Pesticides in Salmonid-bearing Streams in an Urban and Agricultural Watershed of the Salish Basin

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Background

The Washington State Departments of Agriculture (WSDA) and Ecology (Ecology) are conducting a multi-year monitoring study to evaluate pesticide concentrations in surface water. The study is designed to assess pesticide presence in salmon-bearing streams during a typical pesticide-use season. The data collected will allow WSDA, the U.S. Environmental Protection Agency, and the National Atmospheric and Oceanic Administration to refine exposure assessments for pesticides that are registered for use in Washington State. Understanding the fate and transport of pesticides allows regulators to assess potential impacts to endangered salmon species.

This monitoring project has been ongoing since 2003. Currently there are 15 monitoring locations in 5 basins across Washington. Emphasis is placed on collecting monitoring data from drainages dominated by agricultural land use; however, one urban basin is monitored for pesticides as well.

Data from the urban basin in Seattle and an agricultural basin in Skagit County are presented. For the purpose of this poster, two representative sites are summarized.
A complete listing of results for this project can be found online at:
http://agr.wa.gov/PestFert/natresources/SWM/default.htm.
Data can be found at www.ecy.wa.gov/eim.

Monitoring Goals

- Measure concentrations of pesticides in surface water during the application season.
- Assess exposure of salmonids and other aquatic organisms to pesticides.
- Determine status and trends of pesticides.

Methods

Sampling occurs weekly during the pesticide application season, generally March through September. Sampling includes field measurements and laboratory analysis (Figure 1).

Field measurements include:
- Flow
- Dissolved oxygen
- Temperature
- pH
- Conductivity

Laboratory measurements include:
- Total suspended solids
- Over 150 pesticides including organochlorines, organophosphates, carbamates, legacy pesticides, and degradate compounds.

Figure 1. Paul Anderson sampling Brown's Slough.

Quality Assurance / Quality Control

Typically 20% of samples analyzed are for assessing data quality. Quality control measures include field and laboratory blanks, field replicates, and laboratory matrix spikes.

Data Assessment

Data for each monitoring site are evaluated in three-year periods. The magnitude of pesticide detections are compared to applicable aquatic life criteria and acute and chronic Toxicity endpoints used for pesticide registration for fish, invertebrates, and aquatic plants. These assessment criteria can be found in Burke et al. (2006).

Locations

Agricultural (Big Ditch – Skagit County)
About 50% of the Big Ditch's 8000-acre drainage is in agricultural crops. The Big Ditch drainage at BD-1 (downstream) is characteristic of the types of Agricultural crops and pesticides seen in the rest of the Skagit-Samish basin (Figure 2). Land-use upstream of the Big Ditch site (BD-2) is commercial-industrial (Figure 2).

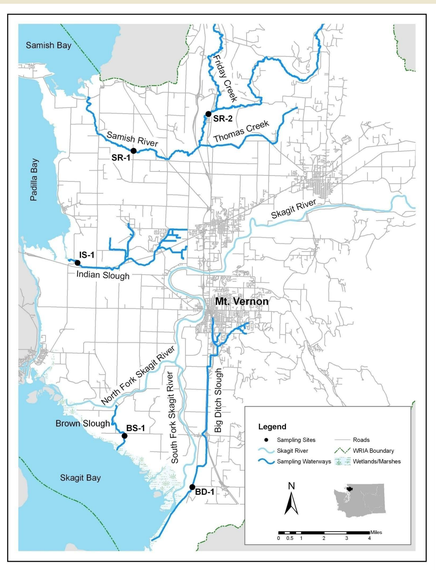

Figure 2. Skagit-Samish basin sample sites.

Locations (continued)

Urban (Thornton Creek – King County)
Thornton Creek was selected to represent an urban drainage because of land-use characteristics, history of pesticide detections, pre-spawning mortality of coho salmon, and habitat use by salmon. Thornton Creek basin is about 7740 acres, with approximately 50% impervious surface (Figure 3).

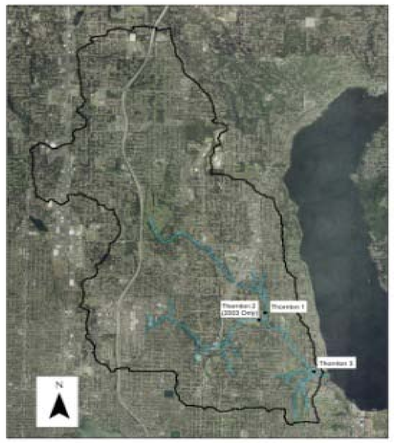

Figure 3. Thornton Creek sample sites.

Results and Discussion

Agricultural (Big Ditch - Skagit County)
Big Ditch downstream has been sampled since 2006 (BD1), and the upstream site has been sampled since 2007. 2008 pesticide residue results for the Big Ditch downstream are presented in Figure 4. A key to interpreting results is presented in Figure 5.

Big Ditch - Lower	3/12	3/18	3/25	3/31	4/9	4/14	4/23	4/28	5/7	5/12	5/21	5/27	6/4	6/9	6/18	6/24	7/2	7/7	7/16	7/22	7/30	8/4	8/13	8/18	8/27	9/2	9/10
1-Naphthol									0.058																	0.048	
3-Hydroxycarbofuran								0.012																			
Aldicarb Sulfone																				0.059							
Carbaryl											0.014																
Carbofuran									0.049	0.1		0.013															
Imidacloprid												0.012						0.014							0.018	0.01	
Methiocarb																										0.017	
Methomyl								0.058												0.057							
Oxamyl																				0.019							
Propoxur							0.015																				
2,4-D[m]				0.029	0.27	0.1	0.49	0.27	0.072	0.65	0.7			0.32		0.039		0.14							0.185		0.027
Bentazon	0.079	0.07		0.071	0.12	0.18		0.12	0.084			0.11	0.069	0.24	0.018	0.11		0.046							0.12	0.14	0.086
Bromoxynil						0.09			0.068																		
Dicamba I									0.016	0.057				0.084	0.024										0.048	0.018	
MCPA								0.16	0.22		0.67	0.074	0.07					0.031							0.028		
MCPP												0.063			0.041										0.028		
Pentachlorophenol																0.012									0.023	0.017	
Trichlopyr											0.12					0.029		0.02							0.098	0.047	0.041
Atrazine																									0.044	0.038	
Bromacil				0.31	0.36	0.072	0.082		0.083	0.17	0.12	0.052	0.059	0.13	0.083	0.027		0.023					0.029		0.044	0.1	
Chlorpropham	1.1	5.6	0.69	0.083	0.043	0.038																					
Chlorpyrifos		0.015																									
Diazinon											0.06																
Dichlobenil				0.044							0.076	0.017		0.017		0.013									0.023	0.013	
Diuron								0.13	0.27	0.37	0.13	0.062	0.1	0.12	0.074	0.046											
Eptam									0.036	0.11	0.18	0.035		0.045	0.037												
Ethoprop										0.038	0.058		0.027														
Hexazinone											0.081																
Metalaxyl					0.039															0.005					0.021		0.039
Metolachlor				0.02				0.038			31	0.18	0.059	8.6	1.3	0.95	0.022	0.064	0.003	0.008			0.006		0.28	3.6	0.435
Metribuzin												0.027		0.14		0.038											

Figure 4. 2008 pesticide residues found in the Big Ditch downstream site.

	Each square represents the period when a sample was taken. If blank, then no pesticide residue detected.
	Analysis not completed.
	Pesticide residue detected. Assessment criteria not available.
	Detection of pesticide residue, concentration below regulatory or toxicological endpoint.
	Magnitude of detection above WAC or NRWQC regulatory endpoint.
	Magnitude of detection above chronic or acute invertebrate endpoint.
	Magnitude of detection above chronic fish endpoint.
	Magnitude of detection above Endangered Species Level of Concern for fish, which is 1/20th of the acute toxicity endpoint

Figure 5. Key to interpreting pesticide residue results. Colors determine whether water quality standards or assessment endpoints have been met or exceeded.

The majority of pesticide compounds detected are herbicides. There are fewer pesticide detections at the downstream site (BD1), including fewer herbicide and insecticide detections. Figure 6 presents insecticide and fungicide detections at both sites.

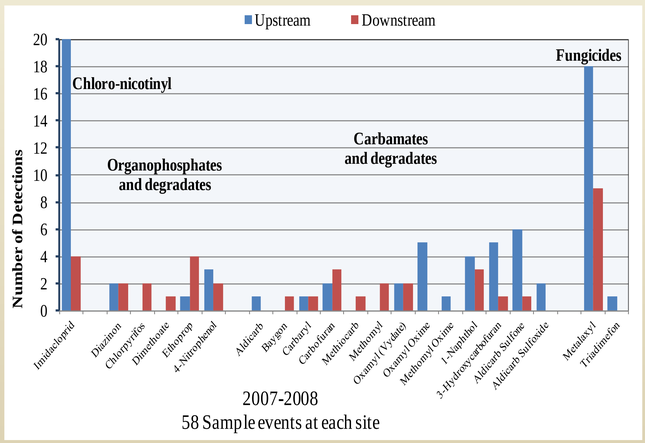

Figure 6. Insecticide/ Fungicide Detections on Big Ditch (2007-08).

Reference

Burke, C., P.Anderson, D. Dugger, J. Cowles, 2006. Surface Water Monitoring Program for Pesticides in Salmonid-Bearing Streams, 2003-2005. Washington State Department of Ecology. Ecology Publication No. 06-03-036. www.ecy.wa.gov/biblio/0603036.html

This Poster: Ecology Publication No. 09-03-008. www.ecy.wa.gov/biblio/0903008.html
February 2009.

Results (continued)

Urban (Thornton Creek - King County)
Upstream and downstream stations have been sampled on Thornton Creek since 2003. 2008 pesticide residue results for Thornton Creek downstream are presented in Figure 7. A key to interpreting results is presented in Figure 5. From 2006-2008, both the upstream and downstream Thornton Creek sites met water quality standards and aquatic life criteria.

Thornton Creek - Lower	3/12	3/18	3/25	3/31	4/9	4/14	4/23	4/28	5/7	5/12	5/21	5/27	6/4	6/9	6/18	6/24	7/2	7/7	7/16	7/22	7/30	8/4	8/13	8/18	8/27	9/2	9/10
1-Naphthol					0.069		0.14	0.067								0.059										0.33	
3-Hydroxycarbofuran													0.035													0.018	
Methomyl							0.031						0.018														
Oxamyl					0.13			0.21																			
2,4-D[m]								0.57					0.089						0.038								0.027
4-Nitrophenol								0.26	0.39																		
DCPA	0.016				0.017					0.033										0.048				0.026			
Dicamba I								0.022					0.012														
MCPP								0.14					0.056						0.028							0.025	
Pentachlorophenol																			0.029					0.019		0.024 0.016	0.016
Trichlopyr																										0.053 0.027	0.047
Diazinon								0.13	0.11																		
Dichlobenil			0.019	0.02	0.026	0.012			0.11	0.032	0.009	0.019	0.018	0.047	0.011	0.017	0.014	0.016	0.011		0.008	0.005		0.01	0.011	0.021	0.015	0.019
Diuron			0.021										0.02	0.04		0.056											
Prometon			0.016								0.024								0.019								

Figure 7. 2008 pesticide residues found in Thornton Creek at the downstream site.

Herbicides are the most frequently detected group of pesticides at both Thornton Creek sites during both time periods (Figures 8 and 9).

Figures 8 and 9 present the distribution of pesticides detected at the mouth of Thornton Creek for both three-year sampling periods (2003-2005 and 2006-2008). There were fewer pesticide detections found in 2006-2008. Fewer detections could be due to better pesticide use practices or higher flows and dilution. Flow averaged 20% higher during the 2006-2008 sample period.

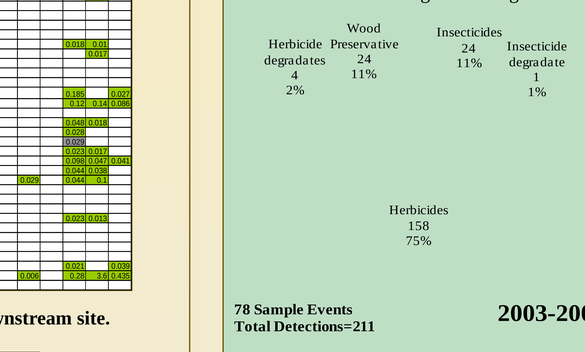

Figure 8. 2003-2005 distribution of pesticide detections at the mouth of Thornton Creek.

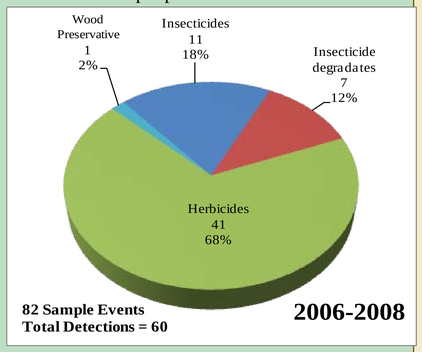

Figure 9. 2006-2008 distribution of pesticide detections at the mouth of Thornton Creek.

Figure 10 presents insecticide detections for Thornton Creek downstream. Changes in insecticide compounds are seen between time periods with decreasing detections of organo-phosphates and increasing detections of carbamate insecticides. A confounding factor is carbamate detection limits have improved over the study duration.

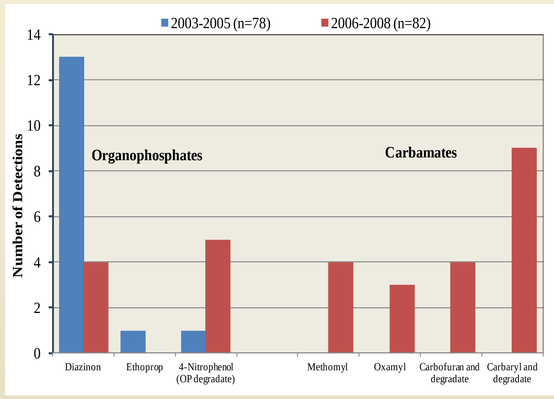

Figure 10. Insecticide detections at the mouth of Thornton Creek for the 2003-2005 and 2006-2008 periods.

Findings

- In 2008, pesticide residues found in Big Ditch and Thornton Creek do not exceed water quality standards or aquatic life criteria endpoints.
- Herbicides are the most commonly detected type of pesticide.
- Pesticide detections in Thornton Creek have decreased over time.
- Insecticide use in Thornton Creek appears to have shifted over time from organophosphates to carbamates. Increases in carbamate detections may be due to improved detection limits over the 2003-2008 study period.

A full report on findings for all sites will be available in the fall of 2009 at:
www.ecy.wa.gov/programs/eap/toxics/pesticides.htm