WILLAMETTE BASIN RIVERS & STREAMS ASSESSMENT

Willamette Basin Rivers Assessment

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OVERVIEW

Multiple Data Sources

The Oregon Department of Environmental Quality (DEQ) recently completed a statistically valid, comprehensive status assessment of the biological, chemical and habitat conditions of rivers and streams in the Willamette Basin. Funded by the Oregon Watershed Enhancement Board (OWEB), DEQ's June 2009 *Willamette Basin Rivers & Streams Assessment* (Report) summarizes information collected over a decade by DEQ monitoring staff, watershed councils, municipalities, the US Environmental Protection Agency (EPA), university researchers, and EPA contractors. The Report would not have been possible without leveraging the data collected by these groups. Incorporating data from 15 different studies at over 400 sites, the contributors used standardized field protocols, a random sample design to select their sites, and compatible laboratory analysis.

Salmon Tie-In

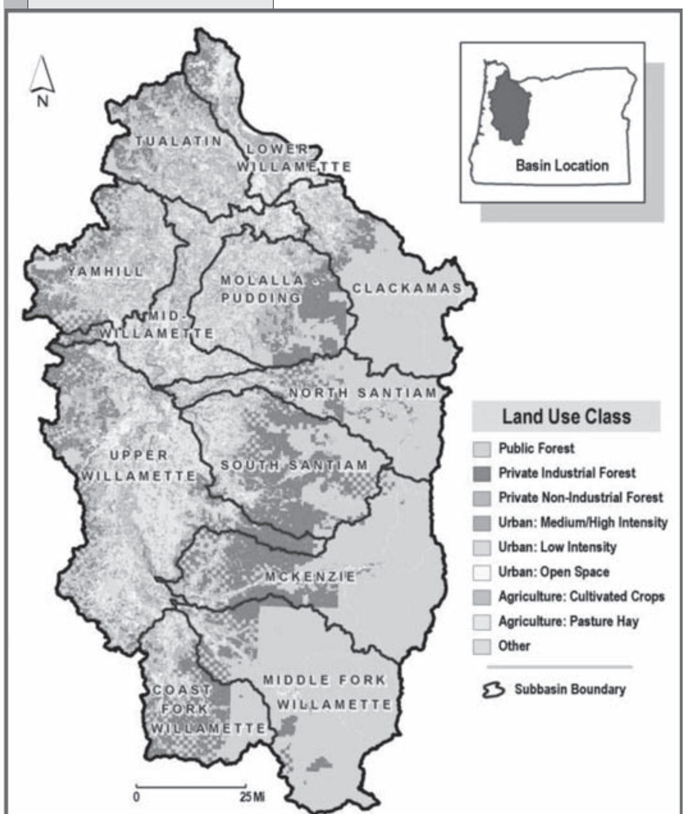
The purpose of the assessment was to provide information on watershed conditions facing threatened salmon in the Willamette Basin. The information in the Report is important for understanding the relationship between land use, water quality and biological conditions and may be used by land use managers to tailor water quality management strategies across the Basin in the future.

Setting Baseline

It also provides a baseline set of conditions which can be used in the future to measure changes in the status of biological, chemical, and habitat conditions.

Streamside Vegetation

Report findings suggest that streamside vegetation, trees, shrubs, and ground cover play an important role in protecting fish, amphibians, aquatic insects, and water quality. Actions taken to protect and restore streamside vegetation are likely to improve the biological health of the Willamette Basin's rivers and streams and will help to improve water quality and reduce water temperature, fine sediment, and nutrient inputs. Healthy streamside vegetation will also play a role in DEQ's toxics reduction strategy (see Masterson, ***Insider*** #452) by creating a buffer to keep airborne and land applied contaminants from getting into rivers and streams.



Willamette River Basin & Sub-Basins

COLOR ORIGINAL DIFFERENTIATES LAND USE CLASSES

SEE: WWW.DEQ.STATE.OR.US/ABOUT/EQC/AGENDAS/ATTACHMENTS/2009OCT/F-WILLAMETTEBASINASSESSMENTRPT.PDF

ASSESSMENT METHODS

ASSIGNING GEOGRAPHIC SCALES

The information in the Report is organized into four geographic scales: 1) the entire Willamette Basin; 2) twelve sub-basins; 3) three major land use scales; and 4) nine minor land use scales. These spatial scales were selected to help understanding the cumulative effects of land use management and their ecological relevance. In some cases a finer geographic scale of analysis would have been desirable; however, the limited number of samples restricted finer scale categorizations.

Land use categories were identified using a Geographic Information Systems (GIS) analysis of four land use coverages:

- "Oregon Zoning" from the Oregon Department of Land Conservation and Development;
- "Public Ownership" from the Oregon GIS Service Center
- National Land Cover Dataset 2001 Land Cover from US Geological Service
- Land Ownership/Allocation 2009 (draft) from the Resources Planning Program at the Oregon Department of Forestry

Combining these data sets, we grouped each site into one-of-three major land uses and nine minor land use categories as follows:

URBAN: High/medium intensity; Low intensity; Open Space
AGRICULTURE: Cultivated crops; Pasture/hay
FOREST: Public forest; Private forest (Private industrial forest, Private non-industrial forest)

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Impairment Extent & Severity

"Reference Condition"

Ecoregion Aspects

Valuation

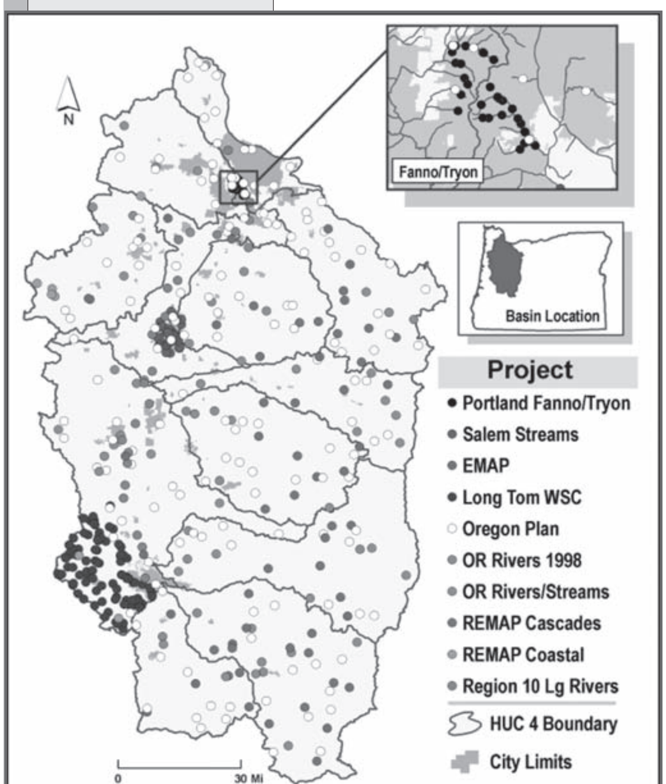
The final classification of sites was done by looking at a 300 meter (984.25 feet) diameter around each site. In most cases, sites were entirely within a single land use. When multiple land uses were contained within the buffer the dominant land use was assigned. In addition, sites with ambiguous designations were screened for more detailed analysis to insure appropriate land use assignments.

SETTING BENCHMARKS for IMPAIRMENT

The Report identifies the "extent" and "severity" of impairment for a variety of chemical, biological and habitat indicators. For parameters having water quality standards (e.g., water temperature, dissolved oxygen and pH) the standards were applied to assess impairment. However, for indicators without standards it was necessary to define what constitutes acceptable conditions for each indicator.

In the absence of clearly defined standards, a widely-used "reference condition" approach was employed. This approach identifies least-disturbed conditions to help set expected values or benchmarks for indicators. In some parts of Oregon much of the landscape is relatively undisturbed, while in other regions the landscape has been altered more extensively by human activities. The least-disturbed conditions at identified reference sites represent "the best of what's left" for any given region. Our expectations of what constituted a natural range for an indicator of stress were based on regional reference sites within Level III Ecoregions (Omernik 2004). Ecoregions combine elements of geology, climate, elevation, and vegetative communities. Similar physiographic and biological characteristics make Level III Ecoregion a useful scale for deriving benchmarks based on reference condition. Study sites are then compared with reference sites from the same ecoregion to determine the level of impairment for parameters without standards.

For some parameters — including fine sediment, total suspended solids and riparian disturbance — higher values indicate less desirable conditions. In these cases, "impairment" was set at the 95th percentile of the reference condition values. For other parameters — including canopy cover, large woody debris and stream bed stability — high values were considered favorable. In these cases, "impairment" was established at the 5th percentile of the reference condition. Study sites were only evaluated against the reference site benchmarks established within the same ecoregion in order to minimize variation associated with natural conditions.



Random Study Sites for the Willamette Rivers & Streams Assessment

COLOR ORIGINAL DIFFERENTIATES SOURCE PROJECTS

SEE: WWW.DEQ.STATE.OR.US/ABOUT/EQC/AGENDAS/ATTACHMENTS/2009OCT/F-WILLAMETTEBASINASSESSMENTRPT.PDF

UNDERSTANDING "RELATIVE RISK"

"Relative risk" is a way to understand the severity of an impaired chemical or habitat condition on the aquatic insect and fish and amphibian communities. The calculation is analogous to the risk calculations used in the medical field — e.g. smoking. For example, there is some risk of contracting lung cancer even if you do not smoke. However, if you do smoke you have "X" times greater risk of contracting lung cancer. Similarly, aquatic insects, fish, and amphibians communities show a greater risk of being impaired if certain chemical or habitat factors exceed water quality standards or benchmark values.

DETERMINING SITE WEIGHTS

In this assessment, 450 randomly chosen sites were compiled from over ten monitoring programs that incorporated a random site selection process in the Willamette Basin. Individually, these programs looked at stream and river conditions by sub-basins, within the borders of a city, by ecoregions, by stream size, by land use, and by salmon and steelhead habitat. The variety of sampling scales presented some unique challenges in combining the data sources into a single assessment. The site map for the Willamette Basin shows a relatively even distribution of sites across the region except for three distinct clusters. The clusters represent random surveys conducted by the Long Tom Watershed Council and the Cities of Portland and Salem. These potential sources of bias are addressed by differential site weighting factors. Site weights are the stream miles that each site in our poll represents in the basin as a whole. Weights were calculated for each site by land use category and by monitoring project. Sites that were part of a dense cluster have a lower site weight than a similar site that is not part of a cluster. Differential site weighting allows us to easily combine projects of very different sampling scales.

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USING INDICATORS OF BIOLOGICAL CONDITION

Bio-Indicator Uses

The federal Clean Water Act sets the nation's goal "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." (33 USC § 1251) Biological indicators of stream health are a direct measure of the extent to which waters achieve this goal.

Using biological indicators of stream health is useful for a number of reasons. Since the aquatic organisms live in the water for extended periods of time, they are indicators of both current conditions and the cumulative effect of a multiple stressors over time. Organisms evolve to use habitats with specific characteristics. Changes in these characteristics due to human disturbance can result in changes in the species composition of a stream relative to what would be found under unimpaired conditions. Such changes are difficult to capture with a typical water quality "grab" sample. Grab samples are collected at one point in time and analyzed for a relatively small number of chemicals. The stressor that caused the impairment may not be present at the time of the sample collection, or the sample may not be analyzed for the appropriate stressor.

Study Focus

In this assessment we looked at two different biological assemblages: 1) the macroinvertebrates that live on the stream bottom and 2) the fish and amphibians of the streams. There are benefits to looking at more than one group. Different groups respond to stressors differently. Macroinvertebrates live in all waters from the largest to the smallest, including some that naturally do not have fish. Macroinvertebrates are the foundation of the animal food chain in streams; they graze on algae, leaves, and wood, and in turn are a source of food for fish. Fish are eaten by other wildlife and humans.

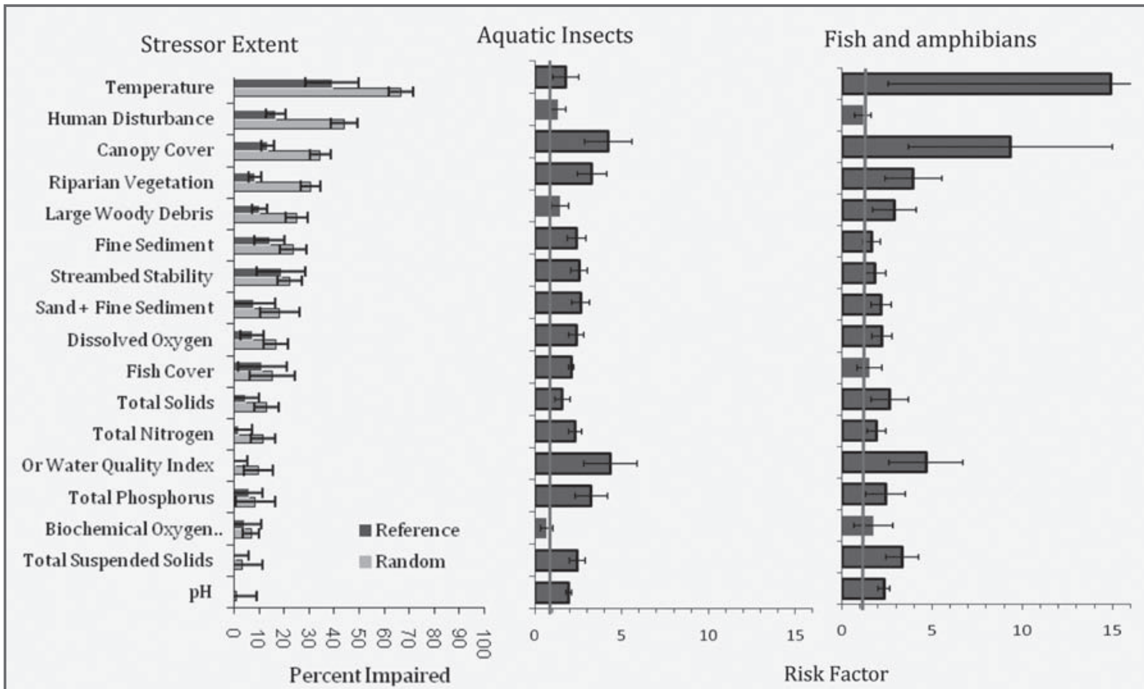

Figure 3: The extent of impairment for various chemical and physical characteristics of rivers and streams and the risk those impairments pose to aquatic organisms.

Water Temperature & Riparian Condition

At the broadest geographic scale, water temperature was the most extensive stressor and posed the greatest risk to fish and amphibians. This was followed by stressors related to human disturbance on stream banks and condition of stream-side vegetation (riparian condition). Next were impairments related to excessive sediment on the stream bottom, a lack of large wood in the stream, and water chemistry factors such as dissolved oxygen and total solids monitored for DEQ's Oregon Water Quality Index.

Taken together, an interesting story emerges. The conditions on the stream bank are intertwined with water temperature, excessive stream sediment, a lack of large woody debris and water chemistry parameters that exceed standards and benchmarks. Healthy streamside vegetation provides shade to help reduce water temperature, stabilizes bank conditions, and keeps out sediment and nutrients that can impair water quality. Streamside vegetation suggests an elegant solution to mitigating some of the other stress factors on the list. Many of the streamside restoration activities that are being funded are likely to have a positive impact on stream conditions and the aquatic organisms that live there.

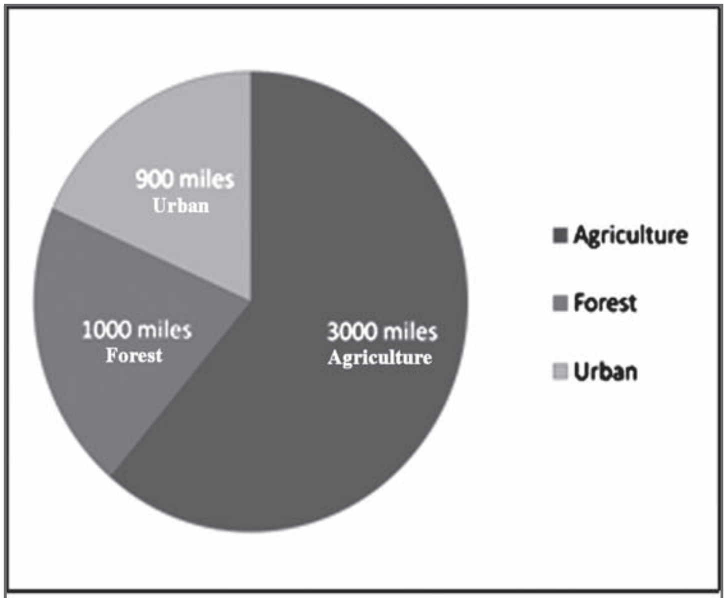

Figure 4: Biologically impaired river and stream miles on major land uses in the Willamette basin.

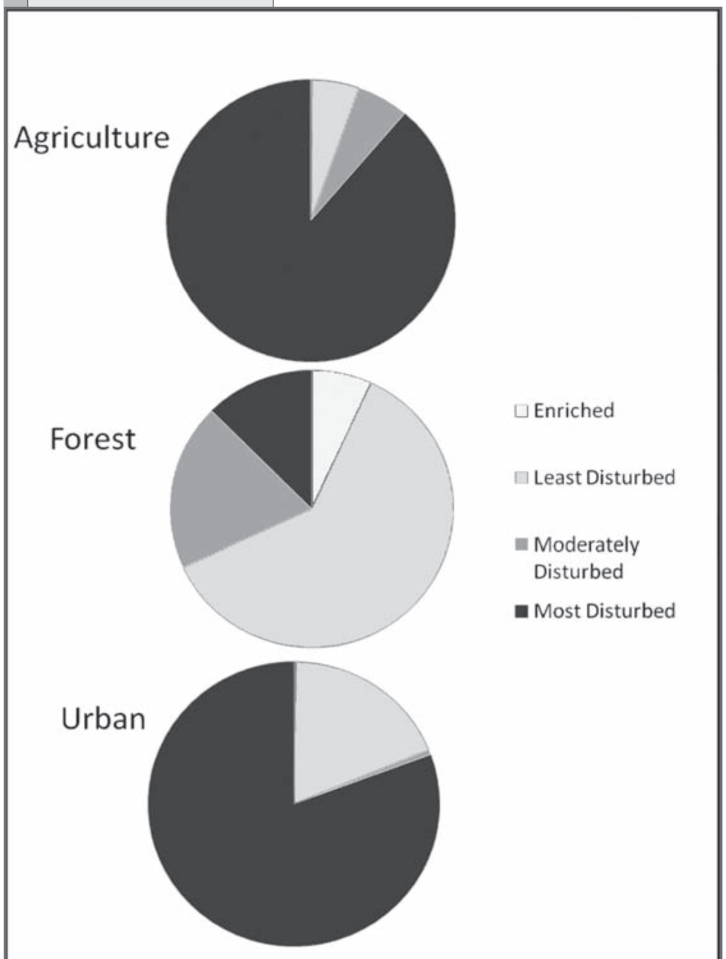

Figure 5: Biological impairment on the three major land use categories analyzed in the assessment.

Sub-Basin Results

In large part, the results of the 12 sub-basins in the assessment reflect the dominant land uses they contain within them. Sub-basins that drain the forest lands of the Cascades like the Clackamas, the McKenzie and the Middle Fork of the Willamette were in better condition than sub-basins that flowed through more urbanized and agricultural landscapes. The impairments in the sub-basins are better understood in the context of the land use analysis. While the sub-basins provide a regional context for where impairments occur in the basin, the relationship between the biological condition and chemical and habitat impairments is better understood in the context of land use.

Land Use Results

In the Willamette Basin there are approximately 11,500 total river and stream miles, 6,600 are on forest lands, 3,200 are on agricultural lands and 1,200 are on urban lands. Biological conditions varied by land use type. Agriculture and forested lands had the most stream miles with biologically impaired conditions (Figure 4). However, urban and agricultural lands had a significantly higher proportion of their lands in impaired condition compared to the forested lands (Figure 5). Almost 90% of agricultural lands and 80% of urban lands had impaired aquatic insect communities compared with only 13% for forested lands. While this is a significant result, it is important to remember that forest lands occur at higher elevations in the basin and agricultural and urban lands are typically the recipients of degradation that has already occurred on forest lands. The "enriched" category represents areas where the biological community exceeded expectations based on reference conditions. This category can include areas where exceptional biological diversity may warrant special protection or where slight nutrient enrichment enhances diversity and abundance of aquatic organisms over the short term. Further investigation is needed to determine which of these conditions may be present.

While there were some subtle differences within the finer scale of land use categories, none were significant. Within agriculture, for instance, we could not detect a difference between the "cultivated crops" and "pasture/hay" categories. Similarly, the finer scales of forest and urban landscapes were mostly indistinguishable. Greater differentiation may have been possible with more data in each category.

At the larger land use scales, the stressors to the aquatic communities showed some subtle differences. Like the basin-wide results, temperature was the most significant stressor across all land uses. However, moving down the list, agricultural impairments were more associated with the condition of streamside vegetation, while the urban streams showed problems with the conditions on the stream bed. On forest lands, impairment was more associated with the availability of stream habitat complexity created by large woody debris and other in-stream sources (Figure 6, next page).

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Information Uses

Importance of Scale

Conclusions

DEQ's *Willamette Rivers & Streams Assessment* provides an important status assessment of the watershed conditions in the Willamette Basin. The assessment demonstrates the importance of trees, shrubs, and ground cover for protecting the native fish, amphibians, and aquatic insects that live in Oregon's rivers and streams. Healthy streamside vegetation is likely to help mitigate impacts from water quality stressors (e.g., warm water temperatures, excessive sediment, excessive nutrient inputs) while at the same time improving overall water quality conditions. In addition, mature streamside vegetation contributes woody debris to the stream channel, enhancing in-stream habitat and cover for organisms that live there. Improving riparian conditions will also play a role in DEQ's toxics reduction strategy by creating a buffer to prevent airborne and land-applied chemicals from getting into rivers and streams.

The Report's findings can be used by agricultural, municipal, and forest land managers to help tailor watershed protection and restoration activities. In the future, this study will provide a foundation for interpreting the effectiveness of watershed restoration and protection actions at major land use scales — important scales for understanding the cumulative effects of protection and restoration activities in the context of ongoing pressure from population growth, land use conversions, and emerging water quality issues.

The assessment also demonstrates the utility and cost effectiveness of using a random sampling design and standardized measurement techniques for sharing information. This report was made possible because of the numerous data contributors adopted common sampling designs and methods — this should be an important consideration when designing monitoring plans in the future.

For Additional Information:

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DEQ website: *Willamette Rivers & Streams Assessment* is available online at:
www.deq.state.or.us/about/eqc/agendas/attachments/2009oct/F-WillametteBasinAssessmentRpt.pdf

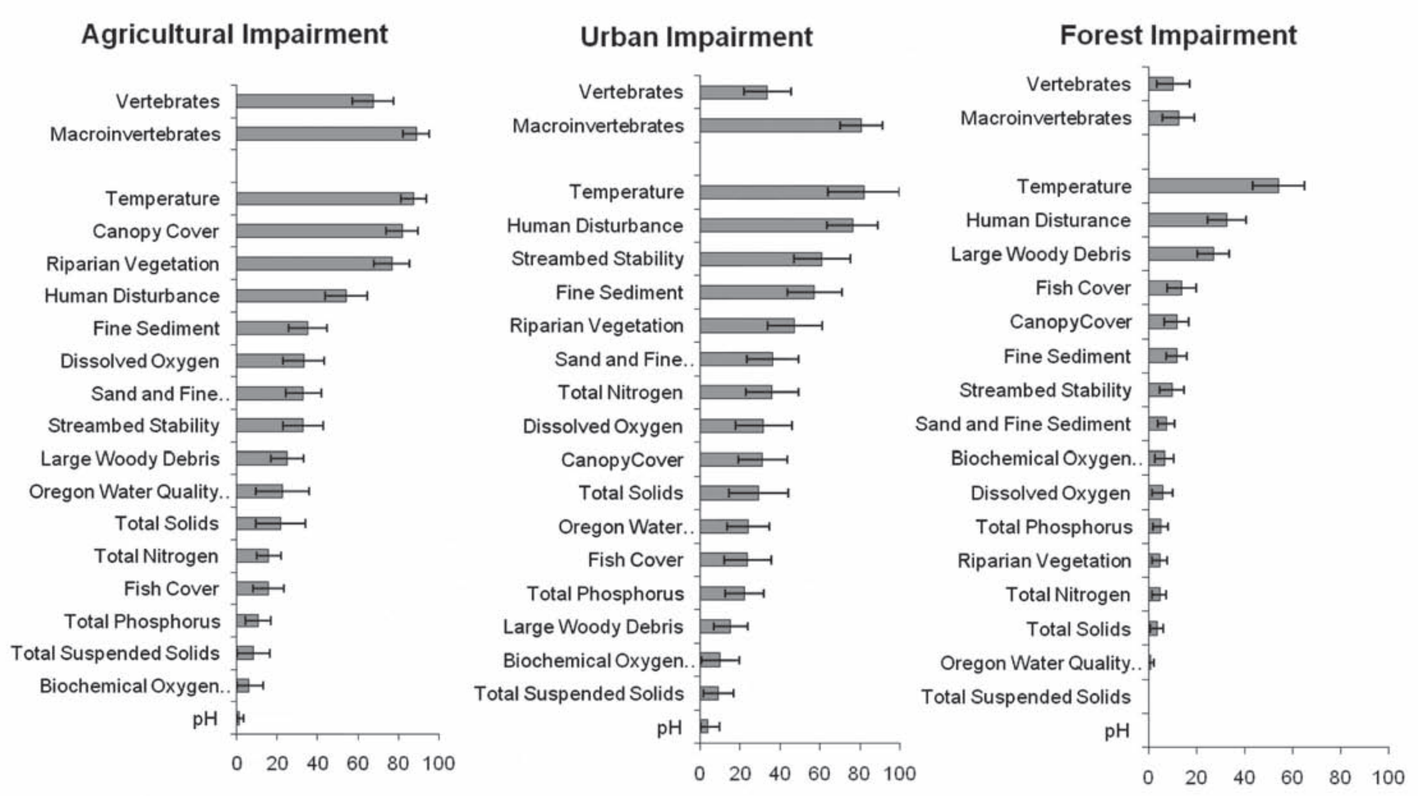

Figure 6: Biological, physical and chemical impairments found on the three major land use categories in the Willamette Basin.