Dangers of Pesticides in the Lower Clackamas River Watershed

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Abstract

This study focused on the Lower Clackamas River Watershed and what, if any, impact that pesticides used for agricultural purposes have on aquatic and human life. Because salmon are an important part of the aquatic ecosystem of the Clackamas River Watershed, we included the potential effects of pesticides on salmon. We examined the pesticides that have been found in samples by the Oregon Department of Environmental Quality (DEQ) over a two year period. DEQ, along with other governmental agencies, provided information as to what the suggested benchmarks of pesticides are, if those benchmarks have been exceeded, and what effects these results may have on the aquatic life, salmon population and the human health of the Lower Clackamas River Watershed.

Background

Due to the large agricultural industry and increasing urbanization within the Clackamas River Watershed, does the usage of pesticides pose a danger to human, salmon, and aquatic life (invertebrates and plants) in the Clackamas River Watershed? The first step was to research the non-regulatory "guidance" benchmark levels by the Environmental Protection Agency (EPA). The following information shows various concentration levels that are suggested by the EPA to help assess potential impacts on Human Health and Aquatic Life. Because the DEQ data is shown in ng/L (nanograms per liter), this data has been converted from µg/L (micrograms per liter) to ng/L. It should be noted that the lowest benchmark for Dichlobenil by the USEPA is 30 ug/L for vascular plants. 2,6-Dichlorobenzamide (commonly known as BAM) is the degradate of Dichlobenil and Fluopicolide. The European Union (EU) has de-authorized the use of Dichlobenil (parent) and 2,6-Dichlorobenzamide (degradate) since 2008 (EC149) due to Human Health and Environmental concerns.

Aquatic Life Benchmarks of Various Pesticides (ng/L – nanograms per liter)

	Fish		Invertebrates		Nonvascular Plants	Vascular Plants
Pesticide	Acute	Chronic	Acute	Chronic	Acute	Acute
Diuron	200,000	26,400	80,000	200,000	2,400	15,000
Glyphosate (AMPA)	2,150,000	1,800,000	26,600,000	49,900,000	12,100,000	11,900,000
Simazine	3,200,000		500,000		2.,240	140,000

Figure1: Chart displaying various pesticide benchmarks for aquatic life in ng/L. This data came from the EPA and was converted to maintain the same units.

Human Health-Based Screening Levels for Evaluating Water-Quality Data

Health-Based Screening Levels (HBSLs) are non-enforceable water-quality benchmarks that can be used for one of the following: (1) supplement U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs) and Human Health Benchmarks for Pesticides (HHBPs), (2) determine whether contaminants found in surface-water or groundwater sources of drinking water may indicate a potential human-health concern, or 3) help prioritize monitoring efforts.

HBSL values current as of June 30, 2014 **USEPA Benchmarks**

Chemical Name	Chemical Class	MCL (ng/L) b	Chronic Noncancer HHBP ng/L)	Carcinogenic HHBP (10^{-6} to 10^{-4}) (ng/L)	Noncancer HBSL (ng/L)	Cancer HBSL (10^{-6} to 10^{-}(ng/L)
Diuron	Pesticide	N/A	N/A	N/A	20,000	2,000-200,000
Glyphosate (AMPA)	Pesticide	700	N/A	N/A	N/A	N/A
Simazine	Pesticide	4,000	N/A	N/A	N/A	N/A

Figure 2: Chart showing Human Health-Based Screening Levels for Evaluating Water-Quality Data. These levels are from the EPA and show human health benchmarks for some of the pesticides that we studied.

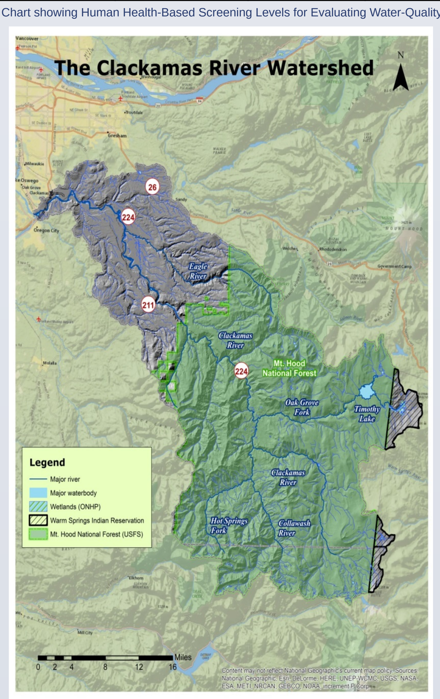
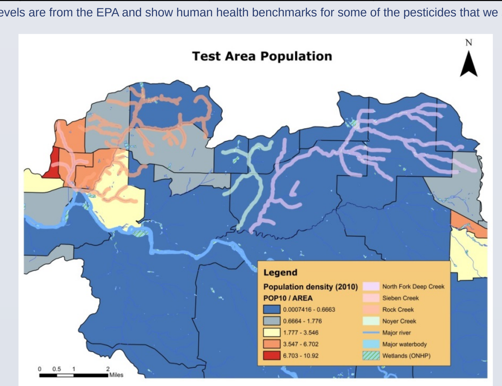


Figure 3: Map showing the Clackamas River Watershed. It is located in Clackamas County, in the state of Oregon and encompasses 933 square miles, serving approximately 300,000 people.



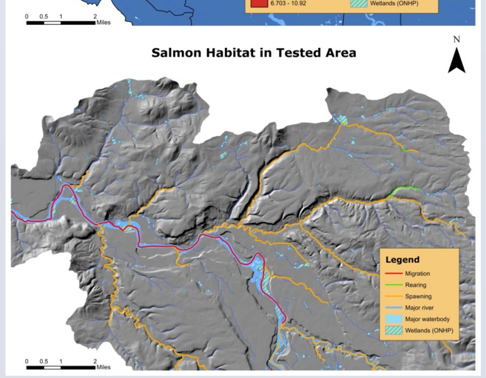


Figure 4 (above): Map showing the 2010 Census population density (population/total land area) of the test watershed areas that we studied in order to show how many potential people could be affected by potentially contaminated drinking sources. Figure 5 (below): Map showing the salmon migration, rearing, and spawning locations within the test watershed areas that we studied.

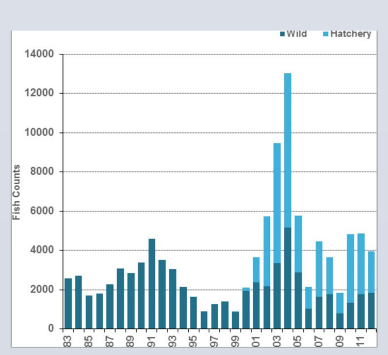
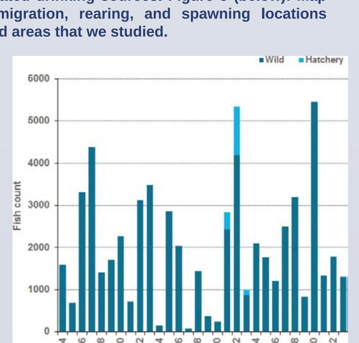


Figure 6 (left): Time series graph showing Chinook salmon counts in the Clackamas River Watershed. Figure 7 (right): Time series graph showing Coho salmon counts in the Clackamas River Watershed. All data is from Portland General Electric.



Materials & Methodologies

The datasets used were: a 10 meter DEM, slope and hillshade rasters, a Forest Service boundary for Mt. Hood National Forest, Warm Springs Indian Reservation boundary, boundaries for Marion and Clackamas counties, US Census Bureau 2010 census, which was clipped to the Clackamas River Watershed, taxlot boundaries, roads, rivers, streams, major water bodies, wetlands, place names and annotation, soils and geology, a raster land use cover file, pesticides sample data from DEQ, and 4 kilometer resolution atmospheric data for the test years of 2013 and 2014. The land use raster dataset was converted to polygons, and was then spatially joined with the taxlot layer. The streams in the test areas were selected by attribute and then spatially joined with the soils and geology layer. The taxlot layer was later joined with the two aforementioned layers in order to create a make a large layer depicting the individual taxlot, landuse, streams, soils and geology layers. A 300 feet buffer, which is the EPA guideline for the use of pesticides, was added along the stream layer. The DEQ data was supplied with results displayed with X,Y data, which was then converted to a layer. The pesticide maps were generated by runoff, which was found to be a direct correlation to the soil type, and the crop type lying within the 300 foot buffer zone in order to create a visual map of the possible source areas of pesticide use. The DEQ site results are measured downstream from these areas. The atmospheric data was generated by overlaying precipitation and mean temperature raster data over the tested watershed areas of the Clackamas River Watershed. The rasters were downloaded from Oregon State University's PRISM Climate Group. Because there wasn't a complete 2014 dataset, the 8 raster files (from January through August) were downloaded and then inserted into ArcGIS. The Raster Calculator tool was used to accurately add these raster files in order to achieve a total mean temperature raster that would be suitable for this study.

Atmospheric Results

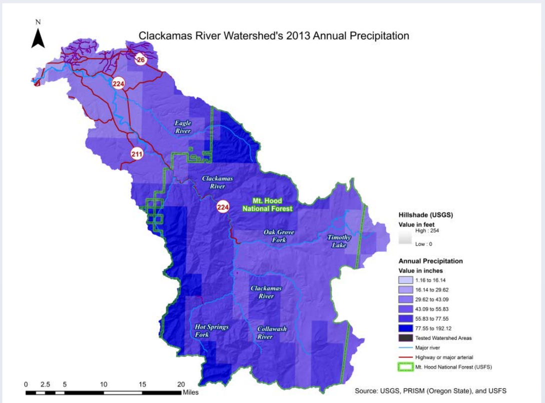


Figure 8: Map showing the 2013 annual precipitation (in inches) within the Clackamas Watershed. The tested watershed areas are also located on the map too.

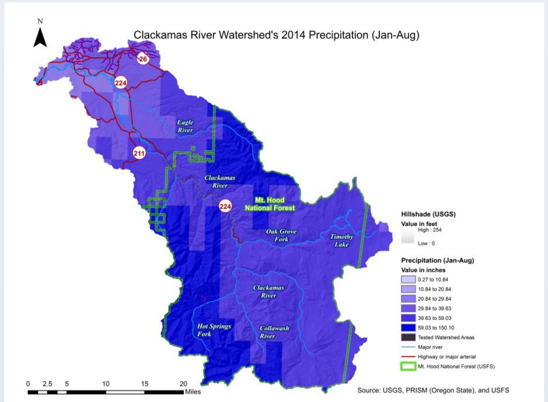


Figure 9: Map showing the precipitation from the months of January to August 2014 (in inches) within the Clackamas Watershed. The tested watershed areas are also located on the map too.

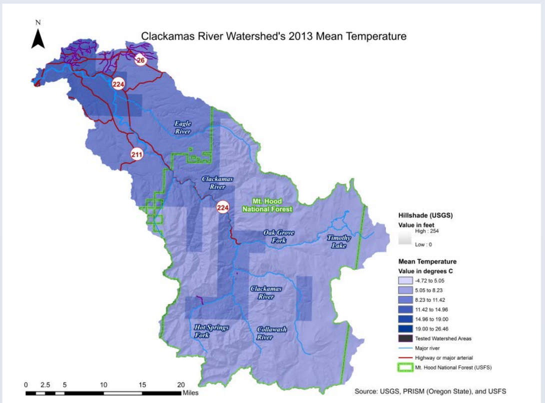


Figure 10: Map showing the 2013 mean temperature (in degrees C) of the Clackamas Watershed. The tested watershed areas are also located on the map too.

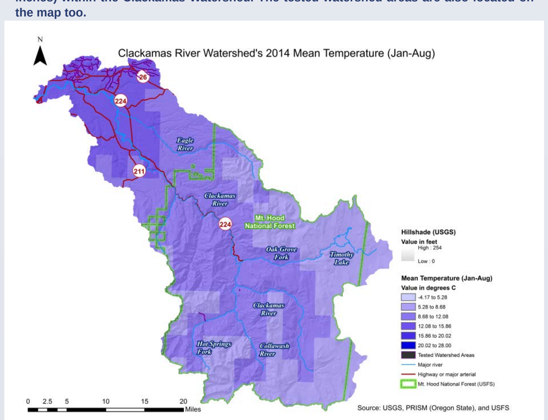


Figure 11: Map showing the January to August 2014 mean temperature (in degrees C) of the Clackamas Watershed. The tested watershed areas are also located on the map too.

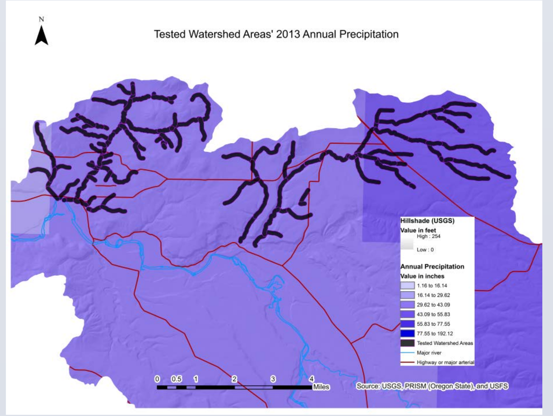


Figure 12: Map showing the 2013 annual precipitation (in inches) within the tested watershed areas that we studied.

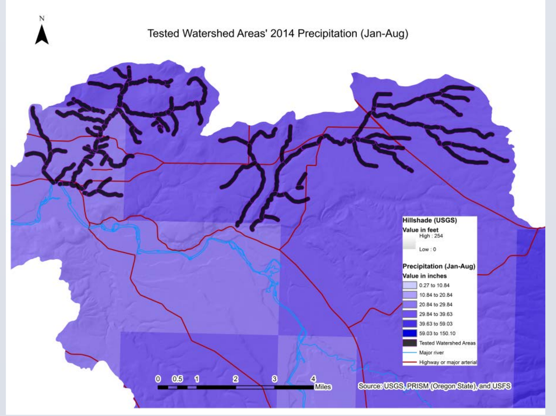


Figure 13: Map showing the precipitation from the months of January to August 2014 (in inches) within the tested watershed areas that we studied.

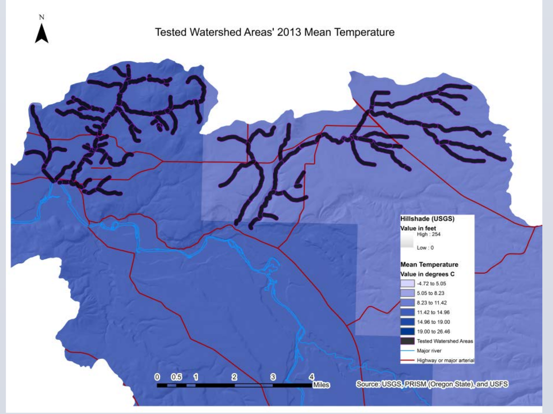


Figure 14: Map showing the 2013 mean temperature (in degrees C) of the tested watershed areas that we studied.

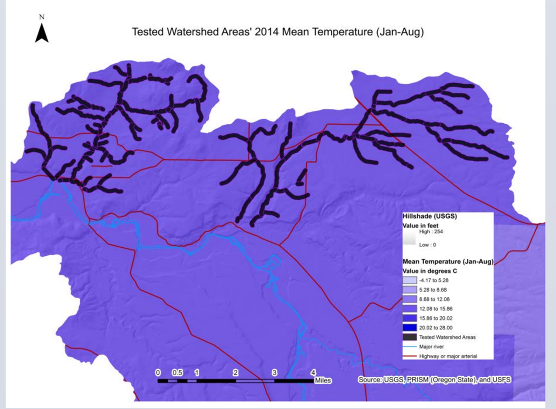


Figure 15: Map showing the January to August 2014 mean temperature (in degrees C) of the tested watershed areas that we studied.

Pesticide Results

The maps below shows the results from the tested watershed areas of North Fork Deep Creek, Noyer Creek, Rock Creek, and Sieben Creek during the periods of April to November 2013, and April to October 2014. The results are based on the pesticides that had a 75% or more detection frequency which are:

1) 2,6-Dichlorobenzamide (2,6-D and Dichlobenil) – Brands: BAM, Barrier – used for: orchards, nurseries, woody shrubs and forests.

2) Aminomethylphosphonic Acid – (AMPA and Glyphosate) – Brands: Roundup, Rodeo, Accord – used for: broad leaf weeds, grasses.

3) Diuron – Brands: Karmex, Direx – used for: broad leaf weeds, grass and brush control

4) Simazine – Brands: Acclaim, Princep – used for: broad leaf weeds, grasses, berries, nurseries

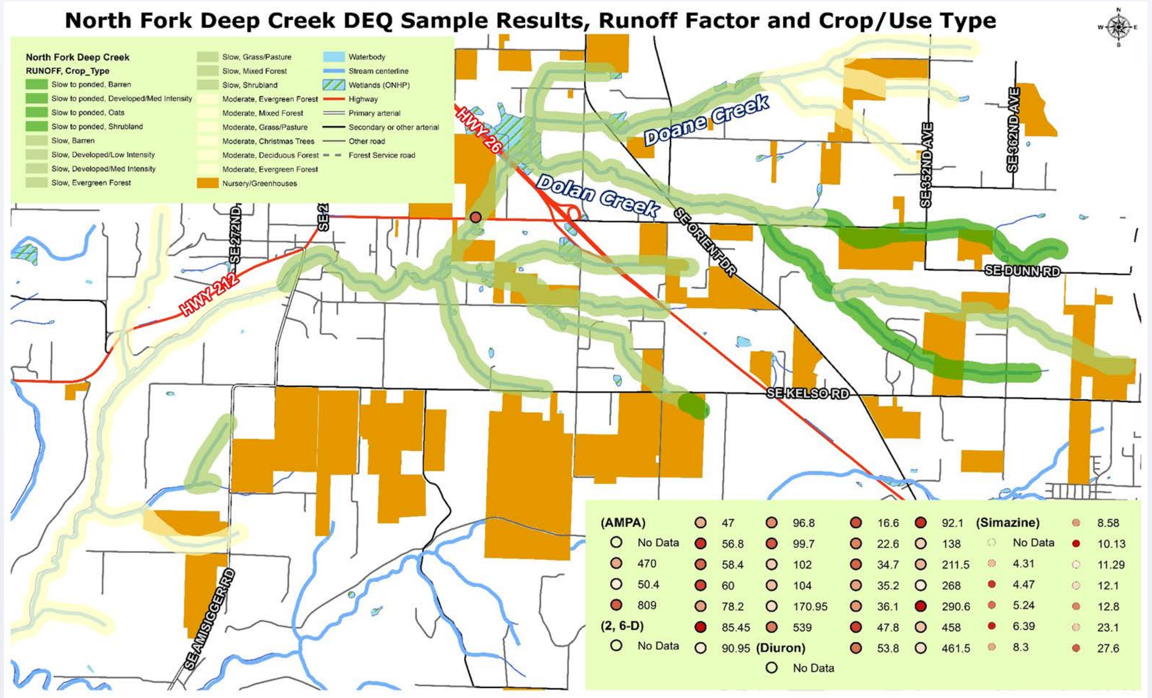


Figure 16: This map shows the DEQ sample results for the pesticides AMPA, 2,6-D, Diuron and Simazine in the North Fork Deep Creek watershed with the runoff factors and crops/use that affect this watershed.

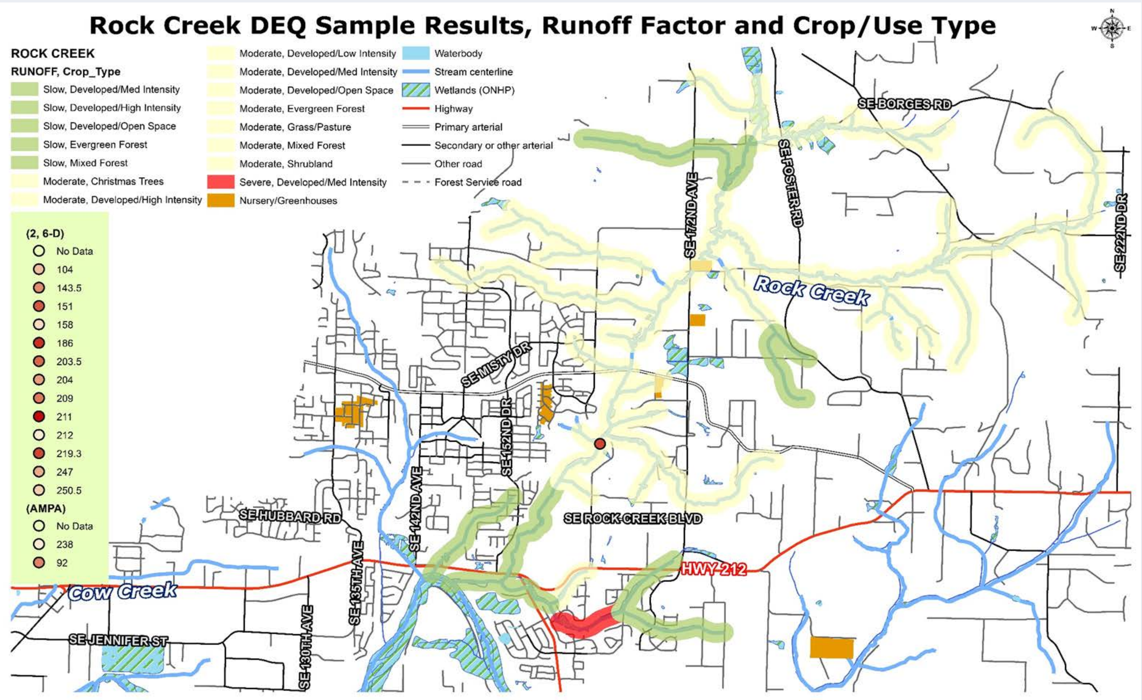


Figure 17: This map shows the DEQ sample results for the pesticides 2,6-D and AMPA in the Rock Creek watershed with the runoff factors and crops/use that affect this watershed.

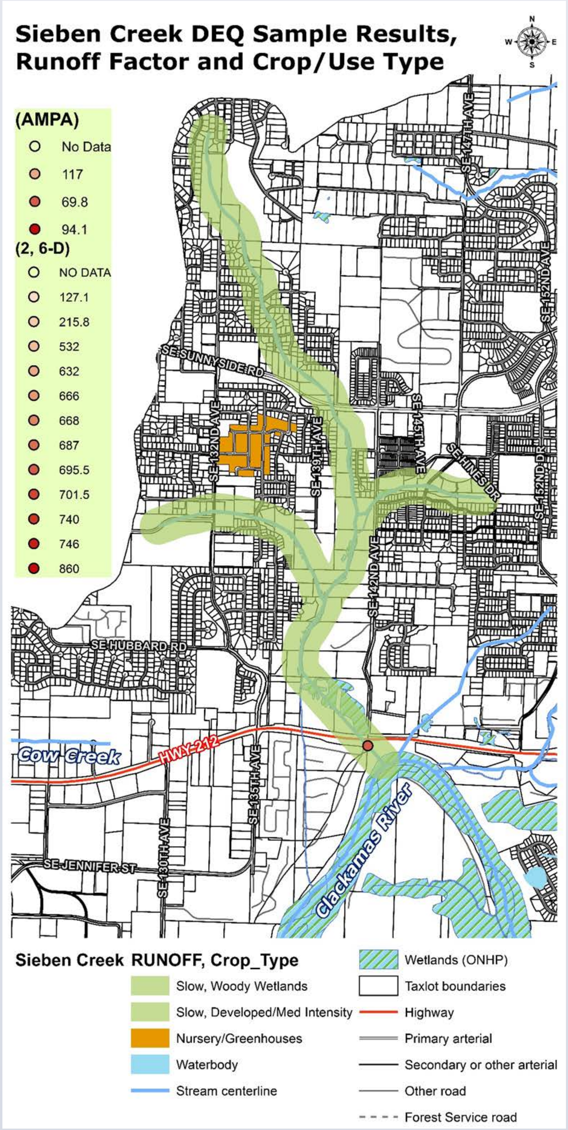


Figure 18: This map shows the DEQ sample results for the pesticides AMPA and 2,6-D in the Sieben Creek watershed with the runoff factors and crops/use that affect this watershed.

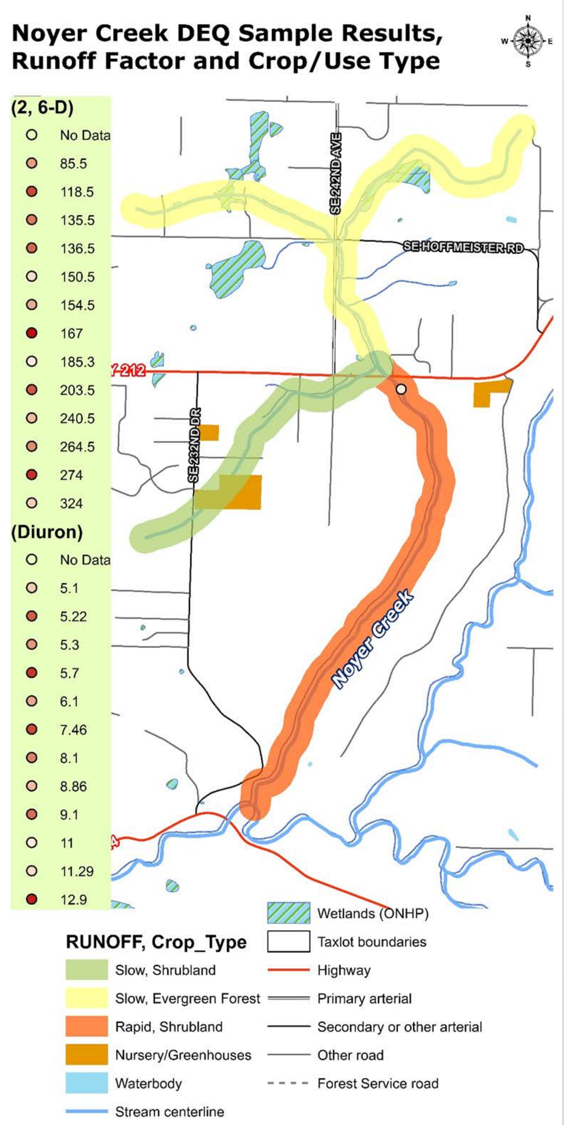


Figure 19: This map shows the DEQ sample results for the pesticides 2,6-D and Diuron in the Noyer Creek watershed with the runoff factors and crops/use that affect this watershed.

Pesticide Results (cont.)

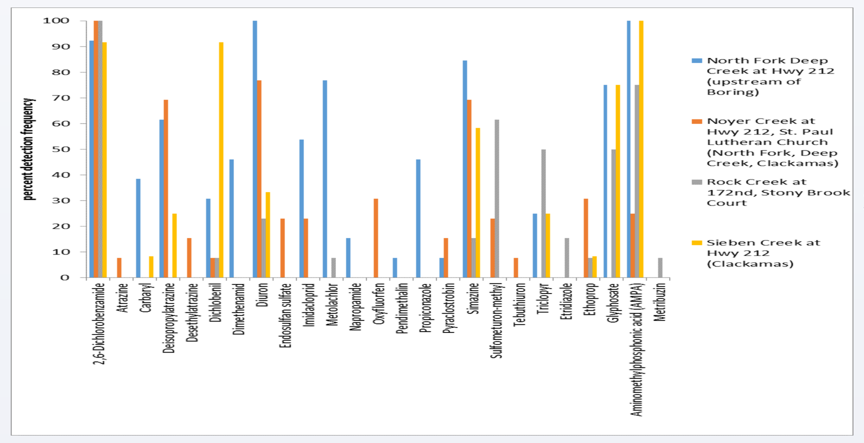


Figure 20: This figure shows the pesticide detection frequency at the tested watershed areas. Data is from DEQ.

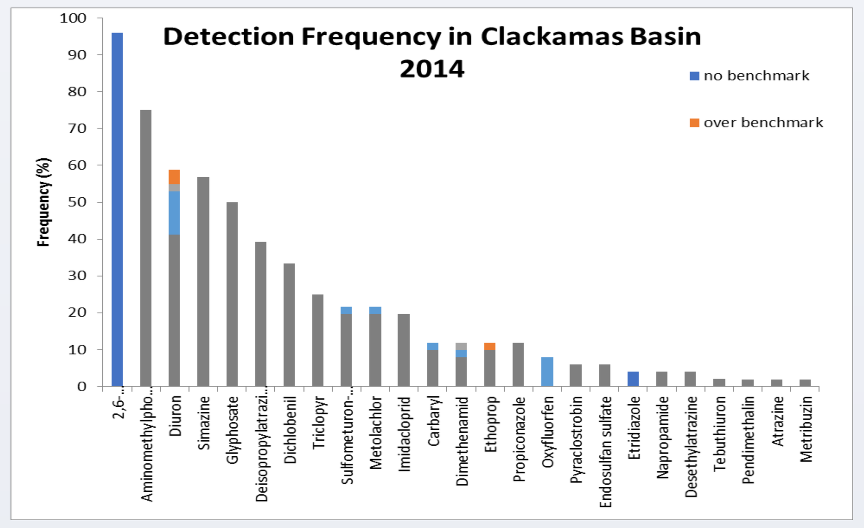


Figure 21: This figure shows the pesticide detection frequency in the Clackamas River Basin as a whole. Data is from DEQ.

Conclusions

While the test results show that there is a definite presence of pesticides in the Lower Clackamas River Basin of Oregon, the overall health of the watershed due to pesticides remains a question. This was not a full or comprehensive study and the nature of different pesticides as a mixture is very complex. At this time only a small percentage of the Clackamas River watershed is being monitored and therefore the health of the watershed as a whole is largely unknown. Atmospheric data seems to show some level of statistical significance, and the long-term effects of pesticides on humans, fish, invertebrates and plant life should be studied further. Naturally, there is room for improvement through better education and increased vigilance in the usage of pesticides. It is noted that although the water treatment plant is further downstream on the Clackamas River from these test sites and removes the majority of the pesticide traces from the water, there are still very low levels of Diuron (classified by the EPA as a "known or likely carcinogen") and other chemicals being detected in treated water.

Resources

Clackamas River Water Providers; Environmental Protection Agency; Metro RLIS; National Agricultural Statistic Service; National Hydrography Dataset; Natural Resources Conservation Services; Oregon Department of Environmental Quality; Oregon Department of Fish and Wildlife; Oregon National Hydrological Plan; Oregon State University; Portland General Electric; PRISM Climate Group at Oregon State University; United States Census Bureau; United States Department of Agriculture; United States Forest Service; United States Geological Survey

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