WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Washington State Pesticide Monitoring Program

1994 Surface Water Sampling Report

February 1996

Publication No. 96-305

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1994 Surface Water Sampling Report

by
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February 1996

Water Body Numbers

WA-03-0020	WA-34-1010
WA-08-2100	WA-45-1010
WA-22-0020	WA-47-9030
WA-23-1090	

Publication No. 96-305

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Abstract

Initiated in 1991 by the Department of Ecology, the Washington State Pesticide Monitoring Program (WSPMP) analyzes ground water, surface water, fish tissue, and sediments for pesticide residues. The results of these analyses are used to provide information on how these residues are distributed in the environment and how these patterns of distribution are changing over time.

WSPMP surface water samples were collected at eight sites in April, June, and October of 1994. Sites were selected to represent various pesticide uses including agricultural use west of the Cascade Mountains, irrigated and dry-land agriculture east of the Cascades, use on orchards, urban use, and use by forest practices (Christmas tree farms). Samples were analyzed for 161 pesticides and breakdown products in the following chemical groups: chlorinated pesticides, organo-phosphorus pesticides, nitrogen-containing pesticides, pyrethroid pesticides, chlorinated herbicides, and carbamates. Conventional parameters measured included total suspended solids, total organic carbon, conductivity, nitrate+nitrite, temperature, pH, and flow.

A total of 33 pesticides and breakdown products were detected. The most frequently detected pesticides were 2,4-D, diazinon, dichlobenil, pentachlorophenol, and simazine. Washington State and/or U.S. Environmental Protection Agency (USEPA) aquatic life criteria were exceeded at three sites. Pesticides above criteria were DDT, DDE, azinphos-methyl (Guthion), and chlorpyrifos (Dursban, Lorsban). Levels of carbaryl, diazinon, and malathion exceeded National Academy of Sciences (NAS) recommended maximum concentrations to protect aquatic life and wildlife.

Azinphos-methyl and chlorpyrifos have been detected consistently in streams adjacent to orchards at concentrations exceeding water quality criteria. DDT, diazinon, carbaryl, malathion, and endosulfan are other insecticides that have been found in samples from streams running through orchards; most at levels above USEPA, Washington State, and/or NAS standards. Mixtures of these insecticides are likely to be more toxic than the individual compounds.

Pesticide use on cranberries in the Grayland area resulted in a high number and frequency of detections in Grays Harbor County Drainage Ditch No. 1 (GHCDD-1). Three compounds were detected in all three sample periods and four were found in two periods. Urban use seems to result in a similar pattern of detections. Six pesticides were found in Mercer Creek each of the three years it was sampled. Four additional compounds were identified in two of the years.

Recommendations include additional sampling in GHCDD-1 and urban streams, an intensive survey of streams flowing through orchards to assess impacts of orchard pesticides on biota, development of BMPs for orchard pesticide use, development of state water quality criteria for selected pesticides, addition of Mission Creek to the 303(d) water quality limited list for total DDT, and improved interagency coordination to reduce pesticide related environmental impacts.

Acknowledgments

The following persons deserve recognition for their contributions to this study:

- Dickey Huntamer, Norm Olson, and Stuart Magoon of Ecology's Manchester Environmental Laboratory for their extra efforts to provide exceptional analytical services and for their valuable technical advice.

- John and Cora Picken for allowing access to their property so samples could be collected from Stink Creek.

- Larry Goldstein, Bill Yake, and Art Johnson for providing valuable review comments for the draft report.

- Joan LeTourneau for preparing and proofing the final report.

Summary

A total of 33 pesticides and breakdown products were detected in 24 surface water samples collected for the WSPMP from eight sites in April, June, and October of 1994. Three of these sites had been previously sampled in 1992 and/or 1993.

The herbicide 2,4-D was found in nine samples from four sites, diazinon in eight from six sites, and dichlobenil (Casoron), simazine, and pentachlorophenol were identified in seven samples from three, four, and five sites, respectively. Azinphos-methyl (Guthion) and chlorpyrifos (Lorsban) were each found five times at four sites, and all detections exceeded water quality guidelines. Sixty-four percent of the detected compounds were in three or fewer samples.

Three pesticides were detected at concentrations exceeding Washington State and/or USEPA aquatic life criteria (Table 1). An additional three compounds, carbaryl, diazinon, and malathion, were above National Academy of Sciences (NAS, 1973) recommended maximum concentrations to protect aquatic life and wildlife.

Table 1. Pesticides Exceeding Water Quality Criteria in 1994 (µg/L, ppb)

Water Body	Pesticide	Date	Concentration	Criteria (chronic)	Reference
Mission Creek	total DDT	June	0.025	0.001	WAC 173-201A
	azinphos-methyl	June	0.027	0.01	USEPA, 1986
Stink Creek	chlorpyrifos	April	0.056	0.041	WAC 173-201A
	azinphos-methyl	June	0.058	0.01	USEPA, 1986
	total DDT	June	0.014	0.001	WAC 173-201A
GHCDD-1	azinphos-methyl	June	0.014	0.01	USEPA, 1986

Three sites, Mission, Stemilt, and Stink Creeks, were sampled to represent orchard pesticide use. Azinphos-methyl, chlorpyrifos, and diazinon were detected at all three sites. These three pesticides were also found in samples from Mission Creek collected in 1993, and azinphos-methyl was detected in Mission Creek in 1992. DDT was found in Mission Creek in 1993 and 1994, and in Stink Creek in 1994. Carbaryl and malathion were each identified once. In 1993, endosulfan was also found in a sample from Mission Creek.

Insecticides used on orchards appear to be a chronic problem in adjacent streams. Concentrations of some compounds are high enough to cause significant adverse effects to resident stream fauna. If the effects are additive or synergistic, mixtures of these insecticides may result in impacts to aquatic fauna that are more damaging than would be expected from the individual pesticides.

The Palouse River was sampled to represent dry-land agriculture. Nine pesticides were detected; eight were herbicides and the ninth was pentachlorophenol, a fungicide. None exceeded water quality standards.

Numerous pesticides are present consistently in water draining from cranberry bogs in Grayland. In Grays Harbor County Drainage Ditch No 1 (GHCDD-1), 12 compounds were detected in water samples collected in 1994. Azinphos-methyl exceeded the USEPA (1986) water quality criterion, and chlorpyrifos and diazinon were above NAS recommendations. Three of the 12 pesticides were detected in all three sample periods and four were found in two periods, which is the second highest number of multiple detections at WSPMP sample sites. This indicates that a high proportion of the compounds found in GHCDD-1 are in the water for extended periods of time, and resident flora and fauna may be experiencing adverse effects that would not be expected for short duration exposures.

In 1993, mevinphos (Phosdrin) was found at a very high concentration in Joe Leary Slough, which prompted additional sampling in 1994. Thirteen pesticides were found in samples collected in 1994, but mevinphos was not detected. Diazinon was above the NAS recommended maximum concentration in April.

In coordination with the Washington State Department of Agriculture (WSDA), samples were collected from Kearny Creek to assess potential water quality impacts from pesticide use on Christmas tree plantations. Only three compounds were detected: atrazine, hexazinone (Velpar), and pentachlorophenol. Hexazinone was found in all three sample periods, and was also detected in one sample collected by the WSDA in June. Detected concentrations were well below any applicable water quality criteria. Water quality impacts appear to be minimal.

Mercer Creek was sampled in 1994 to verify detections from samples collected in 1992 and 1993. 2,4-D, DCPA, diazinon, dichlobenil, MCPP, and prometon were detected all three years. Concentrations of diazinon were above the NAS recommended maximum for all detections. Malathion was found once each year in 1993 and 1994, and both detections were above the NAS recommendation. Of 13 pesticides found in 1994, three were detected in all three sample periods and four were found in two sample periods. A high proportion of the pesticides identified in 1993 were also detected multiple times. Flora and fauna in Mercer Creek may be experiencing adverse effects from long-term exposure to multiple pesticides.

Recommendations

Additional Sampling for the WSPMP

- Continue sampling Grays Harbor County Drainage Ditch No. 1 to verify the high number and frequency of detections.

- Sample additional streams that are representative of urban pesticide usage to determine if the compounds and concentrations found in Mercer Creek are typical of urban use.

Intensive Surveys

(Intensive surveys are not an objective of the WSPMP and would require separate funding and implementation)

- Perform an intensive survey of streams that flow through orchards to assess the impacts of high concentrations of multiple insecticides on stream biota and associated wildlife.

Additional Recommendations

- Develop and implement Best Management Practices (BMPs) that will minimize pesticides used on orchards from entering waters of the state.

- Develop Washington State Water Quality Criteria for the following insecticides that are frequently detected at concentrations potentially harmful to aquatic life: azinphos-methyl (Guthion), carbofuran, diazinon, and malathion.

- Develop Washington State Water Quality Criteria for the following herbicides that are the most frequently detected pesticides in the state: (in order of frequency of detection) 2,4-D, DCPA (Dacthal), simazine, atrazine, dichlobenil, and bromacil.

- Develop guidelines for Washington State Water Quality Criteria that address additivity for cases where multiple pesticides are detected in the same sample.

- Develop a fact sheet, pamphlet, or other public education medium that identifies urban pesticide use as a significant problem and lists "BMPs" that will reduce the number and amount of pesticides entering waters of the state.

303(d) Listing

- Mission Creek should be evaluated for potential listing on the Federal Clean Water Act, water quality limited 303(d) list, based on three water samples (two in 1993 and one in 1994) that contained concentrations of total DDT that exceeded Washington State Water Quality Criteria

Interagency Coordination

- Present findings of this study to the Washington State Department of Agriculture and the Washington State University Cooperative Extension

- Collaborate with these agencies to develop alternative substances, application rates, integrated pest management, or other BMPs to mitigate potential adverse effects from continued use of target compounds

- Collaborate with agencies and growers to design studies to evaluate effectiveness of BMP implementation

Introduction

The Washington State Pesticide Monitoring Program (WSPMP) was initiated in 1991 by the Department of Ecology (Ecology) to monitor pesticide residues in ground water and surface water, including associated biota such as fish, shellfish, and waterfowl and bed sediments. Ground water and surface water monitoring are being implemented as separate tasks; this report addresses surface water sampling for 1994. Fish samples were collected in September of 1994 and will be covered in a separate report. The goal and objectives of the WSPMP are as follows:

Goal

To characterize pesticide residues geographically and over time in ground water and surface water (including sediments and biota) throughout Washington.

Objectives

- Identify and prioritize aquifers, lakes, and streams with known or potential pesticide contamination.
- Quantify pesticide concentrations in high priority areas
- Document temporal trends in pesticide concentrations at selected sites.
- Provide data to the State Department of Health for assessment of potential adverse effects on human health.
- Assess the potential for adverse effects of pesticides on aquatic biota.
- Construct and maintain a pesticide database for ground water and surface water in Washington.
- Provide information for the improvement of pesticide management in Washington State.

Methods

Sampling Design

Samples were collected at eight sites (Figure 1) in April, June, and October of 1994. April and June represent the peak pesticide application period (late-March to early-July). Sampling in October is conducted to represent previously applied pesticide residues transported to streams in fall storm-water runoff. The number of sample sites and the frequency of sampling were determined primarily by the funding available. Latitude, longitude, and state plane coordinates are listed for each site in Appendix A.

Sampling for the WSPMP is currently being integrated into the five-year cycle developed for Ecology's watershed approach to water quality management. Pesticide sampling for each watershed is implemented one year prior to the scoping period scheduled for that watershed. Results from the WSPMP are used to identify areas with potential pesticide-related problems. These results are presented during the scoping sessions so needs can be assessed more effectively using recent, pertinent data.

The sampling emphasis for the 1994 WSPMP was within the Wenatchee, Western Olympic, and Upper and Lower Snake River watersheds. The Nooksack/San Juan watershed is also included in this group, but higher priority sites were identified in the other watersheds. In addition, sites within the Nooksack watershed were sampled in 1992 and 1993.

Two of the eight sites, Mercer Creek and Mission Creek, were sampled for the third year to verify detections. Verification sampling does not necessarily follow the watershed approach cycle. Mission Creek is within the Wenatchee watershed, but Mercer Creek is in the Cedar River watershed, which is not scheduled to be sampled until 1996 in the watershed cycle.

Samples were analyzed for 161 pesticides and breakdown products (Appendix B). Samples were also collected for total suspended solids (TSS), total organic carbon (TOC), conductivity, and nitrate+nitrite. Field measurements were taken for temperature, pH, and flow.

Washington State Pesticide Monitoring Program

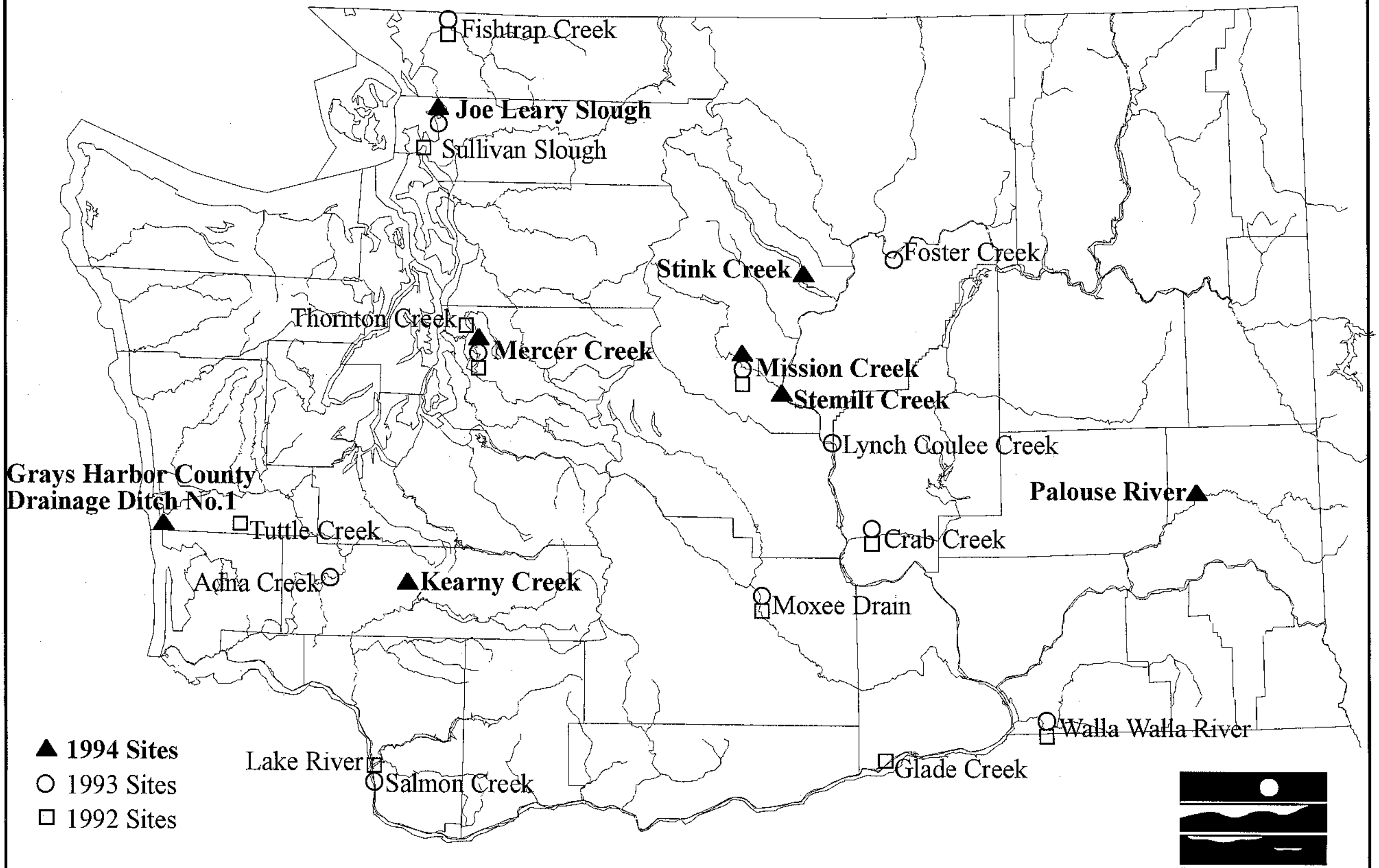

Figure 1. 1992, 1993, and 1994 WSPMP Surface Water Sampling Sites

Sampling Sites

Sample sites were selected to represent various pesticide uses (Table 2).

Table 2. List of Sample Sites, Locations, and Pesticide Uses Typical of the Site

Sample Site	Location	Represented Pesticide Use
Mission Creek	at Cashmere, Chelan Co.	orchards
Stemilt Creek	near Wenatchee, Chelan Co.	orchards
Stink Creek	near Manson, Chelan Co	orchards
Palouse Creek	at Winona, Whitman Co.	dry-land agriculture
GHCDD-1	at Grayland, Grays Harbor Co.	cranberries
Joe Leary Slough	near Sedro Wooley, Skagit Co.	various row crops
Kearny Creek	near Alpha, Lewis Co.	Christmas tree farms
Mercer Creek	near Bellevue, King Co.	urban

Sampling Procedures, Analytical Methods, and QA/QC

Details of sampling procedures are outlined by Davis (1993). Procedures essentially followed those described in the Illinois EPA (1987) field methods manual. A report by Ecology's Manchester Environmental Laboratory (Huntamer, *et al.*, 1992) gives the details of the analytical methods used for the WSPMP and modifications to the methods necessary to incorporate the expanded target analyte list. A brief discussion of sampling procedures, analytical methods, and quality assurance/quality control is in Appendix C. A data quality review is presented in Appendix D.

Results and Discussion

Pesticides Detected

A total of 33 pesticides and breakdown products were detected in water samples collected for the 1994 WSPMP (Table 3). The concentrations of most compounds were in the parts per trillion range. Only dichlobenil from GHCDD-1 in April was detected in the parts per billion range (1.7 µg/L). Pesticides that exceed water quality criteria are highlighted with bold type in Table 3.

Water quality criteria and aquatic toxicity data for detected pesticides are listed in Appendix H; sources for this information are included in this Appendix. Supplemental information (e.g., trade names and applications) for each detected pesticide are presented in Appendix I. For reference, pesticides detected in the 1992 and 1993 WSPMP have been included in Appendix J-1 and J-2.

Detection frequencies in samples collected in 1994 were similar to results from 1992 and 1993. Figure 2 illustrates detection frequencies for all pesticides identified by the WSPMP in surface water samples (1992-1994). For the 1994 data, 2,4-D was found most often, being detected in nine of the 24 samples (38%) at four of the eight sites. Diazinon was found in eight samples and at six sites. Dichlobenil (Casoron), simazine, trichlopyr, and pentachlorophenol were detected in at least 25% of the samples (6 out of 24). Azinphos-methyl and chlorpyrifos were each found five times at four sites, and all detections exceeded water quality guidelines. Sixty-four percent of the detected compounds were found in three or fewer samples.

For the combined data in Figure 2, 2,4-D was the most frequently detected compound, being found in 27 of the 73 samples analyzed (37%). DCPA (Dacthal), atrazine, simazine, diazinon, and dichlobenil were identified in at least 20% (15) of the samples. Azinphos-methyl (Guthion) and chlorpyrifos (Lorsban) were detected in 16% and 15% of the samples, respectively, and were the two pesticides that exceeded water quality criteria most often. Forty-three percent of the detected pesticides were identified in three or fewer samples.

Breakdown Products

Four breakdown products of target pesticides were detected. DDE is a metabolite of DDT and is more persistent in the environment than DDT, but less toxic. Since the ban of DDT in 1972, it would be expected that the proportion of metabolites would increase as the limited supply of the parent compound slowly degrades. DDE was detected in the sample from Mission Creek collected in June at a concentration similar to DDT. DDT was identified in Stink Creek in June, but no DDT metabolites were detected.

The breakdown product of carbofuran, 3-hydroxycarbofuran, was found in four samples, but carbofuran was detected in only one of the four samples. 3-hydroxycarbofuran is less toxic than the parent compound (USEPA, 1984a).

Table 3. Pesticides Detected in Water Samples Collected for the 1994 WSPMP (μg/L, ppb)

	Sample Sites East of the Cascades											
	Mission Creek			Stemilt Creek			Stink Creek			Palouse River		
	April	June	October	April	June	October	April	June[1]	October	April	June	October
Insecticides												
3-hydroxycarbofuran			0.421					0.07				
4,4'-DDE		0.013										
4,4'-DDT		0.012						0.014				
total DDT		**0.025**[2]						**0.014**[2]				
azinphos-methyl (Guthion)	**0.004**[4]	**0.027**[3]		**0.010**[4]				**0.058**[3]				
carbaryl		**0.059**[4]										
chlorpyrifos	**0.02**[4]			**0.005**[4]			**0.056**[2]					
diazinon	**0.031**[4]			0.009			**0.021**[4]					
malathion					**0.012**[4]							
Herbicides												
2,4-D										0.028	0.069	
atrazine											0.053	0.069
bromacil		0.022	0.044									
bromoxynil				0.060			0.088					
DCPA (Dacthal)										0.012		
dichlobenil							0.017					
diclofop-methyl										0.030		
MCPA										0.036	0.020	
MCPP											0.029	
norflurazon									0.078			
norflurazon desmethyl									0.10			
simazine	0.25		0.011			0.006	0.025	0.092	0.075		0.55	
triallate										0.018	0.043	
Fungicide												
pentachlorophenol						0.0054					0.0091	

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds Washington State water quality standards

[3] - Exceeds USEPA, 1986 water quality criteria

[4] - Exceeds NAS, 1973 recommended maximum concentrations

Table 3 (cont.). Pesticides Detected in Water Samples Collected for the 1994 WSPMP (μg/L, ppb)

	Sample Sites West of the Cascades											
	GHCDD-1			Joe Leary Slough			Kearny Creek			Mercer Creek		
	April[1]	June	October	April	June	October	April	June	October	April	June	October[1]
Insecticides												
4-nitrophenol				0.084						0.13		
azinphos-methyl (Guthion)		**0.014**[2]										
carbofuran	0.08	0.054										
3-hydroxycarbofuran		0.054			0.059							
chlorpyrifos		**0.021**[3]	**0.03**[3]									
diazinon	**0.011**[3]		**0.029**[3]	**0.017**[3]						**0.032**[3]		**0.042**[3]
malathion										**0.028**[3]		
Herbicides												
2,4-D	0.11	0.22	0.091	0.077						0.17	0.014	0.035
atrazine							0.008					
bromacil										0.014	0.035	
chlorpropham					0.081							
DCPA (Dacthal)					0.0069					0.035	0.021	
dicamba				0.036						0.013		
dichlobenil	1.7	0.21	0.92							0.051	0.032	0.023
dichlorprop		0.011								0.018		
EPTC (Eptam)				0.060								
hexazinone							0.071	0.11	0.15			
MCPA				0.043								
MCPP					0.14						0.019	
metribuzin					0.076							
napropamide	0.20		0.17									
norflurazon	0.16	0.16	0.47									
prometon		0.021								0.012		
triclopyr		0.017			0.019	0.010				0.062	0.046	0.040
Fungicide												
pentachlorophenol					0.075	0.013			0.0047		0.023	0.024

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds USEPA, 1986 water quality criteria

[3] - Exceeds NAS, 1973 recommended maximum concentrations

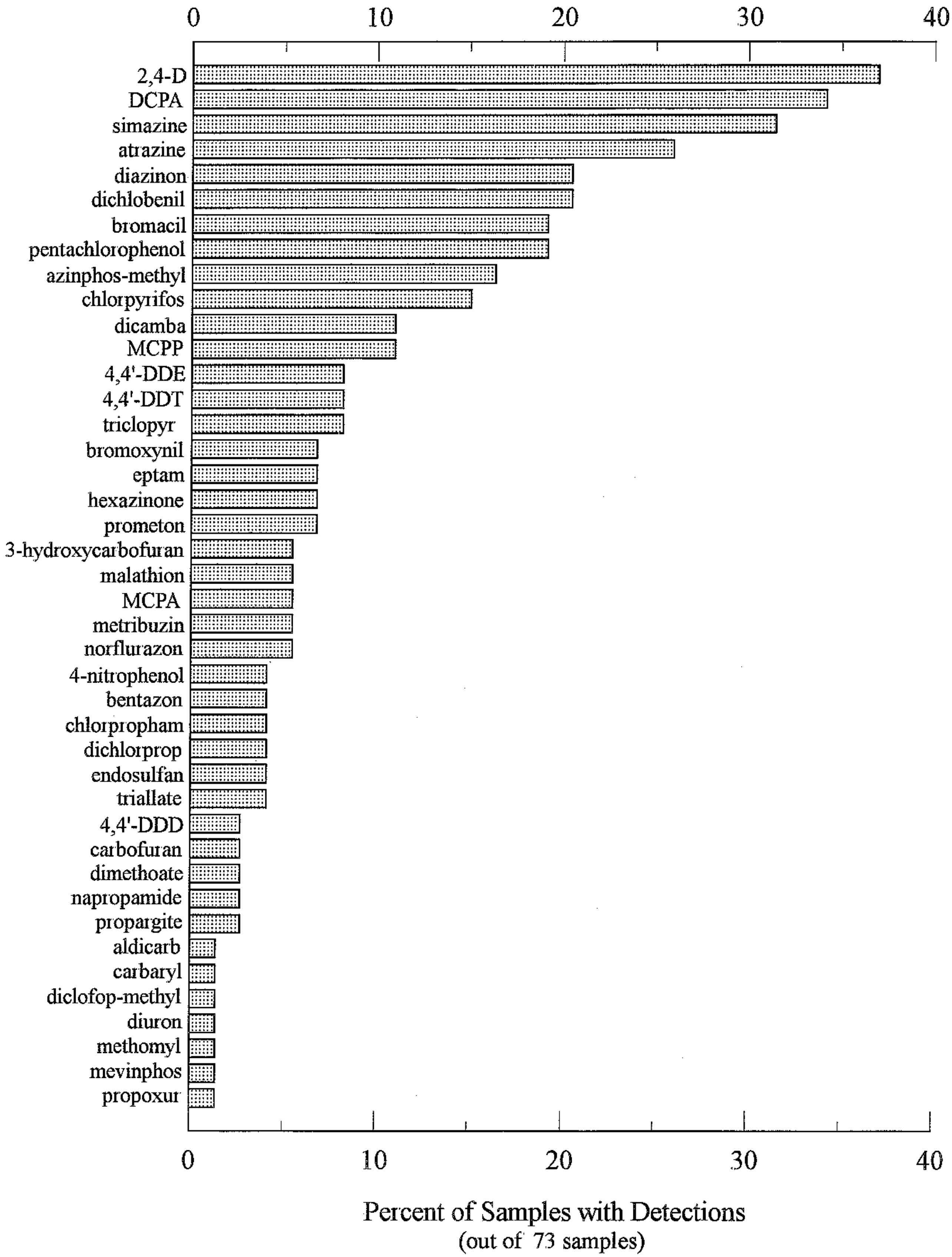

Figure 2. Detection Frequency of Pesticides in 1992, 1993, and 1994 WSPMP Surface Water Samples

Norflurazon desmethyl, a metabolite of norflurazon, was found once in a sample from Stink Creek. Norflurazon was also detected. Norflurazon was found in all three samples from GHCDD-1, but no breakdown products were detected.

A degradation product of parathion, 4-nitrophenol, was identified twice, once at Joe Leary Slough and once at Mercer Creek, but the parent compound was not detected.

Conventional Parameters

Results of conventional parameter analyses and field measurements are presented in Table 4. Significant findings are discussed in the next section.

Site Evaluations

Mission Creek

The source of Mission Creek extends high into the Wenatchee Mountains south of Cashmere. Mission Creek also receives water from Little Camas Creek and Sand Creek. Most of Mission Creek runs through uninhabited land, but the lower section flows directly through several pear and apple orchards and then discharges into the Wenatchee River. The sampling site in 1994 was at the mouth, below the confluence with Brender Creek. Mission Creek was also sampled for the WSPMP in 1992 and 1993, but the sample site was upstream from Brender Creek, at a bridge near the intersection of Meadow Sweet Place and Mission Creek Road.

Azinphos-methyl exceeded USEPA (1986) water quality criteria in WSPMP samples collected from Mission Creek in 1992 and 1993. Chlorpyrifos, endosulfan (Thiodan), and total DDT (t-DDT = DDT+DDE+DDD) concentrations were above Washington State water quality standards for the protection of aquatic life (WAC 173-201A) in 1993 (Davis, 1993; Davis and Johnson, 1994). Mission Creek was sampled again in 1994 to determine if these pesticides are consistently present from year to year. Stemilt and Stink Creeks were sampled in 1994 to determine if the same pesticides that exceeded water quality criteria in Mission Creek were also present in other streams that flow through orchards

In 1994, azinphos-methyl and total DDT were detected in samples from Mission Creek at 0.027 and 0.025 µg/L, respectively, which again exceeded USEPA or Washington State water quality criteria. In addition, levels of carbaryl (Sevin), chlorpyrifos, and diazinon were above the National Academy of Sciences (NAS, 1973) recommended maximum concentrations for the protection of aquatic life and wildlife.

Chlorpyrifos and azinphos-methyl are heavily used on the orchards that Mission Creek flows through (Smith, 1994). Chlorpyrifos is used in early spring to control aphids. Azinphos-methyl is used in late spring to control codling moths. DDT was heavily used on orchards prior to its ban in 1972, and it is still commonly found where there is soil erosion from the orchards.

Table 4. Results of Conventional Parameters for the 1994 WSPMP

	TOC (mg/L)			TSS (mg/L)			Nitrate+Nitrite (mg/L-N)			Conductivity (µmho/cm)		
Sample Site	April	June	October	April	June	October	April	June	October	April	June	October
Mission Creek	13.8	1.4	1.3	1850	10	5	0.26	0.75	3.38	150	193	501
Stemilt Creek	4.3	1.8	3.0	1U[2]	4	1U	2.81	0.21	3.40	667	165	790
Stink Creek	12.7	5.3[1]	3.2	31	12[1]	1U	0.05	2.70[1]	3.29	626	652[1]	631
Palouse River	23.3	5.5	4.5	31	23	8	0.23	0.08	0.37	122	238	522
GHCDD-1	11.5[1]	8.6	10.7	5[1]	5	8	0.18[1]	0.08	0.14	228[1]	234	225
Joe Leary Slough	17.4	9.0	3.1	139	104	51	0.30	0.35	0.52	362	403	8070
Kearny Creek	2.4	2.1	2.8	5	4	3	0.47	0.25	0.23	464	56.5	69.4
Mercer Creek	10.3	3.5	4.7[1]	29	2	2[1]	0.72	0.52	0.40[1]	211	223	204[1]

	Temperature (°C)			pH			Flow (CFS)		
Sample Site	April	June	October	April	June	October	April	June	October
Mission Creek	9.4	13.5	11.5	8.0	8.5	7.8	42.9	12.8	1.8
Stemilt Creek	16.7	15.5	12.4	8.1	8.2	8.3	0.2	4.4	0.2
Stink Creek	10.0	21.3	13.6	7.6	7.8	8.1	1.4	0.51	0.21
Palouse River	8.7	23.4	13.0	7.1	8.3	8.6	266	28.6	11.6
GHCDD-1	11.8	14.3	10.6	6.3	7.4	6.5	3.8	1.2	3.0
Joe Leary Slough	13.8	19.6	9.5	6.7	6.5	6.8	DNC[3]	DNC	DNC
Kearny Creek	12.2	16.8	7.7	7.4	6.2	7.3	11.7	4.8	2.1
Mercer Creek	11.7	14.8	9.2	6.8	6.5	6.6	15.79	6.93	7.14

[1] - Values are means of duplicate analyses

[2] - Not detected at or above the reported value

[3] - Data not collected

Measured concentrations of azinphos-methyl, carbaryl, chlorpyrifos, diazinon, and DDT approach acute toxicity values (*i.e.*, within an order of magnitude) for some invertebrates (Appendix H). All of these pesticides are highly toxic insecticides, and all except DDT are acetylcholinesterase (AChE) inhibitors. The toxicity of insecticide mixtures is generally at least additive, and mixtures of AChE inhibitors are often synergistic (Macek, 1975; Faust *et al.*, 1994). Although the detected concentrations of the individual pesticides are lower than published toxicity values, combinations of the insecticides are likely to be acutely toxic to some aquatic fauna.

Total suspended solids (TSS) in the sample from Mission Creek collected in April were extremely high (1850 µg/L, Table 4). Flow was also very high at that time. These high values were probably due to snow-melt runoff in the mountains above the orchards. Aquatic communities may have been impacted by the high suspended solids. The concentration of TSS was in the range as determined by the NAS (1973) that provides a very low level of protection for aquatic communities (>400 µg/L).

Stemilt Creek

Like Mission Creek, Stemilt Creek starts in the Wenatchee Mountains and flows through orchards in the Wenatchee Valley. Orr and Middle Creeks are tributaries and enter Stemilt Creek above the orchards in Wenatchee Heights. The sampling site was at the bridge on the Malaga-Alcoa Highway just before the creek discharges into the Columbia River.

Four insecticides, azinphos-methyl, chlorpyrifos, diazinon, and malathion, and two herbicides, bromoxynil and simazine, were identified in samples from Stemilt Creek. Pentachlorophenol was also detected. Azinphos-methyl, chlorpyrifos, and malathion at 0.010, 0.005, and 0.012 µg/L, respectively, exceeded NAS (1973) recommended maximum concentrations, and approach acute toxicity values for some invertebrates.

Stemilt Creek is a very small stream with a flow of less than one cubic foot per second (CFS) most of the year. However, the flow in June went up to 4.4 CFS, indicating that irrigation accounts for most of the flow in the summer. It should be noted that only malathion was detected in June. This suggests that the irrigation water does not run directly off into the creek. If it did, more and higher concentrations of pesticides would be expected as the flow increased.

Stink Creek

Stink Creek is another stream that flows through orchards. Stink Creek is only about a mile long and drains Roses and Dry Lakes. These lakes sit in a small valley above the north shore of Lake Chelan near Manson, and are surrounded by orchards. Near Lake Chelan, the creek enters a pipe that discharges into the lake. Samples were collected just upstream of the pipe.

Ten compounds were detected in water samples. Four were insecticides, four were herbicides, and two were breakdown products. All four insecticides exceeded water quality criteria. Chlorpyrifos was found in April at a concentration of 0.056 µg/L, and 4,4'-DDT was detected in June at 0.014 µg/L; both pesticides were above Washington State chronic standards. The

USEPA (1986) criterion for azinphos-methyl was exceeded in June (0.058 µg/L), and in April diazinon, at 0.021 µg/L, was above the NAS (1973) recommended maximum concentration. All four also approach acute toxicity values, particularly chlorpyrifos which was at the low end of the range of the 96 hour LC_{50} for *Gammarus lacustris* (0.07 to 0.17 µg/L, Johnson and Finley, 1980).

In sediment samples collected from Roses Lake by Ecology (Serdar *et al.*, 1994), total DDT concentrations were extremely high (average of 1600 µg/Kg, ppb). Water from Roses Lake passes into Dry Lake before discharging into Stink Creek. Vegetation in Dry Lake is very thick at the end where it discharges into Stink Creek, and most particulates carrying DDT would be filtered out by the vegetation. However, during a storm event that substantially increases flow through the lakes, high concentrations of DDT may be carried into the creek.

Stink Creek is classified as a AA stream (feeder to a lake). As such, the maximum temperature should not exceed 16.0°C. In June, the temperature in Stink Creek was 21.3°C, but this high value was probably not the result of human activity. Dry Lake, which feeds Stink Creek, is shallow and probably heats up quickly in the hot summer sun.

Orchard Pesticide Use Summary

Six insecticides were identified in samples from the three sites representing orchard pesticide use. All detections for these six compounds exceeded water quality criteria. Azinphos-methyl, chlorpyrifos, and diazinon were found at all three sites. These three pesticides were also found in samples from Mission Creek collected in 1993. In addition, azinphos-methyl was detected in Mission Creek in 1992. DDT was found in Mission Creek in 1993 and 1994, and in Stink Creek in 1994. Carbaryl and malathion were each identified once. In 1993, endosulfan was also found in a sample from Mission Creek.

Azinphos-methyl is the most consistently detected insecticide in samples from orchard use areas. Most concentrations of azinphos-methyl have exceeded the USEPA (1986) water quality criterion for protection of aquatic wildlife; the remainder have been above the NAS (1973) recommended maximum concentration. The level of azinphos-methyl detected in June of 1993 was above concentrations toxic to some invertebrates (Davis and Johnson, 1994).

Chlorpyrifos has been found consistently in samples collected in April from orchard use areas. It is used from late March through April to control aphids in orchards. Chlorpyrifos is moderately persistent, but it generally does not reach surface waters because it is not readily soluble in water and it adsorbs strongly to organic matter (Seyler *et al.*, 1994). Apparently, some makes its way into the streams in detectable concentrations during application periods, but residues have not been detectable shortly thereafter. Some levels of chlorpyrifos have exceeded the Washington State water quality standard for protection of aquatic wildlife (WAC 173-201A); others were above the NAS recommended maximum concentration.

DDT is apparently associated with soil particles originating from the orchards. It is detected most frequently in June, probably from storm-water runoff. Orchard runoff also occurs in April, but snow melt probably dilutes the concentrations below detectable levels DDT in Stink Creek will probably increase substantially during any high flow event.

Diazinon has also been detected consistently in orchard area streams. Some concentrations have exceeded the NAS recommendation; no state or federal criteria exist.

Azinphos-methyl and chlorpyrifos appear to be chronic problems in orchard streams, and either individually or in combination have the potential, at the concentrations detected, to cause significant adverse effects to the resident stream fauna. By itself, diazinon does not appear to be a problem in orchard streams. If the effects of insecticides are additive, then the presence of diazinon, along with azinphos-methyl, chlorpyrifos, and/or any other insecticides, may result in significant adverse effects to the aquatic fauna.

Palouse River

The south fork of the Palouse River originates southeast of Pullman and runs northwest through Pullman to Colfax, where it joins with the north fork. The north fork originates in Idaho and flows westward through the town of Palouse and on to Colfax. After the confluence, the river flows northwest for a few miles and then begins turning southwest until it flows into the Snake River

Samples for the WSPMP were collected at Winona, upstream of the confluence with Rebel Flat Creek. The Palouse River was chosen to represent dry-land agriculture pesticide use, which is the predominant land use upstream from Winona. Downstream from Winona the river receives water from streams that are not primarily representative of dry-land agriculture.

Nine pesticides were detected in water samples from the Palouse River collected in 1994. Eight of these were herbicides that are typically used on grain crops. Pentachlorophenol, a fungicide/molluscicide used to treat wood, was also found. Concentrations of all detected pesticides were well below any criteria or toxicity values.

The temperature in June (23.4°C) exceeded the Washington State water quality standard for Class B surface waters (21.0°C, WAC 173-201A) High temperatures in this river may be partially the result of human activities Air temperatures during the summer in this watershed become quite high and much of the protective vegetation along the river has been removed or disturbed by human activity.

Grays Harbor County Drainage Ditch No.1

This ditch drains cranberry bogs in the northern portion of the Grayland area and flows north into South Bay in Grays Harbor. This is a natural drainage of an area that was probably once a wetland, but it has been channeled to drain the cranberry bogs and surrounding residential property more efficiently. The sample site was at the bridge on Schmid Road in Grayland.

Cranberry bogs in the southern part of Grayland drain into another ditch (Pacific County Drainage Ditch No 1) that flows south into Willapa Bay near Tokeland. Discharge from this ditch has been sampled by the USEPA (Watson, 1995), but the data are not yet available.

Twelve pesticides were found in samples collected for the WSPMP. Seven of these are recommended for use on cranberries by the Washington State University Cooperative Extension (Antonelli *et al.*, 1995). Azinphos-methyl was detected in June at 0.014 µg/L, slightly above the criterion set by the USEPA (1986) of 0.01 µg/L. Detections of chlorpyrifos in June (0.021 µg/L) and October (0.03 µg/L), and diazinon in April (0.011 µg/L) and October (0.029 µg/L) exceeded NAS recommended concentrations. All three of these insecticides approach toxicity values for some invertebrates.

Of the 12 pesticides detected in GHCDD-1, three insecticides, carbofuran, chlorpyrifos, and diazinon were each found in two of the three sample periods. Three of the herbicides, 2,4-D, dichlobenil, and norflurazon, were present in all three sample periods. Napropamide was also found in two sample periods. Multiple detections are important because it suggests that the flora and fauna are being exposed to these pesticides for long periods of time. Water quality criteria for chronic exposures are typically based on relatively short durations, such as 24 to 96 hours. Little information is available for longer exposures, but the toxicity of some pesticides is likely to be higher for durations on the order of months as suggested by multiple detections. Flora and fauna in GHCDD-1 appear to be exposed to multiple pesticides for extended periods of time, and may be experiencing adverse effects that would not be expected for short duration exposures.

Multiple detections of insecticides can be explained by reviewing the pesticide application schedule recommended by the WSU Cooperative Extension (Antonelli *et al.*, 1995). Four time periods for insecticide application are recommended throughout the growing season to control various pests. However, multiple detections of herbicides are not so easily explained. Herbicide application takes place primarily in the winter and early spring when the cranberry plants are dormant, and generally ends by late April.

The pH for GHCDD-1 in April was 6.3, which is slightly below the state standard for class A waters of 6.5 to 8.5 (WAC 173-201A-030). The reason for this low pH is not known.

Joe Leary Slough

Joe Leary Slough drains the Olympia Marsh, northwest of Mount Vernon, into Padilla Bay. Land use adjacent to the slough is predominantly agriculture, including orchards, caneberries, pasture land, and a variety of row crops.

This slough was sampled once in June of 1993, and mevinphos (Phosdrin) was found at a very high concentration (Davis and Johnson, 1994). Mevinphos is a highly toxic organo-phosphorus insecticide, and it was found at a level high enough to kill some fish. Joe Leary Slough was resampled in 1994 to determine if mevinphos continued to be present at high concentrations

Thirteen pesticides were detected in water samples from Joe Leary Slough in 1994. Diazinon, at 0.017 µg/L, was above the NAS recommended maximum concentration. No other pesticides were above water quality criteria, and none exceeded acute toxicity values. Only two of the compounds detected were found in more than one sampling period. Mevinphos was not detected in 1994, probably because most uses were canceled by the Washington State Department of Agriculture (AENews, 1994).

Joe Leary Slough is classified as a Class A water body. The water temperature in June (19.6°C) exceeded the state standard of 18.0°C. Historically, this area was an estuary/wetland. Agricultural practices in the area have modified this water body so extensively that for most of its length it is little more than a drainage ditch with little or no protective vegetation. It is probably safe to assume that the high temperature is due to human activity.

Kearny Creek

Sampling of Kearny Creek was coordinated with the Washington State Department of Agriculture (WSDA). The WSDA was investigating potential water quality impacts from pesticide use on Christmas tree plantations. Coordination consisted of sampling of the same stream and sharing the results. Sampling sites and schedules, target analyte lists, and analytical methods were different.

Kearny Creek originates in the foothills north of highway 508 near Cinebar, runs through about four miles of Christmas tree and "hobby" farms, and then flows into the south fork of the Newaukum River. About a mile and a half upstream from the confluence with the river, Door Creek flows into Kearny Creek. The sample site for the WSPMP was at the bridge on Frase Road, just downstream of the confluence with Door Creek. The WSDA collected samples at two sites, one on Kearny Creek about one mile upstream of the WSPMP site and one on Door Creek about a mile and a half upstream from the confluence with Kearny Creek.

Only three pesticides were detected in samples collected for the WSPMP. Atrazine was found in April and hexazinone (Velpar) was identified in samples from all three sampling periods. Pentachlorophenol was also detected at a low level in October. In samples collected by the WSDA on June 8, hexazinone was detected in Door Creek at 0.77 µg/L, but nothing was found in Kearny Creek (Foss, 1994). All concentrations were well below any applicable criteria.

The hexazinone detected at the WSPMP site was probably from Door Creek. During a reconnaissance of the area on April 8, 1994, signs were seen posted around a large Christmas tree farm along the upper end of Door Creek that indicated that the farm had been treated with Velpar. The WSDA data support this with a detection of hexazinone in Door Creek, but not in Kearny Creek.

Kearny Creek is a Class A water body. The acceptable pH range for class A waters is 6.5 to 8.5. In June, the pH in Kearny Creek was 6.2. The reason for this low value is not known.

Kearny Creek is the third stream sampled by the WSPMP representing forest practices pesticide use. Tuttle Creek was sampled in 1992 (Davis, 1993) and Adna Creek was sampled in 1993 (Davis and Johnson, 1994). No pesticides were detected in Tuttle Creek and only one, 2,3,4,6-tetrachlorophenol, was found in samples from Adna Creek.

The low concentrations and number of detections at these sites appear to indicate that forest practices pesticide use is having little impact on surface waters and associated biota. In general, this may be true because few pesticides are regularly used on forest practices applications, pesticide applications are made infrequently on individual sites, and sites are typically isolated from one another. However, under certain circumstances some pesticides may reach concentrations that could adversely impact stream biota. Shortly after application on a Christmas tree farm, levels of chlorothalonil (Daconil) and oxydemeton-methyl (Metasystox-R) in a stream flowing through the farm were found to be higher than recommended maximum concentrations (Rashin and Graber, 1993). While impacts from forest practices pesticide use do not appear to be common, isolated incidents do take place.

Mercer Creek

Mercer Creek drains the Bellevue area east of Interstate-405, including street runoff, into Lake Washington, and represents urban pesticide use. Much of this area is residential, but includes a bridle trail park, shopping centers, schools, and two golf courses. The creek was sampled at the mouth where it flows into Mercer slough.

This site was also sampled in 1992 and 1993 for the WSPMP (Davis, 1993; Davis and Johnson, 1994), and was sampled again in 1994 to verify detections. Thirteen pesticides were detected in samples collected in 1994. Ten of these were also found in 1993. Only one sample was collected in 1992, but all of the six target compounds that were detected were also found in 1993 and 1994 These six were 2,4-D, DCPA, diazinon, dichlobenil, MCPP, and prometon. 2,4-D, DCPA, and dichlobenil were the most consistently detected pesticides at Mercer Creek. Other frequently detected compounds were bromacil, pentachlorophenol, simazine, and trichlopyr.

Diazinon was found above the NAS (1973) recommended maximum concentration for every detection over the three years. Malathion was found once each in 1993 and 1994, and both detections exceeded the NAS recommendation. Although the concentrations of diazinon and malathion approached toxicity values for some invertebrates, none were above LC_{50} values (Appendix H).

Of the 13 pesticides found in 1994, three were detected in all three sample periods and four were found in two sample periods. A high proportion of the pesticides identified in 1993 were also detected multiple times. Flora and fauna in Mercer Creek may be experiencing adverse effects from long-term exposure to multiple pesticides

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USEPA 1988a Pesticide Fact Sheet No. 166 DCPA U.S Environmental Protection Agency, Office of Pesticides and Toxic Substances, Office of Pesticide Programs, Washington, D.C.

USEPA 1988b Pesticide Fact Sheet No. 192 MCPP U.S Environmental Protection Agency, Office of Pesticides and Toxic Substances, Office of Pesticide Programs, Washington, D.C.

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Appendices

Appendix A. Surface Water Sampling Site Positions for the 1994 WSPMP

Site Name	Latitude			Longitude			State Plane	
	deg	min	sec	deg	min	sec	X	Y
Mission Creek at Mission Creek Road	47	30	43.5	120	28	18.5	2006970	794559
Stemilt Creek at Malga-Alcoa Highway	47	22	31	120	14	47	2062841	744759
Stink Creek at mouth	47	55	48	120	11	26	2075881	947173
Palouse River at Winona	46	56	44	117	48	13	2673351	599435
GHCDD-1 at Schmid Road	46	48	58	124	05	25	1101412	561171
Joe Leary Slough at Bayview-Edison Road	48	31	2.7	122	28	17.3	1521965	1167366
Kearny Creek at Frase Road	46	36	38	122	36	10	1471591	472798
Mercer Creek at mouth	47	36	6.0	122	10	58.2	1584813	831668

Appendix B. Target Pesticides List for Surface Water

EPA Method 1618 - Modified
(one extraction)

Chlorinated Pesticides
(one analysis)

Compound	Quantitation Limits* µg/L	Compound	Quantitation Limits µg/L
2,4'-DDT	0.05	chlordene-gamma	0.05
2,4'-DDE	0.05	dicofol (Kelthane)	0.50
2,4'-DDD	0.05	dieldrin	0.05
4,4'-DDT	0.05	endrin	0.05
4,4'-DDE	0.05	endrin aldehyde	0.05
4,4'-DDD	0.05	endrin ketone	0.05
DDMU	0.05	endosulfan I	0.05
aldrin	0.05	endosulfan II	0.05
BHC-alpha	0.05	endosulfan sulfate	0.05
BHC-beta	0.05	heptachlor	0.05
BHC-delta	0.05	heptachlor epoxide	0.05
BHC-gamma (Lindane)	0.05	methoxychlor	0.08
captafol	0.25	mirex	0.05
captan	0.15	nonachlor-cis	0.05
chlordane-alpha	0.05	nonachlor-trans	0.05
chlordane-gamma	0.05	oxychlordane	0.05
chlordene-alpha	0.05	toxaphene	1.00

Pyrethroid Pesticides
(one analysis)

Compound	Quantitation Limits µg/L	Compound	Quantitation Limits µg/L
cis-permethrin	0.17	phenothrin	0.17
fenvalerate	0.30	resmethrin	0.17

* - Quantitation limits are approximate and may change between samples.

Appendix B (cont.). Target Pesticides List for Surface Water

EPA Method 1618 - Modified (cont.)

Organo-Phosphorus Pesticides
(one analysis)

Compound	Quantitation Limits μg/L	Compound	Quantitation Limits μg/L
abate (Temephos)	0.75	fenamiphos	0.13
azinphos-ethyl	0.13	fenitrothion	0.06
azinphos-methyl (Guthion)	0.16	fensulfothion	0.08
carbophenothion	0.08	fenthion	0.06
chlorpyrifos (Lorsban)	0.06	fonofos	0.05
chlorpyrifos-methyl	0.06	imidan (Phosmet)	0.09
coumaphos	0.09	malathion	0.06
DEF (Tribufos)	0.11	merphos	0.13
demeton-o	0.06	mevinphos	0.08
demeton-s	0.06	monocrotophos	0.58
diazinon	0.07	paraoxon-methyl	0.15
dichlorvos	0.07	parathion	0.06
diethyl fumarate	0.25	parathion-methyl	0.06
dimethoate	0.06	phorate	0.06
dioxathion	0.14	phosphamidan	0.19
disulfoton	0.05	propetamphos	0.16
EPN	0.08	ronnel	0.06
ethion	0.06	sulfotepp	0.05
ethoprop	0.07	sulprofos	0.06
		tetrachlorvinphos (Gardona)	0.17

Sulfur-Containing Pesticides
(one analysis)

Compound	Quantitation Limits μg/L
propargite	0.18

Appendix B (cont.). Target Pesticides List for Surface Water

EPA Method 1618 - Modified (cont.)

Nitrogen-Containing Pesticides
(one analysis)

Compound	Quantitation Limits µg/L	Compound	Quantitation Limits µg/L
Triazines			
ametryn	0.08	cycloate	0.13
atraton	0.25	di-allate (Avadex)	0.30
atrazine	0.08	EPTC (Eptam)	0.14
cyanazine	0.12	triallate (Fargo)	0.20
hexazinone	0.13	vernolate	0.14
metribuzin	0.08		
prometon	0.08	**Substituted Amides**	
prometryn	0.08	diphenamid	0.25
propazine	0.08	napropamide	0.25
simazine	0.08	pronamide	0.25
terbutryn	0.08		
		Uracils	
Anilines		bromacil	0.50
benfluralin (Benefin)	0.12	terbacil	0.25
ethalfluralin	0.12		
pendimethalin	0.12	**Ureas**	
profluralin	0.19	diuron	0.45
trifluralin	0.12	tebuthiuron	0.08
Anilides		**Miscellaneous**	
alachlor	0.20	carboxin	0.86
butachlor	0.29	chlorpropham	0.35
metolachlor	0.25	fenarimol	0.25
propachlor	0.17	fluridone	0.55
		metalaxyl	0.52
Cyano		MGK264	0.55
chlorothalonil	0.20	molinate	0.20
dichlobenil	0.10	norflurazon	0.13
		oxyfluorfen	0.25
Thiocarbamates		pebulate	0.20
butylate	0.13	triadimefon	0.22

Appendix B (cont.). Target Pesticides List for Surface Water

EPA Method 515.1
(one extraction, one analysis)

Chlorinated Herbicides

Compound	Quantitation Limits µg/L	Compound	Quantitation Limits µg/L
2,4-D	0.04	chloramben	0.04
2,4-DB	0.05	DCPA (Dacthal)	0.03
2,4,5-TB	0.04	dalapon (DPA)	0.11
2,4,5,-TP	0.03	dicamba	0.04
2,4,5-trichlorophenol	0.02	dichlofop-methyl	0.06
2,4,6-trichlorophenol	0.02	dichlorprop	0.04
2,3,4,6-tetrachlorophenol	0.02	dinoseb	0.06
3,5-dichlorobenzoic acid	0.04	ioxynil	0.04
4-nitrophenol	0.07	MCPA	0.08
5-hydroxydicamba	0.04	MCPP	0.08
acifluorfen (Blazer)	0.16	pentachlorophenol	0.02
bentazon	0.06	picloram	0.04
bromoxynil	0.04	triclopyr (Garlon)	0.03

EPA Method 531.1
(one extraction, one analysis)
Carbamates

Compound	Quantitation Limits µg/L	Compound	Quantitation Limits µg/L
1-napthol	0.04	carbofuran	0.04
3-hydroxycarbofuran	0.04	methiocarb	0.04
aldicarb	0.04	methomyl	0.04
aldicarb sulfone	0.04	oxamyl	0.04
aldicarb sulfoxide	0.04	propoxur (Baygon)	0.04
carbaryl	0.04		

Appendix C.

Sampling Procedures

Samples were collected using U S Geological Survey (USGS) depth integrating samplers modified so that the water sample contacts only teflon or glass Samples were hand composited, filling containers one-third full from each point in a quarter point transect across the streams Samples were held on ice during transportation to the laboratory

Analytical Methods

Analytes in Appendix B are grouped by analytical method Chlorinated pesticides, organophosphates, nitrogen-containing pesticides, pyrethroids, and sulfur-containing pesticides were all analyzed with EPA Method 1618 (modified) Chlorinated herbicides were analyzed using EPA Method 615 and carbamates with EPA Method 531 1 Methods were not modified from those reported in 1993 (Davis and Johnson, 1994)

Quality Assurance/Quality Control

Matrix spike and matrix spike duplicate (MS/MSD) and field duplicate (split) samples were collected from a different site for each collection period In April, the MS/MSD and field duplicate samples were collected from GHCDD-1, from Stink Creek in June, and from Mercer Creek in October MS/MSD samples were used to estimate analytical precision and accuracy Field duplicates were also used to assess analytical precision

In 1993, a field spike was submitted to the laboratory to assess analytical accuracy and loss of target analytes in the period from collection to analysis Out of 41 target analytes submitted in the field spike, all but one was detected, and reported concentrations were very close to the expected values (Davis and Johnson, 1994), indicating excellent accuracy

A transfer/bottle blank was prepared in June of 1993 to ensure that decontamination procedures were effective No target analytes were detected in the blank

Appendix D.

Data Review

Data packages and quality control results from samples analyzed by Ecology's Manchester Environmental Laboratory were reviewed and assessed by Dickey Huntamer

No significant problems were encountered for most of the analyses Problems with a new HPLC system used to analyze carbamate samples resulted in loss of most October carbamate data The computer system was not set up correctly causing it to overwrite raw data from the previous analysis Results from only one sample and one matrix spike were recovered During the analysis, an incorrect autosampler pump setting resulted in oversampling so there was not enough sample remaining to permit reanalysis During the chlorinated herbicides analysis for October the Mission Creek sample was contaminated by the carry over of methylation reagent during the methylation process, resulting in loss of all data from that sample.

Quality Control Samples

No accuracy or precision criteria have been established for any of the analytical methods used, but duplicate field samples, and matrix and surrogate spike analyses provide estimates of accuracy and precision Results are shown in Appendices E (duplicates), F (matrix spikes), and G (surrogate spikes) In general, low relative percent difference (RPD) between duplicates indicates high precision and recoveries near 100% indicate good accuracy.

Precision of duplicate analyses was generally excellent. RPD values ranged from 0 to 64% and the average was 18%.

Matrix spike recoveries for chlorinated herbicides in June were low, ranging from 8 to 51%, with four compounds below 20% These four compounds were "J" qualified (the analyte was positively identified and the associated value is an estimate) in the matrix spike source sample. Aldicarb had a recovery of 15% in the June carbamate matrix spike, but was 52% in the spike duplicate The laboratory explained this as the result of aldicarb breaking down to aldicarb sulfoxide, which had a recovery of 151% in the matrix spike. Otherwise, matrix spike and duplicate recoveries were acceptable.

Surrogate recoveries ranged between 0 and 136%, and averaged 76% Samples were qualified with a "J" when the surrogate recovery was less than 20% No pesticides were detected in samples with surrogate recoveries less than 20%

Many of the detected compounds were qualified as estimates (J or NJ) These qualifiers have not been included in this report for clarity of presentation Complete results are available from the author on request

Appendix E. Duplicate Analysis Results for 1994 WSPMP Surface Water Samples (μg/L, ppb)

Analyte	Sample 1	Sample 2	RPD[1]
April (GHCDD-1)			
2,4-D	0.11	0.11	0
carbofuran	0.08	0.08	0
diazinon	0.011	0.011	0
dichlobenil	2.1	1.3	47
napropamide	0.19	0.20	5
norflurazon	0.16	0.15	6
simazine	0.086 U[2]	0.015	NC[3]
June (Stink Creek)			
3-hydroxycarbofuran	0.09	0.059	42
4,4'-DDD	0.011	0.055 U	NC
4,4'-DDT	0.019	0.0098	64
azinphos-methyl	0.054	0.062	14
simazine	0.085	0.099	15
October (Mercer Creek)			
2,4-D	0.037	0.033	11
diazinon	0.044	0.040	10
dichlobenil	0.024	0.021	13
pentachlorophenol	0.025	0.022	13
triclopyr	0.045	0.035	25

1 - RPD = Relative Percent Difference, (difference/mean) x 100

2 - Not detected at or above reported value

3 - NC = Not Calculated

Appendix F. Matrix Spike Recoveries for 1994 WSPMP Surface Water Samples (%)

	April			June			October		
	MS[1]	MSD[2]	RPD[3]	MS	MSD	RPD	MS	MSD	RPD
chlorinated pesticides									
2,4'-DDT	NAF[4]	NAF		102	78	27	NAF	NAF	
4,4'-DDT	93	86	8	89	75	17	NAF	NAF	
2,4'-DDE	NAF	NAF		89	72	21	NAF	NAF	
2,4'-DDD	NAF	NAF		92	72	24	NAF	NAF	
aldrin	56	24	80	42	51	19	NAF	NAF	
BHC-gamma (lindane)	94	87	8	85	72	17	NAF	NAF	
captafol	NAF	NAF		90	71	24	NAF	NAF	
captan	NAF	NAF		85	71	18	NAF	NAF	
chlordane-gamma	87	82	6	81	72	12	NAF	NAF	
endrin	98	87	12	91	77	17	NAF	NAF	
endosulfan I	89	90	1	87	75	15	NAF	NAF	
heptachlor	63	38	50	59	62	5	NAF	NAF	
kelthane	NAF	NAF		115	82	34	NAF	NAF	
nonachlor-trans	NAF	NAF		91	73	22	NAF	NAF	
methoxychlor	99	83	18	91	76	18	NAF	NAF	
mirex	NAF	NAF		97	77	23	NAF	NAF	
pyrethroid pesticides									
fenvalerate	85	86	1	85	73	15	NAF	NAF	
sulfur-containing pesticides									
propargite	88	102	15	NAF	NAF		NAF	NAF	

[1] - MS = Matrix Spike

[2] - MSD = Matrix Spike Duplicate

[3] - RPD = Relative Percent Difference, (difference/mean x 100)

[4] - NAF = Not Analyzed For

Appendix F (cont.). Matrix Spike Recoveries for 1994 WSPMP Surface Water Samples (%)

	April			June			October		
	MS[1]	MSD[2]	RPD[3]	MS	MSD	RPD	MS	MSD	RPD
organo-phosphorus pesticides									
abate	NAF[4]	NAF		94	86	9	NAF	NAF	
azinphos-ethyl	87	90	3	86	75	14	NAF	NAF	
azinphos-methyl	NAF	NAF		NAF	NAF		107	100	7
chlorpyrifos	89	107	18	93	78	18	NAF	NAF	
coumaphos	NAF	NAF		NAF	NAF		107	112	5
DEF	NAF	NAF		89	71	23	NAF	NAF	
diazinon	86	102	17	75	68	10	110	106	4
dichlorvos	NAF	NAF		84	85	1	NAF	NAF	
dimethoate	NAF	NAF		84	72	15	104	105	1
dioxathion	NAF	NAF		92	74	22	NAF	NAF	
ethion	88	95	8	90	76	17	NAF	NAF	
ethoprop	78	91	15	95	83	13	94	101	7
fenamiphos	NAF	NAF		86	69	22	NAF	NAF	
fensulfothion	NAF	NAF		88	72	20	104	101	3
fenthion	NAF	NAF		NAF	NAF		100	97	3
fonofos	85	97	13	NAF	NAF		NAF	NAF	
imidan	NAF	NAF		NAF	NAF		112	105	6
malathion	88	105	18	95	80	17	NAF	NAF	
parathion	NAF	NAF		NAF	NAF		103	99	4
mevinphos	NAF	NAF		87	78	11	NAF	NAF	
parathion-methyl	77	97	23	95	80	17	106	107	1
phorate	78	92	16	92	76	19	110	107	3
phosphamidan	NAF	NAF		101	81	22	NAF	NAF	
ronnel	NAF	NAF		NAF	NAF		104	104	0
sulprofos	NAF	NAF		NAF	NAF		101	107	6
tetrachlorvinphos	NAF	NAF		90	74	20	NAF	NAF	

1 - MS = Matrix Spike

2 - MSD = Matrix Spike Duplicate

3 - RPD = Relative Percent Difference, (difference/mean x 100)

4 - NAF = Not Analyzed For

Appendix F (cont.). Matrix Spike Recoveries for 1994 WSPMP Surface Water Samples (%)

	April			June			October		
	MS[1]	MSD[2]	RPD[3]	MS	MSD	RPD	MS	MSD	RPD
nitrogen-containing pesticides									
alachlor	93	85	9	62	60	3	NAF	NAF	
ametryn	NAF[4]	NAF		NAF	NAF		103	89	15
benfluralin	NAF	NAF		NAF	NAF		100	87	14
bromacil	82	100	20	82	73	12	NAF	NAF	
butylate	NAF	NAF		NAF	NAF		89	87	2
chlorothalonil	NAF	NAF		NAF	NAF		105	103	2
cycloate	NAF	NAF		NAF	NAF		109	108	1
di-allate	81	66	20	NAF	NAF		NAF	NAF	
dichlobenil	NAF	NAF		92	81	13	NAF	NAF	
diuron	80	83	4	NAF	NAF		NAF	NAF	
eptam	NAF	NAF		NAF	NAF		98	98	0
hexazinone	128	130	2	101	94	7	137	131	4
metalaxyl	97	104	7	NAF	NAF		NAF	NAF	
metribuzin	102	109	7	69	63	9	NAF	NAF	
profluralin	82	78	5	NAF	NAF		NAF	NAF	
prometon	NAF	NAF		NAF	NAF		80	74	8
pronamide	93	92	1	99	88	12	NAF	NAF	
propazine	NAF	NAF		NAF	NAF		119	122	2
simazine	97	106	9	92	77	18	NAF	NAF	
tebuthiuron	NAF	NAF		69	60	14	NAF	NAF	
terbutryn	NAF	NAF		NAF	NAF		96	79	19
triallate	NAF	NAF		NAF	NAF		85	86	1
trifluralin	84	84	0	50	48	4	NAF	NAF	
vernolate	NAF	NAF		NAF	NAF		94	90	4

1 - MS = Matrix Spike

2 - MSD = Matrix Spike Duplicate

3 - RPD = Relative Percent Difference, (difference/mean x 100)

4 - NAF = Not Analyzed For

Appendix F (cont.). Matrix Spike Recoveries for 1994 WSPMP Surface Water Samples (%)

	April			June			October		
	MS[1]	MSD[2]	RPD[3]	MS	MSD	RPD	MS	MSD	RPD
chlorinated herbicides									
2,4-D	77	104	30	33	52	45	80	93	15
2,4-DB	59	87	38	32	48	40	72	85	16
2,4,5-T	56	76	30	37	46	22	78	91	16
2,4,5-TB	58	86	39	36	45	22	66	80	20
2,4,5-TP	58	89	42	NAF[4]	57		86	101	16
2,4,5-trichlorophenol	52	77	39	34	33	3	78	95	19
2,4,6-trichlorophenol	44	56	24	35	47	29	83	105	23
2,3,4,5-tetrachlorophenol	64	96	40	32	44	32	80	98	20
3,5-dichlorobenzoic acid	48	82	52	37	50	30	84	110	26
4-nitrophenol	52	68	27	26	25	4	47	91	64
5-hydroxydicamba	56	75	29	30	32	6	63	82	26
acifluorfen	60	48	22	10	14	33	12	15	28
bentazon	54	63	15	40	48	18	65	55	17
bromoxynil	64	83	26	37	51	32	76	89	16
chloramben	39	79	68	21	16	27	30	49	50
DCPA (dacthal)	26	40	42	23	24	4	34	40	15
dalapon	47	45	4	8	7	13	NAF	NAF	
dicamba	57	83	37	36	51	34	85	99	16
dichlofop-methyl	61	84	32	32	51	46	64	80	22
dichlorprop	57	86	41	36	48	29	82	93	13
dinoseb	54	58	7	8	8	0	14	19	31
ioxynil	59	79	29	35	50	35	57	70	21
MCPA	59	84	35	34	49	36	75	91	19
MCPP	58	89	42	34	52	42	83	96	15
pentachlorophenol	59	92	44	37	50	30	84	102	19
picloram	40	44	10	28	39	33	57	58	2
triclopyr	57	86	41	37	51	32	81	94	16

1 - MS = Matrix Spike
2 - MSD = Matrix Spike Duplicate
3 - RPD = Relative Percent Difference, (difference/mean x 100)
4 - NAF = Not Analyzed For

Appendix F (cont.). Matrix Spike Recoveries for 1994 WSPMP Surface Water Samples (%)

	April			June			October		
	MS[1]	MSD[2]	RPD[3]	MS	MSD	RPD	MS	MSD	RPD
carbamates									
3-hydroxycarbofuran	97	97	0	84	91	8	78	NAF[4]	
aldicarb	72	74	2	15	52	110	30	NAF	
aldicarb sulfone	91	91	0	92	91	0.1	89	NAF	
aldicarb sulfoxide	90	84	6	151	111	31	88	NAF	
carbaryl	92	93	2	90	88	2	94	NAF	
carbofuran	90	92	2	85	81	5	49	NAF	
methiocarb	95	85	12	75	76	0.3	22	NAF	
methomyl	90	89	1	90	87	4	65	NAF	
oxamyl	99	95	4	92	89	3	61	NAF	
propoxur	87	87	0	91	81	11	36	NAF	

[1] - MS = Matrix Spike

[2] - MSD = Matrix Spike Duplicate

[3] - RPD = Relative Percent Difference, (difference/mean x 100)

[4] - NAF = Not Analyzed For

Appendix G. Surrogate Recoveries for 1994 WSPMP Surface Water Samples (%)

	DCBP	TCMX	TPP	DMNB	IBP	BDMC
April						
Mission Creek	67	SNA[1]	68	49	59	79
Stemilt Creek	73	SNA	76	50	65	71
Stink Creek	30	SNA	77	60	122	52
Palouse River	70	SNA	101	66	65	86
GHCDD-1	89	SNA	108	59	41	83
GHCDD-1 Dup	93	SNA	103	51	63	77
Joe Leary Slough	108	SNA	119	56	118	84
Kearny Creek	80	SNA	91	42	52	70
Mercer Creek	75	SNA	87	54	58	79
June						
Mission Creek	88	79	119	95	57	72
Stemilt Creek	89	72	98	99	86	77
Stink Creek	90	25	95	0	59	96
Stink Creek Dup	83	60	95	76	86	75
Palouse River	86	71	98	80	68	102
GHCDD-1	84	73	105	95	61	67
Joe Leary Slough	95	77	107	98	65	72
Kearny Creek	106	87	125	107	86	29
Mercer Creek	112	91	136	106	118	82
October						
Mission Creek	65	60	99	68	DL[2]	96
Stemilt Creek	77	73	112	89	93	DL
Stink Creek	72	69	114	67	93	DL
Palouse River	75	65	112	70	75	DL
GHCDD-1	63	9	127	72	88	DL
Joe Leary Slough	68	59	105	67	81	DL
Kearny Creek	81	11	113	58	88	DL
Mercer Creek	78	54	107	48	106	DL
Mercer Creek Dup.	48	42	96	59	95	DL

[1] - SNA = Surrogate Not Added

[2] - DL = Data Lost, an analytical problem resulted in a loss of data

Appendix G (cont.). Surrogate Recoveries for 1994 WSPMP Surface Water Samples (%)

	DCBP	TCMX	TPP	DMNB	TBP	BDMC
April						
Lab Blank 1	95	SNA[1]	85	71	81	76
Lab Blank 1 Duplicate	91	SNA	87	64	75	84
Lab Blank 2	95	SNA	110	57	60	NAF[2]
Lab Blank 2 Duplicate	116	SNA	114	73	76	NAF
Matrix Spike	109	SNA	110	56	58	85
Matrix Spike Duplicate	93	SNA	97	61	85	97
June						
Lab Blank 1	69	43	84	76	54	70
Lab Blank 1 Duplicate	46	24	59	53	64	79
Lab Blank 2	82	19	97	87	68	NAF
Lab Blank 2 Duplicate	84	21	105	84	74	NAF
Matrix Spike	80	29	96	66	71	84
Matrix Spike Duplicate	73	28	80	61	51	72
October						
Lab Blank 1	66	46	110	58	87	DL[3]
Lab Blank 1 Duplicate	80	65	105	78	94	DL
Lab Blank 2	89	29	96	65	91	DL
Lab Blank 2 Duplicate	75	8	109	60	92	DL
Matrix Spike	NAF	NAF	106	61	91	100
Matrix Spike Duplicate	NAF	NAF	102	61	106	DL

[1] - SNA = Surrogate Not Added

[2] - NAF = Not Analyzed For

[3] - DL = Data Lost, an analytical problem resulted in a loss of data

Surrogate Key

DCBP = Decachlorobiphenyl (chlorinated pesticides)
TCMX = Tetrachlorometaxylene (chlorinated pesticides)
TPP = Triphenyl Phosphate (organophosphorus pesticides)
DMNB = Dimethylnitrobenzene (nitrogen-containing pesticides)
TBP = 2,4,6-Tribromophenol (chlorinated herbicides)
BDMC = 4-Bromo-3,5-dimethylphenyl n-methylcarbamate (carbamates)

Appendix H-1. Water Quality Criteria and Recommended Maximum Concentrations of Pesticides Detected in 1994 WSPMP Surface Water Samples for the Protection of Aquatic Life (µg/L, ppb)

Pesticide	WAC 173-201A Freshwater Acute	WAC 173-201A Freshwater Chronic	EPA, 1986 Freshwater Acute	EPA, 1986 Freshwater Chronic[3]	NAS, 1973 Maximum Conc.	CCREM, 1987 Maximum Conc.	Norris and Dost, 1991 Invertebrates Acute	Norris and Dost, 1991 Invertebrates Chronic[3]	Norris and Dost, 1991 Fish Acute	Norris and Dost, 1991 Fish Chronic[3]
2,4-D					4.0	4	120	12	60	6
4,4'-DDT										
total DDT	1.1	0.001[3]	1.1	0.001	0.002	0.001				
atrazine						2.0	14	1	90	9
azinphos-methyl				0.01	0.001					
bromoxynil						5				
carbaryl					0.02		0.6	0.06	70	7
carbofuran						1.75				
chlorpyrifos	0.083	0.041[2]			0.001					
diazinon					0.009					
dicamba					200	10	390	39	3500	350
dichlobenil					37.0					
diclofop-methyl						6.1				
hexazinone							1120	110	6400	640
malathion				0.1	0.008					
MCPA						2.6				
metribuzin						1.0				
pentachlorophenol	5.5[4]	3.5[4]	5.5[4]	3.5[4]		0.5				
simazine					10.0	10	20	2	50	5
triallate						0.24				
triclopyr							30	3	70	7

[1] - 1 hour average

[2] - 4 day average

[3] - 24 hour average

[4] - at pH 6.5 (minimum pH of sites where pentachlorophenol was detected)

Appendix H-2. Acute Toxicity (Johnson and Finley, 1980) of Pesticides Detected in 1994 WSPMP Surface Water Samples (µg/L, ppb; 96 hour LC_{50})

	Aquatic Invertebrates		Fish	
Pesticide	Most Sensitive sp.	*Gammarus* spp.	Most Sensitive sp.	Rainbow Trout
azinphos-methyl	0.11 - 0.16	0.11 - 0.20	0.27 - 0.48	3.0 - 6.4
carbaryl	1.4 - 2.4	16 - 39	520 - 910	1,450 - 2,630
carbofuran	NA[1]	NA	115 - 188	272 - 531
chlorpyrifos	0.07 - 0.17	same	1.1 - 5.1	6.0 - 8.4
DDE	NA	NA	26 - 40	same
DDT	0.12 - 0.30	0.7 - 1.5	0.9 - 2.4	6.8 - 11.4
diazinon	0.15 - 0.28	same	90	same
dicamba	>56,000	>100,000	28,000	same
dichlobenil	3,300 - 4,200	8,000 - 15,000	4,000 - 9,100	4,700 - 8,400
eptam	15,000 - 36,000	66,000	14,800 - 17,700	same
malathion	0.63 - 0.92	same	59 - 70	160 - 240
pentachlorophenol	NA	NA	23 - 44	48 - 56
simazine	560 - 2,200	>100,000	>100,000	same
2,4-D	90 - 1,400	1,900 - 3,000	190 - 330	same

[1] - NA = Not Available

Appendix H-2 (cont.). Acute Toxicity of Pesticides Detected in 1994 WSPMP Surface Water Samples (µg/L, ppb; 96 hour LC_{50})

Pesticide	Most Sensitive Species Tested: Fish	Most Sensitive Species Tested: Invertebrates	References
atrazine	4,500	NA[1]	Tetra Tech, 1988
bromacil	28,000	non-toxic (bees)	FCH, 1991
bromoxynil	63	non-toxic (bees)	Seyler *et al*., 1994
carbofuran	94	9.8	USEPA, 1984a
chlorpropham	3,020	NA	USEPA, 1987
DCPA (dacthal)	30,000	6,200	USEPA, 1988a
diclofop-methyl	toxic[2]	non-toxic (bees)	FCH, 1991
hexazinone	320,000	NA	Tetra Tech, 1988
MCPA	89,000	>180,000	USEPA, 1989
MCPP	115,000	NA	USEPA, 1988b
metribuzin	>10,000	4,180	USEPA, 1985
napropamide	9,400	14,300	Seyler *et al*., 1994
norflurazon	8,100	15,000 (NOEL[3])	USEPA, 1984b
prometon	12,000	NA	Tetra Tech, 1988
triallate	1,200	430	Seyler *et al*., 1994
triclopyr	117,000	1,170,000	Seyler *et al*., 1994

[1] - NA = Not Available

[2] - Toxicity to fish not measurable due to insolubility of the compound in water

[3] - NOEL = No Observed Effects Level

Appendix I. Supplemental Information for Pesticides Detected in 1994 WSPMP Surface Water Samples

Common Name	Trade Name[1]	Chemical Group	Activity	Application
2,4-D	Aqua-Kleen	chlorinated phenoxy	hormone-type herbicide	systemic control of broadleaf weeds
DDT	Genitox	chlorinated pesticide	insecticide	all use banned in 1972
DDE				breakdown product of DDT
atrazine	Gesaprin	triazine	selective herbicide	weed control on corn and other crops
azinphos-methyl	Guthion	organophosphate	broad spectrum insecticide	insect control on tree fruit, melons, nuts, and field crops
bromacil	Bromax	uracil	broad spectrum herbicide	general control of weeds and brush
bromoxynil	Brominex	nitrile	selective herbicide	postemergent control of weeds in grain crops
carbaryl	Sevin	carbamate	broad spectrum insecticide	insect control on fruit, forests, lawns, livestock, etc.
carbofuran	Furadan	carbamate	broad spectrum insecticide	controls insects, mites, and nematodes on crops
chlorpropham	Chloro IPC	carbamate	plant growth regulator	preemergent weed control
chlorpyrifos	Dursban, Lorsban	organophosphate	broad spectrum insecticide	control of a wide variety of agricultural and household pests
DCPA	Dacthal	benzoic acid	selective herbicide	preemergent control of grasses
diazinon	Knox-Out	organophosphate	broad spectrum insecticide	control of a wide variety of agricultural and household pests
dicamba	Banvel	benzoic acid	selective herbicide	control of brush and broadleaf weeds
dichlobenil	Casoron	benzonitrile	broad spectrum herbicide	control of grasses, and broadleaf and aquatic weeds
dichlofop-methyl	Hoelon	chlorinated phenoxy	selective herbicide	controls annual grassy weeds
dichlorprop	2,4-DP, Weedone	chlorinated phenoxy	hormone-type herbicide	systemic control of brush and weeds
EPTC	Eptam	thiocarbamate	selective herbicide	control of grasses in corn, potatoes, beans, etc.
hexazinone	Velpar	triazine	contact and residual herbicide	controls many annual, biennial, and perennial weeds
malathion	Cythion	organophosphate	broad spectrum insecticide	control of sucking and chewing insects on fruits and vegetables
MCPA	Agritox	chlorinated phenoxy	hormone-type herbicide	postemergent control of broadleaf weeds on small grains
MCPP	Mecoprop	chlorinated phenoxy	hormone-type herbicide	control of broadleaf weeds on ornamentals and grasses
metribuzin	Lexone, Sencor	triazinone	selective herbicide	control of annual grasses and broadleaf weeds
napropamide	Devrinol	amide	selective herbicide	systemic control of some annual grasses and broadleaf weeds
norflurazon	Telok, Solicam	fluorinated pyridazinone	selective herbicide	preemergent control of annual grasses and broadleaf weeds
pentachlorophenol	Dowicide	phenol	fungicide, molluscicide	wood preservative
prometon	Pramitol	triazine	nonselective herbicide	pre- and postemergent control of most grasses & broadleaf weeds
simazine	Simanex, Aquazine	triazine	selective herbicide	control of annual grasses and broadleaf weeds
triallate	Avadex, Far-Go	thiocarbamate	selective herbicide	preemergent control of grass weeds
triclopyr	Garlon	pyridine	selective herbicide	systemic control of woody and broadleaf plants

[1] - Each trade name listed is typically one of many available formulations using the same active ingredient and is the trade name most familiar to the author

Detected pesticides are not necessarily residues from use of the specific formulations listed here

Appendix J-1. Pesticides Detected in Water Samples Collected for the 1992 WSPMP (µg/L,ppb)

	Mission Creek	Crab Creek	Walla Walla River	Glade Creek	Fishtrap Creek	Moxee Drain[1]
Insecticides						
4,4'-DDD						0.027
4,4'-DDE						0.018
4,4'-DDT						0.015
total DDT						**0.060**[3]
azinphos-methyl	**0.033**[2]					
diazinon						
malathion						**0.054**[4]
Herbicides						
2,4-D		0.980	0.055		0.27	0.16
atrazine		0.088		0.24	0.11	
atrazine desethyl				0.38		
bromacil						
chlorpropham						
DCPA (Dacthal)		1.24	12.1	0.028	0.006	0.011
dichloro-DCPA			0.046			
trichloro-DCPA			0.55			
dicamba[5]		0.080		0.019		
dichlobenil						
dichlorprop						
EPTC (Eptam)		0.31		0.20		
glyphosate	1.13	0.38	0.49			0.49
hexazinone			0.063			
MCPP					1.5	
metribuzin				0.043		
prometon						
simazine	0.041	0.033	0.078		0.091	
Fungicide						
pentachlorophenol	0.002					0.015

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds USEPA, 1986 water quality criteria

[3] - Exceeds Washington State water quality standards

[4] - Exceeds NAS, 1973 recommended maximum concentrations

[5] - Listed as disugran in Davis, 1993

Appendix J-1 (cont.). Pesticides Detected in Water Samples Collected for the 1992 WSPMP (µg/L,ppb)

	Mercer Creek[1]	Thornton Creek	Sullivan Slough	Lake River	Tuttle Creek
Insecticides					
4,4'-DDD					
4,4'-DDE					
4,4'-DDT					
azinphos-methyl					
diazinon	**0.091[2]**	**0.077[2]**			
malathion					
Herbicides					
2,4-D	0.20	0.23	0.039		
atrazine			0.24		
atrazine desethyl					
bromacil			0.046		
chlorpropham			0.10		
DCPA (Dacthal)	0.061	0.066	0.017	0.011	
dicamba[3]		0.038			
dichlobenil	0.19	0.054			
dichlorprop		0.052			
EPTC (Eptam)					
glyphosate	0.78	0.58			
hexazinone					
MCPP	1.7				
metribuzin			0.036		
prometon	0.082				
simazine					
Fungicide					
pentachlorophenol					

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds NAS, 1973 recommended maximum concentrations

[3] - Listed as disugran in Davis, 1993

Appendix J-2. Pesticides Detected in Water Samples Collected for the 1993 WSPMP (μg/L, ppb)

	Sample Sites West of the Cascades																Joe Leary Slough	Lynch Coulee Creek
	Adna Creek				Fishtrap Creek				Mercer Creek				Salmon Creek					
	April	June	August	October	April	June	August	October	April	June	August	October*	April	June	August	October	June	
Insecticides																		
4-nitrophenol												0.22						
chlorpyrifos																**0.044[1]**		
diazinon										**0.03[2]**		**0.083[2]**				**0.022[2]**		
malathion												**0.085[2]**						
methomyl															0.068			
mevinphos																	**11[2]**	
propoxur											0.047							
Herbicides																		
2,4-D						0.069			0.05		0.039	0.29						
aldicarb														0.76				
atrazine					0.02	0.024	0.010	0.035		0.025			0.02					
bentazon																	0.075	
bromacil					0.03	0.054	0.047	0.058		0.11	0.037	0.073						
chlorpropham																	6.0	
DCPA (Dacthal)									0.06	0.041	0.032							0.20
dichlobenil							0.035		0.17	0.11	0.034	0.09				0.039		
diuron										0.19								
EPTC (Eptam)																	0.17	
MCPA												0.10						
MCPP						0.043					0.029	0.17						
prometon										0.024		0.089						
simazine					0.02	0.011				0.048	0.018	0.029		0.38	0.044	0.039		
Fungicides																		
2,3,4,6-tetrachlorophenol				0.025														
pentachlorophenol					0.008				0.007				0.005					

Values in bold exceed water quality criteria

* - Values are means of duplicate analyses

[1] - Exceeds Washington State Water Quality Standards

[2] - Exceeds NAS, 1973 recommended maximum concentrations

Appendix J-2 (cont.). Pesticides Detected in Water Samples Collected for the 1993 WSPMP ($\mu g/L$, ppb)

Sample Sites East of the Cascades

	Crab Creek				Foster Creek				Misson Creek				Moxee Drain				Walla Walla River			
	April*	June	August	October	April	June	August	October	April	June*	August	October	April	June	August	October	April	June	August*	October
Insecticides																				
4,4'-DDD																0.002				
4,4'-DDE									0.002				0.006	0.029		0.003				
4,4'-DDT									0.002	0.018			0.002	0.028						
total DDT									**0.004[1]**	**0.018[1]**			**0.008[1]**	**0.057[1]**		**0.005[1]**				
azinphos-methyl		**0.019[2]**				**0.016[2]**				**0.13[2]**		**0.012[2]**		**0.1[2]**	**0.056[2]**					
chlorpyrifos									**0.14[1]**				**0.078[1]**	0.027	**0.29[1]**	0.01				
diazinon												0.007		**0.14[3]**						
dimethoate		0.022												0.037						
endosulfan I									0.031				0.031	0.012						
endosulfan II									0.013				0.014	0.013						
endosulfan sulfate									0.004				0.008	0.023						
total endosulfan									**0.048[3]**				**0.053[3]**	**0.048[3]**						
propargite															0.10	0.03				
Herbicides																				
2,4-D		0.34	0.090			0.035								0.23	0.24			0.024	0.25	
atrazine	0.02	0.052	0.015	0.015															0.011	0.016
bentazon		0.093		0.11																
bromacil																	0.02		0.090	
bromoxynil					0.20	0.035	0.023													
DCPA (Dacthal)		0.59	0.49	0.96										0.015	0.033	0.009		2.2	3.9	2.7
dicamba I		0.032												0.022					0.11	
dicamba II																			0.044	
EPTC (Eptam)		0.13																		
hexazinone		0.033																		
metribuzin																	0.16			
simazine	0.02	0.016																	0.061	0.018
triallate																			0.034	
Fungicide																				
pentachlorophenol													0.005	0.012						

Values in bold exceed water quality criteria

* - Values are means of duplicate analyses

[1] - Exceeds Washington State Water Quality Standards

[2] - Exceeds EPA, 1986 water quality criteria

[3] - Exceeds NAS, 1973 recommended maximum concentrations