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

Technical Appendix

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Abstract

This technical appendix presents details about the assessment methods and sampling locations used to develop the report, *Washington State Water Quality Conditions in 2004, Based on Data from the Freshwater Monitoring Unit* (Ecology Publication Number 05-03-036).

Seven analyses are presented:

1. The Stream Water Quality Index, derived from eight variables that describe water quality at river and stream monitoring stations measured in water year 2004 (October 2003 through September 2004).

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Introduction

This technical appendix presents details about the assessment methods, sampling locations, and fine-scale results used to develop the report, *Washington State Water Quality Conditions in 2004, Based on Data from the Freshwater Monitoring Unit.*

Stream Water Quality Index

Water quality indices 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 (see *Uses and Limitations*), indices make water quality information accessible to a much wider audience, including elected officials, administrators, and the general public. Several water quality indices that summarize data in an easily understood format are reviewed by Couillard and Lefebvre (1985).

The stream Water Quality Index (WQI) is a unitless number ranging from 1 to 100 that is intended to represent general water quality. A higher number indicates better water quality. 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 exceeded 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 aggregated over time to produce a single score for each sample station.

Uses and Limitations

By design, indices contain less information than the raw data they summarize. An index cannot provide all the information expressed by the original water quality data. An index is most useful for comparative purposes (*What stations have particularly poor water quality*?) and for general questions (*What is the general water quality in my stream*?). Indices are less suited for answering specific questions. Site-specific decisions should be based on an analysis of the original water quality data. In short, an index is a useful tool for "communicating water quality information to the lay public and to legislative decision makers;" it is not "a complex predictive model for technical and scientific application" (McClelland, 1974).

Besides being general in nature, there are at least two reasons that an index may fail to accurately communicate water quality information. First, most indices are based on a pre-identified set of water quality constituents. A particular station may receive a good WQI score, and yet have water quality impaired by constituents not included in the index. Second, aggregation of 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 (for evaluated constituents, at least) was not chronic.

Strategies

Different approaches to indexing water quality results are possible. One approach is to rate quality objectively (e.g., using ranked data) (Harkins, 1974). While this approach does not require developing subjective rating curves, it also does not permit comparisons between values generated from different data sets. For example, results between years could not be compared unless scores were re-calculated using data from all years. Any time additional data are added and the index re-calculated (for example, to compare years), results for the same stations and dates would change because the rank order changes. Finally, this approach ranks results from pristine stations where high quality would be expected, along with stations where water quality would not be expected to be pristine (regardless of human impacts). Hence, a score could only be interpreted in comparison to another known station.

A more useful index for managing environmental resources is one that allows water quality comparisons with criteria that support beneficial uses. However, this approach requires subjective determinations of the beneficial uses that a particular stream segment should support, the level of water quality required to support those uses, and how critical variations from that level of quality are. For several key parameters, the first two of these determinations are already codified in Washington's Administrative Code (Chapter 173-201A WAC). Washington's WQI follows this approach.

Water Quality Constituents Included in the Index

For this analysis, index scores were determined for eight constituents monitored monthly by the Washington State Department of Ecology (Ecology) Freshwater Monitoring Unit: temperature, dissolved oxygen, pH, fecal coliform bacteria, total nitrogen, total phosphorus, total suspended sediment, and turbidity.

Rather than aggregating scores for total nitrogen and total phosphorus separately, the score for the limiting nutrient was used in the aggregation of the overall index because total nitrogen and total phosphorus are highly correlated and they measure similar impacts on water quality. Similarly, a harmonic mean of sediment-related constituents (total suspended solids and turbidity) was used. Data collection and quality control are discussed in our annual reports (e.g., Hallock, 2004).

Methodology

The methodology used to determine WQI scores was originally developed by the U.S. Environmental Protection Agency (EPA), Region 10. Initial development was documented only in the "gray" literature (Peterson and Bogue, 1989), but the methodology appears to be based on the well-known National Sanitation Foundation index. This index used curves to relate concentrations or measurements of various constituents to index scores and then aggregated the scores into a single number (Brown et al., 1970). The EPA curves were "a synthesis of national criteria, state standards, information in the technical literature, and professional judgment" (Peterson and Bogue, 1989).

In the 1980s, Ecology produced a WQI using the EPA methods, with further modifications of some curves to align curves with water quality standards (e.g., Hallock, 1990). The index was calculated by a Fortran program run on an EPA mainframe computer using data in the national STORET database. These procedures were somewhat cumbersome and Ecology stopped producing the index in the early 1990s. Ecology recently re-programmed the WQI procedures to assess data in Ecology's ambient stream monitoring database.

For temperature, oxygen, pH, and fecal coliform bacteria, data were converted to index scores using the same relationships used by EPA's WQI, except that the original tabulated results have been converted to quadratic equations. Because there were discontinuities in the original tables, the equations do not fit the tabulated data perfectly. For these parameters, a WQI score is related to the water quality standards criteria for that waterbody and, therefore, to the support of beneficial uses.

The original curves for turbidity, total suspended solids, total phosphorus, and total nitrogen do not account for natural differences caused by wide variations in geomorphology across the state. Furthermore, there are no water quality standards criteria for these constituents. Therefore, Ecology developed new curves based on the distribution of data at stations within each ecoregion during high- and low-flow seasons. WQI scores were matched to various quantiles. A quadratic equation was then fit to the WQI-concentration relationships.

The formulas used for a station and constituent depend on the stream class or ecoregion for that station. Calculated results <1 or >100 are converted to 1 or 100, respectively.

There were insufficient data from three ecoregions to develop independent curves. Curves developed for the Puget Lowlands, Cascades, and Northern Rockies are used for stations in the Willamette Valley, Eastern Cascades Slopes and Foothills, and Blue Mountains ecoregions, respectively. For more information on the WQI methodology, see Hallock (2002).

Because the index scores for nutrient and sediment constituents are based on the distribution of past data and not on ecological impacts or degree of degradation, poor index scores for these constituents indicate poor water quality relative to other stations in the same ecoregion, and may not necessarily indicate impairment or inability to support beneficial uses. Conversely, good index scores for these constituents may not necessarily indicate a lack of impairment or an ability to support beneficial uses.

Scores should not be compared between various "Conditions" reports due to possible changes in methodologies or station classification. To compare year-to-year changes, see results posted to our website (www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html), where scores will be re-calculated as necessary using consistent procedures.

Results

The WQI was applied to water quality data collected from 2004 (Table 1). To place the WQI scores into categories used for statewide assessment, the cut-points used by EPA in the original WQI were used. According to this categorization scheme, stations with WQI scores 80 and above are considered to be of *lowest concern*, scores from 40 to 79 are of *moderate concern*, and those below 40 are of the *highest concern*. In 2004, 23 stations were categorized as *lowest concern*, 52 as *moderate concern*, and 7 as *highest concern*.

Table 1. Water Quality Index (WQI) scores for stations sampled in 2004.

Station	Location	Ecoregion	Overall WQI
01A050	Nooksack R @ Brennan	Puget Lowlands	55
01A120	Nooksack R @ No Cedarville	Puget Lowlands	62
03A060	Skagit R nr Mount Vernon	Puget Lowlands	64 [a]
03B050	Samish R nr Burlington	Puget Lowlands	35
04A100	Skagit R @ Marblemount	Cascades	64 [a]
05A070	Stillaguamish R nr Silvana	Puget Lowlands	56
05A090	SF Stillaguamish @ Arlington	Puget Lowlands	55
05A110	SF Stillaguamish nr Granite Falls	Puget Lowlands	56
05B070	NF Stillaguamish @ Cicero	Puget Lowlands	60
05B110	NF Stillaguamish nr Darrington	Cascades	45 [a]
07A090	Snohomish R @ Snohomish	Puget Lowlands	75
07C070	Skykomish R @ Monroe	Puget Lowlands	93
07D050	Snoqualmie R nr Monroe	Puget Lowlands	81
07D130	Snoqualmie R @ Snoqualmie	Puget Lowlands	93
08C070	Cedar R @ Logan St/Renton	Puget Lowlands	77
08C110	Cedar R nr Landsburg	Puget Lowlands	96
08L070	Laughing Jacobs Cr nr mouth	Puget Lowlands	34
08M070	SF Thornton Cr @ 107th Ave NE	Puget Lowlands	19
09A080	Green R @ Tukwila	Puget Lowlands	76
09A190	Green R @ Kanaskat	Puget Lowlands	91
09C070	Des Moines Cr nr mouth	Puget Lowlands	22
09D070	Miller Cr nr mouth	Puget Lowlands	41
09J090	Longfellow Cr abv 24-25th St junction	Puget Lowlands	39
10A070	Puyallup R @ Meridian St	Puget Lowlands	53
10A080	Puyallup R nr Sumner	Puget Lowlands	55
10C095	White River @ R Street	Puget Lowlands	57
11A070	Nisqually R @ Nisqually	Puget Lowlands	76
13A060	Deschutes R @ E St Bridge	Puget Lowlands	61
16A070	Skokomish R nr Potlatch	Puget Lowlands	73
16C090	Duckabush R nr Brinnon	Coast Range	75
18A050	Dungeness R nr mouth	Puget Lowlands	72
18B070	Elwha R nr Port Angeles	Coast Range	73
20B070	Hoh R @ DNR Campground	Coast Range	51
22A070	Humptulips R nr Humptulips	Coast Range	74
23A070	Chehalis R @ Porter	Puget Lowlands	56
23A100	Chehalis R @ Prather Rd	Puget Lowlands	44
23A160	Chehalis R @ Dryad	Puget Lowlands	71
24B090	Willapa R nr Willapa	Coast Range	49
24F070	Naselle R nr Naselle	Coast Range	69
26B070	Cowlitz R @ Kelso	Puget Lowlands	69
27B070	Kalama R nr Kalama	Puget Lowlands	83
27D090	EF Lewis R nr Dollar Corner	Willamette Valley	81

Station	Location	Ecoregion	Overall WQI
28C070	Burnt Br Cr @ mouth	Willamette Valley	31
31A070	Columbia R @ Umatilla	Columbia Basin	90
32A070	Walla Walla R nr Touchet	Columbia Basin	68
33A050	Snake R nr Pasco	Columbia Basin	86
34A070	Palouse R @ Hooper	Columbia Basin	67
34A170	Palouse R @ Palouse	Columbia Basin	77
34B110	SF Palouse R @ Pullman	Columbia Basin	60
34F090	Pine Cr @ Rosalia	Columbia Basin	15
35A150	Snake R @ Interstate Br	Columbia Basin	79
35B060	Tucannon R @ Powers	Columbia Basin	87
36A070	Columbia R nr Vernita	Columbia Basin	87
37A090	Yakima R @ Kiona	Columbia Basin	66
37A205	Yakima R @ Nob Hill	Columbia Basin	82
39A090	Yakima R nr Cle Elum	Cascades	70
41A070	Crab Cr nr Beverly	Columbia Basin	56
45A070	Wenatchee R @ Wenatchee	Columbia Basin	83
45A110	Wenatchee R nr Leavenworth	Cascades	73
45C060	Chumstick Cr nr mouth	Cascades	47
45D070	Brender Cr nr Cashmere	Columbia Basin	69
45E070	Mission Cr nr Cashmere	Columbia Basin	74
45Q060	Eagle Cr nr mouth	Cascades	71 [b]
45R050	Noname Creek nr Cashmere	Columbia Basin	68
46A070	Entiat R nr Entiat	Columbia Basin	82
48A070	Methow R nr Pateros	Columbia Basin	82
48A140	Methow R @ Twisp	Columbia Basin	89
49A070	Okanogan R @ Malott	Columbia Basin	70
49A190	Okanogan R @ Oroville	Columbia Basin	70
49B070	Similkameen R @ Oroville	Columbia Basin	76
53A070	Columbia R @ Grand Coulee	Columbia Basin	88
54A120	Spokane R @ Riverside State Pk	Northern Rockies	83
55B070	Little Spokane R nr mouth	Northern Rockies	79
55B300	Little Spokane River @ Scotia	Northern Rockies	86
55C070	Peone (Deadman) Creek abv L Deep Cr	Northern Rockies	68
55C200	Deadman Cr @ Holcomb Rd	Northern Rockies	77
56A070	Hangman Cr @ mouth	Columbia Basin	67
57A150	Spokane R @ Stateline Br	Columbia Basin	81
60A070	Kettle R nr Barstow	Northern Rockies	65
61A070	Columbia R @ Northport	Northern Rockies	81
62A090	Pend Oreille R @ Metaline Falls	Northern Rockies	84
62A150	Pend Oreille R @ Newport	Northern Rockies	86

[a] Streams with glacial influence may receive inappropriately low scores. Scores for these streams are particularly affected by glacial sediment. Excluding sediment-related constituents, scores would have been 95 for station 03A060, 95 for station 04A100, and 76 for station 05B110.

[b] Score not based on a full year's data. Use with caution.

Trend Analysis

The presence or absence of trends over time is a good indication of the degree to which water quality is responding to changes in the watershed and climate. Formal statistical trend analysis provides a rational, scientific basis for addressing issues with natural variations in water quality that can obscure human-caused trends. Human-caused changes in water quality can sometimes be masked by natural variability. For example, if a distinct relationship exists between streamflow and a water quality indicator, then a trend in flow may obscure a human-caused trend or create a trend in the indicator data not due to watershed changes.

The Seasonal Kendall's Tau test is a good choice for evaluating trends when water quality varies by season (Gilbert, 1987). This test can be used even if there are missing values or if some values are below the analytical detection limit. The validity of the test does not depend on data being normally distributed. The Seasonal Kendall test with correction for autocorrelation was used when autocorrelation was present. The statistical software WQHYDRO (Aroner, 2002) was used to evaluate for trends at each station using the flow-adjusted residual (see below) or raw indicator data at a 95% confidence level for statistical significance.

Water quality constituents are frequently correlated with flow. During high-flow years, some constituents are typically higher (e.g., sediment) and others lower (e.g., temperature) than during low-flow years. As a result, year-to-year changes in an index could actually be attributable to variability in flow (natural or human-caused), rather than to changes in watershed conditions. Therefore, a second set of annual flow-adjusted WQI scores was calculated for long-term stations after removing variability in water quality constituents due to flow. This was done for each station by 1) determining the residuals from a hyperbolic regression of each constituent (raw data) with flow, 2) adding the mean of each constituent back to the residuals, 3) calculating WQIs on the adjusted data, and 4) adjusting mean flow-adjusted annual scores to match the raw indicator means for each station. Flow-adjustments were done with WQHYDRO (Aroner, 2002) and Access.

An analysis was performed of trends in monthly WQI scores, calculated using data collected from water year 1995 through 2004 at long-term stations. Trends were also performed on monthly scores adjusted for variability in flow, as described above. Reported probabilities include corrections for auto-correlation.

Prior to adjusting for flow, statistically significant ($p < 0.05$) improving trends were indicated at 21 stations and declining trends at two stations (Table 2). Adjusting for flow decreased the trend slope at 78 percent of the stations, and resulted in improving trends at 13 stations and declining trends at two stations. That is, variability in flow was responsible for apparent improving trends in water quality at some stations. Whether that is because flows were increasing or decreasing has not been evaluated and is station-specific, depending on which constituent(s) drive the WQI at a particular station. Some constituents are positively correlated with flow (e.g., sediment and nutrients) and some negatively (e.g., temperature and pH).

Table 2. Trend analysis of monthly overall WQI scores from 1995 through 2004. Statistically significant trends ($p<0.05$) are shown in bold. Positive slopes indicate improving conditions.

Station	Location	Not Flow-adjusted		Adjusted for Flow	
		Slope	Probability (p)	Slope	Probability (p)
01A050	Nooksack R @ Brennan	0.626	0.106	0.253	0.403
01A120	Nooksack R @ No Cedarville	-0.027	0.932	-0.125	0.471
03A060	Skagit R nr Mount Vernon	-0.011	0.933	-0.371	0.131
03B050	Samish R nr Burlington	**0.559**	**0.037**	**0.441**	**0.007**
04A100	Skagit R @ Marblemount	0.062	0.720	-0.157	0.389
05A070	Stillaguamish R nr Silvana	0.058	0.724	-0.093	0.534
05A090	SF Stillaguamish @ Arlington	-0.241	0.366	-0.34	1.000
05A110	SF Stillaguamish nr Granite Falls	-0.236	0.661	-2.211	0.773
05B070	NF Stillaguamish @ Cicero	0.206	0.273	-0.006	1.000
05B110	NF Stillaguamish nr Darrington	**1.248**	**0.001**	-0.136	0.828
07A090	Snohomish R @ Snohomish	**0.373**	**0.016**	**0.343**	**0.042**
07C070	Skykomish R @ Monroe	**0.145**	**0.007**	**0.137**	**0.009**
07D050	Snoqualmie R nr Monroe	**0.607**	**0.014**	**0.625**	**0.011**
07D130	Snoqualmie R @ Snoqualmie	0.09	0.093	-0.011	0.857
08C070	Cedar R @ Logan St/Renton	0.163	0.346	0.123	0.190
08C110	Cedar R nr Landsburg	0.004	0.842	0.044	0.149
09A080	Green R @ Tukwila	**1.219**	**0.000**	**0.74**	**0.018**
09A190	Green R @ Kanaskat	**0.148**	**0.011**	**0.213**	**0.000**
10A070	Puyallup R @ Meridian St	0.187	0.436	-0.057	0.792
11A070	Nisqually R @ Nisqually	0.125	0.068	0.116	0.593
13A060	Deschutes R @ E St Bridge	0.477	0.350	0.167	0.692
16A070	Skokomish R nr Potlatch	0.025	0.638	0.089	0.354
16C090	Duckabush R nr Brinnon	-0.035	0.526	-0.088	0.604
18B070	Elwha R nr Port Angeles	-0.023	0.938	**-0.313**	**0.002**
20B070	Hoh R @ DNR Campground	-0.027	0.816	-0.004	1.000
22A070	Humptulips R nr Humptulips	-0.044	0.677	0.26	0.196
23A070	Chehalis R @ Porter	0.427	0.245	0.08	0.737
23A160	Chehalis R @ Dryad	-0.024	0.938	0.154	0.480
24B090	Willapa R nr Willapa	0.545	0.184	**1.124**	**0.000**
24F070	Naselle R nr Naselle	-0.078	0.607	0.416	0.128
26B070	Cowlitz R @ Kelso	0.236	0.515	-0.053	0.754
27B070	Kalama R nr Kalama	-0.062	0.290	-0.369	0.069
27D090	EF Lewis R nr Dollar Corner	0.042	0.486	0.053	0.332
31A070	Columbia R @ Umatilla	0.153	0.141	0.051	0.491
32A070	Walla Walla R nr Touchet	**2.104**	**0.006**	**0.667**	**0.026**
33A050	Snake R nr Pasco	**0.393**	**0.034**	**0.32**	**0.017**
34A070	Palouse R @ Hooper	**2.589**	**0.012**	**1.313**	**0.029**
34A170	Palouse R @ Palouse	**0.725**	**0.002**	**0.657**	**0.002**
34B110	SF Palouse R @ Pullman	**3.89**	**0.000**	**2.031**	**0.000**
35A150	Snake R @ Interstate Br	0.249	0.141	0.058	0.758
35B060	Tucannon R @ Powers	**1.698**	**0.005**	0.542	0.221

Station	Location	Not Flow-adjusted		Adjusted for Flow	
		Slope	Probability (p)	Slope	Probability (p)
36A070	Columbia R nr Vernita	0.148	0.159	0.124	0.169
37A090	Yakima R @ Kiona	**1.463**	**0.000**	**1.151**	**0.016**
37A205	Yakima R @ Nob Hill	0.146	0.347	-0.168	0.231
39A090	Yakima R nr Cle Elum	0.316	0.091	-0.383	0.114
41A070	Crab Cr nr Beverly	**0.918**	**0.036**	0.544	0.137
45A070	Wenatchee R @ Wenatchee	0.123	0.206	0.037	0.654
45A110	Wenatchee R nr Leavenworth	**0.365**	**0.034**	-0.015	0.918
46A070	Entiat R nr Entiat	-0.015	0.857	-0.008	0.957
48A070	Methow R nr Pateros	**-0.118**	**0.045**	-0.12	0.070
48A140	Methow R @ Twisp	**-0.079**	**0.047**	**-0.067**	**0.047**
49A070	Okanogan R @ Malott	0.226	0.219	-0.055	0.902
49A190	Okanogan R @ Oroville	-0.04	0.740	-0.039	0.813
49B070	Similkameen R @ Oroville	**0.131**	**0.048**	0.104	0.499
53A070	Columbia R @ Grand Coulee	**0.136**	**0.022**	0.111	0.070
54A120	Spokane R @ Riverside State Pk	**0.719**	**0.014**	0.398	0.206
55B070	Little Spokane R nr mouth	0.789	0.477	0.107	0.754
56A070	Hangman Cr @ mouth	**1.417**	**0.041**	0.348	0.161
57A150	Spokane R @ Stateline Br	0.022	0.721	0.063	0.609
60A070	Kettle R nr Barstow	-0.05	0.803	-0.257	0.068
61A070	Columbia R @ Northport	0.074	0.286	0.013	0.953
62A090	Pend Oreille R @ Metaline Falls	0.22	0.080	0.151	0.247
62A150	Pend Oreille R @ Newport	**0.21**	**0.008**	0	1.000

Trends of multiple stations can be evaluated together using a statistical method called meta-analysis (Reckhow et al., 1993). Stations can be grouped from various geographic regions or watershed land uses to draw a collective assessment of trend. Stations were grouped according to their location in each ecological region as defined by EPA (Omernick and Gallant, 1986). Results of the station trend test were used in meta-analysis to evaluate trends in indicators for each ecoregion and also on a statewide basis.

For the 10-year period evaluated, a statistically significant improvement in water quality was observed statewide, with the greatest improvement in the Columbia Basin Ecoregion. Statewide, WQI scores improved by 4 WQI units over the 10 years; in the Columbia Basin, scores improved 7 units (Table 3).

Table 3. Regional trends in WQI (not flow-adjusted). Positive Z scores indicate improving water quality. Significant ($p<0.05$) trends are shown in bold.

Ecoregion	Number of Stations	Trend in Monthly WQI Scores		
		Regional Z score	Probability	Mean Annual Change Last 10 years (WQI units)
Coast Range	6	-0.223	0.82	Not significant
Puget Lowlands	24	5.259	**<0.01**	0.21
Willamette Valley	1	0.697	0.49	Not significant
Cascades	4	3.799	**<0.01**	0.50
Columbia Basin	22	7.866	**<0.01**	0.74
Northern Rockies	6	3.428	**<0.01**	0.33
STATEWIDE	63	9.929	**<0.01**	0.41

Water Quality

Long-term stations are monitored monthly every year to track water quality changes over time (trends) and to assess inter-annual variability, as well as to collect current water quality information. These stations are generally located near the mouths of major rivers, below major population centers, upstream from most anthropogenic sources of water quality problems, or where major streams enter the state. Most of these stations are located low in their basins and integrate upstream water quality impacts.

Basin stations are generally monitored monthly for one year only (although they may be re-visited every five years) to collect current water quality information. The basin monitoring stations are selected to support Ecology's basin approach to water quality management and to address site-specific water quality issues. These stations are selected to support National Pollution Discharge Elimination System permits, Total Maximum Daily Load assessments, site-specific needs, and to allow expanded coverage over a long-term network. Often, basin stations are selected to target known problems and, as a group, will not reflect general ambient conditions. The current basin monitoring program conducts monthly monitoring of 12 water quality constituents at approximately 20 stations across the state. During water year 2004, basin station sampling was focused in the following basins: Spokane, Lower Yakima, Cedar/Green, and Eastern Olympics.

Water quality data collected at the long-term and basin monitoring stations sampled in water year 2004 were evaluated against the numeric criteria in Washington's water quality standards. These criteria are designed to protect beneficial uses. Table 4 shows the number of times criteria were exceeded for the 12 monthly samples at each station. Exceeding a criterion does not necessarily indicate a water quality violation; however, often other requirements must also be met. For example, Ecology has established listing rules requiring that a minimum number of results exceed a criterion depending on the number of samples taken. There are also exceptions for natural causes. Ecology's Water Quality Program periodically promulgates a list of waterbodies in violation of state standards; this is known as the 303(d) list.

Table 4. Monitoring stations and the number of monthly samples that exceeded criteria in 2004.

Station	Location	Temp.	pH	Oxygen	Bacteria	Other
Long-term Stations						
01A050	Nooksack R @ Brennan				1	
01A120	Nooksack R @ No Cedarville					
03A060	Skagit R nr Mount Vernon					
03B050	Samish R nr Burlington				2	
04A100	Skagit R @ Marblemount					
05A070	Stillaguamish R nr Silvana	3	1			
05A090	SF Stillaguamish @ Arlington	3			1	
05A110	SF Stillaguamish nr Granite Falls	2		2	1	
05B070	NF Stillaguamish @ Cicero	2				
05B110	NF Stillaguamish nr Darrington					
07A090	Snohomish R @ Snohomish	2				
07C070	Skykomish R @ Monroe	1				
07D050	Snoqualmie R nr Monroe	2			1	
07D130	Snoqualmie R @ Snoqualmie					
08C070	Cedar R @ Logan St/Renton		2			
08C110	Cedar R nr Landsburg				1	
09A080	Green R @ Tukwila	2				
09A190	Green R @ Kanaskat	1		1		
10A070	Puyallup R @ Meridian St				1	
11A070	Nisqually R @ Nisqually					
13A060	Deschutes R @ E St Bridge				1	
16A070	Skokomish R nr Potlatch					
16C090	Duckabush R nr Brinnon					
18B070	Elwha R nr Port Angeles					
20B070	Hoh R @ DNR Campground				1	
22A070	Humptulips R nr Humptulips	1				
23A070	Chehalis R @ Porter	3			1	
23A160	Chehalis R @ Dryad	2				
24B090	Willapa R nr Willapa	2			1	
24F070	Naselle R nr Naselle	2				
26B070	Cowlitz R @ Kelso					
27B070	Kalama R nr Kalama					
27D090	EF Lewis R nr Dollar Corner	2				
31A070	Columbia R @ Umatilla	1				
32A070	Walla Walla R nr Touchet	2	1			
33A050	Snake R nr Pasco	2				
34A070	Palouse R @ Hooper	2	4			
34A170	Palouse R @ Palouse	2	1			
34B110	SF Palouse R @ Pullman			2	2	
35A150	Snake R @ Interstate Br	2	1	1		
35B060	Tucannon R @ Powers	2				
36A070	Columbia R nr Vernita	3				
37A090	Yakima R @ Kiona	2	3			
37A205	Yakima R @ Nob Hill	1	3			
39A090	Yakima R nr Cle Elum	1		3		
41A070	Crab Cr nr Beverly	2	2			
45A070	Wenatchee R @ Wenatchee	2	2			
45A110	Wenatchee R nr Leavenworth	1		1		

Station	Location	Temp.	pH	Oxygen	Bacteria	Other
46A070	Entiat R nr Entiat	2	3			
48A070	Methow R nr Pateros	2	2			
48A140	Methow R @ Twisp		1			
49A070	Okanogan R @ Malott	2	1			
49A190	Okanogan R @ Oroville	4	3	2		
49B070	Similkameen R @ Oroville	1	1			
53A070	Columbia R @ Grand Coulee	2		1		
54A120	Spokane R @ Riverside State Pk					
55B070	Little Spokane R nr mouth			1		
56A070	Hangman Cr @ mouth	2	1	3	1	
57A150	Spokane R @ Stateline Br	2		1		7 [a]
60A070	Kettle R nr Barstow	3		2		
61A070	Columbia R @ Northport	3		1		
62A150	Pend Oreille R @ Newport	1				
Basin Stations						
08L070	Laughing Jacobs Cr nr mouth			3	8	
08M070	SF Thornton Cr @ 107th Ave NE	2		1	8	2 [b]
09C070	Des Moines Cr nr mouth	3		2	5	
09D070	Miller Cr nr mouth				4	
09J090	Longfellow Cr abv 24-25th St junction				5	
10A080	Puyallup R nr Sumner				1	
10C095	White River @ R Street				1	
18A050	Dungeness R nr mouth					1 [c]
23A100	Chehalis R @ Prather Rd	3		2	1	
28C070	Burnt Br Cr @ mouth	2			7	
34F090	Pine Cr @ Rosalia	2		7	3	
45C060	Chumstick Cr nr mouth				1	
45D070	Brender Cr nr Cashmere			1	5	
45E070	Mission Cr nr Cashmere	1	1		1	
45Q060	Eagle Cr nr mouth				1	
45R050	Noname Creek nr Cashmere			1	7	
55B300	Little Spokane River @ Scotia					
55C070	Peone (Deadman) Creek abv L Deep Cr				2	
55C200	Deadman Cr @ Holcomb Rd				2	
62A090	Pend Oreille R @ Metaline Falls	1	1			
	Total number exceeding criteria	93	33	38	77	10

[a] The Spokane River exceeded the dissolved lead chronic criterion on one occasion and the dissolved zinc chronic criterion on six occasions.

[b] SF Thornton Creek slightly exceeded the dissolved lead chronic criterion on one occasion and the total mercury criterion on one occasion

[c] The Dungeness River exceeded the total mercury criterion on one occasion

Continuous Temperature Measurements

In the summer of 2004, Ecology's Environmental Monitoring and Trends Section continued for a fourth year collecting temperature data at 30-minute intervals at most of our long-term ambient monitoring stations as well as some basin stations. Fifty-two sites were monitored in 2004. The purpose of this monitoring is to collect season-long diel (24-hour) temperature data that may be used for trend analyses and to determine compliance with current and proposed water quality standards.

Seasonal maximums and the maximum seven-day average of daily maximums were derived for the 52 stations monitored in 2004. The seasonal maximum at 46 stations (88 percent) exceeded water quality criteria (Table 5).

A new temperature criterion of 16˚C, based on the maximum seven-day average of maximum daily measurements, is being proposed as a water quality standard for most streams in Washington. Forty-seven stations exceeded this criterion.

Table 5. Temperature monitoring (30-minute intervals) summary for 2004. Temperatures in bold exceed the current or proposed (max 7-day mean=16ºC) water quality criterion.

Station	Location	Current Criterion	Deployment Maximum		Max 7-day Mean[a]	
			°C	Date/Time [b]	°C	Date [b,c]
01A050	Nooksack R @ Brennan	18	**19.1**	18:00 10-Aug	**18.6**	12-Aug
01A120	Nooksack R @ No Cedarville	18	**19.2**	19:30 24-Jul	**18.5**	25-Jul
01T050	Anderson Cr @ South Bay Road	16	**20.6**	16:30 01-Aug	**17.2**	04-Aug
03A060	Skagit R nr Mount Vernon	18	**18.2**	19:30 23-Jul	**17.6**	26-Jul
03B050	Samish R nr Burlington	18	**19.7**	19:00 24-Jul	**18.8**	21-Jul
04A100	Skagit R @ Marblemount	16	14.5	19:00 01-Aug	14.0	30-Jul
05A070	Stillaguamish R nr Silvana	18	**23.6**	19:30 29-Jul	**23.0**	16-Aug
05A090	SF Stillaguamish @ Arlington	18	**25.3**	18:30 29-Jul	**24.5**	16-Aug
05A110	SF Stillaguamish nr Granite Falls	16	**22.8**	15:30 24-Jul	**21.8**	17-Aug
05B070	NF Stillaguamish @ Cicero	18	**22.5**	18:30 15-Aug	**22.1**	12-Aug
05B110	NF Stillaguamish nr Darrington	18	**20.0**	17:30 24-Jul	**19.3**	14-Aug
07C070	Skykomish R @ Monroe	18	**21.3**	19:00 19-Aug	**21.1**	16-Aug
07D050	Snoqualmie R nr Monroe	18	**22.9**	19:30 24-Jul	**22.3**	17-Aug
07D130	Snoqualmie R @ Snoqualmie	18	**21.2**	22:00 24-Jul	**20.3**	26-Jul
08C070	Cedar R @ Logan St/Renton	18	**21.9**	18:30 24-Jul	**20.7**	26-Jul
08C110	Cedar R nr Landsburg	16	14.7	18:00 31-Aug	14.2	29-Aug
08M070	SF Thornton Cr @ 107th Ave NE	16	**19.4**	18:30 24-Jul	**18.5**	26-Jul
09A190	Green R @ Kanaskat	16	**20.5**	18:00 19-Aug	**20.0**	12-Aug
09C070	Des Moines Cr nr mouth	16	**20.2**	16:30 24-Jul	**19.3**	24-Jul
09D070	Miller Cr nr mouth	18	**20.0**	18:00 24-Jul	**18.8**	25-Jul
09J090	Longfellow Cr abv 24-25th St	18	**18.7**	20:00 06-Aug	**17.4**	23-Aug
11A070	Nisqually R @ Nisqually	18	**18.1**	17:00 24-Jul	**17.4**	26-Jul
13A060	Deschutes R @ E St Bridge	18	**21.3**	18:30 24-Jul	**20.5**	26-Jul
16A070	Skokomish R nr Potlatch	16	15.2	17:30 24-Jul	14.7	23-Jul
16C090	Duckabush R nr Brinnon	16	15.2	18:00 29-Jul	15.0	30-Jul

Station	Location	Current Criterion	Deployment Maximum		Max 7-day Mean[a]	
			°C	Date/Time [b]	°C	Date [b,c]
18A050	Dungeness R nr mouth	18	**19.0**	17:00 19-Aug	**18.6**	30-Jul
18B070	Elwha R nr Port Angeles	16	**19.5**	17:30 31-Jul	**18.6**	31-Jul
22A070	Humptulips R nr Humptulips	18	**22.4**	19:30 27-Jul	**21.2**	12-Aug
23A070	Chehalis R @ Porter	18	**24.9**	18:00 27-Jul	**23.7**	14-Aug
23A160	Chehalis R @ Dryad	18	**25.4**	18:30 24-Jul	**24.3**	26-Jul
24F070	Naselle R nr Naselle	18	**22.9**	16:00 24-Jul	**21.7**	26-Jul
27D090	EF Lewis R nr Dollar Corner	18	**25.9**	17:30 24-Jul	**25.1**	14-Aug
32A070	Walla Walla R nr Touchet	21	**28.9**	16:30 29-Jul	**27.8**	30-Jul
34A170	Palouse R @ Palouse	20	**28.8**	17:30 16-Jul	**27.3**	22-Jul
34B110	SF Palouse R @ Pullman	18	**22.2**	19:30 15-Jul	**21.1**	17-Jul
34F090	Pine Cr @ Rosalia	16	**23.5**	18:00 02-Aug	**22.7**	23-Jul
35B060	Tucannon R @ Powers	18	**26.8**	18:00 24-Jul	**25.6**	26-Jul
39A090	Yakima R nr Cle Elum	16	**22.9**	18:00 13-Aug	**21.9**	15-Aug
41A070	Crab Cr nr Beverly	21	**29.8**	19:30 25-Jun	**28.1**	25-Jun
45A110	Wenatchee R nr Leavenworth	16	**24.1**	18:00 17-Aug	**23.5**	14-Aug
45C060	Chumstick Cr nr mouth	18	16.0	15:00 20-Aug	15.2	17-Aug
45D070	Brender Cr nr Cashmere	18	**19.5**	16:00 20-Aug	**19.1**	18-Aug
45E070	Mission Cr nr Cashmere	18	**24.1**	18:30 13-Aug	**23.5**	16-Aug
45R050	Noname Creek nr Cashmere	18	**20.1**	17:00 25-Jul	**19.6**	17-Aug
46A070	Entiat R nr Entiat	18	**24.4**	16:30 13-Aug	**23.8**	14-Aug
48A070	Methow R nr Pateros	18	**24.4**	16:30 16-Aug	**23.6**	15-Aug
48A140	Methow R @ Twisp	18	**21.5**	18:00 15-Aug	**20.3**	13-Aug
49A190	Okanogan R @ Oroville	18	**28.7**	21:30 16-Aug	**28.2**	16-Aug
55B070	Little Spokane R nr mouth	18	18.0	19:30 25-Jul	**17.7**	23-Jul
55C070	Peone (Deadman) Creek abv Little Deep Cr	18	**18.5**	17:00 16-Jul	**18.0**	22-Jul
55C200	Deadman Cr @ Holcomb Rd	18	**20.6**	18:00 18-Aug	**20.0**	17-Aug
56A070	Hangman Cr @ mouth	18	**26.5**	20:00 16-Jul	**25.3**	23-Jul

a This is the seven-day period with the highest average of daily maximum temperatures.

b There may be other dates or other seven-day periods with the same maximum.

c Date shown is middle of seven-day period.

Sanitary Conditions

Acceptable water quality for the support of swimming and shellfish harvesting is commonly determined by use of the indicator bacteria, fecal coliform. Since it is impossible to test for all pathogenic organisms, fecal coliform bacteria is used as an indicator of pollution. Fecal coliform originate from the intestinal tract of warm-blooded animals, and their levels in water are relatively easy to measure. Because of this, water quality standards for fecal coliform have been promulgated to protect the beneficial water uses of swimming and shellfish harvesting.

Washington's water quality standard for fecal coliform bacteria has two criteria, one based on the geometric mean and one on the 90th percentile (i.e., not more than 10 percent of results may exceed the criterion). Any evaluation of the reduction in fecal coliform needed to comply with standards must address both criteria. One approach to determine the amount of reduction needed is the Statistical Rollback Method (Ott, 1995). This analysis determines 90^{th} percentiles parametrically, assuming a log-normal distribution; 90^{th} percentiles determined non-parametrically will be different.

Water quality data collected by Ecology show that standards in 2004 were not met for fecal coliform bacteria at four of the long-term stream monitoring stations (6 percent) and 12 of the basin stations (60 percent); basin stations are often sited in known problem areas (Table 6). All 16 stations exceeded their 90^{th} percentile criterion; eight of the basin stations also exceeded their geometric mean criterion. The Statistical Rollback Method was applied to these data, and the percent reduction in fecal coliform levels needed to meet the standards was derived. These reductions are based on the assumption that the distribution will not change when fecal coliform levels are reduced. This information on the amount of fecal coliform loading that needs to be reduced may help decide where pollution-control efforts should be targeted.

Table 6. Fecal coliform levels sampled in 2004, and the percent reductions required to meet water quality standards. Only stations requiring a reduction are shown; mean and percentile units are colonies/100mL. Percentiles were calculated assuming a log-normal distribution.

Station	Location	Water Class	Geometric Mean	90th Percentile	Percent Reduction Required
Long-term Stations					
03B050	Samish R nr Burlington	A	39	546	63
08C070	Cedar R @ Logan St/Renton	A	36	274	27
13A060	Deschutes R @ E St Bridge	A	27	378	47
34B110	SF Palouse R @ Pullman	B	73	458	56
Basin Stations					
08L070	Laughing Jacobs Cr nr mouth	AA	144	746	87
08M070	SF Thornton Cr @ 107th Ave NE	AA	343	1727	94
09C070	Des Moines Cr nr mouth	AA	96	620	84
09D070	Miller Cr nr mouth	A	109	662	70
09J090	Longfellow Cr abv 24-25th St junction	A	136	1094	82
28C070	Burnt Br Cr @ mouth	A	261	961	79
34F090	Pine Creek at Rosalia	AA	34	284	65
45C060	Chumstick Cr nr mouth	A	21	271	26
45D070	Brender Cr nr Cashmere	A	159	533	63
45E070	Mission Cr nr Cashmere	A	18	247	19
45R050	Noname Creek nr Cashmere	A	171	1073	81
55C200	Deadman Cr @ Holcomb Rd	A	15	211	5

Biological Health

Ecology's Freshwater Monitoring Unit surveyed 22 sites between July and October 2004, including 10 reference sites (Table 7). The biological condition of these sites is presented in terms of RIVPACS scores, based on a predictive model (Ostermiller and Hawkins, 2003) and Biological Index scores, based on a multimetric scoring system (Wiseman, 2003).

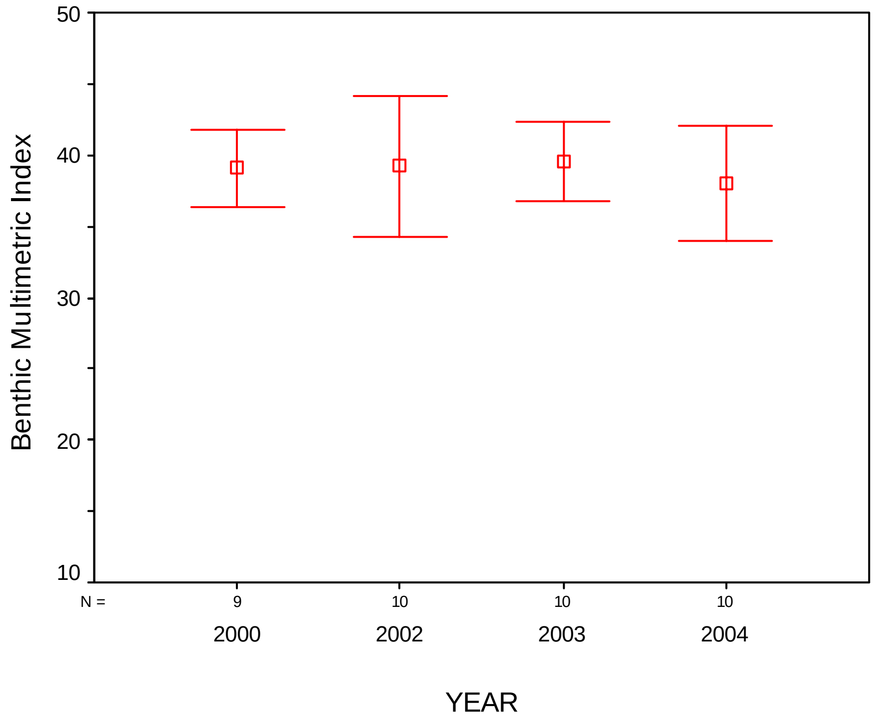
According to Rapid Bioassessment protocols (Barbour at al., 1999), sites were considered *impaired* if their index score fell below the 25th percentile of their associated reference stream distribution. Sites were considered *healthy* if they had index scores above the 25th percentile of their associated reference stream distribution. Water Quality Index (WQI) scores were calculated without including fecal coliform bacteria (which do not impact macroinvertebrates). WQI scores in Table 7, therefore, may not match WQI scores given elsewhere.

Table 7. Biological surveys and ambient WQI results for 2004. WQI scores are based on Hallock (2002).

Station Name	Station ID	RIVPACS		Biological Index		Water Quality Index	
		Score	Narrative	Score	Narrative	WQI	Narrative
Jimmycomelately Cr @ Hwy 101	17C070	1.13	Good	42	Good	95	Good
Big Quilcene R nr mouth	17A060	0.94	Good	22	Fair	94	Good
Big Mission Cr @ Hwy 300	15J050	0.67	Poor	28	Fair	91	Good
Boise Cr nr Buckley	10D070	0.80	Fair	32	Good	89	Good
Kalama R nr Kalama	27B070	0.86	Good	40	Good	86	Good
Stimson Cr @ Hwy 300	15H050	1.18	Good	36	Good	83	Good
E.F. Lewis R nr Dollar Corner	27D090	0.85	Fair	36	Good	78	Fair
Union R @ Timberline Dr.	15E070	0.76	Fair	38	Good	75	Fair
Skokomish R @ Hwy 101	16A070	0.84	Fair	30	Fair	73	Fair
Olalla Cr @ Hwy 300	15K070	1.00	Good	40	Good	65	Fair
Burnt Br Cr	28C070	0.55	Poor	26	Fair	36	Poor
Ellis Cr nr Hwy 101	NA	0.71	Poor	32	Good	NA	NA
South Branch Little R [a]	NA	1.03	Good	44	Good	NA	NA
Ellsworth Cr [a]	NA	1.03	Good	38	Good	NA	NA
Trapper Cr @ Trapper Cr Wilderness [a]	NA	0.97	Good	38	Good	NA	NA
Austin Cr [a]	NA	0.87	Good	42	Good	NA	NA
Middle Fork Teanaway R [a]	NA	0.87	Good	22	Poor	NA	NA
Diobsud Cr [a]	NA	0.72	Poor	30	Good	NA	NA
Cummings Cr @ Wooten [a]	NA	NA	NA	40	Good	NA	NA
North Fork Sullivan Cr [a]	NA	NA	NA	44	Good	NA	NA
Oak Creek [a]	NA	NA	NA	42	Good	NA	NA
Umtanum Cr nr Durr Rd [a]	NA	NA	NA	40	Good	NA	NA

[a] Reference Site

In Figure 1, 2004 results from reference sites were compared to results from the same stations in past years. The average signal at these sites remained very stable. These results indicate that our surveys are very repeatable.



	2000	2002	2003	2004
Mean	39.1	39.2	39.6	38
90% Confidence Interval	± 2.7	± 5.0	± 2.8	±4.0

Figure 1. Average Multimetric Index scores of ten reference sites plotted over time.

The error bars represent 90% confidence intervals. The Multimetric Index scores are based on benthic macroinvertebrate samples.

Although both RIVPACS and the Multimetric Index have their merits, occasionally scores for an individual site will result in different narrative determinations (i.e., *good, fair, poor*). These small differences are the result of different development and calibration methods. Overall, these two biological indicators have a high rate of concurrence. Differences between these two biological indicators and the Water Quality Index (WQI), on the other hand, are considered diagnostic of the type of stream pollution occurring. Big Mission Cr. @ Hwy 300 (15J050), and Big Quilcene R. nr mouth (17A060) had *fair* biological index scores, but *good* WQI scores. Examining the components of the Biological and WQI index can be useful in reconciling these differences.

Big Mission Cr. @ Hwy 300 (15J050) had relatively few predators, a low percentage of taxa that must cling to stable substrates, and a high percentage of nutrient tolerant taxa (www.ecy.wa.gov/programs/eap/fw_benth/index.html). The low number of predator taxa and low percentage of "clinger" taxa are most likely the result of fine and unstable sediments, as measured during the 2004 survey (www.ecy.wa.gov/programs/eap/fw_benth/index.html). Unstable environments tend to limit the complexity of biological communities, particularly limiting the taxa that require stable substrate, and the taxa at the top of the food web, such as predators. The numerical shift to nutrient tolerant taxa concurs with high nitrogen and phosphorus values, measured during the 2003 water year (www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html). The high nutrient values were not enough to produce a low WQI score, but were relevant to the biology of the stream.

Big Quilcene R. nr mouth (17A060) had relatively few predators, a low percentage of taxa that must cling to stable substrates, and relatively few taxa that live for more than one year (www.ecy.wa.gov/programs/eap/fw_benth/index.html). These biological indicators suggest unstable substrate, possibly from hydrological disturbance. The low number of "clinger" taxa could have also been the result of dense algal mats covering the stream bottom. The riparian zone had very little shading, and was dominated by the invasive Japanese Knotweed (*Polygonum cuspidatum*). This station had good water quality, but it appears as though the physical habitat was moderately degraded.

Aquatic Weeds

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

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

Table 8 identifies lakes where invasive exotic aquatic plants have been discovered since 1994. This list only includes locations of the true Class A or B aquatic weeds. Class C weeds, such as fragrant waterlily or riparian weeds like yellow flag iris, are not included. (See www.nwcb.wa.gov for a definition of weed classes.)

Table 8. Location of invasive exotic aquatic weeds in Washington, by county.

County	Waterbody Name	Scientific name	Common name	Legal location
Adams	Hutchinson Lake	Myriophyllum spicatum	Eurasian water-milfoil	16N-28E-15
Chelan	Chelan Lake	Myriophyllum spicatum	Eurasian water-milfoil	27N-22E-13
Chelan	Cortez (Three) Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-21E-29
Chelan	Roses (Alkali) Lake	Myriophyllum spicatum	Eurasian water-milfoil	28N-21E-26
Chelan	Wapato Lake	Myriophyllum spicatum	Eurasian water-milfoil	28N-21E-23
Clallam	Sutherland Lake	Myriophyllum spicatum	Eurasian water-milfoil	30N-08W-22
Clallam	Unnamed (30N-04W-17)	Myriophyllum spicatum	Eurasian water-milfoil	30N-04W-17
Clark	Battleground Lake	Egeria densa	Brazilian elodea	04N-03E-30
Clark	Caterpillar Slough	Myriophyllum spicatum	Eurasian water-milfoil	03N-01W-36
Clark	Columbia River at Ridgefield	Myriophyllum spicatum	Eurasian water-milfoil	04N-01W-24
Clark	Klineline Pond	Egeria densa	Brazilian elodea	03N-01E-26
Clark	Lacamas Lake	Egeria densa	Brazilian elodea	01N-03E-02
Columbia	Snake River at Little Goose Dam	Myriophyllum spicatum	Eurasian water-milfoil	13N-38E-26
Columbia	Snake River near Lyons Ferry	Myriophyllum spicatum	Eurasian water-milfoil	13N-37E-30
Cowlitz	Kress Lake	Myriophyllum spicatum	Eurasian water-milfoil	07N-01W-31
Cowlitz	Silver Lake	Egeria densa	Brazilian elodea	10N-01W-36
Cowlitz	Solo Slough	Cabomba caroliniana	fanwort	08N-03W-14
Cowlitz	Solo Slough	Egeria densa	Brazilian elodea	08N-03W-14
Cowlitz	Solo Slough	Ludwigia hexapetala	water primrose	08N-03W-14
Cowlitz	Solo Slough	Myriophyllum aquaticum	parrotfeather	08N-03W-14
Cowlitz	Willow Grove Slough	Cabomba caroliniana	fanwort	08N-03W-14
Cowlitz	Willow Grove Slough	Egeria densa	Brazilian elodea	08N-03W-14
Cowlitz	Willow Grove Slough	Myriophyllum spicatum	Eurasian water-milfoil	08N-03W-14

County	Waterbody Name	Scientific name	Common name	Legal location
Douglas	Pateros Lake	Myriophyllum spicatum	Eurasian water-milfoil	28N-24E-06
Franklin	Mesa Lake	Myriophyllum spicatum	Eurasian water-milfoil	13N-30E-34
Franklin	Scooteney Res	Myriophyllum spicatum	Eurasian water-milfoil	14N-30E-27
Franklin	Snake River at Ice Harbor Dam	Myriophyllum spicatum	Eurasian water-milfoil	09N-31E-24
Franklin	Snake River at Lower Monumental	Myriophyllum spicatum	Eurasian water-milfoil	13N-34E-34
Franklin	Snake River at Lyons Ferry	Myriophyllum spicatum	Eurasian water-milfoil	13N-37E-19
Grant	Babcock Ridge Lake	Myriophyllum spicatum	Eurasian water-milfoil	20N-23E-10
Grant	Banks Lake	Myriophyllum spicatum	Eurasian water-milfoil	25N-28E-33
Grant	Billy Clapp Lake	Myriophyllum spicatum	Eurasian water-milfoil	23N-28E-36
Grant	Burke Lake	Myriophyllum spicatum	Eurasian water-milfoil	19N-23E-23
Grant	Caliche Lake	Myriophyllum spicatum	Eurasian water-milfoil	18N-23E-22
Grant	Evergreen Lake	Myriophyllum spicatum	Eurasian water-milfoil	19N-23E-22
Grant	Moses Lake	Myriophyllum spicatum	Eurasian water-milfoil	18N-28E-09
Grant	Potholes Reservoir	Myriophyllum spicatum	Eurasian water-milfoil	17N-28E-11
Grant	Priest Rapids Lake	Myriophyllum spicatum	Eurasian water-milfoil	14N-23E-16
Grant	Red Rock Lake	Myriophyllum spicatum	Eurasian water-milfoil	16N-26E-17
Grant	Stan Coffin Lake	Myriophyllum spicatum	Eurasian water-milfoil	19N-23E-10
Grays Harbor	Chehalis River	Myriophyllum aquaticum	parrotfeather	17N-06W-02
Grays Harbor	Connor Creek	Myriophyllum spicatum	Eurasian water-milfoil	18N-12W-03
Grays Harbor	Duck Lake	Egeria densa	Brazilian elodea	17N-12W-14
Grays Harbor	Duck Lake	Myriophyllum spicatum	Eurasian water-milfoil	17N-12W-14
Island	Lone Lake	Egeria densa	Brazilian elodea	29N-03E-07
Island	Unnamed Pond	Egeria densa	Brazilian elodea	30N-03E-32
Island	Unnamed Pond (31N-02E-35)	Myriophyllum aquaticum	parrotfeather	32N-02E-35
Jefferson	Leland Lake	Egeria densa	Brazilian elodea	28N-02W-26
King	Bass Lake	Myriophyllum spicatum	Eurasian water-milfoil	20N-06E-02
King	Desire Lake	Myriophyllum spicatum	Eurasian water-milfoil	23N-05E-36
King	Dolloff Lake	Egeria densa	Brazilian elodea	21N-04E-10
King	Dolloff Lake	Myriophyllum spicatum	Eurasian water-milfoil	21N-04E-10
King	Fenwick Lake	Egeria densa	Brazilian elodea	22N-04E-26
King	Green Lake	Myriophyllum spicatum	Eurasian water-milfoil	25N-04E-05
King	Lucerne Lake	Hydrilla verticillata	hydrilla	22N-06E-28
King	Lucerne Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-06E-28
King	Meridian Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-05E-27
King	Neilson (Holm) Lake	Myriophyllum spicatum	Eurasian water-milfoil	21N-05E-14
King	Number Twelve Lake	Myriophyllum spicatum	Eurasian water-milfoil	21N-06E-12
King	Otter (Spring) Lake	Myriophyllum spicatum	Eurasian water-milfoil	23N-06E-31
King	Phantom Lake	Myriophyllum spicatum	Eurasian water-milfoil	24N-05E-02
King	Pipe Lake	Hydrilla verticillata	hydrilla	22N-06E-28
King	Pipe Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-06E-28
King	Sammamish Lake	Egeria densa	Brazilian elodea	25N-04E-13
King	Sammamish Lake	Myriophyllum spicatum	Eurasian water-milfoil	25N-04E-13
King	Sawyer Lake	Myriophyllum spicatum	Eurasian water-milfoil	21N-06E-04

County	Waterbody Name	Scientific name	Common name	Legal location
King	Shadow Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-06E-07
King	Shady Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-05E-01
King	Ship Canal	Myriophyllum spicatum	Eurasian water-milfoil	
King	Star Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-04E-34
King	Steel Lake	Myriophyllum spicatum	Eurasian water-milfoil	21N-04E-09
King	Union Lake	Egeria densa	Brazilian elodea	25N-04E-19
King	Union Lake	Myriophyllum spicatum	Eurasian water-milfoil	25N-04E-19
King	Unnamed Pond, Bellevue	Myriophyllum aquaticum	parrotfeather	24N-05E-11
King	Washington Lake	Egeria densa	Brazilian elodea	25N-04E-16
King	Washington Lake	Myriophyllum spicatum	Eurasian water-milfoil	25N-04E-16
King	Wilderness Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-06E-27
Kitsap	Long Lake	Egeria densa	Brazilian elodea	23N-02E-17
Kitsap	Long Lake	Myriophyllum spicatum	Eurasian water-milfoil	23N-02E-17
Kittitas	Fiorito Ponds	Myriophyllum spicatum	Eurasian water-milfoil	17N-19E-30
Kittitas	Lavender Lake	Myriophyllum spicatum	Eurasian water-milfoil	20N-14E-20
Kittitas	Mattoon Lake	Myriophyllum spicatum	Eurasian water-milfoil	17N-18E-11
Kittitas	Private Pond (20N-16E-10)	Myriophyllum spicatum	Eurasian water-milfoil	20N-16E-10
Klickitat	Columbia River at Bingen	Myriophyllum spicatum	Eurasian water-milfoil	03N-11E-32
Klickitat	Columbia River at Maryhill	Myriophyllum spicatum	Eurasian water-milfoil	02N-15E-14
Klickitat	Horsethief Lake	Myriophyllum spicatum	Eurasian water-milfoil	02N-14E-19
Lewis	Carlisle Lake	Myriophyllum spicatum	Eurasian water-milfoil	13N-01E-30
Lewis	Chehalis River	Egeria densa	Brazilian elodea	14N-03W-02
Lewis	Chehalis River	Myriophyllum aquaticum	parrotfeather	14N-03W-02
Lewis	Cowlitz River near Blue Cr	Myriophyllum spicatum	Eurasian water-milfoil	11N-01E-01
Lewis	Interstate Ave Slough	Myriophyllum aquaticum	parrotfeather	14N-02W-32
Lewis	Mayfield Reservoir	Myriophyllum spicatum	Eurasian water-milfoil	12N-02E-29
Lewis	Plummer Lake	Egeria densa	Brazilian elodea	14N-02W-07
Lewis	Riffe Lake	Myriophyllum spicatum	Eurasian water-milfoil	12N-03E-10
Lewis	South County Park Pond	Myriophyllum spicatum	Eurasian water-milfoil	11N-01W-17
Lewis	Swofford Pond	Myriophyllum spicatum	Eurasian water-milfoil	12N-03E-26
Lincoln	Franklin D. Roosevelt Lake	Myriophyllum spicatum	Eurasian water-milfoil	28N-37E-33
Mason	Island Lake	Myriophyllum spicatum	Eurasian water-milfoil	20N-03W-06
Mason	Limerick Lake	Egeria densa	Brazilian elodea	21N-03W-27
Mason	Mason Lake	Myriophyllum spicatum	Eurasian water-milfoil	22N-02W-34
Mason	Mason Lake	Sagittaria graminea	slender arrowhead	22N-02W-34
Okanogan	Conconully (Salmon) Lake	Myriophyllum spicatum	Eurasian water-milfoil	35N-25E-06
Okanogan	Conconully Reservoir (35N-25E-18)	Myriophyllum spicatum	Eurasian water-milfoil	35N-25E-18
Okanogan	Osoyoos Lake	Myriophyllum spicatum	Eurasian water-milfoil	40N-27E-22
Okanogan	Palmer Lake	Myriophyllum spicatum	Eurasian water-milfoil	39N-25E-11
Okanogan	Rat Lake	Myriophyllum spicatum	Eurasian water-milfoil	31N-24E-22
Okanogan	Whitestone Lake	Myriophyllum spicatum	Eurasian water-milfoil	38N-27E-17
Pacific	Black Lake	Egeria densa	Brazilian elodea	10N-11W-28
Pacific	Black Lake	Myriophyllum spicatum	Eurasian water-milfoil	10N-11W-28

County	Waterbody Name	Scientific name	Common name	Legal location
Pacific	Loomis Lake	Egeria densa	Brazilian elodea	11N-11W-21
Pacific	Loomis Lake	Myriophyllum spicatum	Eurasian water-milfoil	11N-11W-21
Pacific	Sloughs near Long Beach	Myriophyllum aquaticum	parrotfeather	10N-11W
Pend Oreille	Davis Lake	Myriophyllum spicatum	Eurasian water-milfoil	32N-44E-31
Pend Oreille	Diamond Lake	Myriophyllum spicatum	Eurasian water-milfoil	30N-44E-03
Pend Oreille	Fan Lake	Myriophyllum spicatum	Eurasian water-milfoil	30N-43E-32
Pend Oreille	Horseshoe Lake	Myriophyllum spicatum	Eurasian water-milfoil	30N-43E-08
Pend Oreille	Little Spokane River	Myriophyllum spicatum	Eurasian water-milfoil	56N-43E-34
Pend Oreille	Marshall Lake	Myriophyllum spicatum	Eurasian water-milfoil	32N-45E-23
Pend Oreille	Nile Lake	Myriophyllum spicatum	Eurasian water-milfoil	37N-42E-35
Pend Oreille	Pend Oreille River	Myriophyllum spicatum	Eurasian water-milfoil	38N-43E-32
Pend Oreille	Sacheen Lake	Myriophyllum spicatum	Eurasian water-milfoil	31N-43E-35
Pierce	Clear Lake	Myriophyllum spicatum	Eurasian water-milfoil	17N-04E-27
Pierce	Harts Lake	Myriophyllum spicatum	Eurasian water-milfoil	16N-03E-07
Pierce	Hidden Lake	Myriophyllum spicatum	Eurasian water-milfoil	20N-05E-20
Pierce	Ohop Lake	Egeria densa	Brazilian elodea	16N-04E-10
Pierce	Slough, Port of Tacoma	Myriophyllum aquaticum	parrotfeather	20N-03E-02
Pierce	Tapps Lake	Myriophyllum spicatum	Eurasian water-milfoil	20N-05E-08
Skagit	Beaver Lake	Myriophyllum spicatum	Eurasian water-milfoil	34N-05E-07
Skagit	Big Lake	Egeria densa	Brazilian elodea	34N-04E-36
Skagit	Big Lake	Myriophyllum spicatum	Eurasian water-milfoil	34N-04E-36
Skagit	Campbell Lake	Myriophyllum spicatum	Eurasian water-milfoil	34N-01E-13
Skagit	Clear Lake (34N-05E-07)	Myriophyllum spicatum	Eurasian water-milfoil	34N-05E-07
Skagit	Erie Lake	Myriophyllum spicatum	Eurasian water-milfoil	34N-01E-11
Skagit	Heart Lake (35N-01E-36)	Myriophyllum spicatum	Eurasian water-milfoil	35N-01E-36
Skagit	McMurray Lake	Myriophyllum spicatum	Eurasian water-milfoil	33N-05E-30
Skagit	Sixteen Lake	Myriophyllum spicatum	Eurasian water-milfoil	33N-04E-15
Skamania	Drano Lake	Myriophyllum spicatum	Eurasian water-milfoil	03N-09E-26
Skamania, Cowlitz	Coldwater Lake	Myriophyllum spicatum	Eurasian water-milfoil	10N-05E-31
Snohomish	Echo Lake	Sagittaria graminea	slender arrowhead	27N-06E-33
Snohomish	Goodwin Lake	Myriophyllum spicatum	Eurasian water-milfoil	31N-04E-33
Snohomish	Loma Lake	Sagittaria graminea	slender arrowhead	31N-04E-35
Snohomish	Meadow Lake	Hydrocharis morsus-ranae	European frog-bit	28N-07E-18
Snohomish	Nina Lake	Myriophyllum aquaticum	parrotfeather	31N-05E-32
Snohomish	Roesiger (north) Lake	Myriophyllum spicatum	Eurasian water-milfoil	29N-07E-21
Snohomish	Roesiger (north) Lake	Sagittaria graminea	slender arrowhead	29N-07E-21
Snohomish	Roesiger (south) Lake	Myriophyllum spicatum	Eurasian water-milfoil	29N-07E-28
Snohomish	Roesiger (south) Lake	Sagittaria graminea	slender arrowhead	29N-07E-28
Snohomish	Serene Lake (28N-04E-34)	Myriophyllum spicatum	Eurasian water-milfoil	28N-04E-34
Snohomish	Serene Lake (28N-04E-34)	Sagittaria graminea	slender arrowhead	28N-04E-34
Snohomish	Shoecraft Lake	Myriophyllum spicatum	Eurasian water-milfoil	31N-04E-33
Snohomish	Silver Lake (28N-05E-30)	Myriophyllum spicatum	Eurasian water-milfoil	28N-05E-30
Snohomish	Stevens Lake	Myriophyllum spicatum	Eurasian water-milfoil	29N-06E-08

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Snohomish	Swartz Lake	Egeria densa	Brazilian elodea	30N-07E-20
Spokane	Eloika Lake	Myriophyllum spicatum	Eurasian water-milfoil	29N-43E-15
Spokane	Liberty Lake	Myriophyllum spicatum	Eurasian water-milfoil	25N-42E-22
Spokane	Long Lake (Reservoir)	Myriophyllum spicatum	Eurasian water-milfoil	27N-39E-13
Spokane	Long Lake (Reservoir)	Nymphoides peltata	water fringe	27N-39E-13
Spokane	Newman Lake	Myriophyllum spicatum	Eurasian water-milfoil	26N-42E-10
Spokane	Silver Lake	Myriophyllum spicatum	Eurasian water-milfoil	24N-41E-32
Stevens	Black Lake	Myriophyllum spicatum	Eurasian water-milfoil	35N-41E-03
Stevens	Gillette Lake	Myriophyllum spicatum	Eurasian water-milfoil	36N-42E-20
Stevens	Heritage Lake	Myriophyllum spicatum	Eurasian water-milfoil	36N-42E-08
Stevens	Loon Lake	Myriophyllum spicatum	Eurasian water-milfoil	30N-41E-33
Stevens	McDowell Lake	Myriophyllum spicatum	Eurasian water-milfoil	34N-41E-06
Stevens	Sherry Lake	Myriophyllum spicatum	Eurasian water-milfoil	36N-42E-20
Stevens	Thomas Lake	Myriophyllum spicatum	Eurasian water-milfoil	36N-42E-18
Thurston	Capitol Lake	Myriophyllum spicatum	Eurasian water-milfoil	18N-02W-15
Thurston	Deep Lake	Myriophyllum spicatum	Eurasian water-milfoil	16N-02W-03
Thurston	Long Lake	Myriophyllum spicatum	Eurasian water-milfoil	18N-01W-22
Thurston	Scott Lake	Myriophyllum spicatum	Eurasian water-milfoil	17N-02W-33
Thurston	Skiview Lake	Myriophyllum spicatum	Eurasian water-milfoil	17N-02W-08
Wahkiakum	Brooks Slough	Myriophyllum aquaticum	parrotfeather	09N-06W-26
Wahkiakum	Columbia River at Cathlamet	Myriophyllum spicatum	Eurasian water-milfoil	08N-06W-02
Wahkiakum	Columbia River at Skamokawa	Myriophyllum aquaticum	parrotfeather	09N-06W-18
Wahkiakum	Puget Island Sloughs	Egeria densa	Brazilian elodea	08N-06W-14
Wahkiakum	Puget Island Sloughs	Myriophyllum aquaticum	parrotfeather	08N-06W-14
Whatcom	Unnamed Pond	Egeria densa	Brazilian elodea	40N-01E-22
Whatcom	Unnamed Pond (39N 3E 19)	Nymphoides peltata	water fringe	39N-03E-19
Whatcom	Unnamed Pond (40N-2E-2)	Myriophyllum aquaticum	parrotfeather	40N-02E-02
Whatcom	Whatcom Lake	Myriophyllum spicatum	Eurasian water-milfoil	38N-03E-28
Whitman	Snake River at Central Ferry	Myriophyllum spicatum	Eurasian water-milfoil	13N-40E-08
Whitman	Snake River at Little Goose Dam	Myriophyllum spicatum	Eurasian water-milfoil	13N-38E-23
Whitman	Snake River at Lower Granite Dam	Myriophyllum spicatum	Eurasian water-milfoil	13N-43E-12
Yakima	Buena Lake	Myriophyllum spicatum	Eurasian water-milfoil	11N-20E-21
Yakima	Byron Lake	Myriophyllum spicatum	Eurasian water-milfoil	08N-23E-12
Yakima	Dog Lake	Myriophyllum spicatum	Eurasian water-milfoil	14N-12E-31
Yakima	Freeway (Rotary) Lake	Myriophyllum spicatum	Eurasian water-milfoil	13N-19E-07
Yakima	I-82 Pond, Exit 50	Myriophyllum aquaticum	parrotfeather	11N-20E-28
Yakima	I-82 Ponds, Exit 52	Myriophyllum aquaticum	parrotfeather	11N-20E-35
Yakima	Parker Ponds	Myriophyllum spicatum	Eurasian water-milfoil	12N-19E-20
Yakima	Pond 1	Myriophyllum spicatum	Eurasian water-milfoil	12N-19E-35
Yakima	Pond 2	Myriophyllum spicatum	Eurasian water-milfoil	12N-19E-35
Yakima	Pond 3	Myriophyllum spicatum	Eurasian water-milfoil	11N-19E-01
Yakima	Pond 4	Myriophyllum spicatum	Eurasian water-milfoil	11N-20E-17
Yakima	Pond 5	Myriophyllum spicatum	Eurasian water-milfoil	11N-20E-20

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