

Watershed Assessment Report

Coastal Coho Stream Assessment: Summary Report by DEQ

**Laboratory and
Environmental
Assessment Division,
Watershed Assessment
Section**

3150 SW 229th Street
Suite 150
Hillsboro, OR 97124
Phone: (503) 693-5732
Fax: (503) 693-4999

Contact: Michael Mulvey
Email: Mulvey.Michael@
deq.state.or.us

Purpose of this Report

In 2005 the State of Oregon completed a comprehensive assessment of Coho populations within the Coastal Coho Evolutionarily Significant Unit (ESU) and the key factors responsible for their decline. The final report was over a thousand pages long and contained sections from each of the eight natural resource agencies in Oregon including the Oregon Department of Environmental Quality (DEQ). The report was submitted to NOAA Fisheries in response to pending listing decisions of Coho within the ESU under the Endangered Species Act. The larger, final report to NOAA Fisheries and all individual agency reports are available on line at:

<http://nrimp.dfw.state.or.us/OregonPlan/>

This summary report attempts to capture DEQ's portion of the overall Coho assessment report in a concise and readable format. This report does not provide all the background material or detailed discussion of data analysis methods provided in the full report. For those details readers are directed to DEQ's complete report at the web site listed above.

activities, were evaluated by other agencies in the larger report.

Study Overview and Objectives

The basic objective of DEQ's assessment was to evaluate water quality conditions within the ESU with an emphasis on those water quality parameters known to be potential factors for decline of Coho populations. Other factors for decline, such as habitat condition, water quantity, or forestry or agricultural land use

Figure 1: Land use and Sub-regions within the ESU. Graphs show extent of poor conditions with 95% confidence intervals.

North Coast

Mid Coast

Mid-south
Coast

Umpqua

Study Design

Three main sources of data were used to evaluate water quality conditions in the ESU and the four sub-regions:

- x Long-term ambient water quality monitoring sites
- x Probabilistic or randomly selected sample sites
- x Reference sites

We did not use data collected by watershed councils or data collected in other DEQ programs. These data collectors tend to look at water quality for a few parameters in smaller areas. While this approach to data collection provides valuable information, these data cannot be used for regional status and trend analysis because of data availability limitations and different parameters and monitoring objectives. These data sources may provide additional information at a relatively small spatial scale on specific water quality issues, but do not characterize larger regional conditions.

Long-term Ambient River Monitoring Sites:

The DEQ maintains a statewide network of more than 130 ambient water quality monitoring stations of which 31 are located within the coastal Coho ESU (Figure 2). These sites are located on larger non-wadeable streams (4th order and larger), often near their mouths, and are typically sampled six times per year for long-term water quality status and trends,

standard compliance, and problem identification. Sites were selected to represent the major rivers in the state and provide statewide geographical representation. Sites are primarily integrator sites; they reflect the integrated water quality impacts from point and nonpoint source activities as well as the natural geological, hydrological and biological impacts on water quality for the watershed they represent.

Some limitations of the ambient monitoring data are important to keep in mind. Ambient monitoring results are based on grab samples typically collected every other month. Because the sites are not randomly selected, the results cannot be extrapolated to all river miles in a monitoring unit or the ESU. For example, it is possible results at an ambient site may not agree with water quality data collected further upstream. Also, some parameters can have wide daily fluctuations, such as temperature, dissolved oxygen and pH. Because the ambient data are collected at a single point in time during a 24-hour period, they do not capture the range of conditions over a 24-hour period. Continuously collected data may show different results. Ambient monitoring data, however, provides the only data available to us for accurately evaluating long-term trends in water quality.

Probabilistic Monitoring Sites:

There are thousands of miles of streams within the ESU, of which over 80% are small wadeable streams. The most effective and accurate method to assess such a large resource is to use a probabilistic or random sampling survey design (Herlihy et al. 2000). This is the same method used to develop public opinion polls. Just as a small sub-sample of people can provide a statistically accurate evaluation of a large population, a relatively small number of randomly selected stream sites can accurately estimate the overall condition of the large network of streams within the entire ESU. For this assessment, data from 129 unique randomly selected stream sites within the range of Coho distribution were analyzed. These sites were sampled from 1994 through 2003.

Reference Sites:

In addition to randomly selected sites used to characterize the overall range of stream conditions in the region, reference sites were selected to characterize stream conditions with minimal human influences. Reference streams help set realistic expectations to which random stream conditions can be compared. Most reference sites used in this analysis were hand picked using a combination of Geographic Information System tools and an in-stream evaluation based on specific human activities following the method in Drake (2004). The quality of reference sites ranges from “least disturbed,” meaning sites with human disturbance but are the best sites available, to “minimally disturbed” sites, which have little or no human disturbance present. Most reference sites within the ESU reflect least disturbed conditions rather than minimally disturbed. This may explain why conditions for reference sites were often not significantly different from conditions at random sites.

How can we tell **which parameters** to target with management activities that will provide the **most benefit** to the streams of the Oregon Coastal Coho ESU?

- extent** of impaired stream miles.
- risk** to stream organisms.
- reference condition** comparison.

Macroinvertebrates like this stonefly are indicators of stream health.

Sampling and Assessment Methods

Sampling Methods:

All selected stream sites – random, reference, and large river ambient sites – were assessed for water chemistry, while random and reference sites were also assessed for physical habitat and biological assemblages (fish & macro-invertebrates). Chemistry samples were analyzed for the following water quality parameters:

- Dissolved oxygen,
- pH,
- Turbidity
- Total Solids
- Total Phosphorus
- Nitrate + Nitrite
- Conductivity
- Total Suspended Solids
- Dissolved Ortho Phosphate
- Alkalinity
- Chloride
- Sulfate
- Total Inorganic Nitrogen
- Biochemical Oxygen Demand (BOD)

Physical habitat data were collected along a longitudinal profile from twenty-one evenly spaced cross sectional transects on a stream reach equal to 40 times the wet channel width (Peck et al 2006). Depending on the stream width, most stream survey reaches were 150 to 500 meters long. Habitat parameters included:

- Channel shape and dimensions
- Shade
- Embeddedness
- Riparian vegetation cover and structure
- Occurrence and proximity of human disturbance
- Substrate size
- Fish cover

Continuous water temperature was also measured at most random and reference sites using recorders set to 30-minute intervals. Temperature recorders were deployed in the streams in mid June and retrieved in mid September.

Fish and aquatic amphibian assemblages were sampled using a single-pass with a backpack electrofisher over the entire stream reach. Benthic macroinvertebrates were collected from riffle habitat using a fine mesh D-frame kick net (ODEQ 2003).

Long-term Ambient River Monitoring Sites:

The Oregon Water Quality Index (OWQI) was used to assess water chemistry data collected from large river ambient sites (Cude 2001). The OWQI incorporates a defined set of water quality variables and produces a score describing general water quality. The water quality variables included in the OWQI are temperature, dissolved oxygen, biochemical oxygen demand (BOD), pH, total solids, ammonia and nitrate nitrogen, total phosphorus, and bacteria (E. coli). OWQI scores range from 10 (worst case) to 100 (ideal water quality). For this assessment, OWQI results were calculated on all samples taken from October 1992 through September 2002. These data were analyzed to determine OWQI scores and which variables limit general water quality at specific sites. Overall OWQI scores that are less than 60 are considered very poor; 60-79 poor; 80-84 fair; 85-89 good; and 90-100 excellent. Each site with sufficient data was also analyzed for the presence of significantly increasing or decreasing water quality trends.

Probabilistic Monitoring Sites:

The probabilistic site results have been summarized using extent bar charts for each parameter (chemical, physical and biological). The extent bar charts show just the percent of stream miles that lie outside specific benchmarks or standards for each parameter. The benchmarks are based on existing water quality standards where they exist (dissolved oxygen, pH, and temperature). For parameters without existing standards, the benchmarks are based on results from references sites or previously established values for aquatic life protection. We also compared the extent of impairment at the random sites with minimally impaired reference sites

Finally, to assess the severity of stress or risk posed by specific parameters to aquatic vertebrate and macro-invertebrate assemblages we calculated the “relative risk” for chemical and physical habitat parameters. Relative risk can be defined as the chance that the biological community will be in poor condition given poor parameter values rather than good parameter values (Lachin 2000). For example, streams with high levels of fine sediment are twice as likely to have impaired macroinvertebrate communities compared to streams with low levels of fine sediment.

Summary of Results

Long-term Ambient River Monitoring Sites:

The status of water chemistry at ambient river monitoring sites is shown in Figures 2. At the ESU scale 42% of sites had excellent to good water quality and 29% had poor to very poor water quality. Within the four monitoring areas the North Coast showed the best overall conditions (6 sites in excellent or good condition out of 9 sites), and the Mid-South coast the poorest conditions (no excellent condition sites and only 2 out of 8 sites in good condition).

No sites had a declining trend in water quality for the ten-year period between October 1992 and September 2002. The area with the most improving trends was the North Coast where 66% of the sites (6 out of 9) had a significant improvement in OWQI scores. The Umpqua basin, with 11% (1 out of 9 sites) showing an improving trend, had the lowest number of improving sites.

We also analyzed individual parameters to determine what was driving the OWQI scores and what parameters posed the greatest risk to water quality. Out of the total 31 sites, the primary risk factors affecting the OWQI were as follows: total solids (58% of the sites), nitrogen (32%), BOD (6%), and bacteria (3%).

Figure 2. Oregon Water Quality Index (OWQI) Scores at Ambient Monitoring Stations.

Ambient monitoring stations are non-randomly selected, long-term monitoring sites, usually on large rivers. For a more detailed report see <http://www.deq.state.or.us/lab/wqm/docs/OregonPlan04ver3.pdf>.

North Coast

Mid Coast

Mid-south Coast

Umpqua

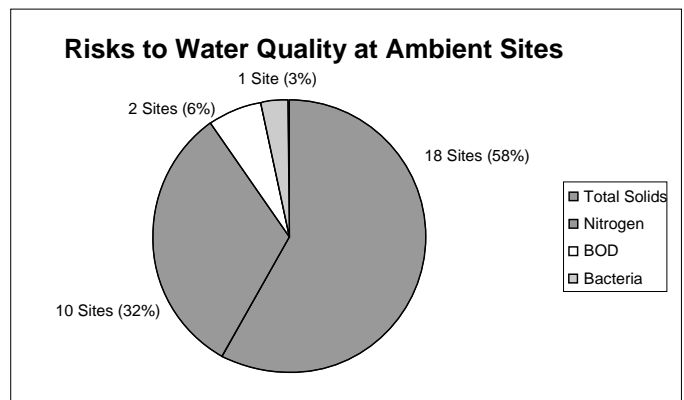
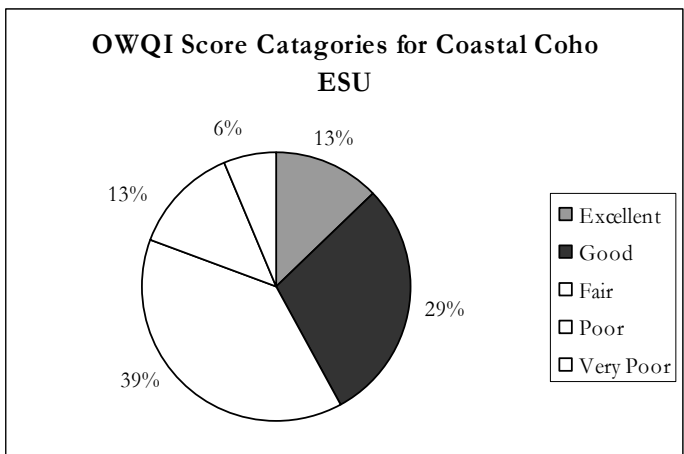
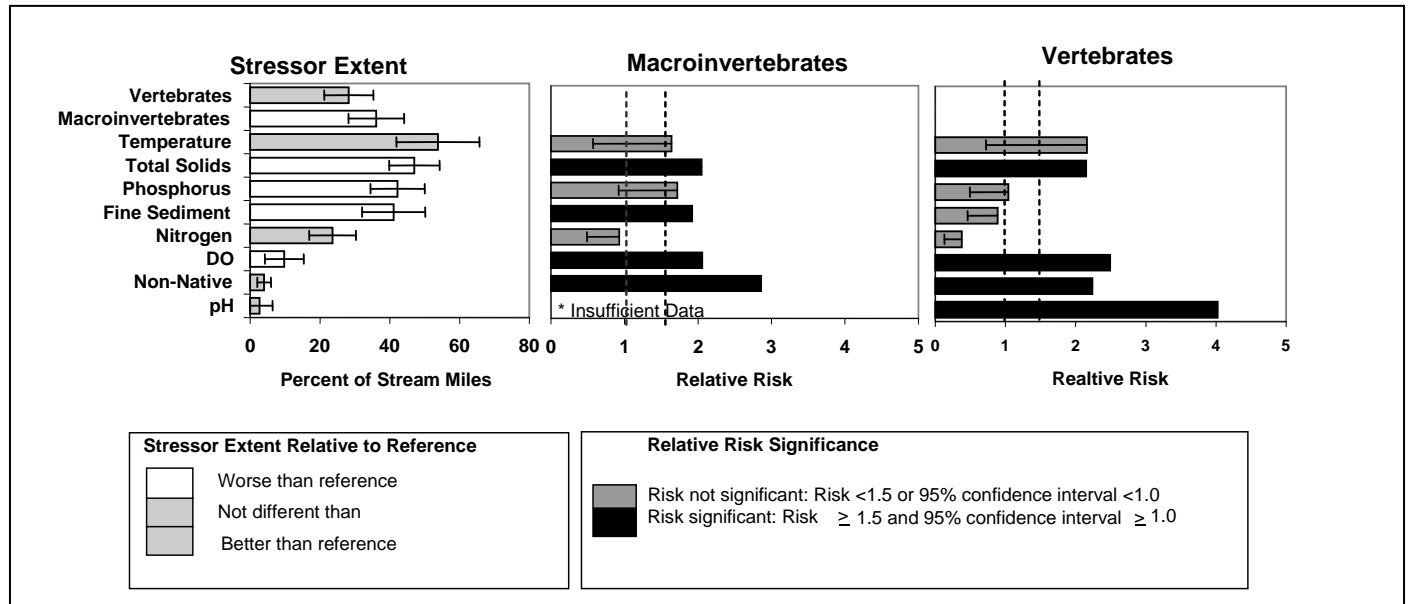


Figure 3. Stream stressor extent and relative risk values for Oregon Coast Coho ESU from randomly selected sites and selected reference sites with 95% confidence intervals. Stressors greater than 1.5 with confidence intervals greater than 1.0 are considered significant stressors.



Probabilistic Monitoring Sites:

ESU Scale –

Thirty-six percent of the stream miles have impaired macrovertebrate communities and 28% have impaired fish and amphibian communities (Figure 3). Warm water temperature have the greatest extent of stream miles above water quality criteria with 53% of stream miles above the criteria. High total solids, phosphorus and fine sediment also impact between 40% and 50% of the stream miles above criteria regionally. High nitrogen levels affect about 24% of the stream miles. Dissolved oxygen, non-native species and pH were more minor factors with less than 10% of the stream miles affected.

Relative Risk –

Figure 3 shows the extent (left graph) and relative risk scores for macroinvertebrates (middle graph) and aquatic vertebrate assemblages (right graph). Relative risk factors of 1.0 or less indicate no parameter effect on the stream biological communities. Non-native species, total solids, fine sediment and dissolved oxygen have risk factors greater than 1.5 and confidence intervals above 1.0 for the macro-invertebrate community. When these parameters exceed standards or benchmarks there is significantly increased probability of impairment. Although temperature and phosphorus risks exceed 1.5 the error bars extend below 1.0 and are not considered statistically significant risks to the macro-invertebrate community. Nitrogen risk was below 1.0. Although low dissolved oxygen, non-native vertebrates and pH are not extensive impairments, they are a significant source of risk when present.

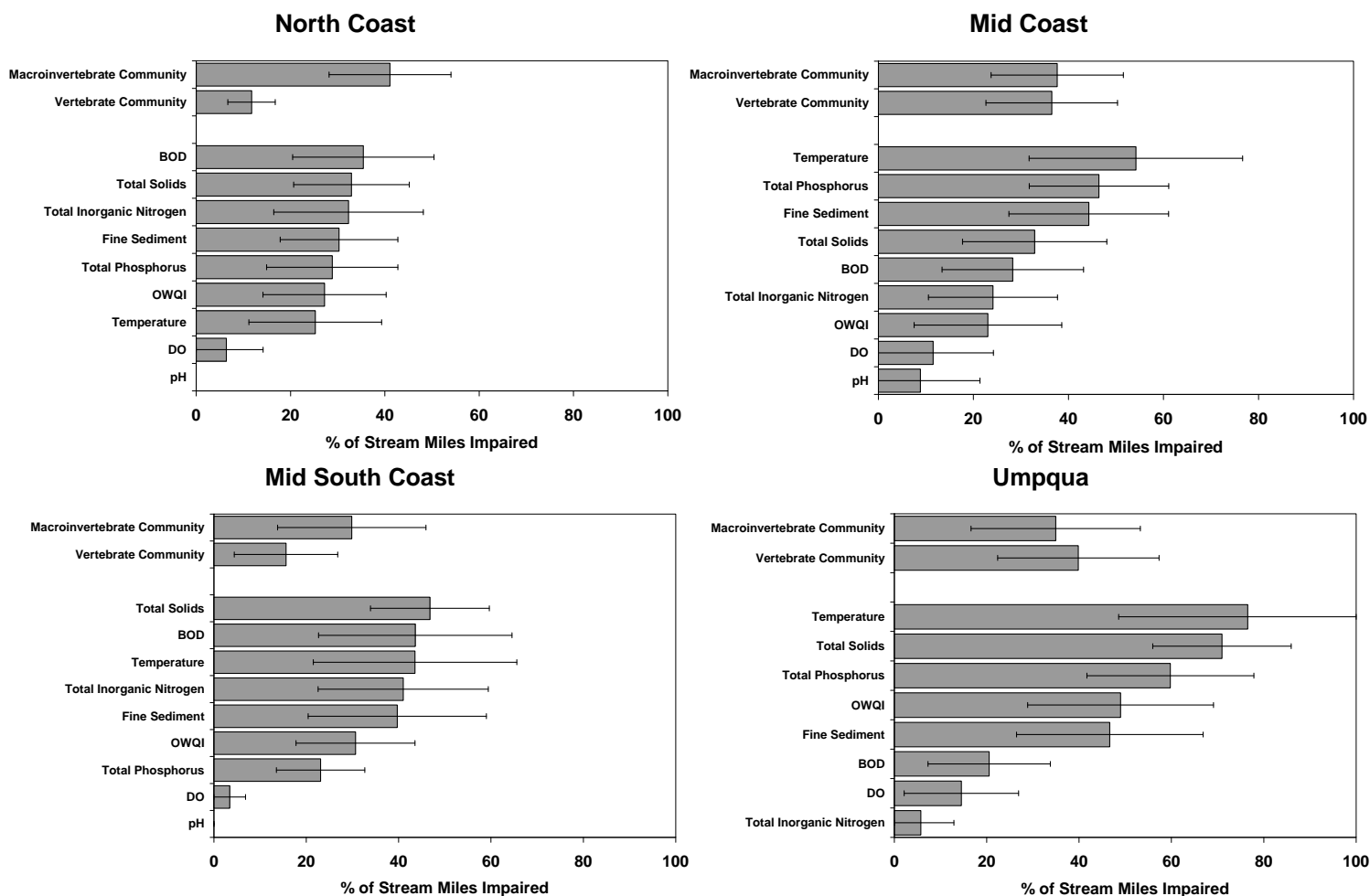
Future management strategies that target these parameters will provide the most benefit:

- Warm water temperature**
- Fine sediment**
- Total solids**

Sub-region Scale –

While conditions between monitoring sub-regions were generally not significantly different, the North Coast tended to have the best water quality conditions and the Umpqua the worst (Figure 4). For example, the percent of wadeable stream miles above the temperature criteria were lowest in the North Coast (31%) and highest in the Umpqua (77%). Excessive fine sediment was also lowest in the North Coast (30%) and highest in the Umpqua (47%). The aquatic vertebrate condition scores reflected these results with the fewest stream miles in poor condition in the North Coast (12%) and most in poor condition in the Umpqua (40%). Macroinvertebrate condition scores followed a different pattern with the Mid-south Coast showing the fewest stream miles in poor condition (30%), and the North Coast showing the largest percent in poor condition (41%). The Umpqua fell between the two with 35% of stream miles in poor condition. Overall, the sub-region results showed that the Umpqua sub-region had the greatest need to improve water temperature and fine sediment conditions. Thirty to 50% of stream miles in all sub-regions, however, showed some type of water quality degradation above current criteria or benchmarks.

Figure 4. Biological condition and stream impairment in the monitoring sub regions of the Oregon Coast Coho ESU from randomly selected sites with 95% confidence interval.

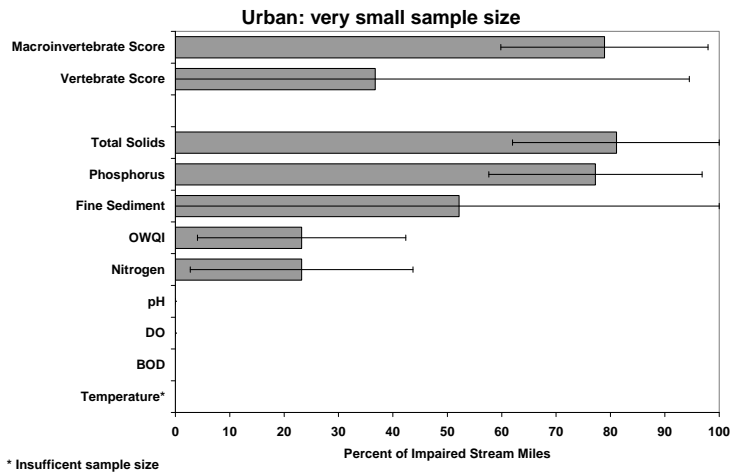
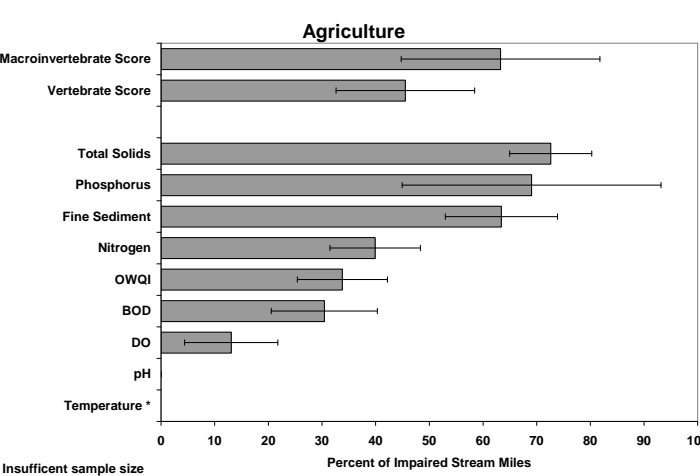
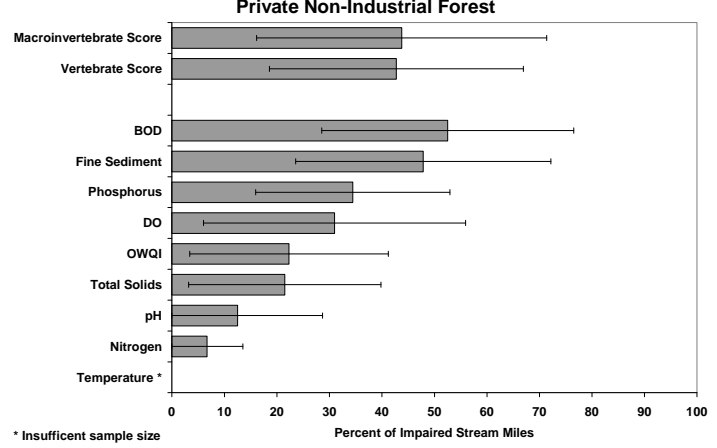
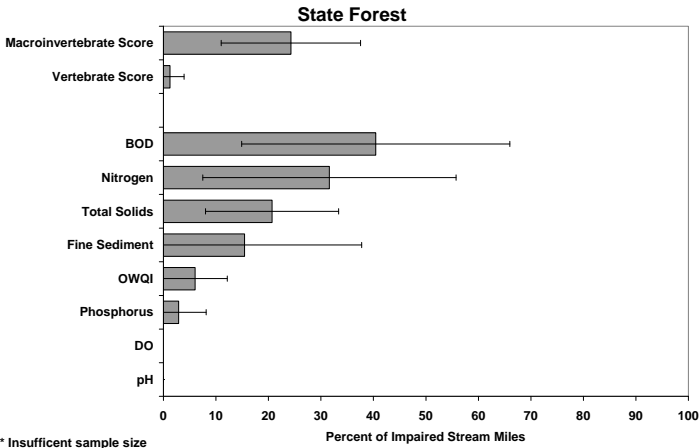
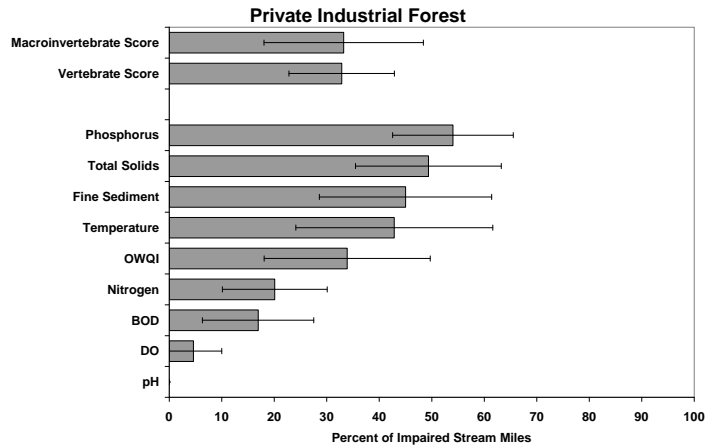
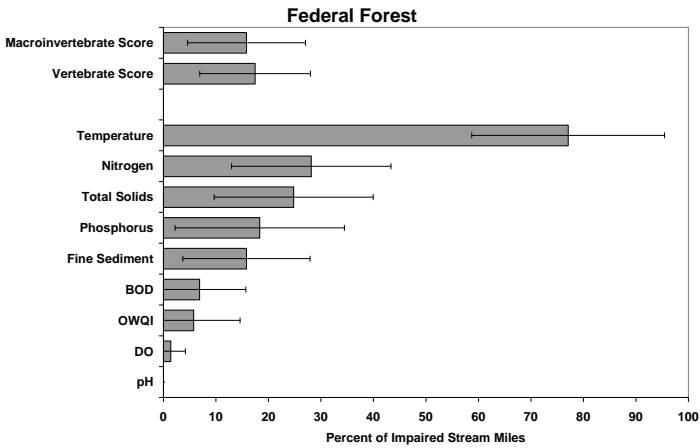
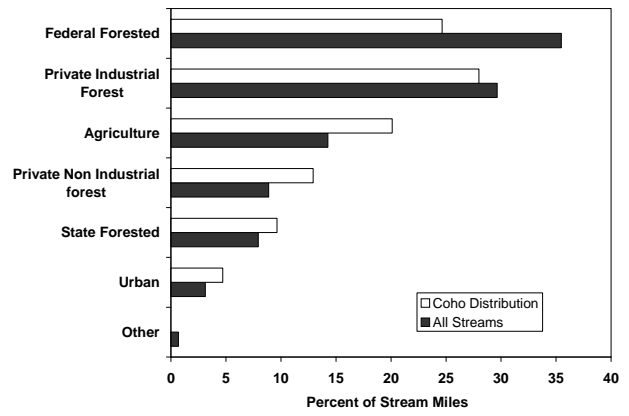


Land Use Scale –

Stream conditions across six different land use types (Federal forest, State forest, Private Industrial forest, Private Non-industrial forest, agriculture, and urban) were also evaluated (Figure 5). This survey was not initially set-up to address land use effects, and therefore, the data are insufficient to provide any critical assessment for some land use categories. For example, the number of sites sampled in urban land use is too small to make any evaluation of urban streams in ESU. While the results tend to show that streams in agricultural and urban land use have the most miles exceeding water quality criteria and State and Federal forest the fewest, the results should not be used to make specific judgments about land use effects on water quality. A survey designed to address this question would be needed.

Figure 5. Biological condition, stream impairment, and land use extent in the different land use classes of the Oregon Coast Coho ESU from randomly selected sites with 95% confidence interval.

Extent of Land Uses for Coho Distribution and All Wadeable Streams



Conclusions

Based on the analysis of both ambient large river water chemistry data and probability survey data from wadeable streams the following conclusions about the coast Coho ESU were made:

- x 36% of stream miles have impaired fish and amphibian communities.
- x 28% of stream miles have impaired macroinvertebrate communities.
- x The North Coast sub-region has the best overall water quality.
- x The Umpqua sub-region has the poorest overall water quality.
- x 42% of large river ambient sites in the ESU have good to excellent water quality based on the OWQI.
- x 19% of the large river ambient sites in the ESU have poor to very poor OWQI scores.
- x None of the large river ambient sites in the ESU show declining trends in water quality and 39% showed improving trends over the ten-year period from 1993 to 2002.
- x Water temperature has the greatest extent of stream miles above criteria designed to protect salmon and other aquatic life.
- x The Umpqua sub-region has the highest percent of stream miles exceeding the temperature criteria (77%).
- x The parameters with the greatest negative impact on aquatic life (including Coho) are water temperature, fine sediment, and total solids.
- x Non-native species, dissolved oxygen, and pH are rare but significant stressors to aquatic life where they exceeded criteria or benchmarks.
- x Nitrogen enrichment is a significant impairment at the large river ambient sites but not in the smaller probabilistic Coho streams

References

- Cude, Curtis G., 2001, Oregon Water Quality Index: A Tool for Evaluating Water Quality Management Effectiveness. Journal of the American Water Resources Association, 37:1, pages 125-127.
<http://www.deq.state.or.us/lab/techrpts/docs/DEQ05LAB0036TR.pdf>.
- DEQ. 2004. Watershed Assessment Section Mode of Operations Manual (MOMs). Version 3.1 03-LAB-0036-SOP. DEQ Laboratory Division, Portland, Oregon.
- Drake, Doug. 2004. Selecting Reference Condition Sites – An Approach for Biological Criteria and Watershed Assessment. DEQ Technical Report WASO4-002. Portland, OR.
- Herlihy, A.T., D.P. Larsen, S.G. Paulsen, N.S. Urquhart, and B.J. Rosenbaum. 2000. Designing a spatially balanced, randomized site selection process for regional stream surveys: The EMAP Mid-Atlantic Pilot Study. Environmental Monitoring and Assessment. 63:95-113. NHEERL-COR-2307J
- Peck, D.V., A.T. Herlihy, B.H. Hill, R.M. Hughes, P.R. Kaufmann, D.J. Klemm, J.M. Lazorchak, F.H. McCormick, S.A. Peterson, P.L. Ringold, T. Magee, and M. Cappert. 2006. *Environmental Monitoring and Assessment Program-Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams*. EPA/620/R-06/003. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

Contact Information

For more information contact Michael Mulvey at Mulvey.Michael@DEQ.state.or.us or at 503-693-5732.

This summary report is part of the
Oregon Plan for Salmon and Watersheds.

The mission of the Oregon Plan is to restore the watersheds of Oregon and to recover the fish and wildlife populations of those watersheds to productive and sustainable levels in a manner that provides substantial environmental, cultural, and economic benefits.

<http://www.oregon.gov/OPSW/index.shtml>