Evaluation of **South Yamhill Pesticide Stewardship Partnership Area**

OREGON WATER QUALITY
PESTICIDE MANAGEMENT TEAM
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OWEB

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Executive Summary

Water quality samples were collected from October 2010 to October 2016 in the South Yamhill watershed as part of an Oregon Pesticide Stewardship Partnership project. The data was collected at three locations established at the downstream ends of the Agency Creek, Gold Creek and Rogue River watersheds. At each of these locations approximately 54 water quality samples were collected. The Oregon Department of Environmental Quality (DEQ) conducted analysis for approximately 130 individual pesticides for each collected sample. Additionally, data was obtained from a single passive sampling device (POCIS) installed at the Rogue River sampling location in October of 2010 for a period of twenty-eight days.

Analytical results from the collected samples indicate that application of forest herbicides, used in the commercial forestry industry, resulted in detections of residues of 6 herbicides or herbicide degradates. Two other pesticide ingredients detected in samples stream are not associated with commercial forest use. The overall frequency of detections within the entire South Yamhill Pesticide Stewardship Partnership (SYPSP) varied by herbicide and ranged from a low of .6% (1 detection out of 157 samples) for imazapyr to a high of 5.2% (8 detections out of 153 samples) for the degradate desethylatrazine. Individual analysis of the three sub-basins yielded slightly different results. POCIS sampling detected three herbicides not detected through water quality sampling conducted during the 28-day period of device deployment at one of the monitoring locations. A grab water sample collected at the same location during POCIS deployment period resulted in no detections.

During the sampling period no detections were identified above the Environmental Protection Agency (EPA) aquatic life benchmarks [1]. For those samples where an herbicide was detected, the percentage of the current EPA benchmark ranged from a low of .00002% for the glyphosate degradate aminomethylphosphonic acid (AMPA) to a high of 14% for metsulfuron methyl. Additionally, based on a review of the existing monitoring data the SYPSP is considered to lie within the low concern category as determined by the EPA approved pesticide management plan for Oregon [2].

The water quality data collected within the SYPSP provides an insight into herbicide occurrences as a result of commercial forest application within Western Oregon. Additional monitoring efforts that use and consider more refined pesticide application and timing information, such as, stream discharge data to calculate herbicide loading estimates, and additional monitoring techniques to compliment periodic sampling would allow for additional certainty of the occurrence and concentrations of herbicides in watersheds with not only commercial forestry activity but all watersheds participating in the Pesticide Stewardship Partnership.

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[1]Samples collected from the Agency Creek monitoring location indicated the presence of the insect repellant DEET. These results are not included here due to questions regarding their presence. The single detection of the aquatic herbicide fluridone at the Gold Creek site in April 2012 is currently under investigation. It is not registered for use in forestry applications.

Introduction

Pesticide Stewardship Partnership Program

The Pesticide Stewardship Partnership (PSP) program is an element of the State of Oregon's Pesticide Management Plan for Water Quality Protection. This "Plan" was approved by the EPA in 2011. The plan utilizes local expertise combined with water quality sampling results to promote pesticide use which protects surface and groundwater resources. Participation in the program is voluntary and relies on the coordination of state, local and tribal agencies, landowner, watershed and grower organizations. Initially, at the request of local stakeholders the state is invited to assess the quality of water bodies within a potential area of concern in regards to pesticide occurrence. When sampling detects the presence of pesticide residues in those resources the results of the sampling are assessed as to the need for changes in pesticide use and practices.

Sampling results can lead to:

1. Cooperative development and implementation of voluntary pesticide management measures to reduce or eliminate pesticide residues in watersheds.
2. Verification that pesticide use under current management has little to no impact on the aquatic resources within the PSP area.
3. Providing information that may highlight the need for modifications in sampling that could better characterize potential pesticide concerns.

The success of the program is dependent upon strong coordination and cooperation between regulatory agencies, tribes, landowners and grower groups, other stakeholder organizations and pesticide applicators. This coordination is necessary to understand current pesticide application practices that may have significant bearing on water quality results. Currently there are nine established PSP areas within the State of Oregon and two areas currently under pilot project assessment. A majority of these areas contain multiple land uses including agricultural, urban, forestry, and industrial. Each of these land uses employ the use of pesticides to some extent in the management of properties.

The SYPSP is unique in that it is the only currently designated PSP where the majority of land use is commercial forestry. This fact has allowed the assessment of the potential impact of pesticide applications for a single land use without potential interference from other uses that may employ similar pesticides. Within the SYPSP the majority of pesticide use is confined to herbicides, a class of pesticides targeting unwanted plants.

Overview

The SYPSP encompasses approximately 140 square miles of primarily forested lands located in northwest Oregon along the eastern slope of the Coast Range. Table 1 illustrates the basic land use characteristics of the entire SYPSP as specified in the 2011 National Land Cover Database. Within the SYPSP three sub-basins were included in the study, Agency Creek, Gold Creek and the Rogue River.

Table 1: Land Use Classification within South Yamhill PSP Sub-Basins

AGENCY CREEK

LAND USE	PERCENT ACREAGE
Forest	96.4
Urban	1.5
Other	2.1
Agriculture	0

GOLD CREEK

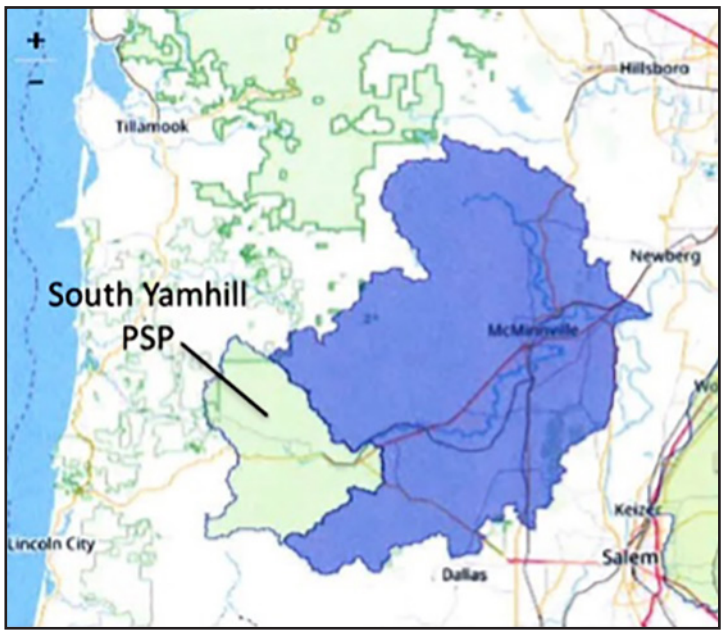
LAND USE	PERCENT ACREAGE
Forest	94.7
Urban	3.3
Other	1.8
Agriculture	.2

ROGUE RIVER

LAND USE	PERCENT ACREAGE
Forest	86.8
Urban	8.6
Other	4.4
Agriculture	.2

Areas classified as other may include lands such as wetlands, grasslands, water, scrublands, and barren lands. Within the agricultural classification, crops that appear within the entire SYPSP include grass/hay and grass for livestock consumption and small Christmas tree parcels.

Figure 1: South Yamhill PSP



In 2010 the Oregon Department of Environmental Quality (DEQ) and the Oregon Department of Forestry (ODF) began discussions with the Confederated Tribes of the Grand Ronde and forest landowners to evaluate potential impacts to surface water bodies from herbicides used in the commercial forestry industry. The South Yamhill was selected because of the connection to the on-going PSP work in the central part of the Yamhill River Basin (near the City of McMinnville, Oregon) and the level of private forest management activities by multiple land owners.

DEQ and ODF met with forest land owners as well as officials from the Confederated Tribes of the Grand Ronde to identify appropriate sites to conduct water quality monitoring. The locations of these sites were selected to isolate (to the greatest extent possible) lands used solely for commercial forestry operations. Monitoring began in October 2010 at three sites. A follow-up meeting in 2014 provided study participants an enhanced understanding from forest land owners of the specific herbicides used and a more refined application timing employed.

Herbicide Applications in Forest Operations

Pesticide application within the SYPSP is limited to the use of herbicides unless specific concerns arise related to known or potential insect damage. The majority of herbicides are applied either through aerial application or ground-based spraying. Aerial applications are the preferred method of herbicide delivery for larger areas and allow for shorter application periods and greater coverage.

The list of herbicides predominately used in the SYPSP by the forest industry is limited and generally consist of the following:

Table 2: Herbicides Predominately Used by Forest Industry

HERBICIDE TRADE NAME	ACTIVE INGRDIENT
Alligare Glyphosate, Rodeo	glyphosate
Alligare Rotary 2 SL, Nufarm Polaris SP	imazapyr
AAtrex	atrazine
Escort XP	metsulfuron-methyl
Oust XP	sulfometuron methyl
Velpar	hexazinone

The application of herbicides following timber harvests is conducted to control undesirable plant species that outcompete newly planted tree seedlings. These applications predominantly occur in the spring and in the fall. Within the first few years of a timber rotation in a managed western Oregon Douglas-fir / hemlock forest, herbicides are typically applied 1-3 times during site preparation and competitive release applications.

Figure 2: Proposed Aerial Application Units for South Yamhill PSP 2010-2017

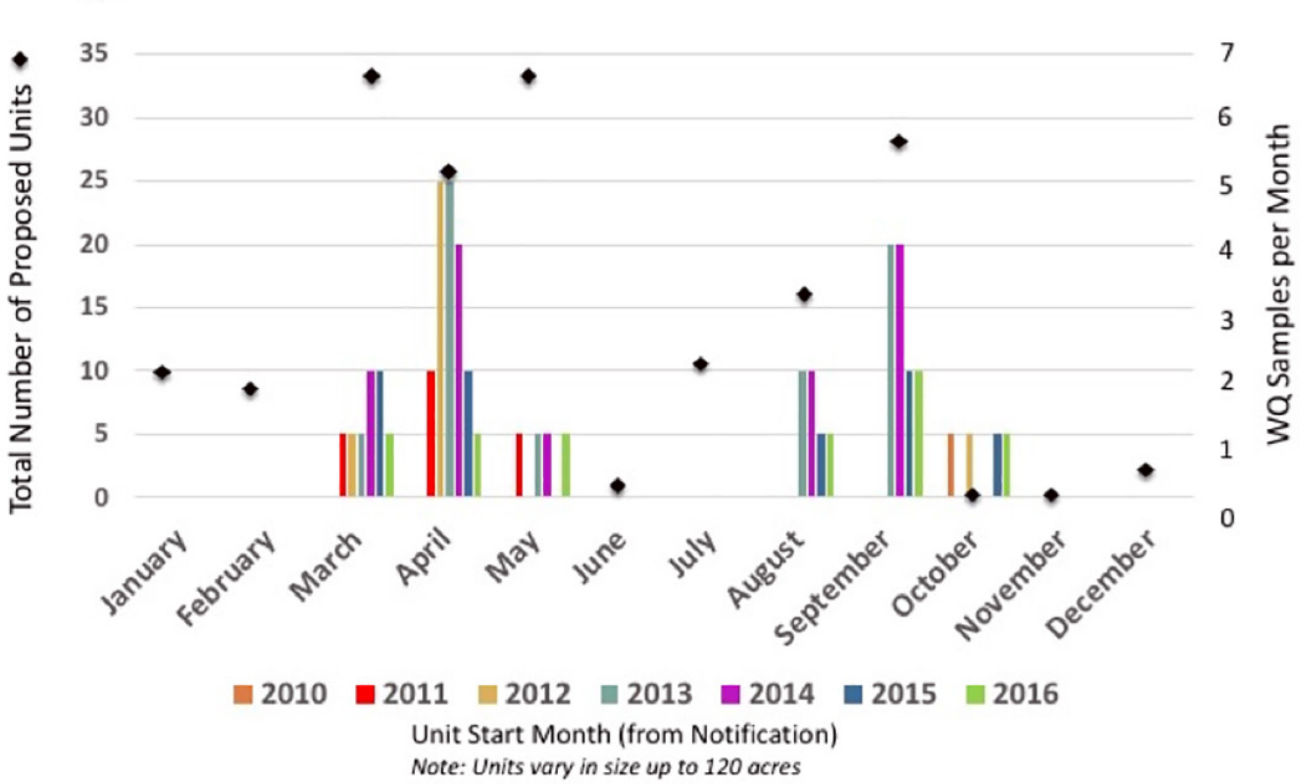


Figure 2 illustrates the relationship between proposed application of herbicides on forest units within the entire SYPSP and the collection of water quality samples during the period 2010-2016. Units are listed as proposed due to the fact that under Oregon's Forest Practices Act land owners are required to notify ODF of proposed pesticide applications and list all pesticide applications that may occur during a specific calendar year. The actual application of herbicides may or may not occur during a specific timeframe. However, data and conversation with landowners generally suggest two windows for applications, spring and fall.

Water Quality Monitoring

Site Selection and Timing

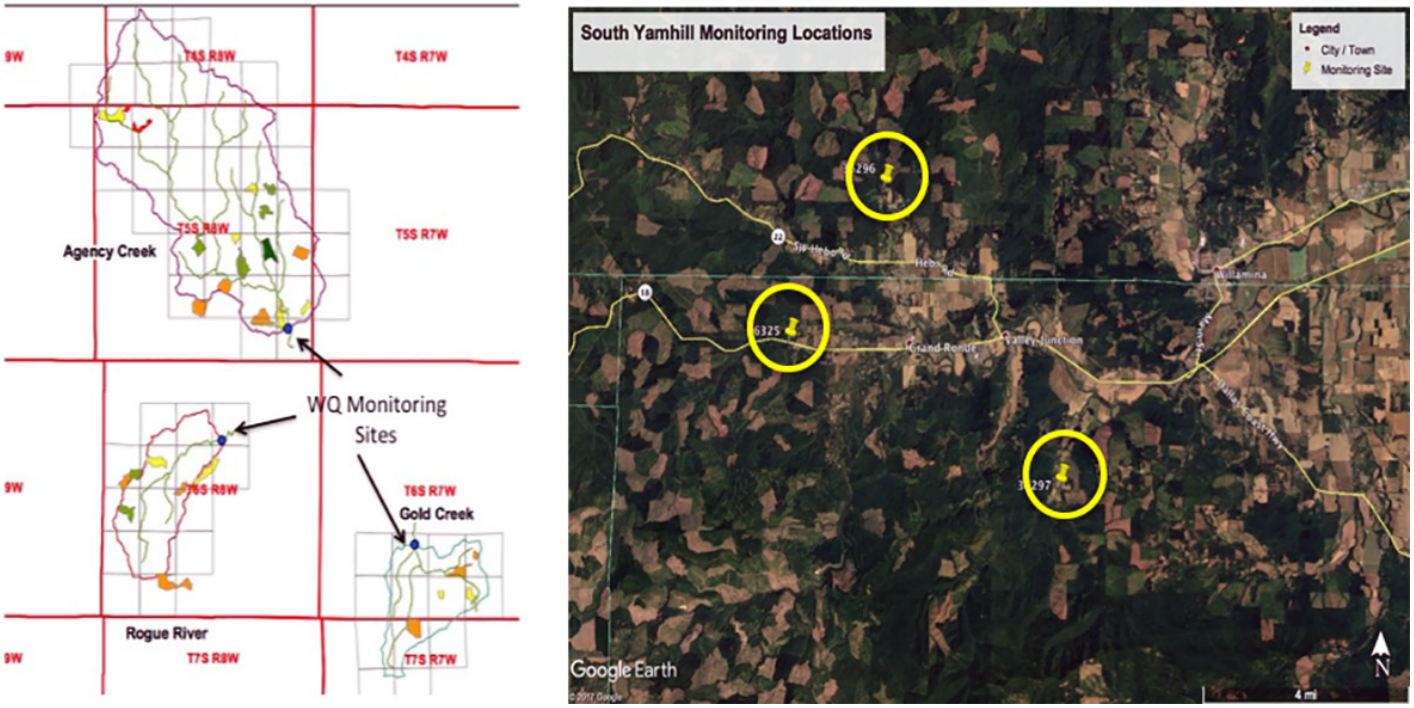
The three monitoring sites selected were characterized as “integrator” sites, or sites located at the lowest point in each of the sub-basins that exist within the SYPSP. These sites were selected such that samples collected provide an indication of water quality from the largest area possible above that sampling location.

Table 3: Locations of Water Quality Sampling Sites

ODEQ STATION ID	SUB-BASIN	LATITUDE / LONGITUDE
36296	Agency Creek	45.09812 / -123.62009
36297	Gold Creek	45.02487 / -123.54897
36325	Rogue River	45.06022 / -123.65803

Latitude and longitude based on NAD83 datum

Figure 3: Water Quality Monitoring Sites



Land use within the SYPSP presents a unique challenge for water quality sampling in that pesticide application(s) while generally having a seasonal pattern, are not conducted at specific predictable spatial locations or during routine, cyclic periods during the year. Rather the location of applications is likely to occur coincident after tree harvest, and for a few years thereafter, which differs from application schedules existing for other land uses namely agriculture for which application windows have been demonstrated to be relatively narrow, defined and annual. This difference results in more sporadic, less frequent pesticide application and makes sampling designed for residue capture more challenging.

In evaluating the sampling results, the authors of this report utilized data provided by ODF to link sampling results with general timeframes of timber harvest and likely herbicide applications. Sampling results and application records indicate most applications likely occurred between March 1 and May 30 and again during September 1 through October 31 (see figure 2).

Timing of sample collection was done with emphasis on spring and fall sampling based on information from forest landowners participating in the study. In addition to sample collection, a passive sampling device (Polar Organic Chemical Integrative Sampler or "POCIS") was deployed for one month at the Rogue River location in the fall of 2010. The intent of using this device was to detect pesticides over a continuous 30-day period that might otherwise be missed on days when water quality samples were not collected. POCIS samplers have been successfully deployed by DEQ in at least one other watershed (Hood River)[3].

Pesticides of Interest

Table 4: General Pesticide Application Timing and Acreage

SPRAY DATE START	SPRAY DATE END	SPRAY WINDOW (DAYS)	POTENTIAL ACREAGE	DETECTIONS	SUB WATERSHED
5/13/15	9/3/15	113	136	0	Agency Creek
5/13/15	12/31/15	232	118	0	Gold Creek
12/17/14	12/31/15	380	298	6	Rogue River
3/26/16	12/31/16	281	618	0	Agency Creek
3/26/16	12/31/16	281	321	0	Gold Creek
3/31/16	12/30/16	275	249	0	Rogue River

Beginning in 2015, more specific data was made available regarding application timing from ODF's electronic notification system. Herbicide application could occur at any time during the timeframe indicated in Table 4.

The water quality samples collected were analyzed for approximately 130 different pesticides. Initially, the relevant analytes included atrazine, imazapyr, hexazinone, triclopyr, and 2,4-D. Substantially lower analytical detection limits were achieved for triclopyr and 2,4-D in 2014 as the result of different analytical methods employed by the DEQ laboratory.

Partway through 2012, the herbicide sulfometuron methyl was added to the analytical suite followed by metsulfuron-methyl and glyphosate in spring 2014. In addition to the parent compounds, degradates (or breakdown products) for atrazine and glyphosate were also analyzed. It should be noted that there were difficulties consistently recovering imazapyr concentrations at low levels in the Laboratory, which resulted in an elevated reporting limit for this compound compared to similar compounds.

Throughout the period of monitoring six herbicides one insect repellent and two degradates were detected in water quality samples:

- atrazine
- DEET[2]
- hexazinone
- fluridone[3]
- imazapyr
- metsulfuron-methyl
- sulfometuron methyl
- aminomethylphosphonic acid (AMPA) — degradate of glyphosate
- desethylatrazine — degradate of atrazine

The analysis of the POCIS device deployed for one month in fall 2010 at the Rogue River location detected triclopyr in addition to atrazine and hexazinone.

As presented in Table 5 the detection frequency of the forest herbicides and degradates ranged between 0.6% and 5.2% (based on the number of samples taken). Fewer samples of metsulfuron-methyl and AMPA were analyzed due to the fact they weren't added to the list of analytes until 2014.

The detection of the insect repellent DEET appeared in several samples during the course of the study. Originally it was thought to have occurred due to contamination from sampling staff. However further review of data from the SYPSP as well as a review of all samples collected statewide within numerous watersheds indicate that it's presence is likely due to contamination from sources other than sample contamination. It should be noted the presence of DEET does not necessarily indicate its source is from commercial forest operations within the SYPSP.

Table 5: Water Quality Sample Monitoring Results SYPSP

HERBICIDE	NUMBER OF SAMPLES	NUMBER OF DETECTIONS	DETECTION FREQUENCY %	AQUATIC LIFE BENCHMARK µg/L	NUMBER OF BENCHMARK EXCEEDENCES
atrazine	183	6	3.3	1	0
AMPA	63	1	1.6	249500	0
DEET	168	3	1.8	37500	0
desethylatrazine	153	8	5.2	N/A	N/A
fluridone	168	1	.6	480	0
hexazinone	168	3	1.8	7	0
imazapyr	157	1	.6	24	0
metsulfuron-methyl	57	2	3.5	.36	0
sulfometuron methyl	153	4	2.6	.45	0

Comparison to Benchmarks

Pesticide aquatic life benchmarks have been developed by the EPA for over 500 pesticides. These benchmarks are advisory in nature and are not intended to be used in a regulatory context. However, they provide a "uniform standard" by which states can measure analytical results. The benchmarks are used by the WQPMT for evaluating sampling results. The results in the right-hand column in Table 5 are based upon the benchmarks, as they existed on December 1, 2017.

None of the analytical data collected within the SYPSP exceeded an aquatic life benchmark. Two results (metsulfuron-methyl at Rogue River on September 9, 2015) and atrazine at Gold Creek in May 2011) exceeded 10% of the lowest benchmark[4].

Benchmarks are also used to derive an aquatic life ratio (ALR). This is a ratio of the highest laboratory result divided by the lowest aquatic life benchmark for a particular pesticide or degradate.

Aquatic Life Ratio = Analytical Result (µg/L) / Lowest EPA Aquatic Life Benchmark (µg/L)

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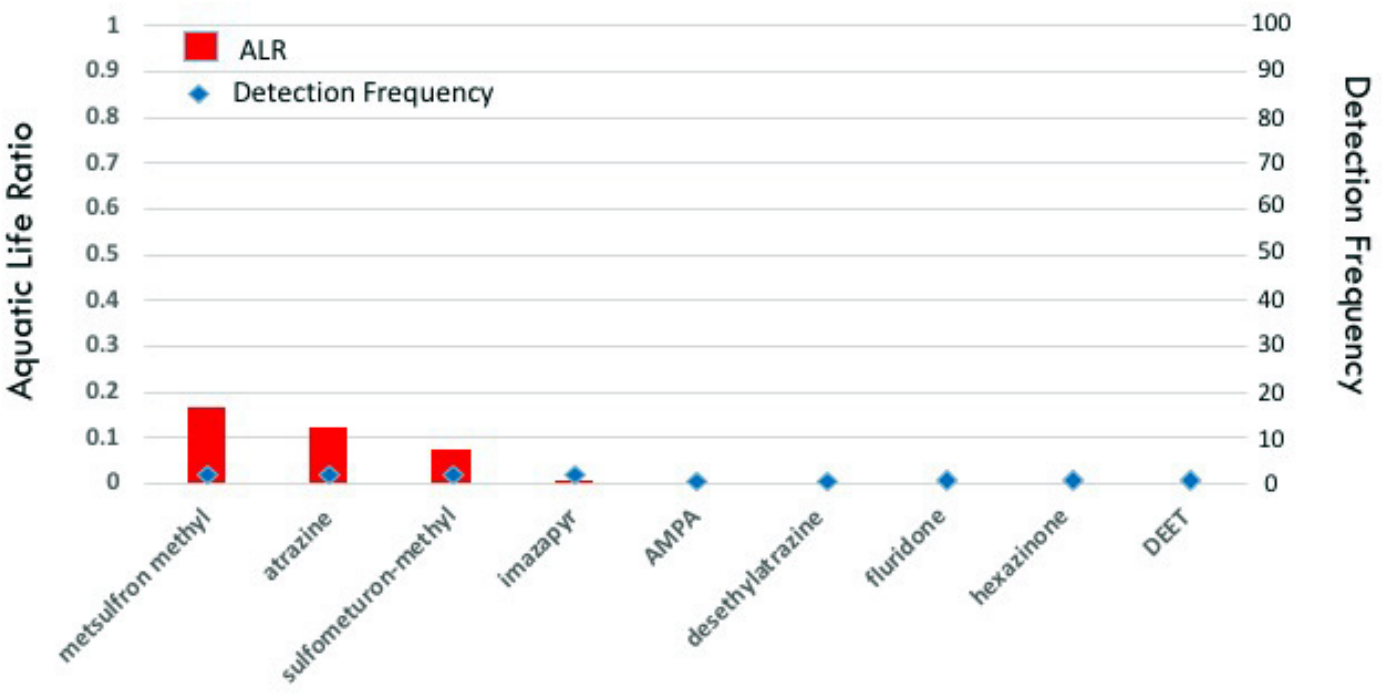
[2] DEET or N,N-diethyl-meta-toluamide was also found once at the Agency Creek site and twice at the Gold Creek site. DEET is an insect repellent providing protection against mosquitoes, ticks, fleas, chiggers, leeches, and many biting insects.

[3] Furidone is an aquatic herbicide not labeled for use in commercial forestry operations. Its presence in the analytical sampling is not attributed to forestry operations.

[4] Metsulfuron-methyl occurred at 14% of benchmark (.36 µg/L) and atrazine occurred at 10.9% of benchmark (1.0 µg/L)

Figure 4: Aquatic Life Ratio for Pesticide Detections within the South Yamhill PSP



Any result nearing the number 1 is cause for concern and indicates potential effects on aquatic life suggesting a change in a management measure(s) or application method is warranted. ALR's between 1 and .5 may indicate further investigation as to the effectiveness of current management measures and/or application methods is warranted. Figure 4 illustrates the aquatic life ratio calculated for each of the pesticides detected in the SYPSP. The water quality monitoring data collected in the SYPSP indicates the ALR never exceeded .175.

Uncertainties Associated with Water Quality Data

Water quality samples collected as part of the PSP program are generally obtained through the use of grab sample techniques. Grab sampling for pesticide residues is the predominate method employed by federal and state agencies for reconnaissance studies like those conducted as part of the PSP sampling activities.

Grab sampling is a technique in which a single sample or measurement is taken at a specific time. This technique provides an immediate sample and is preferred for the constituents of concern in the PSP program. The primary advantage of grab sampling is that set-up costs are small and sample scheduling can be easily modified to account for application or weather events.

Use of grab samples for water quality collection does have several disadvantages over more extensive and expensive monitoring techniques. A grab sample takes a snapshot of the characteristics of the water at a specific point and time, so it may not be completely representative of the entire flow of the water body being sampled. Because they represent a snapshot in time, results can be influenced by stream flow, weather conditions leading up to and following pesticide application, timing of the collection in relationship to pesticide applications, and distance from sampling location from pesticide application areas. The disadvantages noted above can contribute to uncertainties in applying laboratory results to characterizations of land use influences related to pesticide use. To be clear the uncertainties lie not with the laboratory results themselves but how those results are applied to characterizations of land use.

Uncertainties as to pesticide contributions to surface waters upstream of land uses can be reduced by addressing some if not all of the disadvantages listed above. Specifically:

- Include the measurement of stream flow at the time of sample collection to allow for loading measurements and for the ability to perform flow-weighted analysis on concentration data
- Schedule sampling events as close to pesticide application as possible to reduce or eliminate factors such as pesticide degradation and dilution

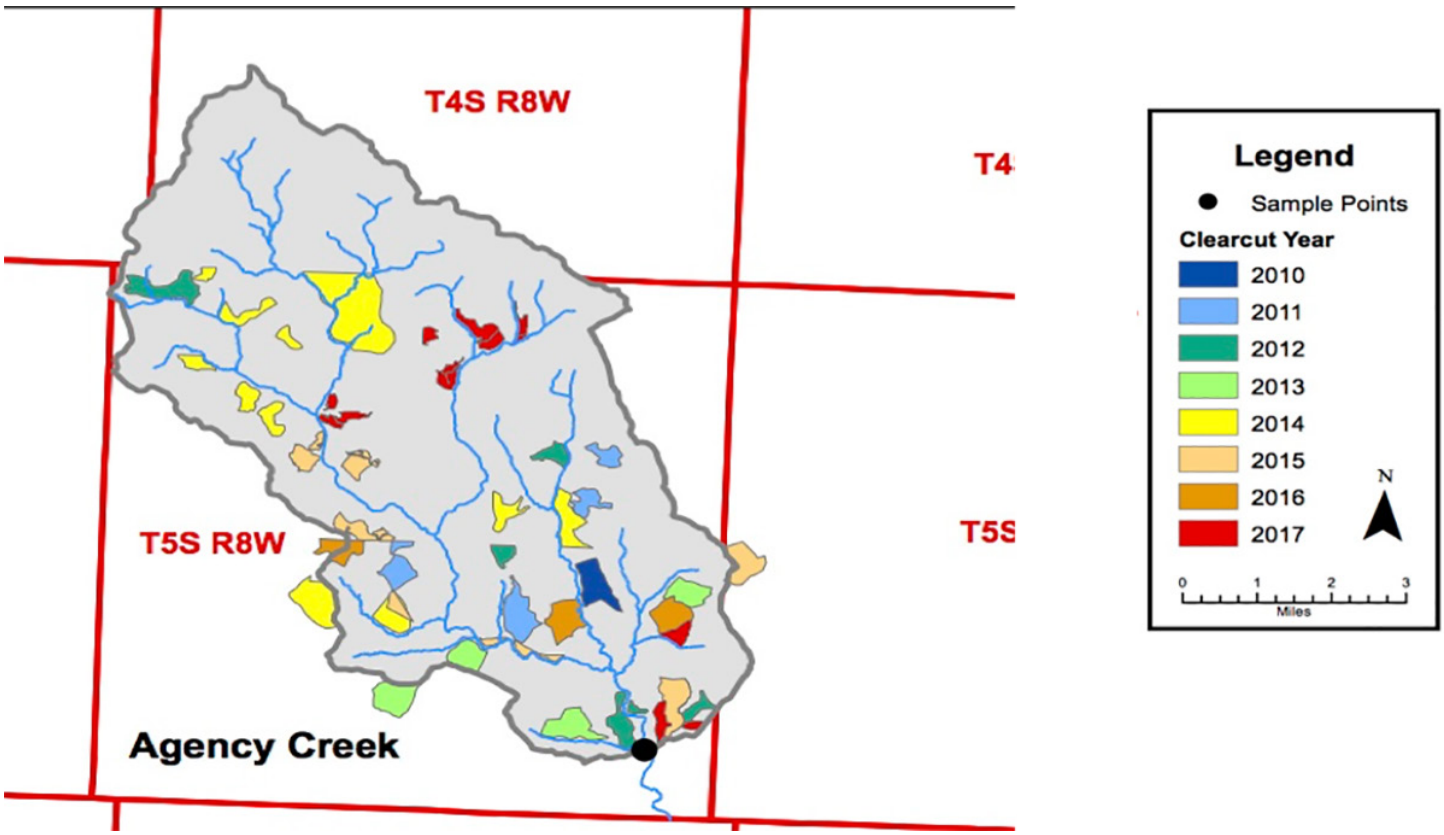
The WQPMT is currently evaluating how to decrease uncertainties with sampling in all PSP areas.

Sub-Watershed Analysis

Agency Creek

The Agency Creek sub-watershed is the largest of the three sub-basins monitored in the SYPSP. The sub-watershed encompasses approximately 16080 acres the majority (96%) of which is in forested land use.

Figure 5: Agency Creek Sub-Watershed and Harvest History



On average, approximately 2% of the land area is subject to harvest in any given year[5]. Herbicide application is estimated to be approximately double the harvest acreage or 4% of the watershed area. Figure 5 illustrates harvest areas from 2010 to 2016 that provide the potential for herbicide application. Table 6 presents information on the total number of herbicide applications reported and the number of water quality samples collected within the Agency Creek watershed.

[5] *Data provided by Oregon Department of Forestry (2017)*

Table 6: Agency Creek Pesticide Application and WQ Sampling History

ACTIVITY	2010	2011	2012	2013	2014	2015	2016
Harvest Parcels	1	5	6	4	11	6	3
Applications	9	7	11	6	5	13	9
WQ Samples	1	4	10	12	13	7	7

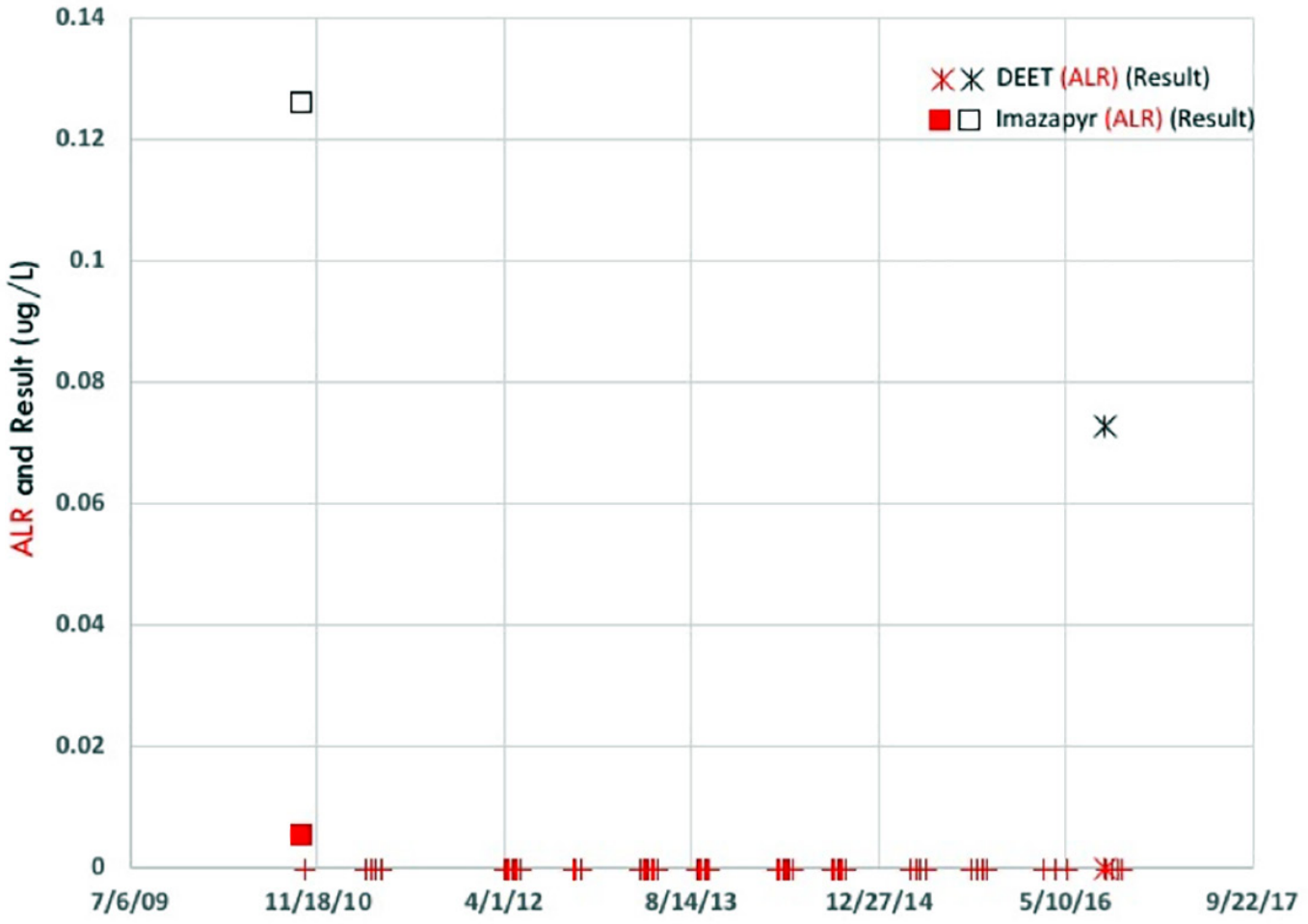
The number of water quality samples specified in Table 6 refer to the number of samples that were obtained per year for a total of 54 at each monitoring station.

This information indicates that in addition to application that may occur following harvest operations, additional parcels can and do receive herbicide treatments in any given year based on threat to the harvestable crop. It is also important to note that herbicide applications filed with the ODF electronic notification system (FERNS) may not actually occur. Water quality monitoring results in the sub-watershed indicate 1 herbicide detection during the study.

Table 7: Agency Creek Pesticide Detections 2010-2016

PESTICIDE	DATE	CONCENTRATION µg/L	AQUATIC LIFE BENCHMARK µg/L	% OF AQUATIC LIFE BENCHMARK	AQUATIC LIFE RATIO
imazapyr	10/12/10	.126	24	.5	.005
DEET	8/22/16	.73	37500	.002	.00002

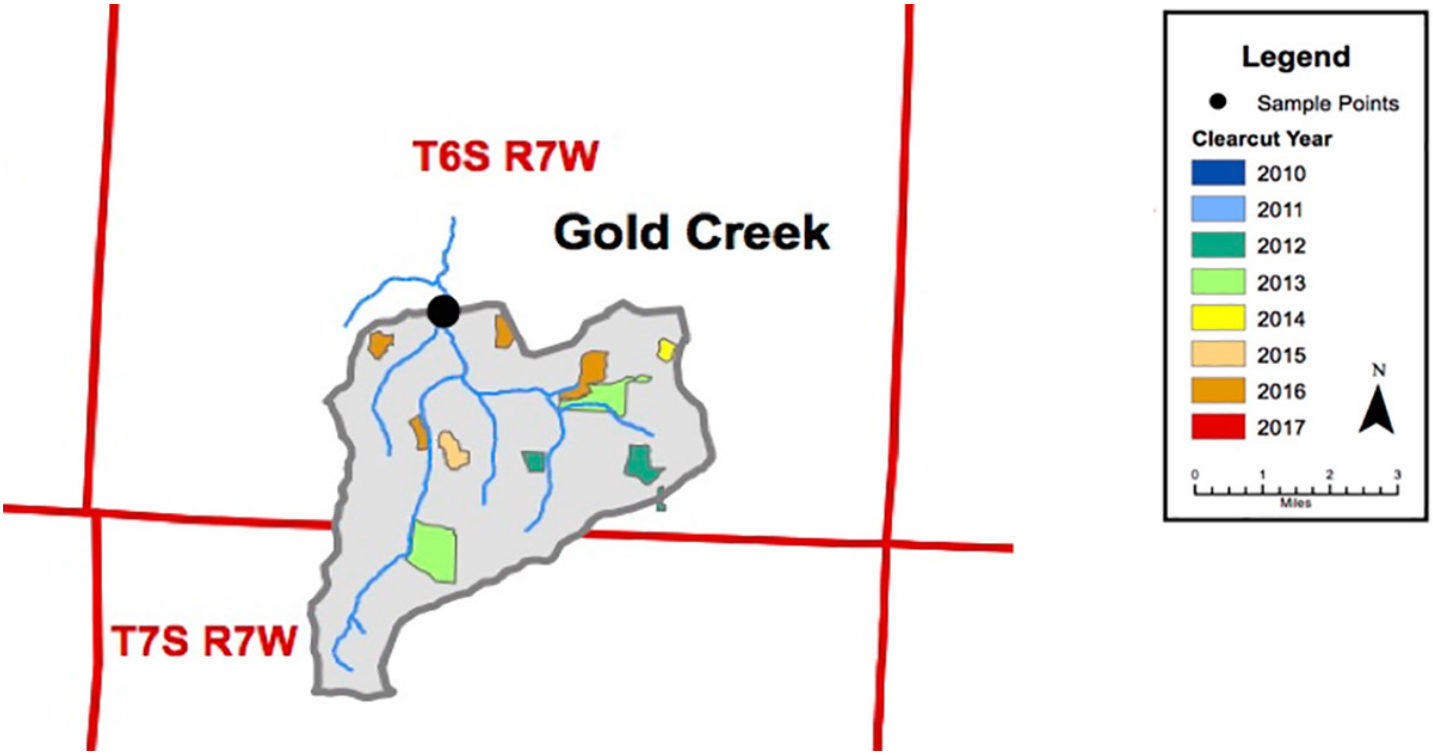
Figure 6: Graphical Water Quality Monitoring Results and Aquatic Life Ratio for Agency Creek



Gold Creek

The Gold Creek sub-watershed is the smallest of the three sub-basins monitored in the SYPSP. The sub-watershed encompasses 3470 acres with a majority (95%) of that acreage in forested land use.

Figure 7: Gold Creek Sub-Watershed and Harvest History



On average, approximately 5-6% of the land area is subject to harvest[6]. Herbicide application may reach 12-14% of the land area in any given year. Figure 7 illustrates the harvest areas from 2010 to 2016 which illustrate a potential for herbicide application.

Table 8: Gold Creek Pesticide Application and WQ Sample History

ACTIVITY	2010	2011	2012	2013	2014	2015	2016
Harvest Parcels	0	0	3	2	1	1	4
Applications	7	5	5	6	3	7	7
WQ Samples	1	4	10	12	13	7	7

The number of water quality samples specified in Table 8 refer to the number of samples that were obtained per year for a total of 54 at each monitoring station

Table 9 illustrates the results of water quality monitoring conducted at the Gold Creek monitoring location.

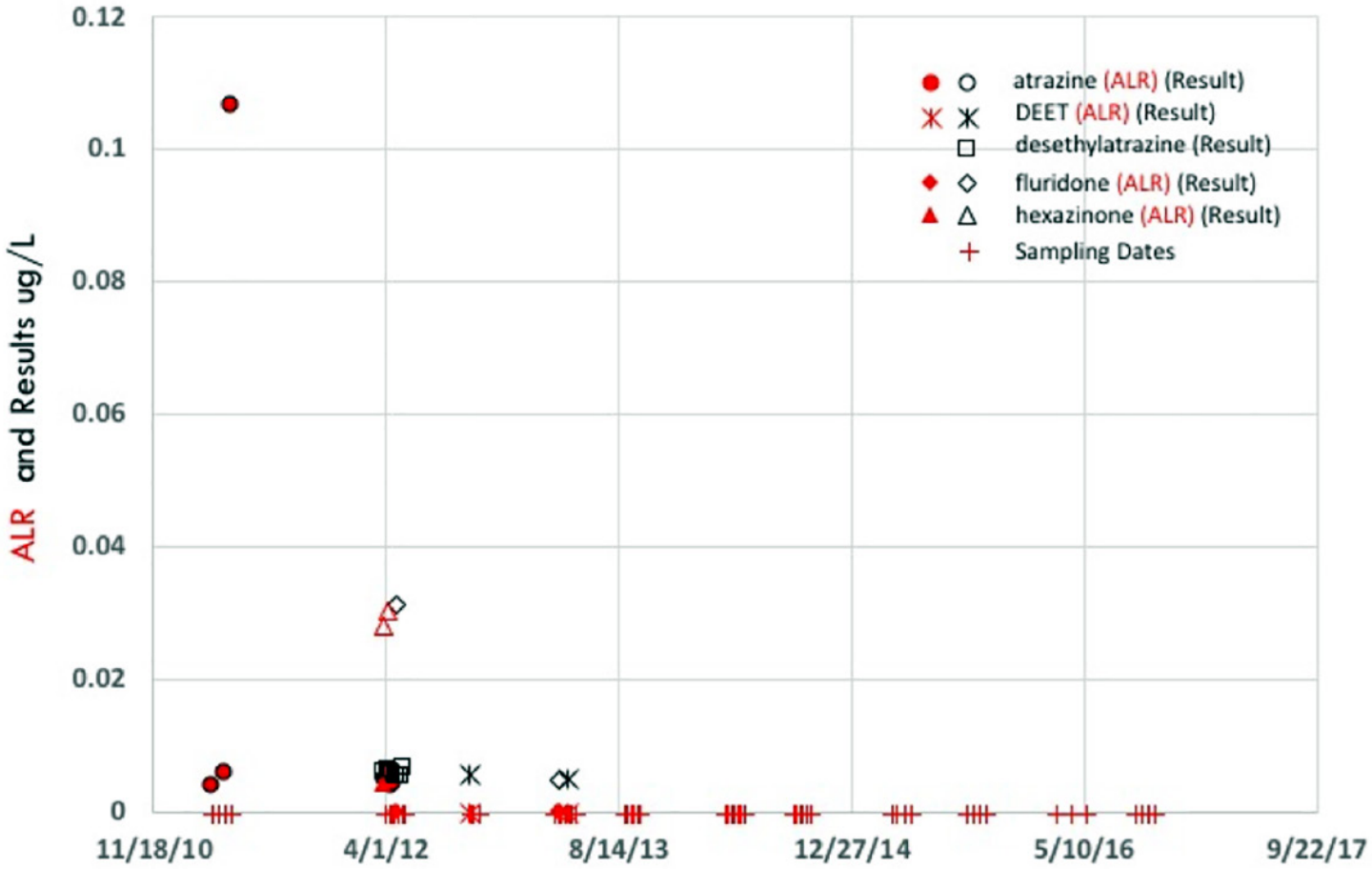
[6] *Data provided by Oregon Department of Forestry (2017)*

Table 9: Gold Creek Pesticide Detections 2010-2016

PESTICIDE	DATE	CONCENTRATION µg/L	AQUATIC LIFE BENCHMARK µg/L	% OF AQUATIC LIFE BENCHMARK	AQUATIC LIFE RATIO
atrazine	3/21/11	.004	1	.4	.004
	4/18/11	.0061	1	.61	.0061
	5/2/11	.107	1	10.7	.107
	3/26/12	.0052	1	.52	.0052
	4/2/12	.0065	1	.65	.0065
	4/9/12	.0042	1	.42	.0042
	4/15/12	.0043	1	.43	.0043
DEET	9/24/12	.0059	37500	<.00001	<.000001
	4/24/13	.0052	37500	<.00001	<.000001
desethylatrazine	3/26/12	.006	NA	NA	NA
	4/2/12	.0062	NA	NA	NA
	4/9/12	.006	NA	NA	NA
	4/9/12	.0057	NA	NA	NA
	4/23/12	.0054	NA	NA	NA
	4/30/12	.0054	NA	NA	NA
	5/7/12	.0068	NA	NA	NA
fluridone	4/23/12	.0313	480	.007	.00007
	4/8/13	.0048	480	.001	.00001
hexazinone	3/26/12	.028	7	.4	.004
	4/2/12	.0303	7	.43	.0043

The Gold Creek sub-watershed has the greatest percentage of potential application area of the three sub-basins (due to application area and size of the sub-watershed). The number of detections are higher than in either the Agency Creek or Rogue River sub-watershed. It should be noted that a large number of degradate results (desethylatrazine) are included in this finding. This tends to indicate that application of triazinine herbicides had occurred shortly before sampling took place. This gap in time would allow for degration of the parent herbicides atrazine or simazine (both registered for use on conifers in Oregon) to occur prior to sampling.

Figure 8: Graphical Water Quality Monitoring Results and Aquatic Life Ratio for Gold Creek



Rogue River

The Rogue River sub-watershed is the second largest of the three sub-basins monitored in the SYPSP. The sub-basin encompasses 3760 acres. Based on evaluation of land cover, a majority (87%) of that acreage is forested land use.

On average, 4-5% of the land area is subject to harvest in any given year. Annual herbicide application is estimated to be approximately 8-9 % of the watershed area. Figure 9 illustrates the estimated harvest areas from 2010 to 2016 that provide the potential for herbicide application in future years. Table 10 presents information on the total number of herbicide potential applications reported within the Rogue River sub-watershed.

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[7] *Data provided by Oregon Department of Forestry (2017)*

Figure 9: Rogue River Sub-Watershed and Harvest History

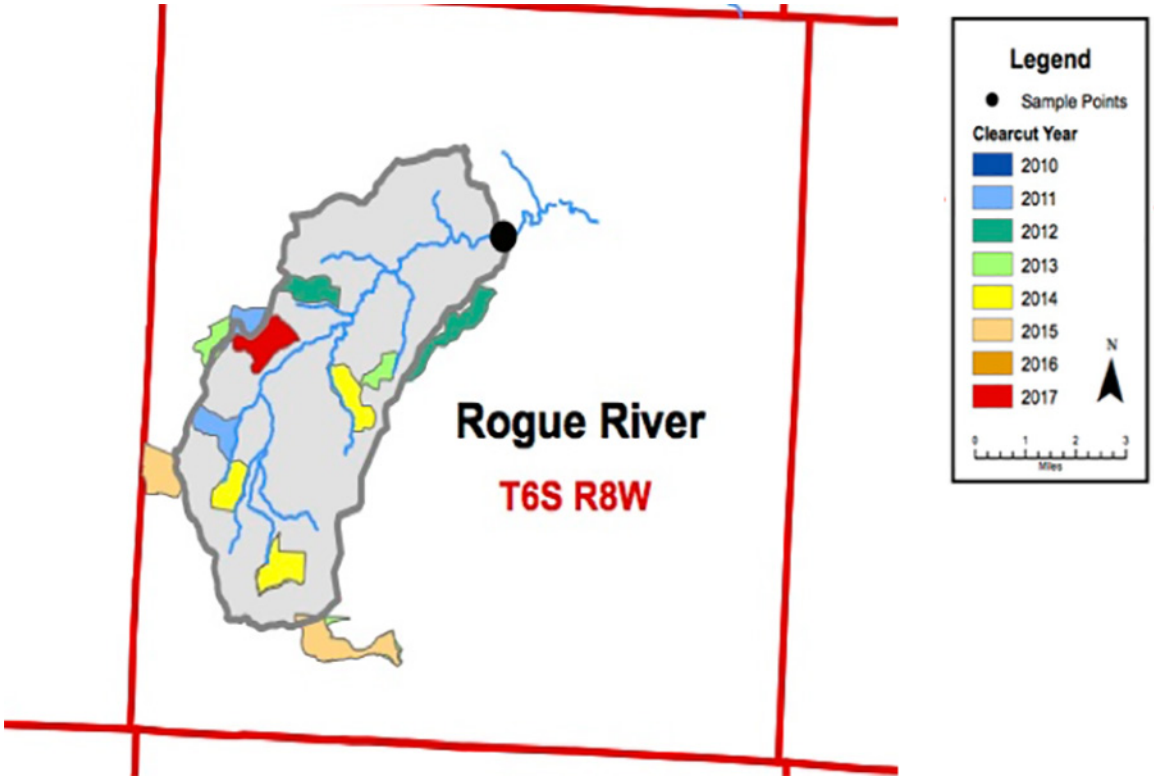


Table 10: Rogue River Pesticide Application and WQ Sampling History

ACTIVITY	2010	2011	2012	2013	2014	2015	2016
Harvest Parcels	0	2	2	2	3	2	0
Applications	14	11	12	8	9	7	5
WQ Samples	1	4	10	12	13	7	7

The number of water quality samples specified in Table 10 refer to the number of samples that were obtained per year for a total of 54 at each monitoring station

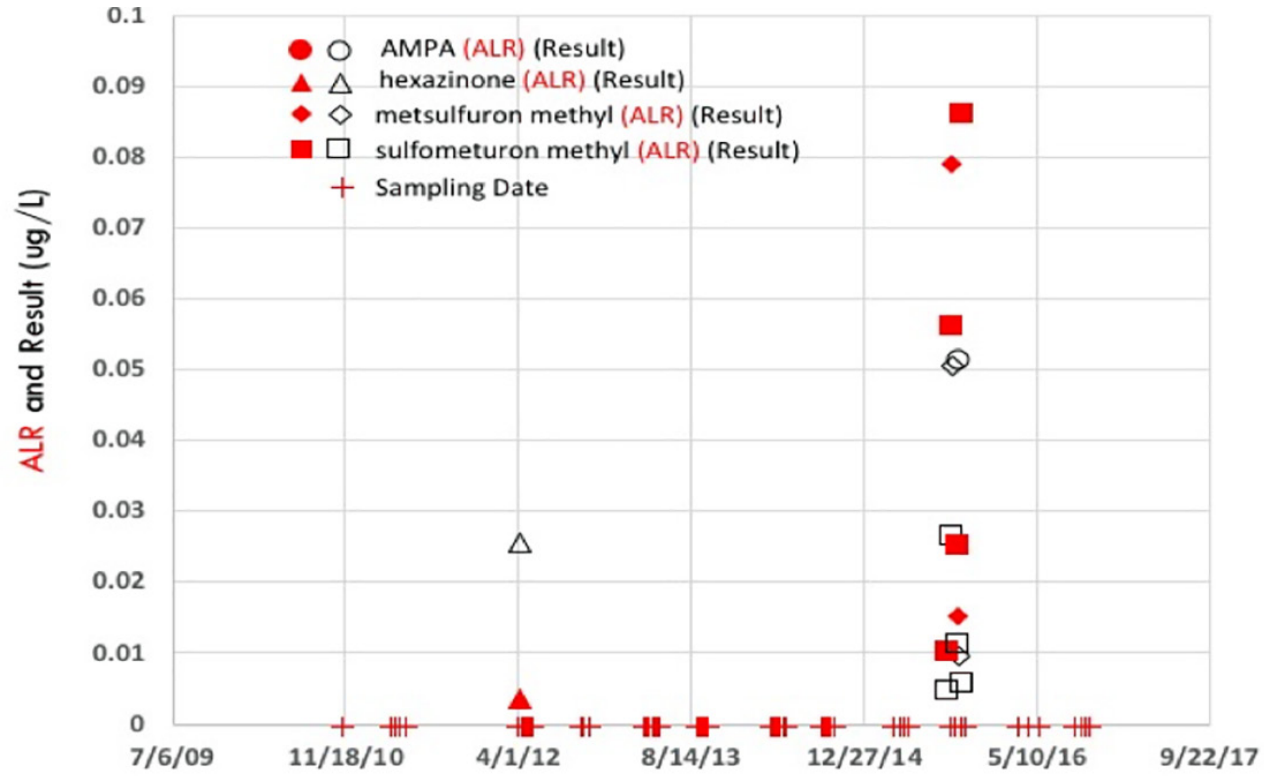
This information indicates that in addition to application that may occur on parcels following harvest operations, additional parcels can and do receive herbicide treatment in any given year. This appears to be the case for each of the sub-watersheds within the SYPSP.

Table 11: Rogue River Pesticide Detections 2010-2016

PESTICIDE	DATE	CONCENTRATION µg/L	AQUATIC LIFE BENCHMARK µg/L	% OF AQUATIC LIFE BENCHMARK	AQUATIC LIFE RATIO
AMPA	9/24/15	.051	249500	.5	.005
hexazinone	4/2/12	.026	7	.37	.0037
metsulfuron-methyl	9/9/15	.051	.36	14.2	.142
	9/24/15	.0099	.36	2.5	.028
Sulfometuron methyl	8/26/15	.0046	.45	1	.0102
	9/9/15	.027	.45	6	.06
	9/24/15	.011	.45	2.4	.024
	10/7/15	.0055	.45	1.2	.012

Water quality monitoring results in the sub-watershed indicate few herbicide detections. Those that have been detected have been at low frequencies and concentrations. A majority of these detections occurred in the early to mid fall of 2015. Additional information is not avaliable that would aid in determining the reason(s) for the relatively high number of detections during that period.

Figure 10: Graphical Water Quality Monitoring and Aquatic Life Ratio Results for Rogue River



In October 2010, DEQ deployed a POCIS sampling device for 28 days in the Rogue River at Highway 18, starting on October 6th. On October 12, 2010 one water quality sample was collected and 105 pesticides were analyzed from that sample. No detections were found in the sample collected; however, the POCIS analysis of the same analytical suite showed three herbicides were detected at low levels: atrazine, hexazinone and triclopyr. These results indicate either the analyses of the grab sample were not sensitive to detect the presence of the herbicide residues or residues were present at times other than October 12th indicating applications occurred at time not coincedent with scheduled water quality sampling. These results are reported as nanograms/POCIS and don't correlate with in-water concentrations. The results from the passive sampling devices are only useful to confirm presence of pesticides.

Table 12: POCIS Monitoring Results October 2010 — Rogue River

PESTICIDE	DATE OF DEPLOYMENT	ANALYTICAL RESULT µg/L/POCIS
atrazine	Fall 2010	.00142
hexazinone	Fall 2010	.0143
triclopyr	Fall 2010	.00622

Detection of Degradates

In 2012 and 2015 breakdown products of two herbicides were detected, desethylatrazine (breakdown product of triazinine herbicides) and aminomethylphosphonic acid or AMPA (breakdown product of glyphosate). Detection of these compounds indicate that the parent herbicides (triazinine herbicides and glyphosate) were applied at some recent time prior to sampling. Detected concentrations of degradates are the result of dilution, and decomposition due to environmental factors (sunlight, dissolution, etc.). In reviewing the analytical results, the presence and concentration of herbicide degradates are included in the results and are considered as part of the overall picture of herbicide application timing and locations.

Data Results Compared with Human Health Benchmarks

In 2012 the EPA began developing human health benchmarks for pesticides. These benchmarks were developed to enable states, tribes, water systems, public and other stakeholders to assess whether the detection of a pesticide in drinking water or source water may indicate a potential health risk. The human health benchmarks for pesticides were developed with the same methods used by the EPA to calculate health advisories for drinking-water and are based on data that is peer-reviewed in EPA's pesticide registration process[4].

The data presented below are for comparison purposes only. Based on data from the Oregon Health Authority there does not appear to be any approved public drinking water supply systems obtaining water upstream from any of the water quality monitoring stations.

Table 13: EPA Derived Human Health Benchmarks for Pesticides

PESTICIDE	FEDERAL DRINKING WATER CRITERIA µg/L	HH ACUTE BENCHMARK µg/L	HH CHRONIC BENCHMARK µg/L	AQUATIC LIFE BENCHMARK µg/L
atrazine	3			1
hexazinone		400		7
imazapyr			16000	24
metsulfuron-methyl			1600	.36
sulfometuron methyl		1830	1760	.45

The herbicide atrazine does have an established maximum contaminant level (MCL) established for drinking water sources. This number is enforceable through the federal Safe Drinking Water Act.

Based on the analytical results obtained from the three sampling locations over this study period there are no exceedances of a human health benchmark. Human health benchmarks for degradates detected in the SYPSP have not yet been developed by EPA.

Conclusion

Water quality data collected in the SYPSP area between 2010-2016 indicate that pesticide residues were detected 0 to 5.2% of the time. Given the limited land use within the watershed, it is reasonable to attribute these detections to use in commercial forestry operations. The frequencies and concentrations at which herbicide residues were detected within the SYPSP as evidenced by the results at the three sampling locations represent a low level of concern (category 1A) based on the WQPMT's "Decision Matrix Based on Water Quality Data" (Appendix 1). The category 1A is the lowest possible section in the matrix.

The low frequency of pesticide detections and the low concentrations of herbicides measured in the SYPSP study are similar to findings of several previous studies [5],[6],[7] and may provide an additional example of water quality impacts in watersheds similar to the SYPSP where the commercial application of herbicides in forestry is employed.

The results of the study help to define data gaps that when addressed through future studies, could provide additional information regarding cause and effects related to herbicide application and potential impacts to nearby water quality.

The purpose of the PSP is to determine the level of potential impact to water from pesticide use and if that impact exists, cooperatively develop voluntary management measures that may reduce those impacts. In the South Yamhill, enhanced coordination of application times to sampling schedules, the addition of discharge measurements allowing for pesticide loading determinations, and further use of alternative monitoring techniques would enhance the ability to determine more refined baselines for pesticide occurrence and concentrations. Without these improvements, it is difficult to define a baseline on which to base PSP related decisions, including whether improvements to current management measures are warranted and when a PSP project is considered complete. Several of these elements are currently underway in other PSP watershed areas.

Recommendations

The use of pesticides on commercial forest operations and the impacts those applications may have on water bodies is a concern for forest landowners and the public alike. The monitoring and subsequent assessment of water quality data along with other pertinent information collected through efforts such as the PSP can address many of those concerns. In order to do so however, close communication and coordination must occur between all parties to ensure efforts like the PSP adequately address existing concerns, provide adequate feedback to landowners regarding adequacy of current management measures and reduce the uncertainties regarding cause and effect related to pesticide applications and water quality impacts.

In consideration of these facts, the WQPMT recommends the following:

1. Build upon the information collected within the SYPSP by assessing a second commercial forestry area. Therefore, PSP pilot activities within the South Umpqua should continue and the watershed be transitioned to full PSP status.
2. Assessment of this second area should build upon the knowledge acquired during the SYPSP study and seek to fill data gaps. These activities would include:

    a. Continue to work more closely with landowners to define application timing/location and seek to schedule water quality sampling as close as possible to those applications

    b. Institute the collection of stream discharge data at several water quality collection sites so that changes in pesticide loading can be better understood.

    c. Enhance cooperation with land owners and applicators to better understand application techniques and

other restraints under which pesticides are applied.

d. Employ alternative monitoring techniques such as POCIS to assess the presence or absence of pesticides when there is a lack of information regarding pesticide application timing.

e. Cooperatively assess the results of water quality sampling and develop (if needed) alternative management practices

f. Assess the effectiveness of those measure in reducing pesticide occurrence in commercial forestry areas

3. Monitoring results place the South Yamhill in the lowest concern category within the Water Quality Pesticide Management Team's data evaluation matrix. With a determination that more precise pesticide application information is not likely to become available, it is recommended that monitoring activities within the SYPSP be suspended.
4. Establish a clear definition as to what constitutes a water quality "baseline" for all land uses within all Pesticide Stewardship Partnerships. A well-defined "baseline" is critical in determining when criteria are met when determining if a PSP project is complete.

References

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[4] U.S. Environmental Protection Agency, Human Health Benchmarks for Pesticides 2017 Update, January 2017 EPA 822 F 17 001

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[6] Kelly, V, C Anderson and K Morgenstern. 2012. Reconnaissance of land-use sources of pesticides in drinking water, McKenzie River, Oregon. U.S. Geological Survey Scientific Investigations Report 2012-5091, 46 p.

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Appendix 1: Surface Water Assessment Matrix

Decision Matrix Based on Water Monitoring Data

Detected concentration relative to a reference concentration, Frequency of Detection, and trend over time

Detection as % of Reference Concentration

Frequency of Detection	>100% (Level 4)*	>50% (Level 3)*	20 – 50% (Level 2)	0 – 20% (Level 1)
>30% (Level C)	4C: Very High Concern (POC)	3C: Mod-High Concern (POC)	2C: Moderate Concern (POC)	1C: Low Concern
11-30% (Level B)	4B: High Concern (POC)	3B: Moderate Concern -Watch List	2B: Moderate Concern	1B: Low Concern
0 -10% (Level A)	4A: Mod-High Concern (POC)	3A: Moderate Concern	2A: Low Concern	1A: Low Concern

* Actions @ levels 3 & 4 if detected 2 out of 3 years of monitoring