Pesticide use practices and surface water loading in the Zollner Creek Watershed
Report to the Oregon Processed Vegetable Commission

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Abstract

Over the past 20 years pesticides have been frequently detected in Zollner Creek within the Pudding Subbasin. A pilot project was initiated early in 2012 to better understand the relationship between pesticide use practices and surface water loading in the Zollner Creek watershed. This project has the following objectives 1) assemble a team of stakeholders, agencies, and organizations prepared to work together in addressing water quality concerns at the watershed scale, 2) prepare a comprehensive summary pesticide surface water monitoring data, 3) prepare a narrative and analysis of the history of water quality initiatives in the Zollner Creek watershed, and 4) develop a draft framework for evaluating crop management, IPM practices, and mitigation measures designed to meet both production and environmental protection goals. A status report will be provided regarding the activities designed to meet these objectives.

Background

The Zollner Creek watershed is located in Marion County, OR and is part of the Molalla-Pudding Watershed (HUC8: 17090009, see Figure 1). The watershed is 3885 ha of which approximately 91% is utilized for agriculture. Examination of the USDA National Agricultural Statistics Service (NASS) 2009 Oregon Cropland Data Layer indicates the heterogeneous nature of cropping practices in the watershed as there are 43 different agricultural land uses designated in the area. Seed/sod grass are the predominant commodities grown in the watershed (30.4% of watershed area) with a variety of vegetable crops (20.3% of watershed area) and grain crops (13.4% watershed area) accounting for much of the remaining watershed area. Zollner Creek watershed also contains stream segments that are identified as Critical Habitat for the Upper Willamette River Chinook and Steelhead species, which are listed as endangered or threatened under the Endangered Species Act (ESA). The Zollner Creek watershed is a fairly flat area located predominately on the floor of the Willamette Valley with its headwaters located in the beginnings of the foothills of the Cascade Mountains. The elevation in the watershed ranges from 37 to 149 m above sea level with the average elevation being 69 m above sea level. Weather in the Willamette Valley is characterized by cool, wet winters followed by warm, dry summers (Ulrich & Wentz 1999). The Zollner Creek watershed receives on average 966 mm of rainfall annually.

The Zollner Creek watershed was chosen for this study based on known pesticide contamination of surface waters in the watershed. Zollner Creek was monitored for pesticides from 1993-2008 by the USGS as part of the National Water Quality Assessment Program (NAWQA), with a monitoring station located near the confluence with the Pudding River serving as a long term trend site. USGS monitoring during this time found high detection frequencies of a wide variety of pesticides and high levels of pesticides in surface waters of the watershed (see Appendix A). The Oregon Department of Environmental Quality (ODEQ) has also performed monitoring in the Zollner Creek watershed. Figure 2 shows USGS and ODEQ sampling locations. In 2008, authorized by the Clean Water Act and associated regulations, ODEQ developed a Total Maximum Daily Load (TMDL) for the Pudding River watershed

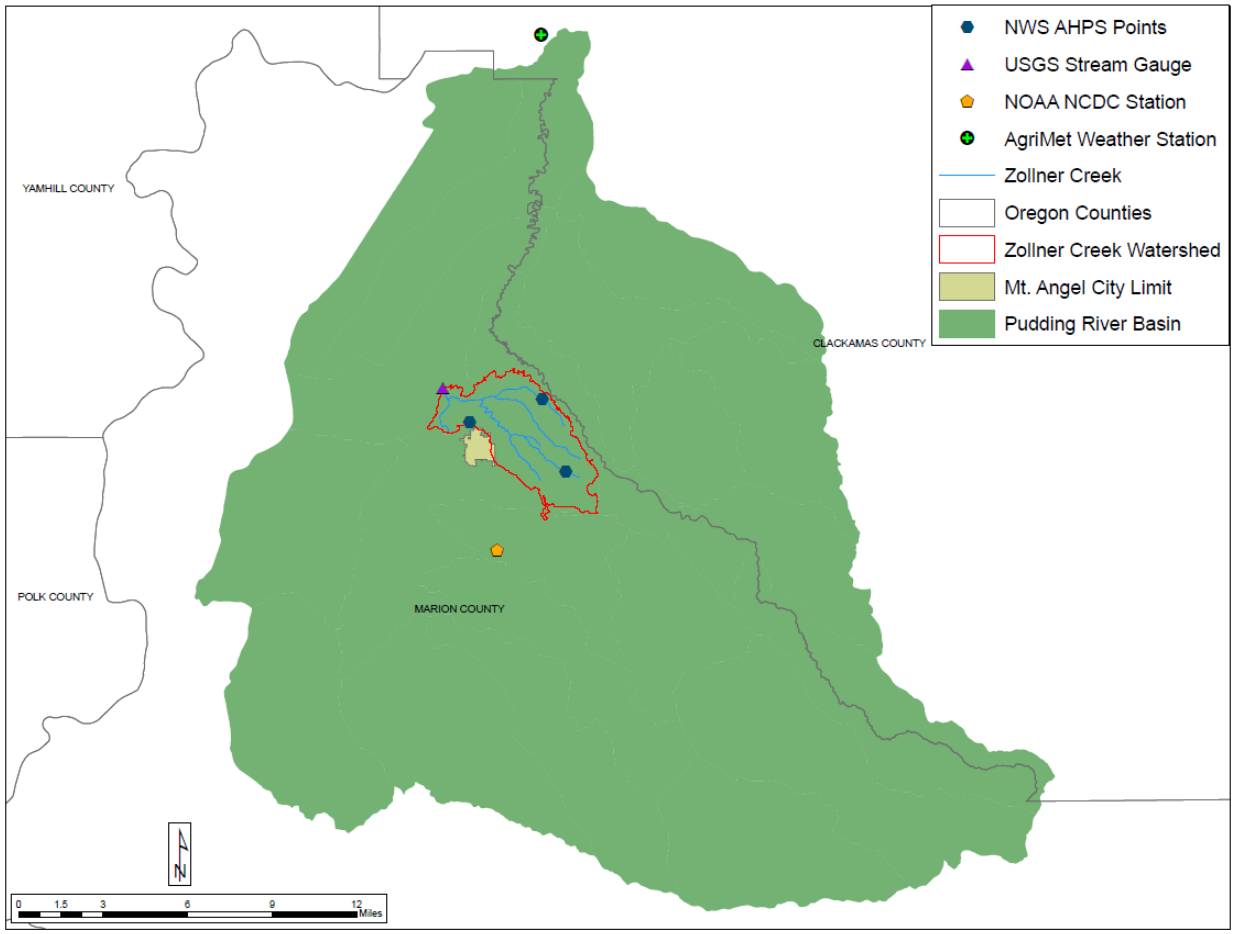

Figure 1. The Zollner Creek watershed located within the Pudding River basin in Marion County, OR. Symbols show locations of the USGS surface water flow gauge, climate stations and precipitation measurement points.

which includes the Zollner Creek area. TMDLs for Zollner Creek were established for temperature, sediment, nutrients, metals and the two legacy pesticides dieldrin and chlordane. While TMDLs were only developed for dieldrin and chlordane, monitoring conducted to develop the TMDLs found many current use pesticides as well. Starting in 2005, the Pudding River watershed including monitoring sites in the Zollner Creek basin have been monitored by ODEQ as part of the Pesticide Stewardship Partnership (PSP)[1] (see Appendix B). The goal of the PSP is to monitor pesticides in surface waters in the state of Oregon in order to establish an understanding of the long term trends of pesticide levels in surface waters. ODEQ then presents this data to stakeholders in the areas monitored in order to encourage voluntary measures to reduce surface water contamination. ODEQ PSP monitoring, like USGS NAWQA monitoring has found high frequency of detections of current use pesticides in the Zollner Creek watershed as well as detection levels higher than those found in other surface waters monitored in the PSP program. While some pesticides have been frequently detected few have exceeded levels of concern. At the Zollner Creek monitoring site ODEQ has detected the organophosphate insecticides azinphos methyl, chlorpyrifos, diazinon, and malathion, and the herbicide diuron above the benchmarks.

[1] http://www.deq.state.or.us/wq/pesticide/pesticide.htm

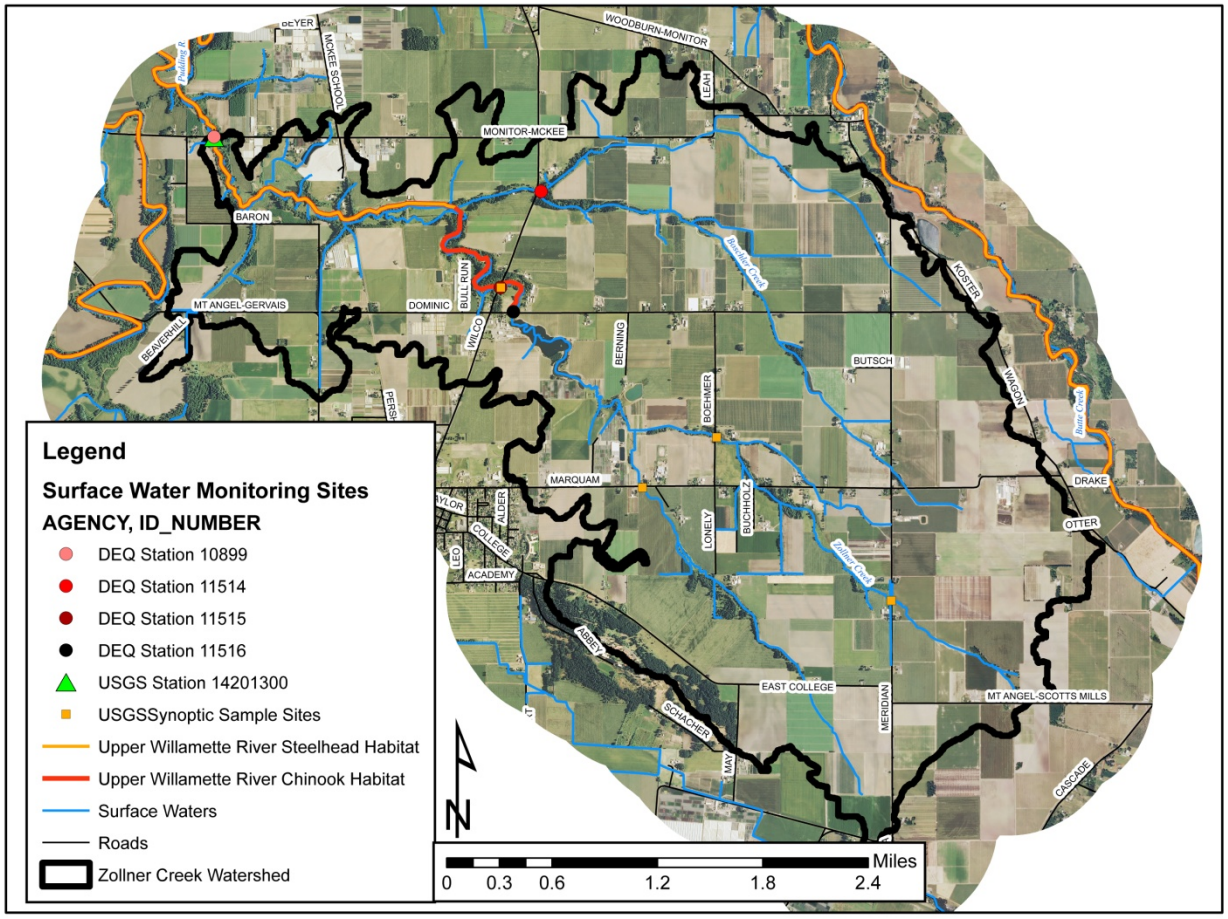

Figure 2. Aerial view of the Zollner Creek watershed (imagery from National Agriculture Imagery Program 2011 imagery for Marion County, OR). Pesticide sampling locations are shown along the surface waters of the basin with circles representing Oregon DEQ sampling sites, triangles representing long term USGS sampling sites and squares representing USGS synoptic sampling sites. Critical habitat for the Threatened and Endangered Upper Willamette River Chinook and Steelhead species are shown in red and orange respectively.

The Oregon Water Quality Pesticide Management Team (WQPMT)[2], composed of representatives from the Oregon Department of Agriculture (ODA), Department of Forestry (ODF), Department of Environmental Quality (ODEQ), the Oregon Health Authority (OHA) and Oregon State University (OSU), was formed in 2007 to address water quality issues in Oregon related to pesticide use. The WQPMT facilitates and coordinates water quality activities such as monitoring, analysis and interpretation of data, effective response measures, and management solutions. The initial goal of the WQPMT was to develop and implement a statewide pesticide management plan (PMP) which was approved by EPA in 2011[3]. On-going efforts include prioritization of "pesticides of concern" and "pesticides of interest", based on the frequency of detection and concentrations in waters of the state. A summary of WQPMT prioritization of pesticides found in Oregon surface water is given in Appendix C.

[2] http://www.oregon.gov/ODA/PEST/Pages/water_quality.aspx
[3] http://www.oregon.gov/ODA/PEST/docs/pdf/wqpmtpmp.pdf

In addition, the Marion Soil and Water Conservation District (SWCD) has partnered with the ODEQ and ODA, OSU Extension Service, agriculture businesses and other partners to address potential pesticide issues in the Pudding subbasin, providing information to growers, IPM tools, waste collection events and other outreach. In addition, Marion SWCD has assisted ODEQ in collecting surface water samples for pesticide analysis. To further evaluate pesticide surface water loading in the Pudding subbasin, beginning in the spring of 2010 through the Fall of 2011 Oregon State University collaborated with the Marion SWCD to continuously monitor for pesticides at the ODEQ sites using a passive sampling device (PSD) employing lay flat tubing (Anderson et al., 2008). Results will be published in 2013.

Pesticide surface water monitoring programs, such as those conducted by Oregon Department of Environmental Quality (ODEQ), and the U.S. Geological Survey (USGS) primarily rely on grab samples to provide point estimates of pesticide surface water concentrations. These sampling strategies are not designed to provide year-round real-time estimates of pesticide exposure throughout Oregon's surface water resources. In addition, modeling efforts employed by the U.S. Environmental Protection Agency (EPA) focus largely on edge-of-field surface water loading (i.e., the Pesticide Root Zone Model (PRZM), the Exposure Analysis Modeling System (EXAMS), and EXPRESS, the user friendly EXAMS-PRZM Exposure Simulation Shell)[4]. As current monitoring data and modeling efforts are inadequate to conduct a robust evaluation of the potential risks to aquatic life associated with pesticide use practices, in formulating risk management strategies, EPA and others (i.e., the National Marine Fisheries Service (NMFS) Biological Opinions for pesticides that may harm 26 Pacific salmonid Evolutionary Signigicant Units (ESUs) listed as endangered or threatened under the Endangered Species Act (ESA), or any of the designated critical habitats[5]) address uncertainty by using models driven by conservative assumptions regarding pesticide use and environmental fate. The use of conservative assumptions often results in a greater chance of over-estimating pesticide in-stream concentrations and the risk to aquatic life (type I error) with the goal of severely limiting the chance of under-estimating the risk (type II error) (Suter et al., 2005). While this approach to dealing with uncertainty in risk assessment is deemed appropriate by many in formulating policies that restrict pesticide use, such an approach may have limited usefulness in informing stakeholders in need of decision aids to guide the selection of practices that meet both production and enviromenntal protection goals.

Using the Soil and Water Assessment Tool (SWAT), Oregon State University is collaborating with the Marion Soil and Water Conservation District (SWCD), the Natural Resources Conservation Service (NRCS), and the Wilco Cooperative in Mt. Angel , to evaluate both site-specific and watershed scale impacts of alternative crop management, IPM practices, and mitigation measures on in-stream pesticide concentrations. Model refinement and evaluation will be aided by stakeholder input, and will be designed to provide a resource for landowner decision-making regarding land use practices that reduce pesticide surface water loading to the greatest extent practicable, and to levels that comply with water quality standards and benchmarks, including the WQPMT levels of concern.

Watershed-scale Pesticide Environmental Fate Modeling

The environmental fate model SWAT, developed by the USDA Agricultural Research Service (ARS), is based on over 30 years of modeling expertise. SWAT is a watershed scale hydrologic model that predicts the impacts of land management on water, sediment and chemical yields in large, variable basins. SWAT uses physical characteristics of the landscape including land use/land cover, soil types and topography

[4] http://www.epa.gov/ceampubl/swater/express/
[5] http://www.nmfs.noaa.gov/pr/consultation/pesticides.htm

along with weather data and physical chemical properties of compounds to perform mathematical simulations of the processes that dictate routing of water, chemicals and sediment. SWAT operates on a daily time step and can perform simulations over long periods of time (Arnold et al 1998, Neitsch et al. 2005).

SWAT has been utilized in a variety of applications worldwide as can be seen in the extensive review of model applications by Gassman et al. 2007. In the United States, SWAT has been accepted as a useful tool in assessing nonpoint source pollution. SWAT has been incorporated in the BASINS model developed by the US EPA as a tool to aide in the development of total maximum daily loads (Di Luzio 2002). SWAT is also one of two models that are utilized for modeling applications in the USDA Conservation Effects Assessment Program (CEAP). Within CEAP, SWAT is considered the preferred model due to its ability to provide more accurate simulations without any calibration of the model parameters (Heathman et al. 2008). The majority of the SWAT applications deal with hydrologic simulations as well as sediment and nutrient loadings, while other applications include the evaluation of land use/ land cover changes, evaluations of mitigation options and potential impacts of climate change. SWAT has also been utilized to evaluate the fate of pesticides at the basin scale. SWAT has been used in the St. Joseph River watershed and the Cedar Creek watershed within the St. Joseph River watershed to evaluate nonpoint source pollution due to the use to the herbicide atrazine (Larose et al. 2007 and Vazquez-Amabile 2006). Model outputs for the St. Joseph River watershed were also used to perform a risk analysis following the National Agricultural Pesticide Risk Analysis framework (Vazquez-Amabile et al. 2006). SWAT has also been utilized to evaluate nonpoint source pollution due to pesticide use in European watersheds (Holveot et al. 2008 and Gevaert et al. 2008). SWAT has also been used to evaluate the impact of implementation of beneficial management practices on water quality (Gassman et al. 2007, Bärlund et.al 2007, Gevaert et al. 2008, Bracmort et al. 2006, Santhi et al 2006 and Holveot et al. 2007).

One advantage of SWAT is the Geographic Information System (GIS) interface that has been developed to manage required input data (Di Luzio et al. 2004, Srinivasan et al. 1998, Tuppad et al. 2009). As SWAT was developed to simulate large watersheds with variable features, geospatial methods are useful for gathering, managing and analyzing watershed data. The GIS interface populates the SWAT inputs that are required to describe the physical characteristics of the watershed. The GIS interface is also beneficial because it affords the user the opportunity to create a static spatial accounting of pesticide use. This static accounting of pesticide use can be used in relation to landscape characteristics to identify areas within a watershed that could contribute to the impairment of water quality due to pesticide use. This information can be used to focus modeling and monitoring efforts or to focus educational outreach efforts to pesticide users within the areas identified.

Environmental models such as SWAT go a step beyond the static account of landscape characteristics and chemical use to simulate the potential movement of chemicals within a watershed. SWAT couples the spatial and temporal chemical use data with the hydrology of the watershed to simulate chemical movement in the system. SWAT uses meteorlogic data to drive the hydrologic cycle of the watershed. The movement of water in the system is the vehicle of chemical movement in the model. The primary routes for chemicals to enter water from the site of application within SWAT are through surface runoff and infiltration of applied chemicals into groundwater that can reach surface waters through lateral flow and recharge. However, in some cases direct input of pesticides into surface water via drift may be considered an important pathway. Recently, SWAT has been modified to evaluate the potential contribution of drift to pesticide surface water loading (Holveot, et al., 2008). The model simulates mechanisms of chemical loss and degradation in the terrestrial environment as well as in the aquatic

environment during the routing of the water through watershed. Coupling the movement of chemical via the routing of water through the watershed and simulating the routes of chemical loss, the model can provide estimated concentrations of chemicals in the waters of the system. This can be used to predict the concentrations of chemicals at certain points within the watershed. Another useful output of SWAT is the exceedance probability, or the probability that the concentration of a chemical in the surface waters will exceed a given level (such as a water quality standard or benchmark) during a period of time. As SWAT simulations are based on decades of meteorological data, it takes into account weather patterns within the study area. Based on this data, the model calculates that probability that the chemical concentration at given points within the watershed will exceed a defined level. These calculations can be used to determine the potential for current chemical use practices to exceed levels defined by regulatory agencies, such as TMDLs.

In previous work we used SWAT to identify hydrologic and landscape characteristics, and land use practices that may affect the pesticide surface water loading in the Zollner Creek watershed (Janney, et al. 2010). Meta data layers were assembled from the USGS National Elevation Dataset, the USGS National Hydrography Dataset and the USDA National Agricultural Statistics Service Oregon Cropland Data layer. The SWAT model was then calibrated for the Zollner Creek watershed using USGS stream gage data. The results of this calibration exercise suggest the importance local information in parameterizing SWAT. Working with agricultural consultants and service providers, and landowners we will continue to seek improvements in model calibration. We propose an iterative approach to engaging landowners; demonstrating how SWAT can use both standardized and local information to develop mitigation strategies to reduce surface water loading, and to evaluate the pesticide use limitations that will be necessary to meet both Clean Water Act and Endangered Species Act in-stream water quality goals. Initially we will introduce the sufficiently calibrated SWAT model to landowners in the Zollner Creek Watershed and seek their input on ways to improve calibration, such as more precise information on cropping practices, pesticide use practices, water management and drainage practices. With additional local information SWAT will be recalibrated and vetted with landowners, agricultural consultants, and service providers. The process will be repeated until there is consensus that the model could be useful in evaluating crop management, IPM practices and mitigation measures. Another use of SWAT is to identify “critical source areas” within a watershed. This information will be used to prioritize sites within the watershed for specific mitigation measures.

Using the Zollner Creek watershed as a case study, we expect that methods for model parameterization and calibration, methods for stakeholder participation in model refinement and evaluation, and methods for employing SWAT as a resource for informed decision-making, will be transferable to other watersheds in the Mollala-Pudding Subbasin and beyond.

Results and Discussion

We have calibrated the hydrologic component of SWAT using meta data from the USGS National Elevation Dataset, the USGS National Hydrography Dataset and the USDA National Agricultural Statistics Service Oregon Cropland Data layer. We collaborated with the Marion SWCD and NRCS to refine our understanding of hydrology in the Zollner Creek watershed, and have met with Dennis Roth and others at the Wilco Cooperative in Mt Angel to develop a plan for further refinement. Working with Wilco we are continuing to refine our understanding of land use practices which will to develop a sufficiently calibrated model which will be presented to a selected group of Zollner Creek landowners and their advisors and seek their input on ways to improve calibration, such as more precise information on cropping practices, water management, and drainage practices.

Use of Surface Water Sampling in Model Calibration and Evaluation

To date pesticide monitoring in the Pudding watershed has relied solely on grab samples. Grab samples provide an instantaneous measurement of concentration. Depending on the expected variability in pesticide surface water concentration, many grab samples may be required to adequately reconstruct the fluctuation pesticide load. Currently ODEQ collects grab weekly samples during the spring and summer pesticide use seasons. However, for some pesticide use practices, water quality concerns may require year round information on daily loads. In addition, depending on the variation in pesticide in-stream concentrations (both amplitude and duration), instantaneous pesticide concentrations derived from seasonally collected individual grab samples may grossly overestimate or underestimate the daily load.

Alternatively, sequentially deployed passive sampling devices (PSDs) can provide information on continuous exposure to aquatic life, as the average pesticide concentrations over the deployment period. The concentration profile derived from the continuous deployment of PSDs should compliment data obtained from weekly grab samples, and in some cases may be more useful in evaluating potential water quality concerns.

An important goal of pesticide surface water sampling within a watershed is to better understand the relationship between land use practices and surface water loading. Pesticide concentrations in surface water at each sampling location are potentially influenced by all upstream land use activity. As pesticide and nutrient use practices upstream of the surface water sampling point can vary significantly in timing, frequency, and distribution across the landscape, watershed-scale models such as SWAT can be very useful in model calibration, evaluating monitoring results, and guiding future monitoring strategies (i.e., when and where to sample). The iterative use of monitoring and models should result in refined model estimates, and the potential to further enhance monitoring strategies.

We believe that we have sufficiently calibrated of the hydrologic component of SWAT, and with the assistance of SWCD and the Wilco Cooperative, we are currently working with stakeholders in the Zollner Creek watershed to develop detailed information on pesticide use practices (i.e., what pesticides and application method, amount, timing, frequency for each crop and sites within the watershed) in order to sufficiently parameterize the pesticide fate component of SWAT. SWAT will then be recalibrated using pesticide monitoring data and vetted with landowners, agricultural consultants, and service providers. Based on model output (i.e., goodness of fit between predicted and measured stream height, pesticide concentrations on a daily time step) meta data needs will be evaluated and model calibration will be repeated until there is consensus that the models could be useful in evaluating crop management, IPM practices and mitigation measures.

Use of SWAT to Evaluate Alternative Land Use Practices

We will select common pesticide use scenarios to evaluate the potential for SWAT to provide useful information in the evaluation of alternative pesticide use practices and/or mitigation measures designed to reduce pesticide surface water loading in the Zollner Creek watershed. Each scenario will represent a suit of practices (crop management, IPM practices, and mitigation measures) that represent current practices by landowners and alternatives under consideration to meet environmental protection goals. For each scenario, using historic climate data (i.e., 1990-2010) the models will be run for 20 years to investigate the relationship between cropping practices, pesticide use (application method, amount, timing, frequency), location in the watershed, and the potential for surface water loading. Pesticide

surface water loading potential will be expressed as an exceedance probability; for example, the probability of exceeding a TMDL or other human health/aquatic life standard or benchmark. Given the inherent uncertainty in model predictions, we will use a relative comparison of surface water loading estimates as a means of ranking alternative scenarios. In addition, this approach will allow the flexibility to conduct ad hoc evaluations (i.e., "what if" scenarios) based on initial findings. For some pesticide for which there is sufficient monitoring data (i.e., chlorpyrifos) we will compare patterns in surface water concentration to model predictions. SWAT may also be useful in deconstructing site-specific crop management, IPM practice, and mitigation measures to investigate what combination of factors may have contributed to the outcome. Model deconstruction is often useful to pesticide users and/or their advisors as it can provide a fundamental understanding of the science and engineering that determines the model output and how well it represents real-world outcomes. The use of models in decision-making should not always be a "black box" exercise; for many users a basic understanding model processes should enhance the their ability understand a model's strengths and weaknesses, and thereby make more informed decisions based on model output.

Outreach on Water Quality Impacts of Alternative Land Use Practices

Marion SWCD is currently partnering with the OSU Integrated Plant Protection Center, working with producers in the Pudding-Molalla and Yamhill watersheds in evaluating IPM practices to improve water quality. The 3-year program titled "Watershed-scale IPM Workshops for the Pudding and Yamhill" was initiated in February, 2009. To date one stakeholder focus group and 4 workshops have been conducted. Future workshops are designed to provide tools and resources useful in IPM decision-making with a focus on water quality at the watershed scale. In addition to presentations on monitoring efforts by ODEQ and USGS, integral to these workshops is the use of SWAT as a decision-aid in evaluating alternative IPM practices and mitigation measures. Future workshops will also include the results of the OSU continuous monitoring program employing PSDs. In addition, as described above, monitoring data and the SWAT model will be used to evaluate the water quality impacts (surface water loading as exceedance probabilities) for alternative crop management, IPM practices, and mitigation measures. In addition to providing a watershed-scale resource to evaluate the water quality impacts of alternative land use practices, this approach can also evaluate current pesticide use practices with regard to the potential for pesticide surface water loading. We expect our outreach efforts to result feedback from producers and other stakeholders. We expect that the presentation of monitoring data and modeling output in a watershed context will be a catalyst for discussing ways to improve model estimates which, in turn, should allow a more robust evaluation of alternative practices. For example, stakeholder engagement could result in a better understanding of cropping and pesticide use practices – key information for refining model estimates.

Transferability of Monitoring and Modeling Methods to Other Oregon Watersheds

Without some understanding of the relationship between pesticide surface water monitoring data and land use practices, monitoring results are of limited usefulness. However, the use of integrated site-specific and watershed scale environmental fate models like SWAT may increase the usefulness of monitoring data, both as a rich information source in developing sampling strategies and as a resource in interpreting monitoring results. More importantly, while monitoring data alone is site or watershed specific, models like SWAT can be applied to any watershed.

At the end of this study we expect to have developed a working SWAT model for the Zollner Creek watershed; a decision aid that can be applied to the evaluation of land use practices that potentially

impact water quality. In addition, we will evaluate transferability of this monitoring and modeling approach to other water watersheds within the Molalla-Pudding River Basin. We will also work with OSU and the ODEQ Pesticide Stewardship Program to evaluate the feasibility of a broader application of these methods.

Summary of Project Goals and Objectives

The goals of this project are:

1. A better understanding of the relationship between Agronomic and other land use practices and pesticide surface water loading in Zollner Creek watershed within the Pudding subbasin.

2. Adoption of crop management, IPM practices, and mitigation measures that meet production goals and result in a reduction in surface water loading of high risk pesticides.

3. A methodology for using the integrated site-specific and watershed scale environmental fate models SWAT in developing pesticide surface water load reduction strategies in other Oregon watersheds.

Below are the objectives that measure the success of methods and procedures in achieving the project goals.

1. Evaluate the feasibility of using SWAT to describe the relationship between agronomic and other land use practices and pesticide surface water loading in the Zollner Creek watershed.

2. Use SWAT, vetted by landowners and their advisors, to evaluate alternative crop management, IPM practices, and mitigation measures with regard to their relative potential to reduce pesticide surface water loading.

3. Conduct outreach efforts that demonstrates the utility of SWAT in evaluating alternative crop management, IPM practices, and mitigation measures in reducing surface water loading of high risk pesticides.

4. Evaluate the transferability of the modeling approach to the implementation of pesticide load reduction strategies in other Oregon watersheds.

5. Use SWAT to provide assistance to landowners in evaluating site-specific land use practices to meet both production goals and watershed-scale environmental protection goals.

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Appendix A

US Geological Survey Pesticide Monitoring Data for the Zollner Creek (Station 14201300)
1993-2012

Pesticide	Units	# Samples	# Detections	Detection Frequency (%)	Minimum Detected	Maximum Detected
Terbuthylazine_ wf	*(ug/L)*	63	0	0.0	-	-
Propachlor_ wf	*(ug/L)*	122	10	8.2	0.154	0.95
Hexazinone_ wf	*(ug/L)*	63	55	87.3	0.1	0.97
Butylate_ wf	*(ug/L)*	122	0	0.0	-	-
Bromacil_ wf	*(ug/L)*	55	7	12.7	0.17	0.728
Cycloate_ wf	*(ug/L)*	44	11	25.0	0.123	0.97
Terbacil_ wf	*(ug/L)*	27	8	29.6	0.11	0.763
Diphenamid_ wf	*(ug/L)*	27	0	0.0	-	-
Simazine_ wf	*(ug/L)*	168	168	100.0	0.11	6.24
Prometryn_ wf	*(ug/L)*	63	0	0.0	-	-
Prometon_ wf	*(ug/L)*	168	3	1.8	0.335	0.5
CEAT_ wf	*(ug/L)*	27	22	81.5	0.146	0.769
CAAT_ wf	*(ug/L)*	24	7	29.2	0.1	0.75
CIAT_ wf	*(ug/L)*	168	167	99.4	0.1	0.996
Cyanazine_ wf	*(ug/L)*	168	1	0.6	0.24	0.24
Fonofos_ wf	*(ug/L)*	168	32	19.0	0.1	0.965
1_2-Dichloroethane_ wu	*(ug/L)*	2	0	0.0	-	-
Acrylonitrile_ wu	*(ug/L)*	2	0	0.0	-	-
alpha-HCH_ wf	*(ug/L)*	120	0	0.0	-	-
beta-Endosulfan_ wf	*(ug/L)*	17	6	35.3	0.14	0.98
alpha-Endosulfan_ wf	*(ug/L)*	63	1	1.6	0.117	0.117
Hexachlorobenzene_ ss	*(ug/L)*	1	0	0.0	-	-
Bromomethane_ wu	*(ug/L)*	2	0	0.0	-	-
4-Chloro-3-methylphenol_ wu	*(ug/L)*	2	0	0.0	-	-
4-Chloro-3-methylphenol_ ss	*(ug/L)*	1	0	0.0	-	-
Pentachlorophenol_ ss	*(ug/L)*	1	0	0.0	-	-
1_2-Dichloropropane_ wu	*(ug/L)*	2	0	0.0	-	-
1_4-Dichlorobenzene_ wu	*(ug/L)*	3	0	0.0	-	-
1_4-Dichlorobenzene_ ss	*(ug/L)*	1	0	0.0	-	-
2_4-Dichlorophenol_ wu	*(ug/L)*	2	0	0.0	-	-
2_4-Dichlorophenol_ ss	*(ug/L)*	1	0	0.0	-	-
2_4-Dimethylphenol_ wu	*(ug/L)*	2	0	0.0	-	-
2_4_6-Trichlorophenol_ wu	*(ug/L)*	2	0	0.0	-	-

2_4_6-Trichlorophenol_ ss	*(ug/L)*	1	0	0.0	-	-
4-Nitrophenol_ wu	*(ug/L)*	2	0	0.0	-	-
4-Nitrophenol_ ss	*(ug/L)*	1	0	0.0	-	-
p_p'-DDE_ wf	*(ug/L)*	122	11	9.0	0.158	0.388
DNOC_ wu	*(ug/L)*	2	0	0.0	-	-
DNOC_ ss	*(ug/L)*	1	0	0.0	-	-
trans-1_3-Dichloropropene_ wu	*(ug/L)*	2	0	0.0	-	-
cis-1_3-Dichloropropene_ wu	*(ug/L)*	2	0	0.0	-	-
Dicamba_ w_gf<.7u	*(ug/L)*	55	16	29.1	0.1139	0.97
Dicrotophos_ wf	*(ug/L)*	63	0	0.0	-	-
Linuron_ w_gf<.7u	*(ug/L)*	55	1	1.8	0.15	0.15
MCPA_ w_gf<.7u	*(ug/L)*	55	20	36.4	0.111	0.9
MCPB_ w_gf<.7u	*(ug/L)*	55	0	0.0	-	-
Mthiocrb_ w_gf<.7u	*(ug/L)*	55	2	3.6	0.1	0.49
Propoxur_ w_gf<.7u	*(ug/L)*	55	0	0.0	-	-
Siduron_ wf	*(ug/L)*	27	0	0.0	-	-
Bentazon_ w_gf<.7u	*(ug/L)*	55	31	56.4	0.1	0.961
Sulprofos_ wf	*(ug/L)*	16	0	0.0	-	-
2_4-DB_ w_gf<.7u	*(ug/L)*	55	0	0.0	-	-
Dichlorvos_ wf	*(ug/L)*	63	0	0.0	-	-
Fenthion_ wf	*(ug/L)*	17	0	0.0	-	-
Fluometuron_ w_gf<.7u	*(ug/L)*	55	3	5.5	0.146	0.957
Oxamyl_ w_gf<.7u	*(ug/L)*	55	1	1.8	1.33	1.33
Chlorpyrifos_ wu	*(ug/L)*	2	2	100.0	0.3	0.3
Chlorpyrifos_ wf	*(ug/L)*	168	136	81.0	0.1	0.999
Disulfoton_ wu	*(ug/L)*	2	0	0.0	-	-
Phorate_ wu	*(ug/L)*	2	0	0.0	-	-
Pentachlorophenol_ wu	*(ug/L)*	2	0	0.0	-	-
p_p'-Ethyl-DDD_ wu	*(ug/L)*	5	0	0.0	-	-
Tribuphos_ wu	*(ug/L)*	2	0	0.0	-	-
Aldrin_ wu	*(ug/L)*	5	0	0.0	-	-
Aldrin_ wf	*(ug/L)*	1	0	0.0	-	-
Aldrin_ ss	*(ug/L)*	1	0	0.0	-	-
Lindane_ wu	*(ug/L)*	5	5	100.0	0.1	0.3
Lindane_ wf	*(ug/L)*	122	10	8.2	0.11	0.64
Lindane_ ss	*(ug/L)*	1	0	0.0	-	-
Chlordane (technical)_ wu	*(ug/L)*	5	0	0.0	-	-
Chlordane (technical)_ wf	*(ug/L)*	1	0	0.0	-	-
Chlordane_ ss	*(ug/L)*	1	0	0.0	-	-
p_p'-DDD_ wu	*(ug/L)*	5	0	0.0	-	-
p_p'-DDD_ wf	*(ug/L)*	1	0	0.0	-	-

p_p'-DDD_ ss	*(ug/L)*	1	0	0.0	-	-
p_p'-DDE_ wu	*(ug/L)*	5	1	20.0	0.2	0.2
p_p'-DDE_ wf	*(ug/L)*	1	0	0.0	-	-
p_p'-DDE_ ss	*(ug/L)*	1	0	0.0	-	-
p_p'-DDT_ wu	*(ug/L)*	5	1	20.0	0.2	0.2
p_p'-DDT_ wf	*(ug/L)*	1	0	0.0	-	-
p_p'-DDT_ ss	*(ug/L)*	1	0	0.0	-	-
Dieldrin_ wu	*(ug/L)*	5	3	60.0	0.1	0.2
Dieldrin_ wf	*(ug/L)*	168	9	5.4	0.11	0.9
Dieldrin_ ss	*(ug/L)*	1	0	0.0	-	-
alpha-Endosulfan_ wu	*(ug/L)*	5	3	60.0	0.1	0.6
Endrin_ wu	*(ug/L)*	5	0	0.0	-	-
Endrin_ wf	*(ug/L)*	1	0	0.0	-	-
Endrin_ ss	*(ug/L)*	1	0	0.0	-	-
Ethion_ wu	*(ug/L)*	2	0	0.0	-	-
Toxaphene_ wu	*(ug/L)*	5	0	0.0	-	-
Toxaphene_ wf	*(ug/L)*	1	0	0.0	-	-
Toxaphene_ ss	*(ug/L)*	1	0	0.0	-	-
Heptachlor_ wu	*(ug/L)*	5	0	0.0	-	-
Heptachlor_ wf	*(ug/L)*	1	0	0.0	-	-
Heptachlor_ ss	*(ug/L)*	1	0	0.0	-	-
Metolachlor_ wf	*(ug/L)*	168	168	100.0	0.1	1.78
Heptachlor epoxide_ wu	*(ug/L)*	5	0	0.0	-	-
Heptachlor epoxide_ wf	*(ug/L)*	1	0	0.0	-	-
Heptachlor epoxide_ ss	*(ug/L)*	1	0	0.0	-	-
p_p'-Methoxychlor_wu	*(ug/L)*	5	0	0.0	-	-
Malathion_ wu	*(ug/L)*	2	0	0.0	-	-
Malathion_ wf	*(ug/L)*	168	10	6.0	0.1	0.84
Malathion_ ss	*(ug/L)*	1	1	100.0	0.79	0.79
Parathion_ wu	*(ug/L)*	2	0	0.0	-	-
Parathion_ wf	*(ug/L)*	122	0	0.0	-	-
Parathion_ ss	*(ug/L)*	1	0	0.0	-	-
Diazinon_ wu	*(ug/L)*	2	2	100.0	1	1
Diazinon_ wf	*(ug/L)*	168	94	56.0	0.1	1.28
Diazinon_ ss	*(ug/L)*	1	1	100.0	0.57	0.57
Methyl parathion_ wu	*(ug/L)*	2	0	0.0	-	-
Methyl parathion_ ss	*(ug/L)*	1	0	0.0	-	-
Atrazine_ wf	*(ug/L)*	168	168	100.0	0.1	4.53
Hexachlorobenzene_ wu	*(ug/L)*	2	0	0.0	-	-
2_4-D_ wf	*(ug/L)*	55	27	49.1	0.1366	2.2138
2_4_5-T_ wf	*(ug/L)*	28	0	0.0	-	-

Mirex_ wu	*(ug/L)*	5	0	0.0	-	-
Mirex_ wf	*(ug/L)*	1	0	0.0	-	-
Mirex_ ss	*(ug/L)*	1	0	0.0	-	-
Silvex_ wf	*(ug/L)*	28	0	0.0	-	-
Silvex_ wf	*(ug/L)*	1	0	0.0	-	-
Carbophenothion_ wu	*(ug/L)*	2	0	0.0	-	-
Alachlor_ wf	*(ug/L)*	168	37	22.0	0.11	0.862
Triclopyr_ w_gf<.7u	*(ug/L)*	55	24	43.6	0.2	2.8654
Propham_ w_gf<.7u	*(ug/L)*	55	0	0.0	-	-
Acetochlor_ wf	*(ug/L)*	150	0	0.0	-	-
Picloram_ w_gf<.7u	*(ug/L)*	54	2	3.7	1.1466	1.822
Oryzalin_ w_gf<.7u	*(ug/L)*	55	7	12.7	0.132	1.8
Norflurazon_ w_gf<.7u	*(ug/L)*	55	29	52.7	0.1	0.967
Neburon_ w_gf<.7u	*(ug/L)*	55	0	0.0	-	-
1-Naphthol_ w_gf<.7u	*(ug/L)*	89	2	2.2	0.33	0.437
Methomyl_ w_gf<.7u	*(ug/L)*	55	2	3.6	0.39	0.66
Fenuron_ w_gf<.7u	*(ug/L)*	55	8	14.5	0.1139	0.436
Esfenvalerate_ w_gf<.7u	*(ug/L)*	28	0	0.0	-	-
DNOC_ w_gf<.7u	*(ug/L)*	28	0	0.0	-	-
Diuron_ w_gf<.7u	*(ug/L)*	55	51	92.7	0.4	14
Dinoseb_ w_gf<.7u	*(ug/L)*	55	29	52.7	0.111	1
Dichlorprop_ w_gf<.7u	*(ug/L)*	55	0	0.0	-	-
Dichlobenil_ w_gf<.7u	*(ug/L)*	28	1	3.6	0.1	0.1
DCPA monoacid_ w_gf<.7u	*(ug/L)*	53	0	0.0	-	-
Clopyralid_ w_gf<.7u	*(ug/L)*	54	13	24.1	0.124	0.768
Chlorothalonil_ w_gf<.7	*(ug/L)*	52	0	0.0	-	-
3-Hydroxy carbofuran_ w_gf<.7	*(ug/L)*	55	4	7.3	0.16	0.35
Carbofuran_ w_gf<.7u	*(ug/L)*	55	34	61.8	0.118	13.2711
Carbaryl_ w_gf<.7u	*(ug/L)*	55	7	12.7	0.14	0.89
Bromoxynil_ w_gf<.7u	*(ug/L)*	55	9	16.4	0.11	0.96
Aldicarb_ w_gf<.7u	*(ug/L)*	55	0	0.0	-	-
Aldicarb sulfone_ w_gf<.7	*(ug/L)*	55	0	0.0	-	-
Aldicarb sulfoxide_ w_gf.7	*(ug/L)*	55	2	3.6	0.42	0.8
Acifluorfen_ w_gf<.7u	*(ug/L)*	55	0	0.0	-	-
Alachlor SA_ w_gf<.7u	*(ug/L)*	13	5	38.5	0.5	0.8
3-Ketocarbofuran_ wf	*(ug/L)*	24	3	12.5	0.312	0.8
Bendiocarb_ wf	*(ug/L)*	27	12	44.4	0.1474	3.473
Benomyl_ wf	*(ug/L)*	27	13	48.1	0.138	0.975
Chlorimuron-ethyl_ wf	*(ug/L)*	27	0	0.0	-	-
Sulfometuron-methyl_ wf	*(ug/L)*	27	4	14.8	0.122	0.41
OIET_ wf	*(ug/L)*	27	27	100.0	0.118	0.968

Imazaquin_ wf	*(ug/L)*	30	0	0.0	-	-
Metalaxyl_ wf	*(ug/L)*	27	26	96.3	0.11	0.931
Nicosulfuron_ wf	*(ug/L)*	27	1	3.7	0.155	0.155
Imazethapyr_ wf	*(ug/L)*	27	3	11.1	0.271	0.67
Oxamyl oxime_ wf	*(ug/L)*	1	0	0.0	-	-
2_4-D methyl ester_ wf	*(ug/L)*	27	2	7.4	0.1834	0.189
Propiconazole_ wf	*(ug/L)*	27	21	77.8	0.1149	0.98
Acetochlor SA_ w_gf<.7u	*(ug/L)*	13	0	0.0	-	-
Acetochlor OA_ w_gf<.7u	*(ug/L)*	13	0	0.0	-	-
Alachlor OA_ w_gf<.7u	*(ug/L)*	13	0	0.0	-	-
Metolachlor SA_ w_gf<.7u	*(ug/L)*	13	13	100.0	0.2	2.36
Metolachlor OA_ w_gf<.7u	*(ug/L)*	13	12	92.3	0.1	1.16
Tribenuron-methyl_ wf	*(ug/L)*	7	0	0.0	-	-
Chloramben ME_ wf	*(ug/L)*	55	0	0.0	-	-
Bifenthrin_ wf	*(ug/L)*	17	0	0.0	-	-
Cyfluthrin_ wf	*(ug/L)*	63	0	0.0	-	-
Cypermethrin_ wf	*(ug/L)*	63	1	1.6	0.62	0.62
Endosulfan sulfate_ wf	*(ug/L)*	63	62	98.4	0.118	0.98
Fenamiphos_ wf	*(ug/L)*	63	0	0.0	-	-
Flumetralin_ wf	*(ug/L)*	17	0	0.0	-	-
Iprodione_ wf	*(ug/L)*	63	43	68.3	0.111	0.975
Isofenphos_ wf	*(ug/L)*	63	0	0.0	-	-
lambda-Cyhalothrin_ wf	*(ug/L)*	63	1	1.6	0.76	0.76
Metalaxyl_ wf	*(ug/L)*	63	63	100.0	0.115	0.997
Methidathion_ wf	*(ug/L)*	63	0	0.0	-	-
Myclobutanil_ wf	*(ug/L)*	63	25	39.7	0.121	0.91
Oxyfluorfen_ wf	*(ug/L)*	63	41	65.1	0.11	0.94
Phosmet_ wf	*(ug/L)*	60	0	0.0	-	-
Tebupirimfos_ wf	*(ug/L)*	17	0	0.0	-	-
Profenofos_ wf	*(ug/L)*	17	0	0.0	-	-
Propetamphos_ wf	*(ug/L)*	17	0	0.0	-	-
Sulfotepp_ wf	*(ug/L)*	17	0	0.0	-	-
Tefluthrin_ wf	*(ug/L)*	63	0	0.0	-	-
Temephos_ wf	*(ug/L)*	16	0	0.0	-	-
Tribuphos_ wf	*(ug/L)*	63	0	0.0	-	-
1_4-Naphthoquinone_ wf	*(ug/L)*	16	0	0.0	-	-
2_5-Dichloroaniline_ wf	*(ug/L)*	17	0	0.0	-	-
EthMePhAminoPropanol	*(ug/L)*	12	0	0.0	-	-
2-Amino-N-isopropylbenzamide	*(ug/L)*	17	1	5.9	0.36	0.36
Alachlor 2nd amide_ wf	*(ug/L)*	63	0	0.0	-	-
2-Ethyl-6-methylaniline_ wf	*(ug/L)*	63	0	0.0	-	-

3_4-Dichloroaniline_ wf	*(ug/L)*	63	63	100.0	0.11	0.953
3_5-Dichloroaniline_ wf	*(ug/L)*	63	17	27.0	0.124	0.9
3-PBA_ wf	*(ug/L)*	9	0	0.0	-	-
TFMA_ wf	*(ug/L)*	17	0	0.0	-	-
4_4'-Dichlorobenzophenone_ wf	*(ug/L)*	17	2	11.8	0.27	0.35
4-Chloro-2-methylphenol_ wf	*(ug/L)*	63	12	19.0	0.112	0.96
4-Chlorophenyl methyl sulfone	*(ug/L)*	17	0	0.0	-	-
Azinphos-methyl oxon_ wf	*(ug/L)*	63	3	4.8	0.144	0.425
Chlorpyrifos oxon_ wf	*(ug/L)*	62	0	0.0	-	-
Butylphenoxycyclohexanol_ wf	*(ug/L)*	17	0	0.0	-	-
Disulfoton sulfone_ wf	*(ug/L)*	63	0	0.0	-	-
Disulfoton sulfoxide_ wf	*(ug/L)*	17	0	0.0	-	-
Endosulfan ether_ wf	*(ug/L)*	17	0	0.0	-	-
Ethion monoxon_ wf	*(ug/L)*	63	0	0.0	-	-
Fenamiphos sulfone_ wf	*(ug/L)*	63	0	0.0	-	-
Fenamiphos sulfoxide_ wf	*(ug/L)*	62	0	0.0	-	-
Fenthion sulfoxide_ wf	*(ug/L)*	17	0	0.0	-	-
Fonofos oxon_ wf	*(ug/L)*	15	0	0.0	-	-
Malaoxon_ wf	*(ug/L)*	63	0	0.0	-	-
Et-Me-Pr-phosphorothioate_ wf	*(ug/L)*	17	0	0.0	-	-
Paraoxon_ wf	*(ug/L)*	17	0	0.0	-	-
Methyl paraoxon_ wf	*(ug/L)*	63	0	0.0	-	-
4(Hydroxymethyl)pendimethalin	*(ug/L)*	8	0	0.0	-	-
Phorate oxon_ wf	*(ug/L)*	63	0	0.0	-	-
Phosmet oxon_ wf	*(ug/L)*	58	0	0.0	-	-
Tebupirimphos oxon_ wf	*(ug/L)*	17	0	0.0	-	-
Tefluthrin acid PFBzE_ wf	*(ug/L)*	4	0	0.0	-	-
Tefluthrin acid BzE_ wf	*(ug/L)*	4	0	0.0	-	-
Terbufos oxon sulfone_ wf	*(ug/L)*	63	0	0.0	-	-
N(4Chlorophenyl)N'methylurea	*(ug/L)*	27	22	81.5	0.114	0.932
Bensulfuron-methyl_ wf	*(ug/L)*	27	0	0.0	-	-
Flumetsulam_ wf	*(ug/L)*	27	1	3.7	0.94	0.94
Imidacloprid_ wf	*(ug/L)*	27	4	14.8	0.11	0.3441
Methomyl oxime_ wf	*(ug/L)*	1	0	0.0	-	-
Metsulfuron-methyl_ wf	*(ug/L)*	26	0	0.0	-	-
Dimethenamid SA_ wf	*(ug/L)*	13	0	0.0	-	-
Flufenacet SA_ wf	*(ug/L)*	13	2	15.4	0.22	0.33
Fipronil_ wf	*(ug/L)*	70	3	4.3	0.112	0.52
Fipronil sulfide_ wf	*(ug/L)*	70	2	2.9	0.43	0.58
Fipronil sulfone_ wf	*(ug/L)*	70	0	0.0	-	-
Desulfinylfipronil amide_ wf	*(ug/L)*	70	0	0.0	-	-

Desulfinylfipronil_ wf	*(ug/L)*	70	1	1.4	0.3	0.3
Dimethenamid OA_ wf	*(ug/L)*	13	0	0.0	-	-
Flufenacet OA_ wf	*(ug/L)*	13	2	15.4	0.13	0.31
AMPA_ w_gf<0.7u	*(ug/L)*	13	13	100.0	0.15	4.51
Glufosinate_ w_gf<.7u	*(ug/L)*	13	0	0.0	-	-
Glyphosate_ w_gf<.7u	*(ug/L)*	13	11	84.6	0.14	0.86
Sum 2_4-D + 2_4-D ME	*(ug/L)*	3	0	0.0	-	-
1_3-Dichloropropane_ wu	*(ug/L)*	2	0	0.0	-	-
1_2_3-Trichloropropane_ wu	*(ug/L)*	2	0	0.0	-	-
1_2-Dibromoethane_ wu	*(ug/L)*	2	0	0.0	-	-
cis-Permethric acid ME_ wf	*(ug/L)*	17	0	0.0	-	-
trans-Permethric acid ME_ wf	*(ug/L)*	17	0	0.0	-	-
(E)-Dimethomorph_ wf	*(ug/L)*	17	2	11.8	0.191	0.41
(Z)-Dimethomorph_ wf	*(ug/L)*	17	2	11.8	0.121	0.412
cis-Propiconazole_ wf	*(ug/L)*	62	56	90.3	0.1	0.93
trans-Propiconazole_ wf	*(ug/L)*	63	59	93.7	0.112	0.98
Carbophenothion_ ss	*(ug/L)*	1	0	0.0	-	-
Ethion_ wf	*(ug/L)*	63	0	0.0	-	-
Ethion_ ss	*(ug/L)*	1	0	0.0	-	-
p_p'-Ethyl-DDD_ wf	*(ug/L)*	1	0	0.0	-	-
p_p'-Ethyl-DDD_ ss	*(ug/L)*	1	0	0.0	-	-
p_p'-Methoxychlor_ wf	*(ug/L)*	1	0	0.0	-	-
p_p'-Methoxychlor_ ss	*(ug/L)*	1	0	0.0	-	-
alpha-Endosulfan_ wf	*(ug/L)*	1	1	100.0	0.2	0.2
Endosulfan_ ss	*(ug/L)*	1	0	0.0	-	-
Fonofos_ wu	*(ug/L)*	2	2	100.0	0.2	0.2
Dibromochloropropane_ wu	*(ug/L)*	2	0	0.0	-	-
Metribuzin_ wf	*(ug/L)*	168	112	66.7	0.11	0.994
2_6-Diethylaniline_ w_gf<.7u	*(ug/L)*	168	0	0.0	-	-
Trifluralin_ w_gf<.7u	*(ug/L)*	168	94	56.0	0.1	0.98
Dimethoate_ w_gf<.7u	*(ug/L)*	63	11	17.5	0.13	0.65
Ethalfluralin_ w_gf<.7u	*(ug/L)*	122	1	0.8	0.75	0.75
Phorate_ w_gf<.7u	*(ug/L)*	168	0	0.0	-	-
Terbacil_ w_gf<.7u	*(ug/L)*	122	70	57.4	0.1	0.98
Linuron_ w_gf<.7u	*(ug/L)*	122	2	1.6	0.155	0.46
Methyl parathion_ w_gf<.7u	*(ug/L)*	168	0	0.0	-	-
EPTC_ w_gf<.7u	*(ug/L)*	168	126	75.0	0.1	2.11
Pebulate_ w_gf<.7u	*(ug/L)*	122	0	0.0	-	-
Tebuthiuron_ w_gf<.7u	*(ug/L)*	168	7	4.2	0.126	0.88
Molinate_ w_gf<.7u	*(ug/L)*	168	0	0.0	-	-
Ethoprop_ w_gf<.7u	*(ug/L)*	168	129	76.8	0.11	1.95

Benfluralin_ w_gf<.7u	*(ug/L)*	168	0	0.0	-	-
Carbofuran_ w_gf<.7u	*(ug/L)*	168	114	67.9	0.1	32.2
Terbufos_ w_gf<.7u	*(ug/L)*	168	0	0.0	-	-
Propyzamide_ w_gf<.7u	*(ug/L)*	168	79	47.0	0.1	0.973
Disulfoton_ w_gf<.7u	*(ug/L)*	168	1	0.6	0.187	0.187
Triallate_ w_gf<.7u	*(ug/L)*	122	2	1.6	0.129	0.288
Propanil_ w_gf<.7u	*(ug/L)*	168	3	1.8	0.3	0.9
Carbaryl_ w_gf<.7u	*(ug/L)*	168	86	51.2	0.1	0.98
Thiobencarb_ w_gf<.7u	*(ug/L)*	168	0	0.0	-	-
DCPA_ w_gf<.7u	*(ug/L)*	168	27	16.1	0.1	0.982
Pendimethalin_ w_gf<.7u	*(ug/L)*	168	72	42.9	0.112	0.96
Napropamide_ w_gf<.7u	*(ug/L)*	122	91	74.6	0.1	1.67
Propargite_ w_gf<.7u	*(ug/L)*	168	1	0.6	0.7	0.7
Azinphos-methyl_ w_gf<.7u	*(ug/L)*	167	44	26.3	0.113	4.24
cis-Permethrin_ w_gf<.7u	*(ug/L)*	168	0	0.0	-	-

Appendix B
Oregon ODEQ Pesticide Stewardship Partnership (PSP)
Monitoring data for Zollner Creek at Monitor-McKee Road Bridge
2006-2011

Pesticide (concentration units)	# Samples	# Detections	Detection Frequency (%)	Minimum Detected	Maximum Detected
2 4-D (µg/L)	22	0	0.00	0	0
4 4`-DDD (ng/L)	18	0	0.00	0	0
4 4`-DDE (ng/L)	14	0	0.00	0	0
4 4`-DDT (ng/L)	14	0	0.00	0	0
Acetamiprid (ng/L)	7	1	14.29	5	5
Acetochlor (ng/L)	21	0	0.00	0	0
Alachlor (ng/L)	24	0	0.00	0	0
Aldrin (ng/L)	9	0	0.00	0	0
alpha-BHC (ng/L)	13	0	0.00	0	0
Ametryn (ng/L)	10	0	0.00	0	0
Atrazine (µg/L)	29	19	65.52	0.016	0.43
Atrazine (ng/L)	17	10	58.82	16.1	900
Azinphos Methyl (ng/L)	24	0	0.00	0	0
Azinphos Methyl Oxon (µg/L)	24	6	25.00	0.2	0.37
Baygon (ng/L)	24	0	0.00	0	0
beta-BHC (ng/L)	14	0	0.00	0	0
Bifenthrin (ng/L)	4	0	0.00	0	0
Bromacil (ng/L)	19	0	0.00	0	0
Butachlor (ng/L)	20	0	0.00	0	0
Butylate (ng/L)	12	0	0.00	0	0
Carbaryl (ng/L)	23	4	17.39	6.6	40.5
Carbofuran (ng/L)	23	0	0.00	0	0
Carboxin (ng/L)	5	0	0.00	0	0
Chlorobenzilate(a) (ng/L)	18	0	0.00	0	0
Chloroneb (ng/L)	13	0	0.00	0	0
Chlorothalonil (ng/L)	7	0	0.00	0	0
Chlorpyrifos (µg/L)	29	14	48.28	0.023	0.177
Chlorpyrifos (Dursban) (ng/L)	17	0	0.00	0	0
Chlorpyrifos oxon (µg/L)	24	6	25.00	0.088	0.12
Cyanazine (ng/L)	15	0	0.00	0	0
Cycloate (ng/L)	14	0	0.00	0	0
Dacthal (ng/L)	14	0	0.00	0	0
DEET (ng/L)	23	3	13.04	7.3	25.5
delta-BHC (ng/L)	15	0	0.00	0	0

Desethyl Atrazine (ng/L)	4	4	100.00	14.6	34
Desisopropyl Atrazine (ng/L)	4	4	100.00	50	123
Diazinon (µg/L)	30	17	56.67	0.014	0.16
Diazinon (ng/L)	8	0	0.00	0	0
Dichlorvos (ng/L)	17	0	0.00	0	0
Dieldrin (ng/L)	15	0	0.00	0	0
Dimethoate (µg/L)	31	6	19.35	0.069	0.11
Dimethoate (ng/L)	14	0	0.00	0	0
Diphenamid (ng/L)	19	0	0.00	0	0
Disulfoton (ng/L)	7	0	0.00	0	0
Diuron (ng/L)	17	17	100.00	246	26900
Endosulfan I (ng/L)	13	0	0.00	0	0
Endosulfan II (ng/L)	15	0	0.00	0	0
Endosulfan sulfate (ng/L)	12	0	0.00	0	0
Endrin (ng/L)	16	0	0.00	0	0
Endrin Aldehyde (ng/L)	9	0	0.00	0	0
EPTC (Eptam) (ng/L)	11	6	54.55	30	2130
Ethoprophos (ng/L)	16	6	37.50	38.3	501.2
Etridiazole (ng/L)	13	0	0.00	0	0
Fenamiphos (ng/L)	15	0	0.00	0	0
Fenarimol (ng/L)	19	0	0.00	0	0
Fenvalerate+Esfenvalerate (µg/L)	31	6	19.35	1.3	2.1
Fenvalerate+Esfenvalerate (ng/L)	20	0	0.00	0	0
Fluometuron (ng/L)	24	0	0.00	0	0
Fluridone (ng/L)	20	0	0.00	0	0
Guthion (Azinphosmethyl) (µg/L)	31	6	19.35	0.091	0.15
Heptachlor (ng/L)	11	0	0.00	0	0
Heptachlor epoxide (ng/L)	13	0	0.00	0	0
Hexazinone (ng/L)	18	2	11.11	29	34
Imidacloprid (ng/L)	11	10	90.91	32	153
Imidan (Phosmet) (µg/L)	31	6	19.35	0.094	0.15
Imidan (Phosmet) (ng/L)	4	0	0.00	0	0
Lindane (ng/L)	13	0	0.00	0	0
Linuron (ng/L)	20	9	45.00	4.2	74.3
Malathion (µg/L)	31	8	25.81	0.067	0.31
Malathion (ng/L)	13	0	0.00	0	0
Malathion Oxon (µg/L)	24	6	25.00	0.097	0.13
Methiocarb (ng/L)	20	0	0.00	0	0
Methomyl (ng/L)	24	0	0.00	0	0
Methoxychlor (ng/L)	15	0	0.00	0	0
Methyl paraoxon (ng/L)	12	0	0.00	0	0

Methyl Parathion (ng/L)	19	0	0.00	0	0
Methylparathion (µg/L)	31	6	19.35	0.11	0.14
Metolachlor (ng/L)	23	18	78.26	24	1290
Metribuzin (ng/L)	19	14	73.68	4.4	37.4
Mexacarbate (ng/L)	2	0	0.00	0	0
MGK-264 (ng/L)	19	0	0.00	0	0
Molinate (ng/L)	14	0	0.00	0	0
Napropamide (ng/L)	20	0	0.00	0	0
Neburon (ng/L)	22	0	0.00	0	0
Norflurazon (ng/L)	16	16	100.00	29	325
Oxyamyl (ng/L)	18	4	22.22	5.2	388
Pebulate (ng/L)	15	0	0.00	0	0
Pendimethalin (ng/L)	21	6	28.57	24.4	45
Permethrin (ng/L)	17	0	0.00	0	0
Phosdrin (Mevinphos) (ng/L)	5	0	0.00	0	0
Phosmet Oxon (µg/L)	24	6	25.00	0.17	0.31
Prometon (ng/L)	11	0	0.00	0	0
Prometryn (ng/L)	13	0	0.00	0	0
Pronamide (ng/L)	15	0	0.00	0	0
Propachlor (ng/L)	17	0	0.00	0	0
Propazine (ng/L)	18	0	0.00	0	0
Prophos (µg/L)	30	22	73.33	0.024	0.27
Propiconazole (ng/L)	16	14	87.50	28	218
Pyraclostrobin (ng/L)	21	0	0.00	0	0
Pyriproxyfen (µg/L)	31	6	19.35	0.71	1.1
Pyriproxyfen (ng/L)	12	0	0.00	0	0
Siduron (ng/L)	18	0	0.00	0	0
Simazine (µg/L)	26	23	88.46	0.072	9.5
Simazine (ng/L)	16	16	100.00	26.4	892
Simetryn (ng/L)	8	0	0.00	0	0
Sulfometuron-Methyl (ng/L)	3	3	100.00	12	56.7
Tebuthiuron (ng/L)	12	0	0.00	0	0
Terbacil (ng/L)	19	6	31.58	29	54
Terbufos (ng/L)	11	0	0.00	0	0
Terbutryne (ng/L)	13	0	0.00	0	0
Terbutylazine (ng/L)	16	0	0.00	0	0
Tetrachlorvinphos (ng/L)	17	0	0.00	0	0
trans-Chlordane (ng/L)	12	0	0.00	0	0
trans-Nonachlor (ng/L)	12	0	0.00	0	0
Triadimefon (ng/L)	20	0	0.00	0	0
Triclopyr (µg/L)	23	0	0.00	0	0

Tricyclazole (ng/L)	8	0	0.00	0	0
Trifluralin (ng/L)	13	0	0.00	0	0
Vernolate (ng/L)	14	0	0.00	0	0
Data in yellow exceed benchmark					

Appendix C

EPA & Oregon Pesticides of Interest (POI) & Those Included in NMFS & 1989 USFW ESA BIOPS

SLR (ODA) 11-15-12

active ingredient	Listed as an EPA or Oregon POI?	Jeopardy[2] in NMFS BIOPS?	Jeopardy in USFS 1989 BIOP?	Lowest OPP Aq. Benchmark (ug/L)	Benchmark Organism[1]	Detection Freq (Benchmark or WQ Criteria Exceedance Rate)[5]	NMFS BiOP - Jeopardy(J) or Adverse Modification(AM) for Oregon ESUs[4]
1,3-D							
2,4-D (acids & salts)	POI	NMFS #4		13.1	AVP		J-12; AM-2
acetochlor	POI			1.43	ANVP		
alachlor	POI			1.64	ANVP		
aldicarb	POI			0.46	CF		
atrazine	POI			1	ANVP	**0.276 (0%)**	
azinphos-methyl	POI	NMFS #3	USFW	0.036	CI	**0.012 (7.7%)**	J-0; AM-0
benfluralin	POI			1.9	CF		
benomyl			USFW				
bensulide		NMFS #3	USFW	290	AI	ND	J-0; AM-0
bentazon	POI			4500	ANVP		
bifenthrin	POI			0.0013	CI		
bromacil	POI			6.8	ANVP		
bromoxynil				2.5			
captan		NMFS #4	USFW	13.1	AF	**0.0 (0%)**	J-0; AM-0
carbaryl	POI	NMFS #2	USFW	0.5	CI	**0.109 (0%)**	J-10; AM-9
carbofuran	POI	NMFS #2	USFW	0.75	CI	**0.029 (0%)**	J-10; AM-9
carbophenothion			USFW				
chlorothalonil	POI	NMFS #4	USFW	0.17	CI	**0.009 (0%)**	J-0; AM-2
chlorpyrifos	POI	NMFS #1	USFW	0.04	CI	**0.049 (59%)**	J-13; AM-13
clopyralid	POI			56500	AI		

copper pesticides	POI			1.11	CI		
cypermethrin	POI			0.07	CI		
dacthal (DCPA)	POI			11000	ANVP		
DBCP	POI			0.09			
deltamethrin	POI			0.0041	CI		
diazinon	POI	NMFS #1	USFW	0.011	AI	**0.002 (0%)**	J-13; AM-13
dicamba	POI			61	ANVP		
dicofol	POI		USFW	1	CF		
dicrotophos			USFW	0.99			
dimethoate		NMFS #3	USFW	0.5	CI	**0 (0%)**	J-0; AM-0
disulfoton		NMFS #3	USFW	0.01	CI	ND	J-0; AM-0
diuron	POI	NMFS #4		2.4	ANVP	**0.602 (5.6%)**	J-0; AM-4
endosulfan	POI		USFW	0.01	CI	**0.007 (0%)**	
endosulfan sulfate	POI			1.9	AF		
esfenvalerate	POI		USFW	0.017	CI		
ethalfluralin	POI			0.4	CF		
ethion			USFW				
ethoprop	POI	NMFS #3	USFW	0.8	CI	**0.030 (0%)**	J-0; AM-0
ethyl parathion			USFW				
fenamiphos		NMFS #3	USFW	0.12	CI	ND	J-0; AM-0
fenbutatin oxide	POI			1.9	CF		
fensulfothion			USFW				
fipronil	POI			0.01	CI		
flumetsulam	POI			3.1	AVP		
fonofos			USFW				
glyphosate	POI			1800	CF		
hexazinone	POI			7	ANVP		
imazamethabenz	POI						
imazapyr	POI			18	AVP		
imidacloprid	POI			1.05	CI		
isoxaflutole	POI			4.9	AVP		
lambda-cyhalothrin	POI			0.002	CI		
lindane	POI			0.5	AI		
linuron	POI	NMFS #4		0.09	CI	**0.015 (0%)**	J-0; AM-0

malathion	POI	NMFS #1	USFW	0.035	CI	**0.023 (60%)**	J-13; AM-13
mancozeb			USFW	47			
mesotrione	POI			*0.29*	AVP		
metalaxyl	POI			1200	CI		
methamidaphos		NMFS #3		4.5	CI	ND	J-0; AM-0
methidathion		NMFS #3	USFW	0.66	CI	ND	J-1; AM-1
methomyl		NMFS #2	USFW	0.7		**0.02 (0%)**	J-6; AM6
methoxychlor	POI				AI		
methyl parathion		NMFS #3		0.25	CI	**0.00 (0%)**	J-0; AM-0
metolachlor	POI			1	CI	**0.173 (0%)**	
metribuzin	POI			1.29	ANVP		
metsulfuron methyl	POI			0.36	AVP		
mevinphos (phosdrin)			USFW				
molinate				105			
MSMA	POI						
myclobutanil	POI			830	ANVP		
naled		NMFS #3	USFW	0.045	CI	ND	J-9; AM-8
napropamide	POI			1100	CI		
norflurazone	POI			9.7	ANVP		
oryzalin		NMFS #5		15.4	AVP	**NA**	
oxamyl			USFW	27			
oxyfluorfen	POI			0.29	ANVP		
PCP	POI			0.6	AI		
pendimethlalin	POI	NMFS #5	USFW	5.4	ANVP	**0.046 (0%)**	
permethrin	POI		USFW	0.041	CI		
phenoxy herbicides	POI						
phorate		NMFS #3	USFW	0.21	CI	ND	J-6; AM-5
phosmet	POI	NMFS #3	USFW	0.8	CI	**0.00 (0%)**	J-6; AM-5
picloram	POI			550	CF		
profenphos			USFW	0.2			
prometon	POI			98	ANVP		
prometryn	POI			1	ANVP		
propachlor			USFW	13.5			
propargite	POI		USFW	9	CI		
propiconazole	POI			93	ANVP		

pyrethrin			USFW	0.86			
simazine	POI			36	ANVP	**0.379 (0%)**	
SSS-tributyl phosphorotrithioate			USFW				
sulfometuron methyl	POI			0.48	AVP		
tebuthiuron	POI			50	ANVP		
terbacil	POI			11	ANVP		
terbufos			USFW	0.03			
thiamethoxam	POI			17.5	AI		
thiobencarb		NMFS #6		1	CI	ND	J-0; AM-0
tralkoxydim	POI			2100	CI		
triadimeton	POI						
triallate	POI			13	CI		
trichlorfon			USFW	0.0057	CI		
triclopyr (BEE)	POI	NMFS #4		19	CF	0.00 (0%)	J-0; AM-0
trifluralin	POI	NMFS #5	USFW	1.14	CF	**0.028 (0%)**	J-6; AM-5

Footnotes

1. AF = Acute Fish OPP Benchmark; CF = Chronic Fish OPP Benchmark; AI=Acute Invertebrate OPP Benchmark; CI=Chronic Invertebrate OPP Benchmark; ANVP = Acute Non-vascular Plant (algae) OPP Benchmark; AVP=Acute Vascular Plant OPP Benchmark; CMC = EPA OW Acute Criterion; CCC = EPA OW Chronic Criterion

2. Jeopardy: an action that is likely to jeopardize or threaten the continued existence of an endangered or threatened species. Jeopardy in the BiOPs determined for 28 different Evolutionarily Significant Units (ESU) or Distinct Populations of salmonid species.

3. CMC = EPA-OW Aquatic Life Criteria: CMC = Maximum Acute Concentration; CCC = Continuous Chronic Concentration

4. 28 Total ESUs / 13 Oregon ESUs: **Chinook Salmon** (Lower Columbia, Snake River Fall-run, Snake River Spring/Summer run); **Chum Salmon** (Columbia River); **Coho Salmon** (Columbia River, Lower Columbia River, Oregon Coast, S. OR & N. CA Coast); **Sockeye Salmon** (Snake River); **Steelhead** (Lower Columbia River, Upper Willamette River, Middle Columbia River, Snake River)

5. Detection Frequency = *No. Detects/Total Samples across all watersheds*; **Benchmark or WQ Criteria Exceedance Rate** = *Detects exceeding Aquatic Life Benchmark or established WQ Criteria / Total No. Detects*

6. Yellow highlighted cells indicate pesticides that NMFS BioPs listed for jeopardy (J) to some salmonid ESUs or adverse modification (AM) of Oregon salmonid-bearing habitat.