Pesticides and Water Quality in Washington State

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Natural Resources Assessment Section
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Natural Resources Assessment Section

Who is NRAS?

- Research group in the Director's office
- Olympia and Yakima
- Wide range of expertise

"Through service, regulation, and advocacy, WSDA supports the viability and vitality of agriculture while protecting consumers, public health, and the environment."
WSDA – Mission Statement

Natural Resources Assessment Section

Work cooperatively with partners to meet WSDA's mission of promoting agriculture while protecting the environment

- Pesticide and Nutrients Use Data
- Agricultural Land Use Mapping
- Ambient Surface Water Monitoring
- Groundwater Protection
- Special Projects including Best Management Practices (BMP) Effectiveness
- Leadership Role
- Interagency collaboration and support

Agricultural Land Use Data

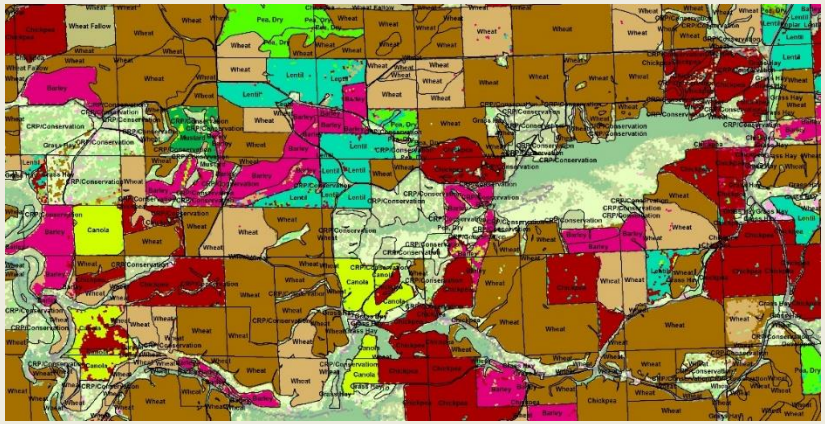
GIS – WSDA Agricultural Crop Mapping

- GIS provides a means of storing and assessing data geospatially

WSDA Agricultural Land Use Data – Internal Uses

- Understanding WA agriculture
- Internal risk assessment/data analysis
- Geographic or spatial analysis of crops
- Water monitoring basin selection (crop diversity & acreage)
- Solve natural resource issues:
  - surface water, groundwater (nutrient and pesticide)
  - climate change, air quality
  - water use
  - drought assessment

WSDA Agricultural Land Use Federal Partnership



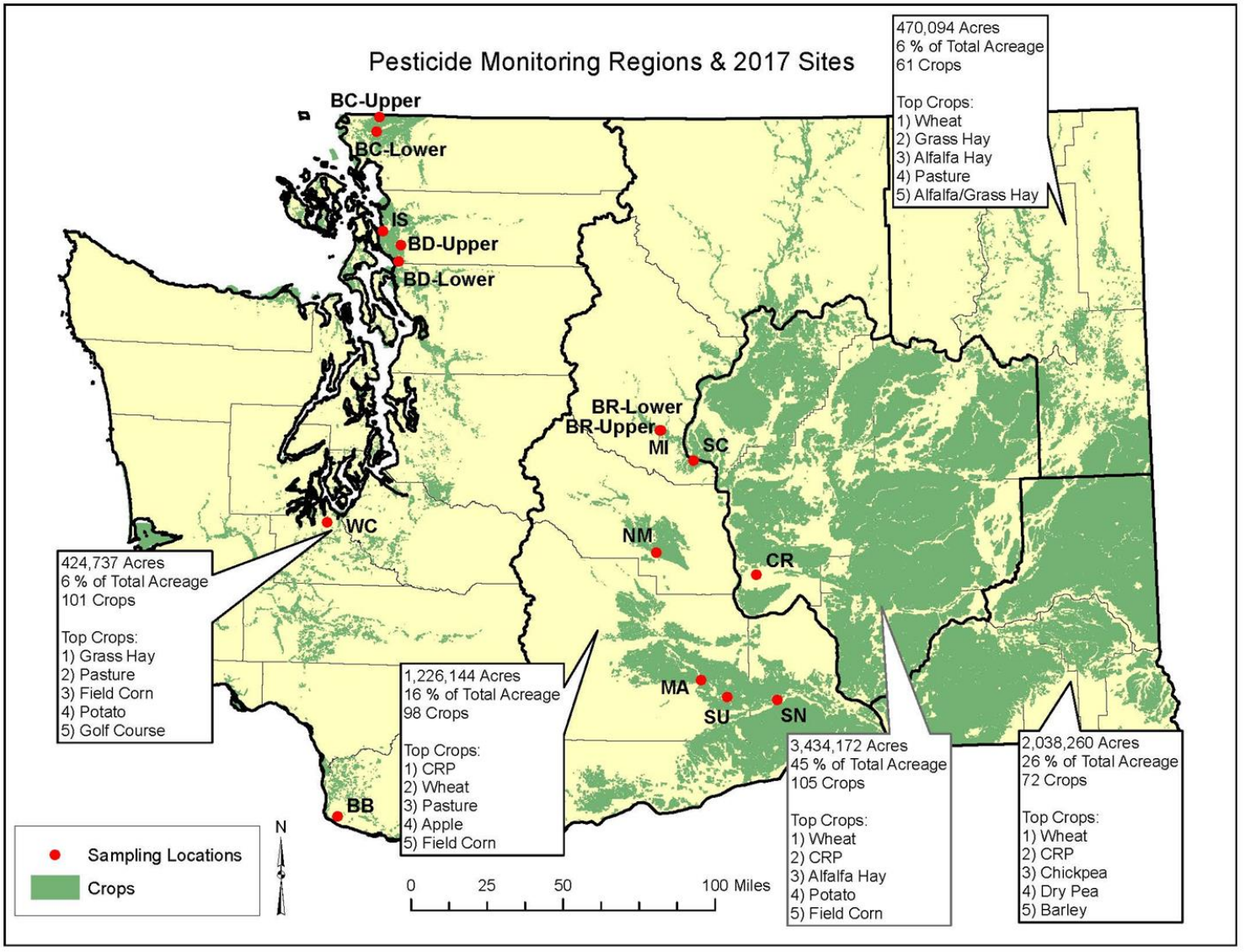
- USDA NASS – WSDA is a partner for Cropland Data Layer (CDL)
  - Satellite remote sensing project
  - CDL uses both FSA and WSDA ground-truth crop data in WA
  - WSDA provides data for areas not covered by FSA
  - Federal partners (NMFS, EPA, and USFWS) use the CDL for pesticide risk assessment in consultation process(BE's)
  - Important that crop data is accurate to minimize impacts to pesticide users in WA

WSDA Pesticide use data

- Typical use data collected through grower meetings
- Allows for creation of a typical use profile for that commodity or area
- Data is used in conjunction with NASS profiles to identify potential areas of concern
- Allows for data collection that is confidential (by WSDA standards)

Pesticide Risk Assessment

- Registration Review: Active ingredients are reevaluated by EPA every 15 years
- Accounts for new data and new risk assessment methods
- EPA uses various models to estimate environmental exposure for each product and its use patterns
- State data is an important component of EPA's risk assessment process…

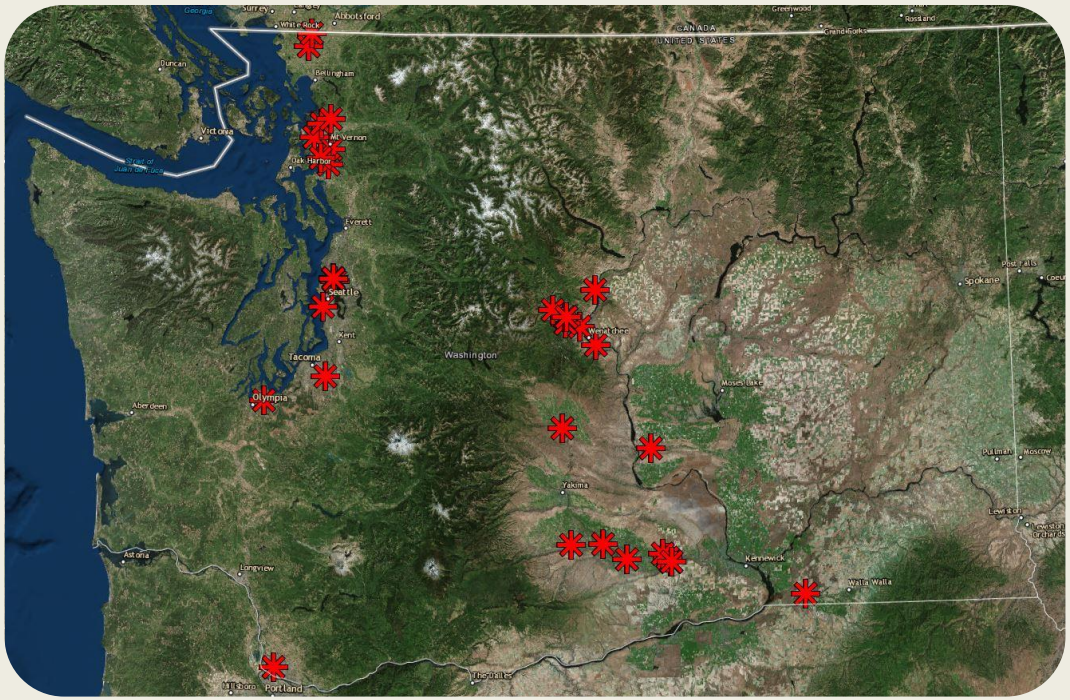

Pesticide Monitoring Regions & 2017 Sites
BC-Upper
BC-Lower
IS
BD-Upper
BD-Lower
BR-Lower
BR-Upper
MI
SC
WC
NM
CR
MA
SU
SN
BB
470,094 Acres
6 % of Total Acreage
61 Crops
Top Crops:
1) Wheat
2) Grass Hay
3) Alfalfa Hay
4) Pasture
5) Alfalfa/Grass Hay
424,737 Acres
6 % of Total Acreage
101 Crops
Top Crops:
1) Grass Hay
2) Pasture
3) Field Corn
4) Potato
5) Golf Course
1,226,144 Acres
16 % of Total Acreage
98 Crops
Top Crops:
1) CRP
2) Wheat
3) Pasture
4) Apple
5) Field Corn
3,434,172 Acres
45 % of Total Acreage
105 Crops
Top Crops:
1) Wheat
2) CRP
3) Alfalfa Hay
4) Potato
5) Field Corn
2,038,260 Acres
26 % of Total Acreage
72 Crops
Top Crops:
1) Wheat
2) CRP
3) Chickpea
4) Dry Pea
5) Barley
Sampling Locations
Crops
N
0
25
50
100 Miles

Surface Water Monitoring Program

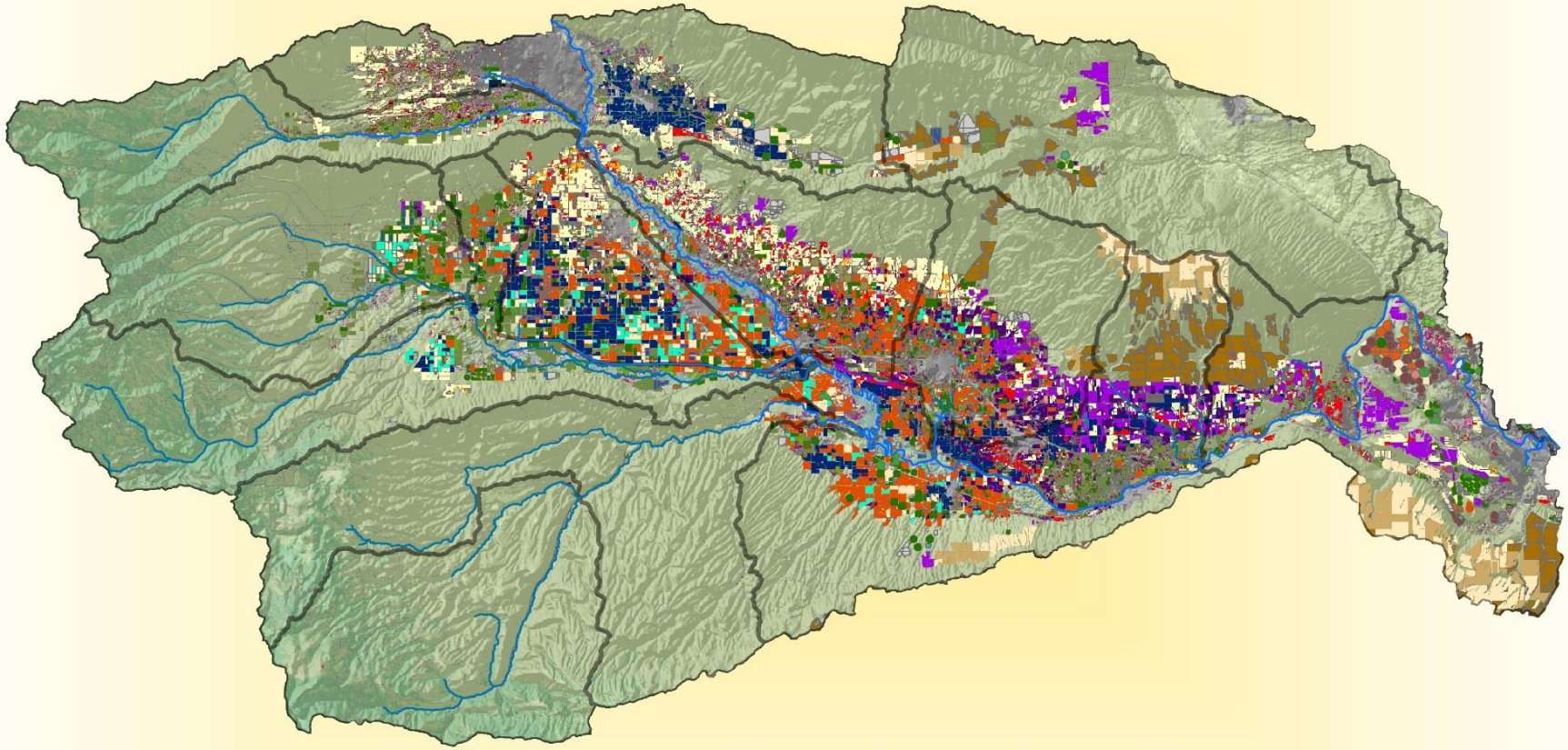
Weekly Sampling (March – October)

Urban and Agricultural Watersheds, 16 Monitoring Sites

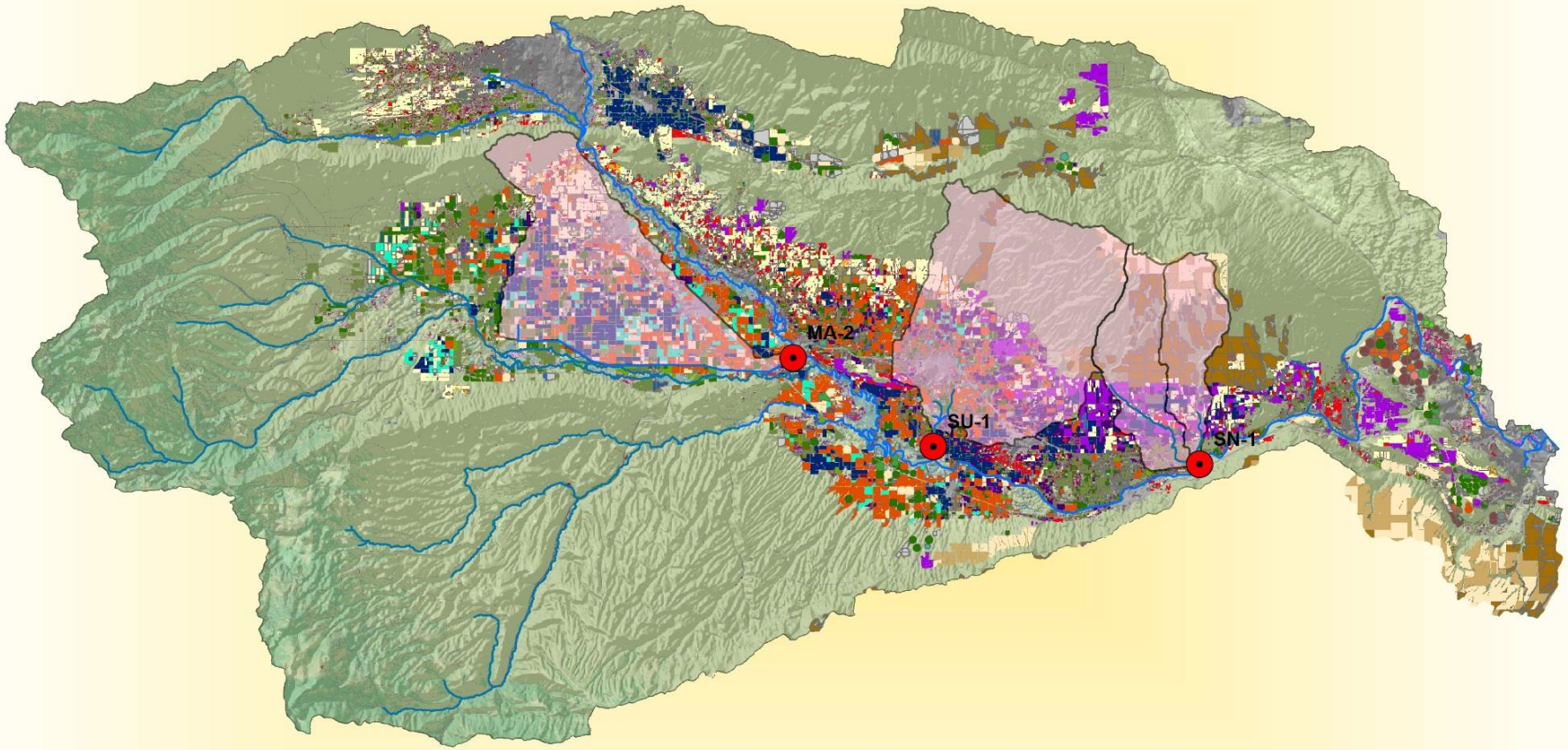
130+ Current Use Pesticides, Legacy Chemicals & Degradates



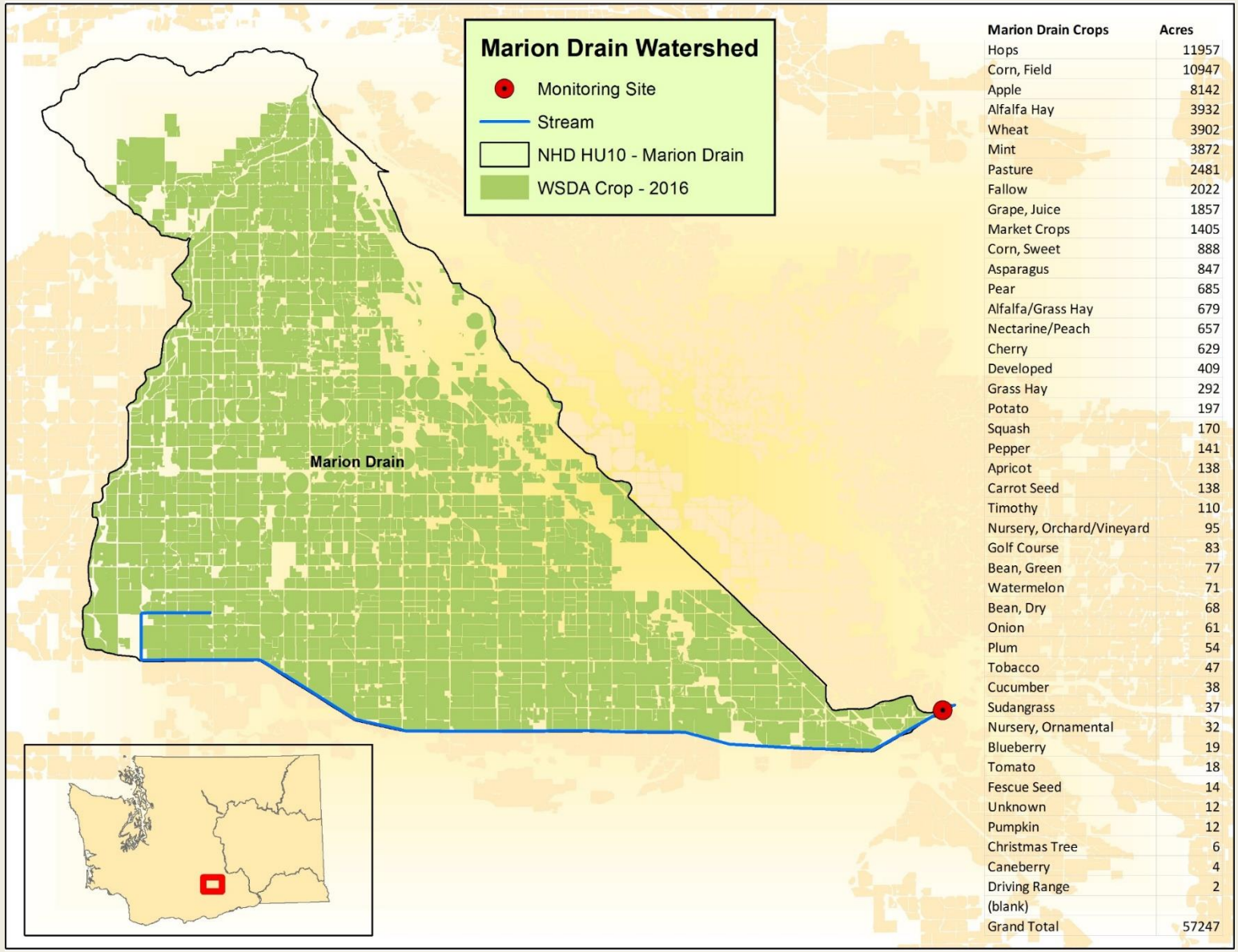
Analyze Watershed



Sub-Basins Monitored
Yakima Watershed



Sub-Basins Monitored (Continued)

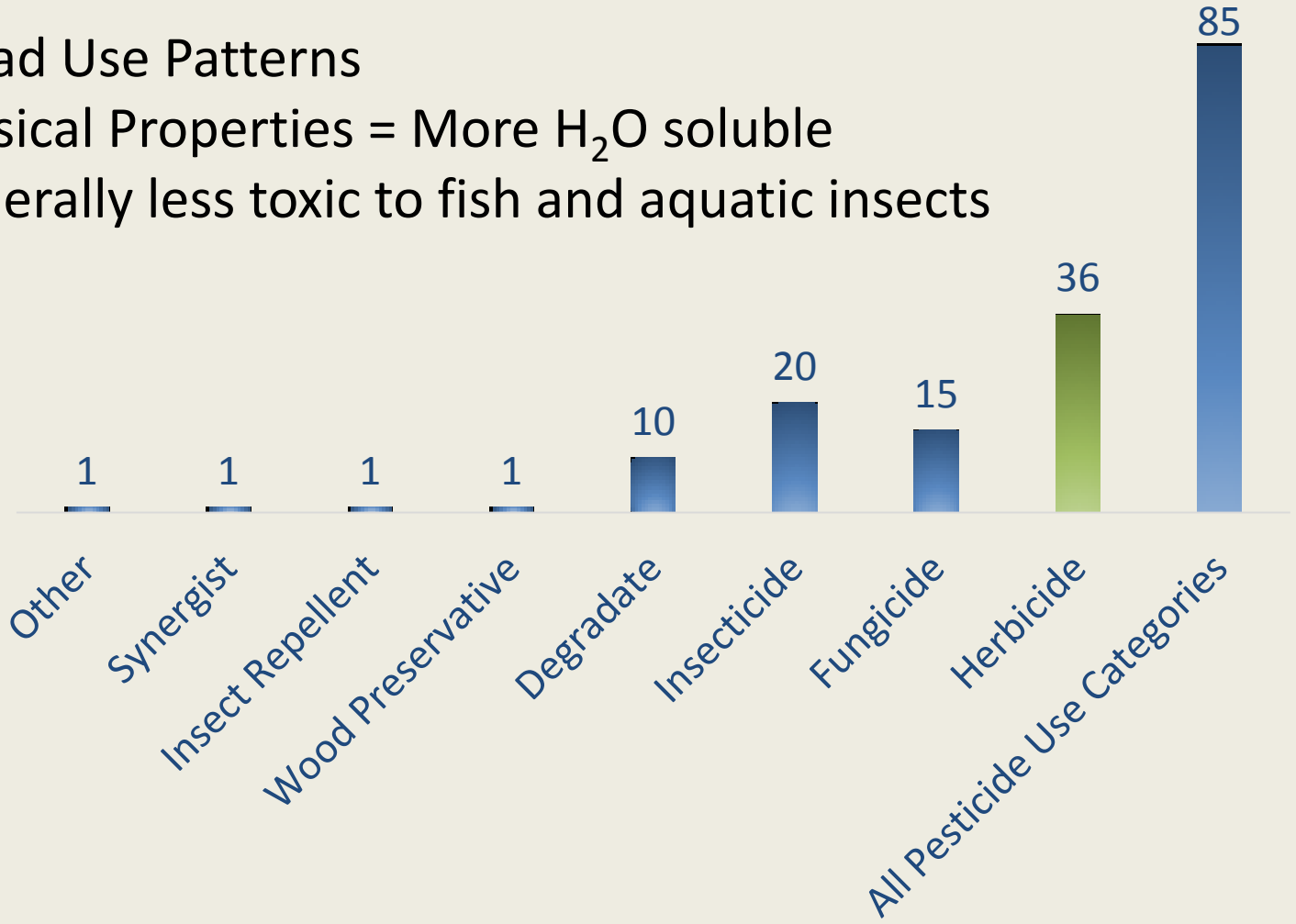


Marion Drain Crops	Acres
Hops	11957
Corn, Field	10947
Apple	8142
Alfalfa Hay	3932
Wheat	3902
Mint	3872
Pasture	2481
Fallow	2022
Grape, Juice	1857
Market Crops	1405
Corn, Sweet	888
Asparagus	847
Pear	685
Alfalfa/Grass Hay	679
Nectarine/Peach	657
Cherry	629
Developed	409
Grass Hay	292
Potato	197
Squash	170
Pepper	141
Apricot	138
Carrot Seed	138
Timothy	110
Nursery, Orchard/Vineyard	95
Golf Course	83
Bean, Green	77
Watermelon	71
Bean, Dry	68
Onion	61
Plum	54
Tobacco	47
Cucumber	38
Sudangrass	37
Nursery, Ornamental	32
Blueberry	19
Tomato	18
Fescue Seed	14
Unknown	12
Pumpkin	12
Christmas Tree	6
Caneberry	4
Driving Range	2
(blank)	
Grand Total	57247

Pesticides Types Detected in 2017

Why are herbicides detected so frequently?

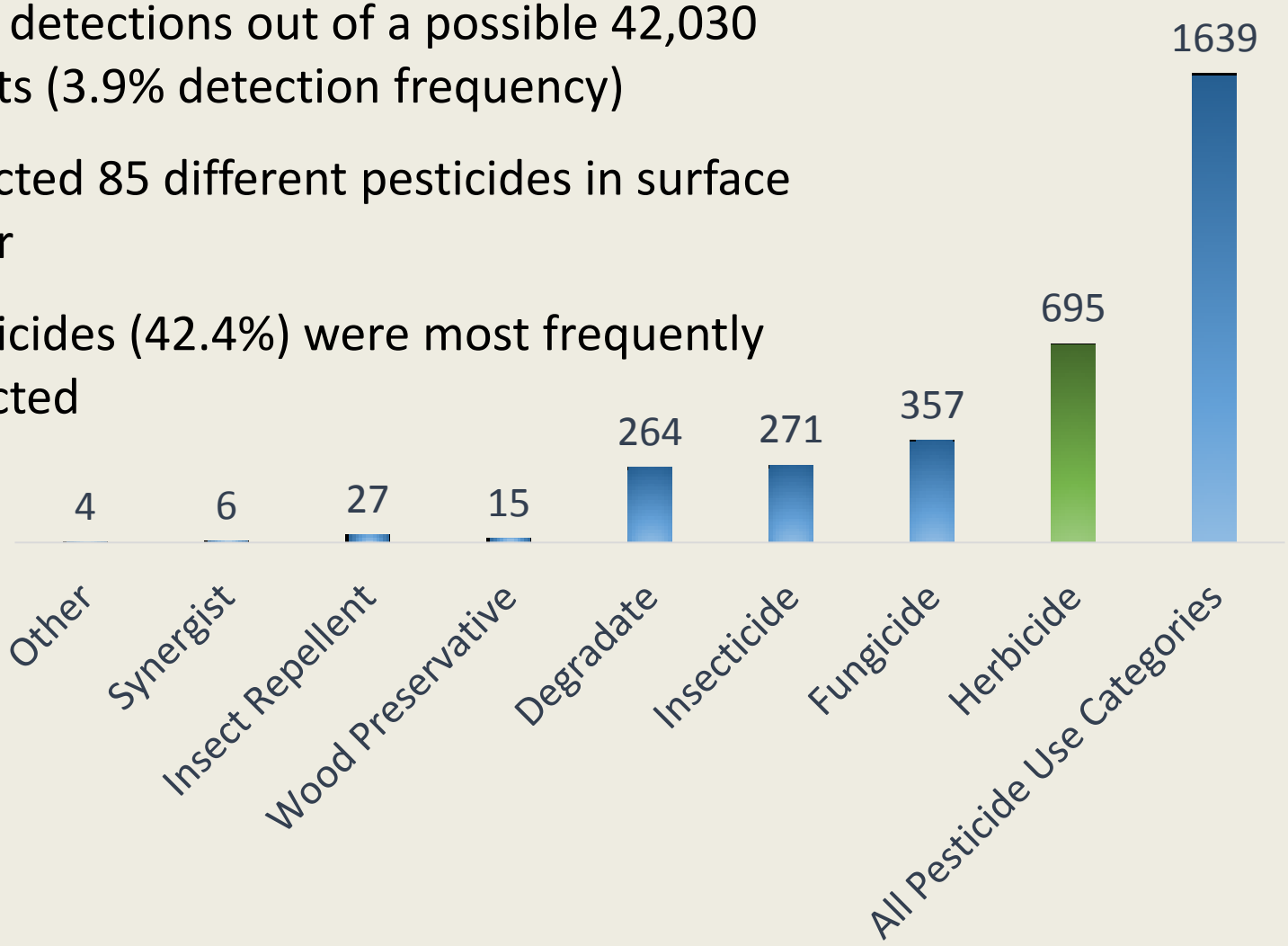
- Broad Use Patterns
- Physical Properties = More H_2O soluble
- Generally less toxic to fish and aquatic insects



Detections in 2017

Pesticide Detections:

- 1639 detections out of a possible 42,030 results (3.9% detection frequency)
- Detected 85 different pesticides in surface water
- Herbicides (42.4%) were most frequently detected



2017 Results – Herbicide Detections - Washington

	Frequently Detected Herbicides	# Detections	Frequency (Site Visits)
Casaron	2,6-Dichlorobenzamide	175	58.92%
	2,4-D	110	44.72%
	Diuron	67	22.56%
Casaron	Dichlobenil	54	18.18%
	Dicamba	44	17.89%
	Metolachlor	47	15.82%
Garlon	Triclopyr	37	15.04%
	MCPA	36	14.63%
Polaris	Imazapyr	40	13.47%
	Tebuthiuron	33	11.11%
Oust	Sulfometuron methyl	30	10.10%
	Simazine	26	8.75%
	Bentazon	20	8.13%
	MCPP	20	8.13%
	Dacthal	19	7.72%
	Oxadiazon	19	6.40%
	Terbacil	19	6.40%

Pesticides of Concern (POC)

2012 - 2016	
Atrazine	Fipronil
Azoxystrobin	Imidacloprid
Bifenthrin	Malathion
Captan	Metolachlor
Chlorothalonil	Oxamyl
Chlorpyrifos	Pyridaben
Diazinon	Simazine
Diuron	Sulfometuron-Methyl
Ethoprop	

2017 Results – Burnt Bridge Creek

Month		Apr		May			Jun		Jul		Aug		Sep		Oct
Day of the Month	Use	5	18	3	17	30	14	27	10	25	8	23	6	19	2
2,4-D	H		0.282	0.082	0.102		0.043							0.314	0.057
2,6-Dichlorobenzamide	D-H	0.135	0.117	0.258	0.134	0.241	0.236	0.217	0.330	0.285	0.216	0.173	0.196	0.170	0.248
Carbaryl	I-C											0.011			
Carbendazim	F									0.002				0.009	
Dicamba acid	H				0.034									0.041	
Dichlobenil	H	0.010	0.019		0.020										
Difenoconazole	F								0.008						
Dithiopyr	H		0.033												
Diuron	H		0.009		4.390									0.037	
Fenarimol	F								0.049						
Fipronil	I-Py										0.023				
Imazapyr	H		0.006		0.008		0.008								
Imidacloprid	I-N				0.116										
Isoxaben	H													0.006	
Mecoprop (MCPP)	H		0.035											0.032	
Metolachlor	H													0.037	
Metsulfuron-methyl	H				0.021										
N,N-Diethyl-m-toluamide (DEE	IR				0.013									0.063	
Pentachlorophenol	WP	0.041	0.034		0.030									0.024	
Propiconazole	F				0.035									0.015	
Pyraclostrobin	F									0.009					
Pyriproxyfen	I									0.010					
Simazine	H													0.052	
Sulfometuron methyl	H				0.028										
Triclopyr acid	H	0.490	0.150	0.048	0.249	0.032	0.087			0.046	0.068	0.032		0.935	0.558
Triclosan	A												0.023		
Total Suspended Solids	N/A	13.0	19.0	11.0	19.0	9.0	7.0	8.0	8.0	6.0	5.0	4.0	9.0	7.0	3.0

Exceedance Summary – Current Use Pesticides

Active Ingredient	Pesticide Category	# of Detections Above Criteria	# of Detections in 2016
Bifenthrin	Insecticide	1	1
Chlorpyriphos	Insecticide	19	19
Diazinon	Insecticide	1	10
Malathion	Insecticide	4	4
Methiocarb	Insecticide	1	1
Pyridaben	Insecticide	1	1
Pyroproxifen	Insecticide	1	1
Simazine	Herbicide	9	19

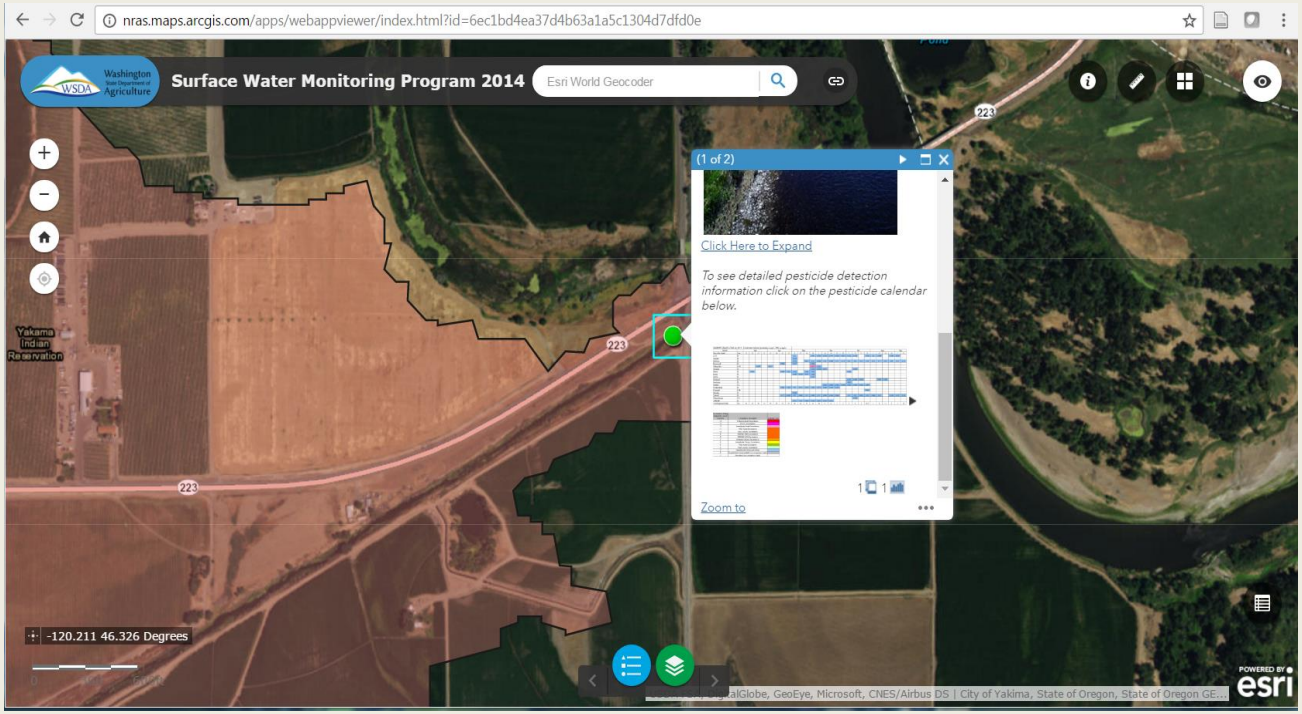
There were 37 detections of current use pesticides that approached or exceeded an aquatic life benchmark or water quality standard in 2016.

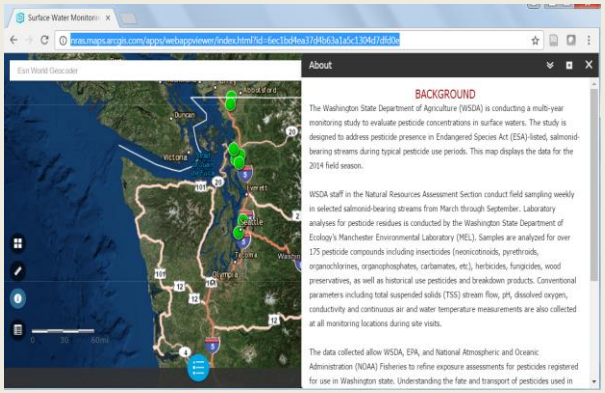
Exceedance Summary – Current Use Pesticides in 2015

Active Ingredient	Pesticide Category	# of Detections Above Criteria	Number of Detections in 2015
Azoxystrobin	Fungicide	1	70
Bifenthrin	Insecticide	4	4
Captan	Fungicide	4	8
Chlorpyrifos	Insecticide	18	18
Malathion	Insecticide	1	1
Metolachlor	Herbicide	2	48
Pyridaben	Insecticide	1	1
Sulfometuron-methyl	Herbicide	1	10

There were 32 detections of current use pesticides that approached or exceeded an aquatic life benchmark or water quality standard in 2015

Sharing Data - Webmaps
Search: WSDA Surface Water Monitoring





http://nras.maps.arcgis.com/apps/webappviewer/index.html?id=6ec1bd4ea37d4b63a1a5c1304d7dfd0e

Sharing Data - Factsheets

Pub No. 102-618 (R/2/18)

Lower Big Ditch

Summary of 2016 Surface Water Monitoring Program Results

Washington State Department of Agriculture
Natural Resources Assessment Section
February 2018

Introduction

The Washington State Department of Agriculture (WSDA) has monitored pesticide concentrations in surface water throughout Washington since 2003. WSDA staff take surface water samples during the typical pesticide use season (March - September). In 2016, 12 sites were monitored in Washington, 3 of which were in Skagit County. State and federal agencies use this data to evaluate water quality and make exposure assessments for pesticides registered for use in Washington State.

Study Area

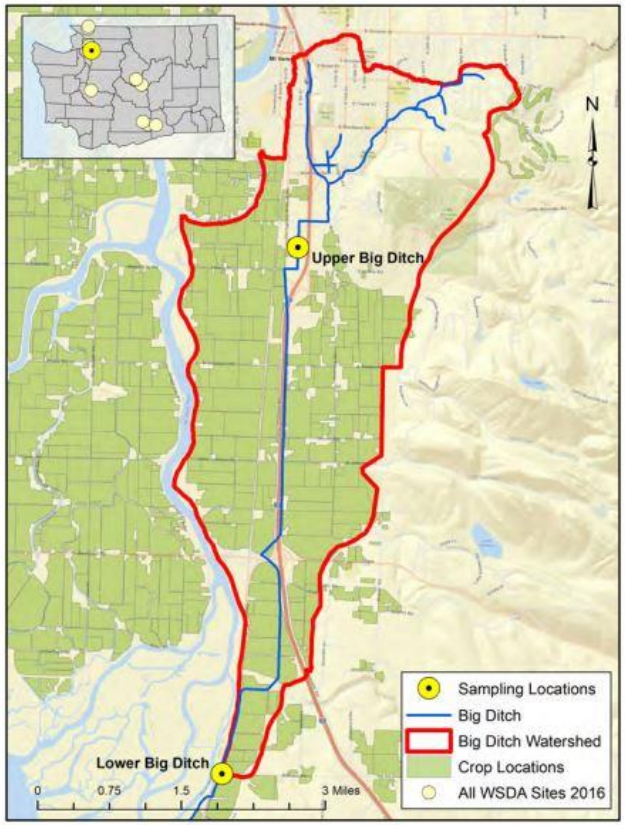
WSDA has sampled water from Lower Big Ditch from 2006 through 2017. The entire Big Ditch watershed drains approximately 8,000 acres and about 51% (4,100 acres) of the watershed is farmland. The main crops include field corn, potatoes, barley, and grass hay. The Big Ditch watershed also contains commercial and urban land cover further upstream near the Upper Big Ditch site. Land use in Upper Big Ditch is primarily non-agricultural while land use in Lower Big Ditch is primarily agricultural.

Big Ditch drains directly into Puget Sound. Lower Big Ditch provides habitat for Chinook, coho, chum, kokanee, and steelhead salmon*. The Skagit Valley (including the Big Ditch watershed) is also a crucial area for migratory waterfowl, including trumpeter swans, tundra swans, snow geese, and other birds.

*Washington State Department of Fish and Wildlife SalmonScape (http://apps.wdfw.wa.gov/salmonscape/)

Sampling Details

- WSDA sampled water for 24 weeks in 2016 from March 15 through September 12.
- Water samples were tested for 152 chemicals: current and legacy insecticides, herbicides, fungicides, rodenticides, wood preservatives, and pesticide breakdown products.
- Sample analysis was conducted at Manchester Environmental Laboratory in Port Orchard, Washington.
- Streamflow and total suspended solids were measured at every sampling event.
- Air and water temperature (measured every 30 minutes) were monitored for the entire sampling season.



Factsheet – back

The table below shows the sample dates and their corresponding detected pesticide concentrations. The detections have been color coded according to assessment criteria, if any, that were surpassed. Assessment criteria for this program are derived by applying a 0.5 safety factor to state and federal water quality criteria. This safety factor is applied to ensure that assessment criteria are protective of aquatic life. Potential water quality issues can be identified early on by using the pesticide data. Watersheds in which detections above assessment criteria occur are a priority for continued monitoring and educational outreach. Please see http://agr.wa.gov/PestFert/natresources/SWM for more information.

Assessment Criteria

- May affect fish survival at sensitive life stages
- Additional level of protection for endangered species
- May affect invertebrate survival
- Nearing a pesticide state water quality standard
- May affect fish growth or reproduction with prolonged exposure
- May affect invertebrate growth or reproduction with prolonged exposure
- May affect aquatic plant growth
- Below all identified criteria
- No published criteria available
- Not detected (below detection limit)

Month	Mar			Apr				May				Jun				Jul			Aug				Sep	
Day of the Month	15	23	29	6	12	20	26	4	10	18	25	7	15	21	28	5	13	20	9	15	23	30	7	12
2,4-D			0.123	0.176		0.050	0.257	0.042			0.070		0.261	0.493	0.143						0.039		0.837	0.152
2,6-Dichlorobenzamide	0.053	0.097	0.184	0.123	0.098	0.058	0.088	0.081					0.039		0.057					0.042		0.035	0.046	0.081
4,4'-DDE																		0.016						
Atrazine															0.074									
Azoxystrobin	0.226	0.877	0.507	1.430	0.066	0.161	0.080	0.080	0.012	0.025	0.062	0.005	0.035	0.043	0.066		0.022			0.022			0.058	0.063
Bentazon	0.058		0.080																					
Boscalid		0.098			0.069	0.113		0.140	0.066	0.077	0.090		0.103	0.065	0.054	0.046			0.038	0.059	0.039	0.059	0.073	0.152
Bromoxynil							0.030																	
Chlorpropham		0.145		0.905							0.047													
Dicamba						0.027	0.082						0.029	0.336	0.053								0.219	0.039
Dichlobenil		0.044	0.047	0.025	0.007		0.018								0.014								0.015	
Difenoconazole	0.023	0.192	0.110	0.152	0.056	0.068	0.054	0.023														0.038		0.035
Dinotefuran		0.088	0.062	0.062	0.081	0.075	0.053	0.116	0.016		0.020		0.039	0.024	0.038	0.034	0.011			0.014		0.014	0.020	0.023
Diuron	0.025	0.025	0.034	0.024	0.019	0.021	0.040	0.014		0.025	0.007				0.011	0.006							0.005	
Fludioxonil		0.396	0.201	0.358	0.116	0.146	0.109	0.155	0.053	0.082	0.070	0.025	0.063	0.130	0.052	0.039	0.046	0.035	0.034	0.040	0.031	0.037	0.062	0.067
Imazapyr								0.013							0.064				0.027	0.013	0.005	0.012	0.032	0.017
Imidacloprid	0.011		0.010			0.013	0.022	0.006			0.016		0.022	0.046	0.077									
Isoxaben																							0.011	0.003
MCPA				0.034		0.031	0.057				0.045			0.049										
Mecoprop (MCPP)			0.044	0.048			0.017																	
Metalaxyl															0.241	0.138								
Metolachlor	0.105	0.051	0.078	0.055	0.052	0.131	0.271		0.032		0.056		0.053		0.130									0.023
Metribuzin											0.300													
Monuron			0.003	0.003	0.004	0.006	0.006																	
DEET							0.041								0.024					0.022			0.026	0.022
Oxamyl oxime																				0.035				
Pentachlorophenol	0.022	0.023	0.043		0.015		0.032				0.007													
Propiconazole						0.104	0.098	0.025						0.028										
Sulfentrazone							0.210																	
Sulfometuron methyl										0.010			0.018											
Tebuthiuron																								0.084
Thiamethoxam	0.026					0.057		0.017					0.029	0.012		0.024	0.005			0.017		0.018	0.027	0.043
Triadimefon														0.207										
Triclopyr acid			0.074	0.100			0.134	0.043			0.045		0.179	0.269	0.084				0.046	0.053			0.532	0.177
Precipitation	0.78	0.30	0.92	0.59	0.00	0.08	0.69	0.00	0.09	0.00	0.42	0.09	2.00	0.82	0.39	0.01	0.20	0.00	0.02	0.00	0.00	0.03	0.57	0.14
Streamflow	40.62	20.51	27.60	18.27	29.91	25.02	34.54	14.01	25.98	16.34	17.35	43.36	16.95	27.40	6.11	24.24	15.73	24.80	1.91	--	10.19	10.24	8.18	2.82
Total Suspended Solids	22	14	10	9	10	16	27	6	39	23	26	42	25	7	5	11	19	8	4	13	8	62	22	29

Units for pesticide detections are in (µg/L), precipitation measurements in (week total inches), streamflow measurements are in (cfs), and total suspended solids in (mg/L). The "--" signifies a sample or measurement was not collected.

Results Summary

- There were 239 total pesticide detections at the Lower Big Ditch site. Of these, 1 detection was above assessment criteria.
- WSDA identifies some pesticides as Pesticides of Concern because they have been found somewhere in the state above WSDA's assessment criteria. Azoxystrobin, chlorpropham, diuron, metolachlor, pentachlorophenol, and sulfometuron methyl are all Pesticides of Concern that were detected in Lower Big Ditch.
- Detections of DDT and its breakdown products (like 4,4'-DDE) are likely due to contaminated sediment erosion into streams.
- Lower Big Ditch had 56 less detections than Upper Big Ditch. Of the 47 chemicals observed in the entire Big Ditch watershed, 11 were unique to Lower Big Ditch. This is likely due to the very different land use patterns observed at the 2 sites.
- There were a total of 4 detections that exceeded assessment criteria in the whole Big Ditch watershed.
- When multiple pesticides are detected simultaneously the effects can combine; multiple pesticides were detected every week.

Recommendations

- Read and follow label directions to protect water quality.
- Choose less-toxic pesticides whenever possible.
- Calibrate, maintain, and inspect application equipment often.
- Check the weather before application to reduce drift or runoff.
- Use best management practices: buffers, filter strips, sediment basins, ground cover, and setbacks.
- Apply to participate in a WSDA waste pesticide collection event: www.agr.wa.gov/wastepesticide

2015 Results - Glyphosate

- Reporting Limit for glyphosate, glufosinate, and AMPA = 8 parts per trillion (0.008 ppb)
- 70 sampling events (14 sites for 5 weeks)
- There were a total of 105 detections

	Detections	Avg Concentration (µg/L)	Max. Concentration (µg/L)	Detection Frequency
Glyphosate	54	0.196	1.5	77%
AMPA	46	0.121	0.38	65%
Glufosinate	5	0.095	0.28	7%

- Acute exposure (96 hour LC50) value for fish is 43,000 µg/L (in terms of acid equivalents of glyphosate) (EPA, 2009)

Assessment of Herbicides in Surface Waters in the Hoh River Watershed

Project Overview

- Hoh Tribe concerns of pesticides and water quality
- Collaboration: EPA, Hoh Tribe, DNR, Private Companies, Non-profit organizations
- Goals
  - Initial surface water assessment of herbicides commonly used in timber practices
  - Develop relationships with partners in forestry
  - Identify future research needs

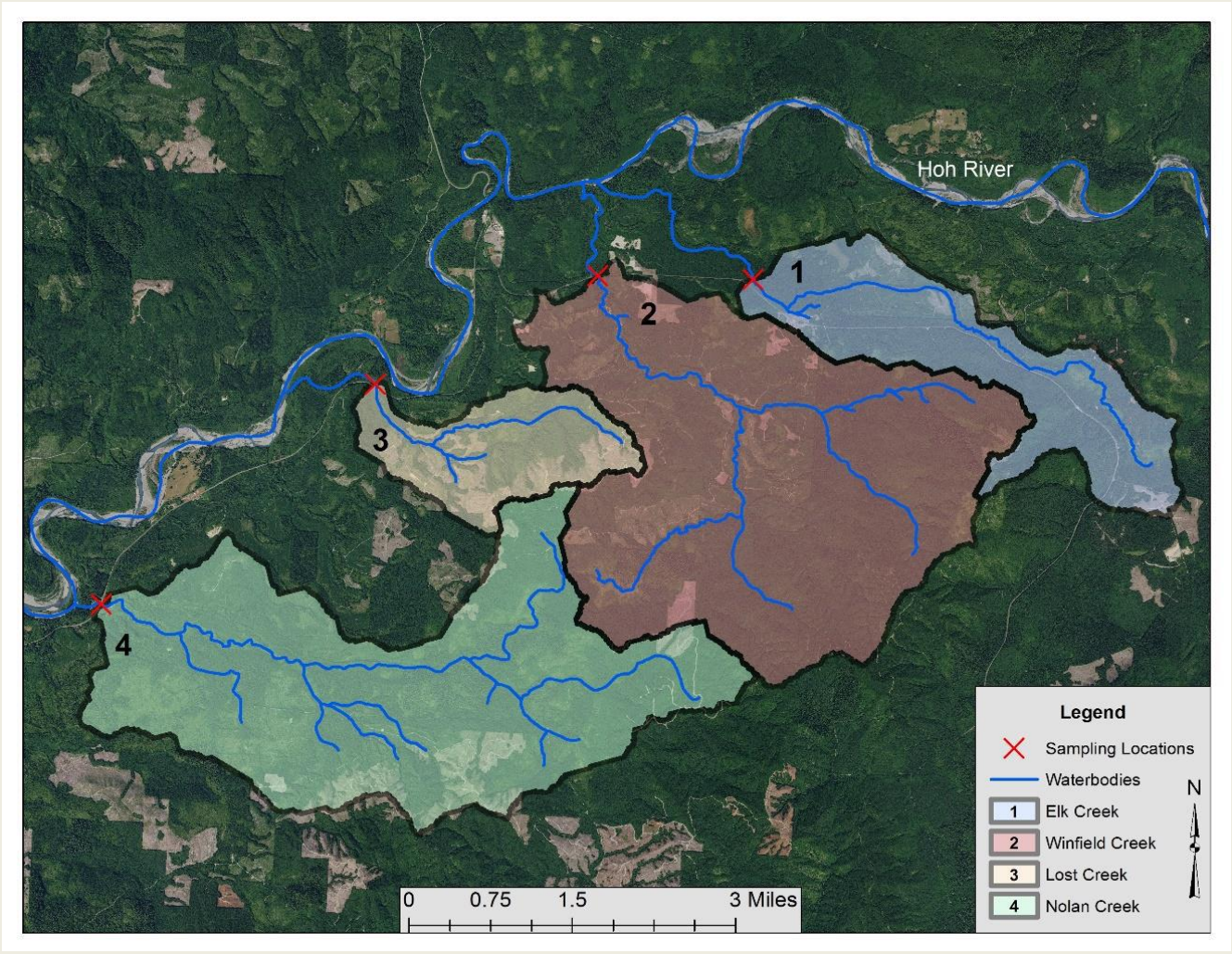
Study Design

- 4 tributaries to Hoh River
- 1 week background samples
- 5 weeks of weekly sampling August/Early Sept
- Analysis: glyphosate, glufosinate-ammonium, AMPA, imazapyr, triclopyr, metsulfuron methyl, sulfometuron methyl, Total Suspended Solids.

Limitations

- Timing of data collection not tied to application events
- Regional specific data. Forestry practices vary depending on location
- Non-forestry uses of herbicides in the watershed

Study Area


Hoh River
1
2
3
4
0
0.75
1.5
3 Miles
Legend
Sampling Locations
Waterbodies
1 Elk Creek
2 Winfield Creek
3 Lost Creek
4 Nolan Creek
N

Sampling Results

	Detections	Avg Concentration (µg/L)	Max. Concentration (µg/L)
Glyphosate	4	0.084	0.266
Aminomethylphosphoric acid (AMPA)	2	0.012	0.015
Glufosinate-ammonium	7	0.015	0.058

- Concentrations lower than 2015 ambient SWMP results
- Acute exposure (96 hour LC50) value for fish is 43,000 µg/L (in terms of acid equivalents of glyphosate) (EPA, 2009)

Next Steps

- Summer of 2018 (preliminary plans)
  - Partnership with 10,000 Years Institute
  - Monitor noxious weed control treatment
  - Collect samples up and downstream of 3 application events
- Future
  - Plan study in partnership with forestry applicators
  - Collect samples following first fall rain event

2015 Streamside Vegetation Study

- Riparian vegetation
- Malathion
- Aerially applied
- Spotted wing Drosophila
- Blueberries

- 5 Sites
  - 2 control
  - 3 vegetated
- 8 Application events
  - 4 control
  - 4 vegetated

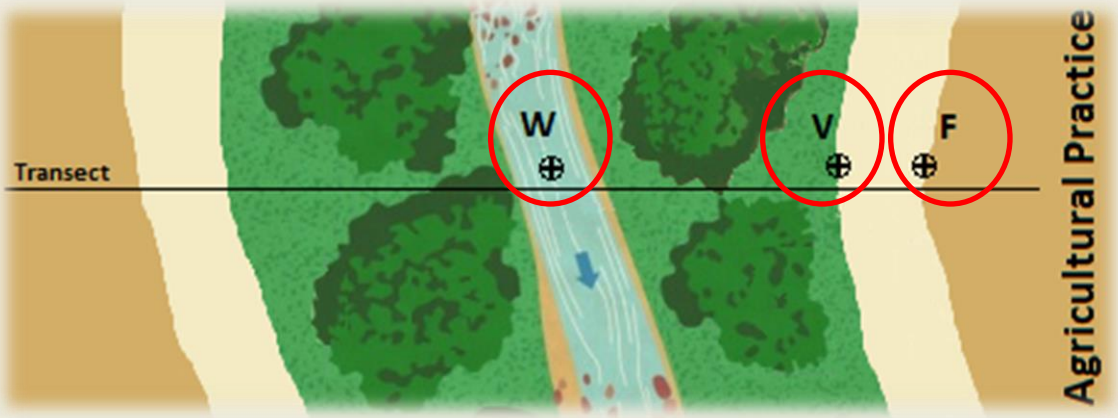
UD1 (Control Site)

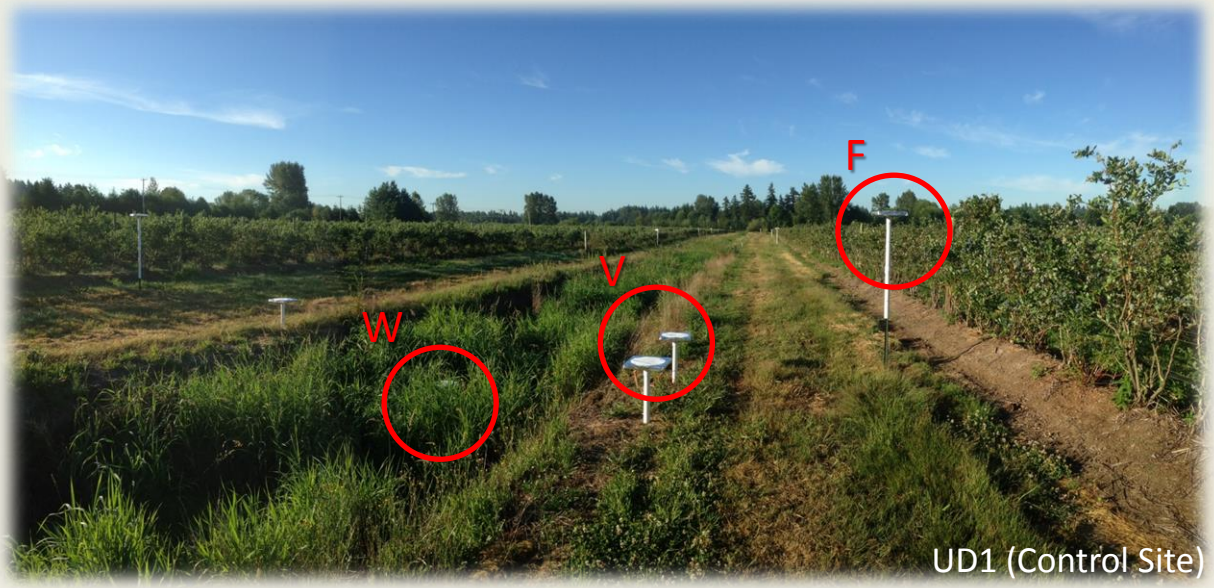
Study Design

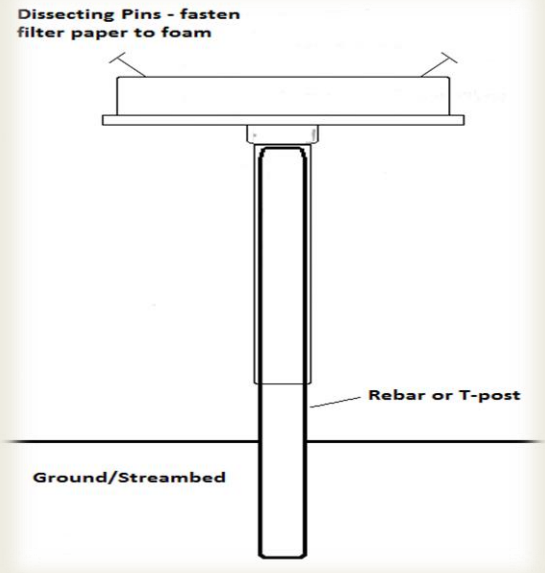
Depositional Samples:

Filter paper mounted on platforms

- Water
- Vegetation edge
- Field edge



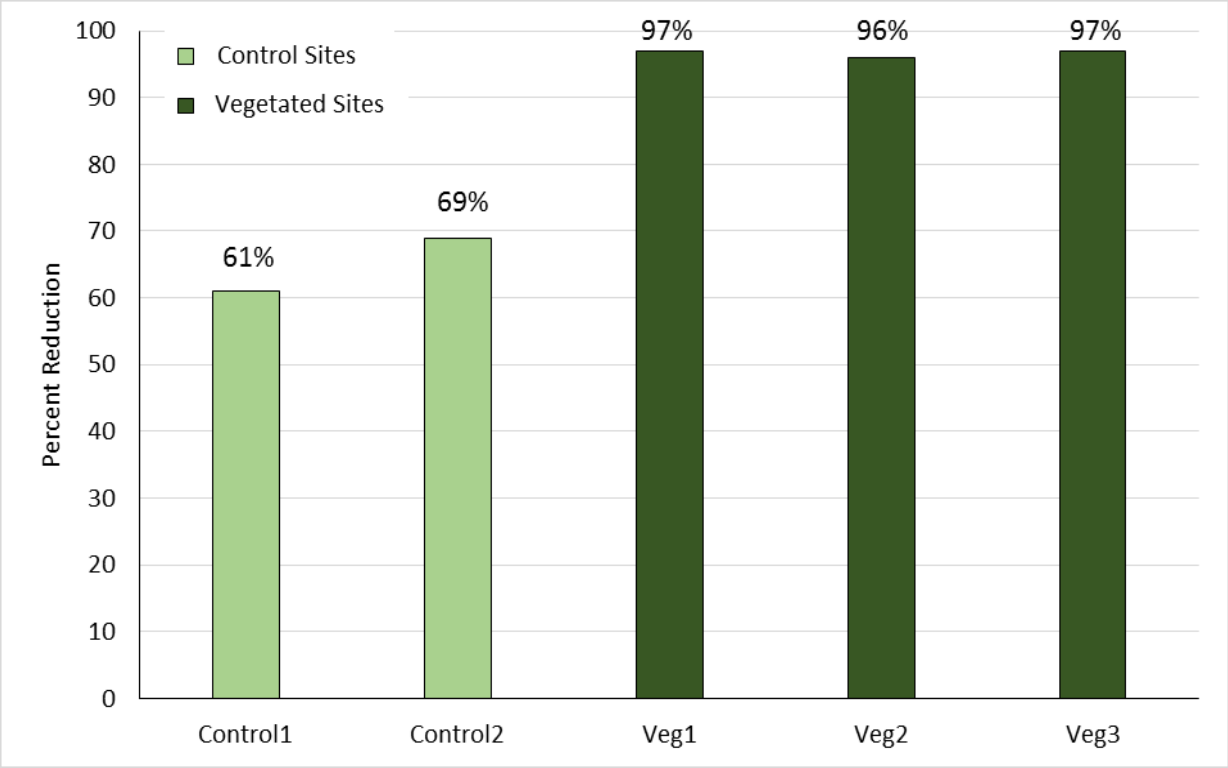




Deposition Results

- Contracted with Washington State University, Department of Mathematics and Statistics

Percent reduction from field-edge (F) to water (W) for all applications



Study Conclusions

- Malathion deposition was significantly reduced at vegetated sites
- Dense woody vegetation significantly reduces instream deposition
- **Canopy cover** and **distance** are significant factors in reducing deposition

Looking into the future...

Pesticides undergoing ESA Consultation:

- Malathion, chlorpyrifos, diazinon (December 2017)
- Carbaryl & methomyl (2019)
- **Glyphosate, atrazine, simazine, & propazine (2022)**

Bulletins Live 2 = additional mandatory label requirements

https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins

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http://www.agr.wa.gov/PestFert/NatResources/