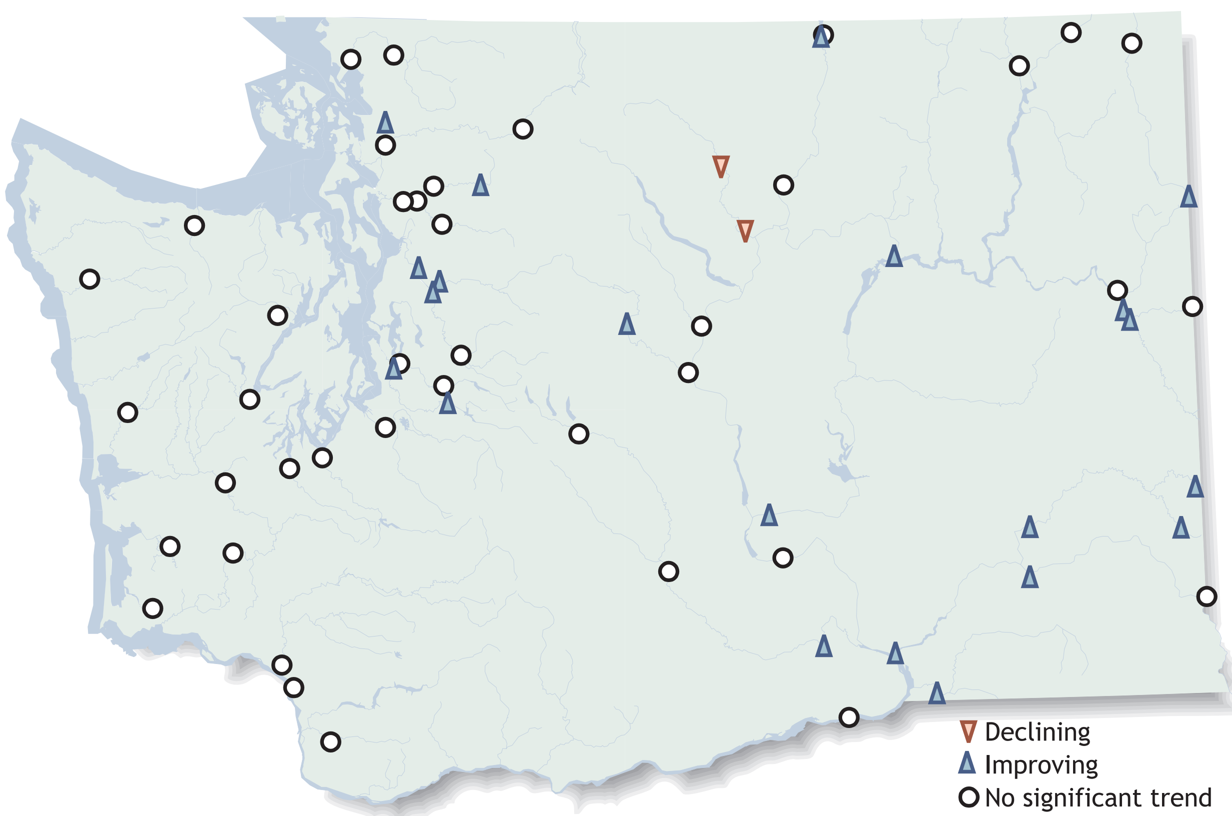
To identify trends, water quality data must be collected routinely over long periods of time. The presence or absence of trends is a good indicator of the degree to which water quality is responding to changes in the watershed. Formal statistical trend analysis provides a rational, scientific basis for 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. Results of the station trend test were used in meta-analysis to evaluate trends in indicators for each ecoregion and on a statewide basis.

Twenty-one stations exhibited improving conditions, and only two stations exhibited declining conditions during the last 10 years; no statistically significant trend was present at 40 stations (Figure 11). Statewide, there was statistically significant improvement in water quality conditions (0.4 WQI units per year). The greatest improvement was in the Columbia Basin Ecoregion (0.7 WQI units per year), though water quality conditions remain of moderate concern in Columbia basin streams.

Figure 11: Water quality trends



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 state water quality standards. After the list is approved by EPA, we at Ecology are required to prepare and implement Total Maximum Daily Load (TMDL) water cleanup plan studies 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:

- to provide feedback on TMDL recommendations;
- to guide implementation efforts;
- to provide data for refinement of modeling used in the initial TMDL study.

Lake Campbell and Lake Erie TMDL effectiveness monitoring

Lakes Campbell and Erie are located in the same 1471-hectare watershed on Fidalgo Island in Skagit County. A 1981 Phase I diagnostic study concluded that both lakes could be classified as eutrophic, and identified phosphorus as the nutrient controlling algal growth. In 1985, as part of the Phase I restoration plan, both lakes received alum treatment to reduce phosphorus levels. Harvesting of the aquatic plants followed in the summer of 1986. A TMDL recommending phosphorus load allocations for both lakes was completed in 1997.

The current TMDL effectiveness monitoring project began in August 2004 and continued through July 2005. It will determine if past treatments have been effective in restoring designated uses in Campbell and Erie and whether current phosphorus concentrations are consistent with the load allocations set in the TMDL. Preliminary results indicate compliance with TMDL goals for both lakes.

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

Lake Campbell in Skagit County, August 2005.

Lower Yakima River Suspended Sediment and DDT TMDL effectiveness monitoring

The Lower Yakima River Suspended Sediment and DDT TMDL study was developed in 1997 to reduce turbidity and suspended sediment – and the associated organochlorine pesticide, DDT – in the lower reaches of the Yakima River in south-central Washington.

TMDL implementation was scheduled to occur over a 20-year span, with specific interim targets at five-year intervals. The fifth-year target included meeting state water quality criteria for turbidity during the irrigation season in the lower mainstem Yakima River, downstream of the city of Yakima.

Also included in that target was that Moxee Drain, Granger Drain, Sulphur Creek, and Spring Creek, tributaries of the Yakima River, would achieve a maximum 90th percentile turbidity of 25 NTU (nephelometric turbidity unit) at their mouths during the irrigation season.

This TMDL effectiveness monitoring project was initiated in April 2003. The data indicated that tremendous improvements have been achieved in reducing sediment in the agricultural drains and Yakima River, but continued improvement is needed to meet all current and future TMDL targets.

Three of the four major agricultural drains met the TMDL criterion for turbidity, and the fourth drain was substantially improved when compared to data from 1994-95 sampling. Mainstem turbidity requirements at the Kiona gage, near Benton City, did not meet state water quality criteria; nor did the intermediate mainstem sampling sites at Sunnyside-Mabton Road Bridge and at Euclid Road Bridge, due primarily to high turbidity noted on two occasions in the early irrigation season.

While the data analysis does not indicate complete success in meeting all elements of the TMDL target, this project has eliminated hundreds of tons of sediment per day from the river and is recognized as a model for agriculturally-based TMDL successes.

Contact: *Chris Coffin*; 508 454-4257; *ccof461@ecy.wa.gov*

Snoqualmie River TMDL effectiveness monitoring

The Snoqualmie River watershed covers 700 square miles (1813 square kilometers) in King and Snohomish counties before meeting the Skykomish River and forming the Snohomish River. The Snoqualmie River valley has been undergoing rapid change in land use and is the focus for additional wasteload discharge proposals. As a result, in 1996, we at Ecology developed a TMDL study for low-flow conditions describing fecal coliform bacteria, ammonia, and biochemical oxygen demand.

Two years of effectiveness monitoring are planned, characterizing water quality conditions in both low-flow and high-flow periods. In addition to post-TMDL monitoring, focused sample collection along several transects have been completed on both riverbanks adjacent to Fall City in order to trace where pollution may originate in that area.

High water temperatures have been identified at some locations during the course of this project. An evaluation of ambient monitoring data for the basin suggests that high water temperatures may play a role in lowering dissolved oxygen concentrations. We plan to deploy continuous temperature data loggers at all sites during the 2005 sampling season to establish where temperature is a problem and the degree of severity at each location.

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

Bill Ward at one of our continuous monitoring sites on the Snoqualmie River.

Skokomish River fecal coliform TMDL: effectiveness of current implementation effort

The Skokomish River has a basin area of about 247 square miles. The river empties into Annas Bay in southern Hood Canal near Potlatch, Washington. The lower 10 miles of the river pass through a broad flood plain that contain most of the residential and agricultural land use in the basin. In all but one year since 1995, the state Department of Health has listed the Annas Bay commercial shellfish harvest area as threatened by fecal coliform contamination. A 1996 TMDL study determined the source areas of fecal coliform loading and developed load allocations that would protect water quality. The focus of this study is to establish whether fecal coliform concentration limits and reduction of seasonal pollutant loading are being met at four sites where reductions were needed.

Sampling, mostly by the Mason Conservation District with Ecology support, is scheduled from January 2005 through November 2006.

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

South fork of the Palouse River in Pullman.

Dragoon Creek TMDL effectiveness monitoring

Dragoon Creek is located in south Stevens County and north Spokane County. The creek is designated as a Class A waterbody. Water sample results that did not meet state standards for ammonia, residual chlorine, and phosphorus led to the development of a TMDL study and removal of the city of Deer Park's wastewater treatment plant discharge from Dragoon Creek.

Monitoring conducted between May and September 2004 indicates that removal of direct effluent discharge into the creek improved water quality conditions for ammonia, total phosphorus, and total chlorine. Although un-ionized ammonia concentrations remained at least an order of magnitude below the state water quality standards criterion, pH and temperature increases in Dragoon Creek between the Monroe/Crawford and the Crescent Road sampling locations caused a substantial increase in the un-ionized fraction of ammonia.

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

South Fork Palouse River TMDL effectiveness monitoring

The South Fork Palouse River is located in Whitman County and has a Class A beneficial use designation. Water sample results that did not meet the state standard for ammonia led to the development of a TMDL and modification of discharge permits for Pullman and Albion wastewater treatment plants.

Monitoring conducted between October 2003 and October 2004 indicated that permit limits were exceeded infrequently for ammonia in the effluent at both Pullman and Albion. These incidents seem most likely to occur when there is an unusual amount of precipitation and runoff. However, TMDL implementation has been effective and the South Fork Palouse River is meeting state standards for ammonia both upstream and downstream of the treatment plants. As the Pullman area grows, wastewater treatment plant capacity will be challenged and further contamination is likely to occur under extreme weather events.

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

Special projects

In addition to the routine monitoring reported above, we in Ecology's FMU occasionally conduct special projects to address particular water quality problems in our areas of expertise. Some examples of projects conducted in 2004 are summarized below.

Herbicidal control methods for aquatic weeds

FMU conducted projects to assess various herbicidal control methods for aquatic weeds. Several herbicides registered for aquatic use in Washington have been tested for impacts to the targeted weed as well as impacts to native plants. The following projects have been completed or are in progress:

- Use of 2,4-D for selective control of an early infestation of Eurasian watermilfoil in Loon Lake, Stevens County (available online at *http://www.apms.org/japm/vol39/v39p117.pdf*)
- Impact of endothall on the aquatic plant community of Kress Lake, Cowlitz County
- Use of diquat to control Brazilian elodea in Battle Ground Lake, Clark County
- Use of fluridone to control Eurasian watermilfoil and Brazilian elodea in Loomis Lake, Pacific County
- Use of triclopyr to control Eurasian watermilfoil in Capitol Lake, Thurston County

We have also assessed the biological control potential of the milfoil weevil (*Euhrychiopsis lecontei*) since 2002. This native weevil has caused declines in Eurasian watermilfoil in other parts of the country and is found naturally in several lakes in Washington. We undertook an augmentation project from 2002-2003 that involved collecting, rearing, and releasing weevils to a test lake where no weevils were previously found. We also have been evaluating the correlation between fish community composition and weevil abundance in several Washington lakes.

Additional information on these projects is available at *http://ecystage/programs/eap/lakes/aquaticplants/index.html*.
Contact: *Jenifer Parsons*; 509 457-7136; *jenp461@ecy.wa.gov*

Lake Tapps water quality monitoring

Lake Tapps is located in Pierce County near the town of Bonney Lake. The lake was created in 1911 when a diversion structure on the White River was established to create an impoundment for power generation. In the process, four smaller pre-existing lakes were joined. At the time of the original diversion and impoundment, the region around the lake was sparsley populated, and hydroelectric power generation was the sole use of diverted water. Today the lake shoreline is densely developed with residential homes, and the lake is used intensively for recreation.

This monitoring project, requested by Ecology's Southwest Regional Office, is intended to document conditions in the lake at four lake stations and three inlet/outlet stations from July 2004 through June 2005. Preliminary results indicate Lake Tapps is oligotrophic, with very low nutrient concentrations; however, signs of mesotrophy included low to moderate chlorophyll levels, low oxygen concentrations near the lake bottom, and filamentous algae in some areas.
Contact: *Dave Hallock*; 360 407-6681; *daha461@ecy.wa.gov*]

Continuous temperature monitoring data management

Elwha and Makah tribal biologists have collected one- and two-hour interval temperature monitoring data for many years at numerous stations in Water Resource Inventory Areas 17-20. The data were stored in separate spreadsheets that were difficult to manage. We developed a batch load module attached to our existing continuous temperature database that allows rapid conversion of temperature data stored in Excel® or Lotus® spreadsheets or text files into a Microsoft Access® database. This database application is available to the public.

About half the data, a quarter million records from 123 stations, have been reviewed for quality; daily maximums, minimums and means have been entered into Ecology's public database (*http://www.ecy.wa.gov/eim/*).
Contact: *Dave Hallock*; 360 407-6681; *daha461@ecy.wa.gov*

Freshwater monitoring needs identified by FMU

This report has focused on our Freshwater Monitoring Unit's (FMU) statewide water quality and biological monitoring programs, and what we have learned from them in 2004. However, there are important environmental areas that we do not monitor and cannot assess. Some of these needs are listed below.

Randomized design monitoring

The action plan outlined by the 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 water quality, habitat, invertebrates, and invasive aquatic plants. In the short-term, we have proposed this monitoring be implemented at the Water Resource Inventory Area or the Salmon Recovery Region level to be rotated through 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, however, Ecology discontinued the program.

Lake monitoring is required by Sections 305(b) and 314(a) of the Clean Water Act. At present, there is no statewide monitoring or assessment of lake water quality.

The EPA is in the planning process of designing a National Lakes Assessment program. This program would provide funds to the states to conduct lake monitoring for one year using a randomized sampling design. Sampling is scheduled for 2007.

Maggie Bell-McKinnon collecting bacteria samples from Lake Tapps, Pierce County.

River geomorphometry monitoring

We should establish a monitoring program to assess changes in geomorphologic characteristics of river systems. River geomorphology, the forming of land by rivers, occurs due to a series of complex processes that are not adequately described by scientific theories. A poor understanding of these processes and the influence of changes (natural or otherwise) that occur on the landscape and within the flood plain can lead to a variety of ecosystem problems.

A small constriction of stream flow from a culvert under a road, or the removal of vegetation along a small section of a river bank, might change the course of a river and result in deepening, widening, increased scour, or failure of stream banks. These changes harm aquatic biota and surrounding ecosystems.

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 reconstruct 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}Pb, ^{137}Cs, or ^{14}C. 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.

Reference stations

We at Ecology collect biological information from rivers and streams throughout the state. The monitoring program is designed to explore spatial patterns and identify temporal trends in 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 number of reference stations that represent high quality landscape fragments needs to be increased.

Kids enjoying Deep Lake in Thurston County.

Lake swimming beach bacteria contamination

Additional information is needed to assess the bacteria levels of lake swimming beaches. In 2003, we began monitoring a few freshwater beaches to provide information to local health jurisdictions. This successful pilot study revealed a need to expand the freshwater beach sampling to lakes with high public use throughout the state.

Aquatic plants

We collect information on aquatic plants from lakes and rivers throughout Washington state. The main objective of this program is to inventory and monitor the spread of invasive, non-native aquatic plant species. The number of aquatic plant surveys conducted each year should be increased.

Related information

Washington State Department of Ecology publications

Washington State Water Quality Conditions in 2004, based on Data from the Freshwater Monitoring Unit: Technical Appendix
Publication No. 05-03-037
www.ecy.wa.gov/biblio/0503037.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 2004
Publication No. 05-03-038
www.ecy.wa.gov/biblio/0503038.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 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

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

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