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DEPARTMENT OF
ECOLOGY

Washington State Toxics Monitoring Program

Toxic Contaminants in Fish Tissue and Surface Water in Freshwater Environments, 2003

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Washington State Toxics Monitoring Program

Toxic Contaminants in Fish Tissue and Surface Water in Freshwater Environments, 2003

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Abstract

The goal of the Washington State Toxics Monitoring Program is to investigate the occurrence and concentrations of toxic contaminants in edible fish tissue and surface waters from freshwater environments in Washington. This program was started in 2001 by the Washington State Department of Ecology due to increasing concerns of contaminants in our environment.

The 2003 exploratory monitoring effort analyzed 25 composite samples of edible fish tissue representing eight species collected from ten sites. Contaminants detected included mercury, PCBs, dioxin and furans (PCDD/Fs), flame retardants (PBDEs), and chlorinated pesticides such as DDT and metabolites, chlordane compounds, dieldrin, aldrin, Beta-BHC, chlorpyrifos, endosulfan sulfate, heptachlor epoxide, hexachlorobenzene, lindane, and mirex.

Fish tissue samples from eight of the ten sites exceeded (did not meet) National Toxics Rule (NTR) criteria for the protection of human health: Banks Lake, Lacamas Lake, Lake Washington, Roses Lake, Scooteney Reservoir, Silver Lake, Spokane River, and Sprague Lake. Few contaminants were detected in samples from Curlew Lake and Twin Lakes.

Six contaminants exceeded the NTR criteria and/or EPA screening values in fish tissue:

- Total PCBs in eight samples – both NTR criteria and EPA screening values
- PCDD/Fs in seven samples – both NTR criteria and EPA screening values
- Dieldrin in two samples – both NTR criteria and EPA screening values
- 4,4’-DDE in one sample – NTR criteria
- Total DDTs in six samples – EPA screening values
- Mercury in 12 samples – EPA screening values

Water samples collected from ten sites were analyzed for 115 chlorinated, organophosphorous, and nitrogen pesticides. Six pesticides were detected at low levels and low frequencies: bromacil, dichlobenil, atrazine, diuron, hexazinone, and terbacil. Stream temperatures measured at eight sites exceeded water quality standards for the protection of aquatic life. Suspended solids measured at several sites appeared unusually high.

Recommendations include (1) evaluating potential risks to human health from consumption of contaminated fish, and (2) adding eight sites to Washington’s 303(d) list.

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Introduction

Humans and wildlife face a variety of risks due to toxic chemicals in the environment. For many areas of Washington State, information is lacking about the levels of toxic contamination in freshwater fish and surface water. Contaminants of particular concern include mercury, polychlorinated biphenyls (PCBs), dioxins and furans (PCDD/Fs), chlorinated pesticides, and a class of flame retardants known as polybrominated diphenylethers (PBDEs).

These chemicals are persistent: they do not break down easily, and they remain in the environment for decades. Many of these chemicals also bioaccumulate and biomagnify in organisms; concentrations increase at higher trophic levels because the contaminant is not broken down or excreted by metabolic processes. The accumulation of these chemicals can have a variety of health effects on humans and wildlife such as reproductive abnormalities, neurological problems, and behavioral changes.

Past monitoring efforts in Washington have detected toxic contaminants in surface water, sediment, and aquatic animal tissues. Statewide monitoring of surface waters is one step in a series of efforts underway at the Washington State Department of Ecology (Ecology) to inform or protect people and wildlife in Washington. Monitoring can signal trends in the quality of our waters statewide. Certain concentrations can threaten the health of humans, wildlife, and fish.

The Washington State Department of Health (DOH) currently lists 16 site-specific consumption advisories for finfish and shellfish in Washington due to contamination by mercury, PCBs, PCDD/Fs, chlorinated pesticides, and /or other metals and organic chemicals (DOH, 2006). In June 2003, DOH issued a statewide fish consumption advisory for smallmouth and largemouth bass due to mercury contamination (DOH, 2003).

Efforts to monitor toxic chemicals in freshwater fish tissue, sediments, water, and wildlife in Washington declined over the last decade due to budget reductions. Renewed concern about impacts on fish and wildlife was addressed in 2000 by an Ecology workgroup, and resources were directed to the development of a statewide toxics monitoring program.

The goals of the Washington State Toxics Monitoring Program (WSTMP) are to:

- Conduct exploratory monitoring to identify new instances and locations of toxic contaminants in freshwater environments.
- Provide a mechanism to disseminate information to citizens and resource managers about toxic contamination. (Website: www.ecy.wa.gov/programs/eap/toxics/index.html).
- Conduct trend monitoring for persistent toxic chemicals using residues in edible fish tissue (on hold at this time).
- Develop other monitoring efforts to address particular issues and to establish cooperative programs with other agencies regarding toxic contaminants (on hold at this time).

Exploratory monitoring was the first component of the WSTMP to be implemented. A project plan was developed in 2001 (Seiders and Yake, 2002) which guided the initial year of the program. This current report presents the results from the third year (calendar year 2003) of the exploratory monitoring component.

Study Design

The study approach for the exploratory monitoring component of the WSTMP involved reviewing existing data on fish tissue and water contaminant levels and then selecting sites for monitoring, target analytes, and fish species. In order to address concerns for humans and wildlife, chemicals that bioaccumulate and persist in fish tissue were selected as target analytes: mercury, PCBs, PCDD/Fs, chlorinated pesticides, and PBDEs.

Game fish were selected as the preferred species for monitoring because they are more commonly pursued and consumed by humans than are other species. Game fish, being at a higher trophic level than many non-game fish, are expected to contain higher levels of contaminants due to bioaccumulation and biomagnification.

Water quality sampling efforts aimed to characterize pesticide contamination of water at various times throughout the growing season when pesticides are commonly used in urban and agricultural landscapes. Target analytes for water included 115 chlorinated, organophosphorous, and nitrogen pesticides, total organic carbon (TOC), total suspended solids (TSS), conductivity, pH, and temperature.

Site Selection

Site selection used the process described in the project plan (Seiders and Yake, 2002) and considered a number of factors such as:

- The potential for site contamination.
- Existences and nature of historical fish tissue or water quality data.
- Value and interest of the fish resource to consumers.
- Nature of the fish resource (e.g., species present, management practices).
- Ability to obtain Scientific Collection Permits from federal and state agencies.
- Scheduling of the Basin Scoping Process according to Ecology's Watershed Approach to Water Quality which runs on a five-year cycle.

Sampling sites for the 2003 WSTMP are shown in Figure 1; Appendix A has detailed information on the locations.

Table 1 lists the sampling sites, species collected, dates, target analytes, and sample information.

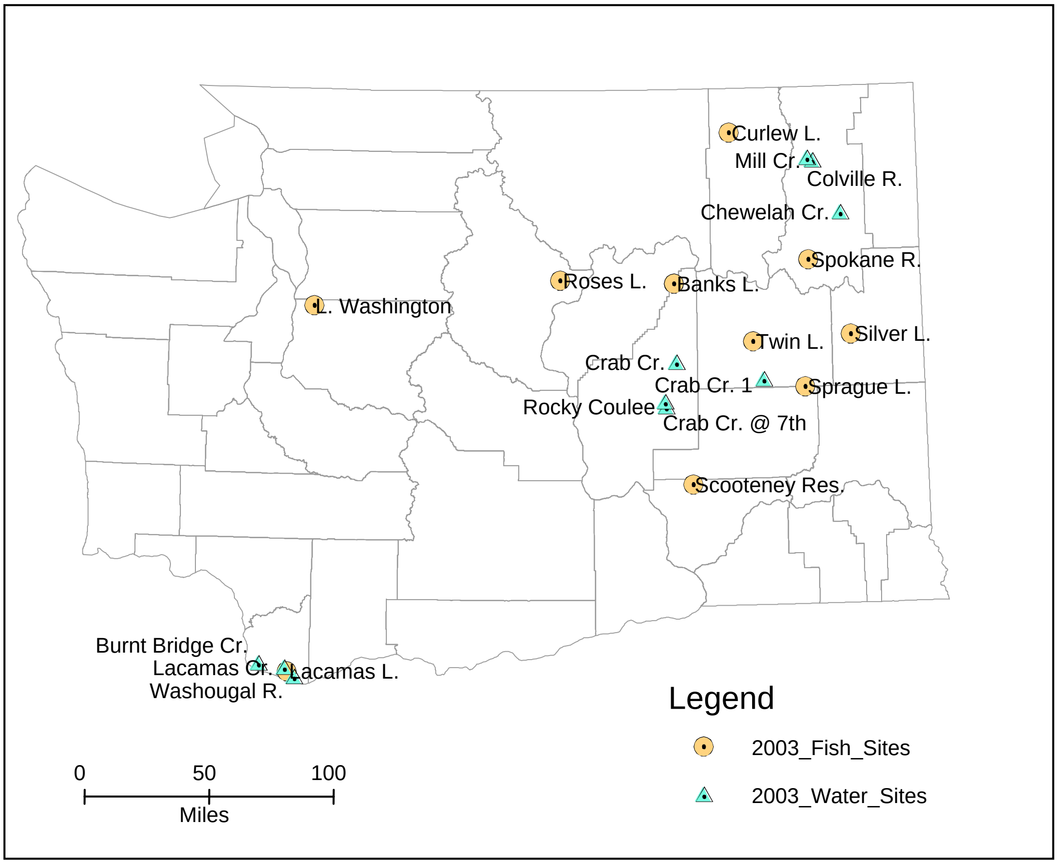

Figure 1. Sample Sites for the 2003 Washington State Toxics Monitoring Program.

Table 1. Sample Sites, Fish Species, and Target Analytes for the 2003 WSTMP.

Site	Species	Mean Total Length (mm)	Mean Weight (gm)	Number of Fish in Composite Sample	Target Analytes				MEL[3] Lab ID (40-)	Collection Date
					OC Pest, PCB, PBDE	Hg	PCDD PCDF	3 DDTs[1] & 3 PCBs[2]		
Banks Lake	Lake whitefish	491	1107	10	X	X	X		64283	10/16/03
	Rainbow trout	446	927	10	X	X	X		64284	10/16/03
	Walleye	531	1484	10	X	X			64285	10/15/03
	Yellow perch	259	232	9		X		X	64286	10/15/03
Curlew Lake	Largemouth bass	266	289	8		X		X	64287	7/16/03
	Rainbow trout	282	289	8	X	X	X		64288	7/17/03
Lacamas Lake	Brown trout	317	281	10	X	X	X		64290	8/28/03
	Largemouth bass	435	1312	10	X	X	X		64289	8/19/03
	Yellow perch	192	93	10		X		X	64291	8/28/03
Lake Washington	Largemouth bass	280	399	6	X	X			64306	10/13/03
Roses Lake	Largemouth bass	428	1439	5		X		X	64292	8/12/03
Scooteney Reservoir	Channel catfish	462	1023	10	X	X	X		64293	9/29/03
	Walleye	546	1690	10	X	X			64294	9/29/03
	Yellow perch	253	228	9	X	X			64295	9/29/03
Silver Lake	Brown trout	533	1536	7	X	X	X		64296	9/19/03
	Largemouth bass	339	642	10	X	X			64297	9/17/03
	Yellow perch	223	145	10		X		X	64298	9/18/03
Spokane River	Rainbow trout	318	359	10		X	X		64307	9/16/03
Sprague Lake	Channel catfish	629	3433	7	X	X	X		64299	10/23/03
	Largemouth bass	242	237	8		X		X	64300	10/22/03
	Rainbow trout	392	686	7	X	X	X		64301	10/23/03
	Smallmouth bass	307	500	5	X	X			64302	10/23/03
	Walleye	461	1066	10	X	X	X		64303	10/22/03
	Yellow perch	315	441	10		X		X	64304	10/23/03
Twin Lakes (upper lake)	Largemouth bass	401	1154	10	X	X			64305	10/21/03

OC Pest – organochlorine pesticides
Hg – mercury

1 - 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT

2 - Aroclors 1248, 1254, and 1260

3 - Manchester Environmental Laboratory

Fish samples were obtained from ten sites throughout the state during the latter half of 2003. In two cases, the WSTMP used fish collected during Total Maximum Daily Load (TMDL) studies being conducted by Ecology. These samples were largemouth bass from Roses Lake and rainbow trout from the Spokane River. For the WSTMP, at least one species of fish was obtained from each site, with five to ten fish of each species forming a composite sample as recommended by EPA (2000).

Water samples were collected from ten sites during 2003. Sites included urban, rural, and agricultural settings where there was reasonable potential for pesticide contamination due to land use. Each site was sampled three times during the spring and summer months except for those on Crab Creek: the Highway 28 bridge site was sampled once only, while the site near 7th NE upstream of the bridge was sampled twice only.

Target Fish Species

Target species were selected based on recommendations from EPA (2000a) and previous experience with fish collection efforts in Washington. Edible game fish were the primary target for collection as described above.

The following criteria were used to select target species:

- Commonly captured and likely to be consumed by humans.
- Potentially bioaccumulate high concentrations of chemicals of interest.
- Abundant, easy to identify, and easy to capture.
- Large enough to provide adequate tissue for analysis.
- Most of lifecycle spent relatively close to the sampling site.

Methods

Field Procedures

Fish Tissue Samples

The collection, handling, and processing of fish tissue samples for analyses were guided by methods described by EPA (2000). Fish were captured by angling, gillnetting, or electrofishing with a 16' Smith-Root electrofishing boat. Captured fish were identified to species, and target species were retained while non-target species were released. Retained fish were inspected to ensure that they were acceptable for further processing (e.g., proper size – smallest fish at least 75% the length of largest fish in the sample, no obvious damage to tissues, skin intact). Field preparation of individual fish involved assigning an identification code, measuring length and weight, wrapping in foil and plastic zip-lock bags, and placing on ice for transport to a freezer for storage at -20°C.

Fish were processed at a later date to form samples that would be sent to the laboratory for analysis. One or both fillets were removed for use in composite samples. For analysis of organic compounds, at least five fish of the same species were used to create a composite sample for each site sampled. Field sampling and fish processing procedures are further described in Appendix B.

Water Samples

Water samples were collected from three points along a transect across each stream using a US DH-81 sampler with a pre-cleaned, one-quart collection jar. At each point, the sampler was lowered from the water surface to the stream bottom and back to the surface to obtain a depth-integrated sample. Samples from each transect were then combined in a pre-cleaned, one-gallon glass jar for pesticides. Sample containers for general chemistry were likewise filled. All containers were placed on ice and delivered to the laboratory within 24 to 72 hours.

In-situ measurements included water temperature, conductivity, pH, and streamflow. These measurements were recorded in field notebooks along with location, time, and other comments. Field sampling procedures are further described in Appendix B.

Laboratory Procedures

Fish Tissue Processing

Frozen fish were processed at Ecology's Lacey laboratory, and samples were then sent to the Ecology Manchester Environmental Laboratory (MEL) for analyses. The edible portion of target species was used for composite samples. For all species except catfish, skin-on fillets from five to ten fish of the same species from the same site were used to create a composite sample.

Fish were partially thawed, fillets removed and cut into smaller pieces, and then the pieces were passed through a Kitchen-Aid food grinder three times for grinding and homogenizing the tissue sample. Equal amounts of the ground and homogenized tissue from each fillet were combined to form a single composite sample. An aliquot of the homogenized tissue was placed in a pre-cleaned jar (I-Chem 200 or 300) for transport to MEL.

The abdominal cavity of the fish was then opened to determine gender. Fish scales, otoliths, or other structures were removed for age determination by Washington Department of Fish and Wildlife (WDFW) biologists in Olympia, WA.

All utensils used for tissue processing were cleaned to prevent contamination of the sample. The cleaning procedure involved soap and water washes followed by acid and solvent rinses. Appendix B more fully describes the tissue processing procedures used.

Analytical Methods

Table 2 describes the analytical methods used for fish tissue and water samples. These methods were selected to achieve a balance of analytical sensitivity, comparability, and cost-effectiveness. The quantitation limits of these methods were adequate for most analytes. Yet some quantitation limits were higher than water quality criteria or screening levels, depending upon performance of the analytical system at the time of analysis. For tissue samples, these analytes include toxaphene, and sometimes PCBs and PCDD/Fs. For water samples, these analytes include DDT and chlordane compounds, aldrin, chlorpyrifos, dieldrin, endrin, endosulfan, heptachlor, lindane, and parathion.

Typical reporting limits for target analytes can be seen in Appendix C, Table C3 for fish tissue and Table C8 for water. These are the values qualified with a U or UJ indicating that the analyte was not detected at the stated reporting limit.

All samples, except PCDD/Fs, were analyzed at MEL. Pace Analytical, Incorporated, of Minneapolis, MN, analyzed tissue samples for PCDD/Fs.

Table 2. Analytical Methods for Fish Tissue and Water Samples, WSTMP 2003.

Parameter	Description	Method	Practical Quantitation Limit
Tissue Samples			
Mercury	CVAA	EPA 245.5; MEL SOP [1]	0.005 mg/kg, wet wt
Chlorinated pesticides	GC/ECD	EPA 8081; MEL SOP [2]	0.25 -15 ug/kg, wet wt
PCBs & PBDEs	GC/ECD	EPA 8082; MEL SOP [2]	0.25 ug/kg, wet wt
PCDD/PCDFs	HiRes GC/MS	EPA 1613B	0.1 - 1.0 ng/kg, wet wt
Lipids - percent	gravimetric	EPA 608.5 [3]	0.1%
Water Samples			
Pesticides (OC, OP, N)	GC/AED with GC/MS confirmation	EPA 8085; MEL SOP [4]	0.01- 1.0 ug/L
Total organic carbon (TOC)	Combustion NDIR	EPA 415.1	1 mg/L
Total suspended solids (TSS)	gravimetric	EPA 160.2	1 mg/L

MEL modifications to analytical methods are documented in their Standard Operating Procedures:

1. EPA 245.5: "Standard Operating Procedure for the Determination of Mercury by Cold Vapor Atomic Absorbance in Sediments, US EPA SW846 7471B Modified, and 245.5, Modified (Sediment)" (also used for tissue).
2. EPA 8081 and EPA 8082 - SOP #730002: Analysis of Water/Soil/Sediment/Fish Tissue Samples for Organochlorine Pesticides, Polybrominated Diphenyl Ethers and Polychlorinated Biphenyls by GC/ECD.
3. Extraction solvents were methylene chloride and hexane. 1:1 by volume.
4. EPA 8085 - SOP #730001: Pesticides Screening and Compound Independent Elemental Quantitation by Gas Chromatography with Atomic Emission Detection (AED), Method 8085.

MEL – Manchester Environmental Laboratory
SOP – standard operating procedure
OC – organochlorine
OP – organophosphorous
N – nitrogen

Data Quality Assessment

A detailed review of data quality is contained in Appendix C. Quality control procedures included analysis of method blanks, matrix spikes, matrix spike duplicates, surrogate recoveries, laboratory duplicates, and field duplicates. Quality control and quality assurance data from laboratories were reviewed, and indicated that analytical systems performance was adequate with most data meeting objectives for quality control. Some data were qualified due to difficulties encountered in analyses of the samples, and all results were useable as qualified.

For chlorinated pesticide/PCB/PBDE analyses of fish tissue, all results were deemed usable as qualified; most qualified results were due to quality control limits being exceeded (Mandjikov, 2004). About 14% of the nearly 1000 results were qualified as estimated values (flagged J or NJ). The detection limits for analytes not detected were estimated for about 31% of the results (flagged UJ). About 47% of results were flagged as non-detects (U), and about 8% of results had no qualifiers. Unfortunately, the reporting limit for PCBs in 14 of 24 tissue samples was too high to allow comparison of water quality criteria to PCB results. Some reporting limits ranged from 9-10 parts per billion (ppb) wet weight (ww) whereas other reporting limits ranged from 2-3 ppb ww.

For PCDD/Fs analyses of fish tissue, data were deemed usable as qualified based on the case narrative. Feddersen (2004) reviewed the data package from the contract laboratory Pace Analytical Services, Inc.

For mercury analysis of fish tissue, four results were qualified as estimates because analysis took place after the six-month holding time (Momohara, 2004).

Results from quality control practices for water samples showed that the analytical system performed adequately and that data were useable as qualified. The laboratory did note some problems with calibration, surrogate recoveries, and matrix spike recoveries that resulted in several results to be qualified as estimated values while other results were rejected (Perez, 2003).

Results and Discussion

Fish Tissue Samples

Contaminants Detected

Four sites yielded a single species for analysis while six sites yielded multiple species. Species included largemouth bass, smallmouth bass, rainbow trout, brown trout, walleye, yellow perch, channel catfish, and lake whitefish (Table 1). Appendix D (Table D1) contains field data and scientific names for all fish collected.

Table 3 summarizes the range of contaminant levels detected in fish tissue. Mercury and dioxins/furans (PCDD/Fs) were detected in all samples analyzed for these compounds. Frequently detected analytes were PCBs (46% of samples), 4,4'-DDE (88%), 4,4'-DDD (63%), trans-nonachlor (53%). The most frequently detected flame retardant was PBDE-47, found in 47% of the tissue samples followed by PBDE-99, found in 41% of tissue samples. Other notable detections were DDMU (a breakdown product of DDT) in 45% of samples, hexachlorobenzene (35%), cis-nonachlor (35%), cis-chlordane (29%), trans-chlordane (24%), and chlorpyrifos (29%).

Two tissue samples collected during other studies were analyzed by this 2003 WSTMP study for contaminants not being analyzed by the other studies. These were rainbow trout from the Spokane River which were analyzed only for PCDD/Fs and mercury; and largemouth bass from Roses Lake which were analyzed only for three DDT compounds, three PCB Aroclors, and mercury. Studies of the Spokane River by Serdar (2005) and of Lake Chelan and adjacent lakes by Coots and Era-Miller (2005) characterized contaminants in multiple species of fish tissue; their results are not described here.

Spatial patterns for contaminants found in the 2003 WSTMP fish tissue results are not examined here due to the many confounding factors across all sites, such as variations in fish species, trophic level of species within the fish community of the site, age and size ranges of fish, suites of target analytes, and effects of local environments.

Table 3. Summary of Contaminant Levels Detected in Fish Tissue, WSTMP 2003.

Analyte	Min Value		Max Value		Median Value		Number Detections	N	Frequency of Detection
Mercury (mg/kg ww)	0.006		0.229		0.047		25	25	100%
PCBs (ug/kg ww)									
PCB-aroclor 1254	3.1	J	17		4.7	J	8	24	33%
PCB-aroclor 1260	2.1	J	18	NJ	4.4	J	11	24	46%
Total PCBs	2.1		33		7.9		11	24	46%
PCDD/PCDFs (ppt ww)[1]	0.0150		0.4500		0.1340		11	11	100%
Chlorinated Pesticides (ug/kg ww)									
2,4'-DDE	0.23	NJ	0.44	NJ	0.36	NJ	3	17	18%
2,4'-DDT	0.21	NJ	0.37	J	0.29	J	2	17	12%
4,4'-DDD	0.22	J	28		0.82	J	15	24	63%
4,4'-DDE	0.46	NJ	97		2.5	J	21	24	88%
4,4'-DDT	0.66	J	3.2		1.5	J	5	24	21%
Total DDTs	0.46		128.2		2.5		21	24	88%
Cis-Chlordane (Alpha-Chlordane)	0.19	NJ	0.49	NJ	0.22	NJ	5	17	29%
Cis-Nonachlor	0.25	J	0.59	NJ	0.335	J	6	17	35%
Oxychlordane	0.3	J	0.33	J	0.315	J	2	17	12%
Trans-Chlordane (Gamma)	0.19	J	0.42	J	0.215	NJ	4	17	24%
Trans-Nonachlor	0.21	J	1.2	NJ	0.5	NJ	9	17	53%
Total Chlordanes	0.21		2.53		0.91		9	17	53%
Aldrin	0.25	J	0.25	J	0.25	J	1	17	6%
Beta-BHC	0.33	J	0.33	J	0.33	J	1	17	6%
Chlorpyriphos	0.24	J	5.2	J	0.91	J	5	17	29%
DDMU	0.23	J	1.8	J	0.355	J	8	17	47%
Dieldrin	2.3		2.4	J	2.35	J	2	17	12%
Endosulfan Sulfate	0.86	J	1.4	J	1.13	J	2	17	12%
Heptachlor Epoxide	0.23	J	0.33	NJ	0.28	J	2	17	12%
Hexachlorobenzene	0.19	J	0.9	J	0.54	J	6	17	35%
Lindane	0.24	J	0.24	J	0.24	J	1	17	6%
Mirex	0.23	J	0.23	J	0.23	J	1	17	6%
PBDEs (ug/kg ww)									
PBDE-047	0.42	J	4	J	0.97	J	8	17	47%
PBDE-099	0.19	J	3.7	J	0.41	J	7	17	41%
PBDE-100	0.24	J	1.4	J	0.625	J	4	17	24%
PBDE-153	0.21		0.46		0.335		2	17	12%
PBDE-154	0.22	J	0.45	J	0.335	J	2	17	12%
Total PBDEs	0.19		10.01		1.195		8	17	47%

N - number
ppb ww: parts per billion (ug/Kg), wet weight.
ppt ww: parts per trillion (ng/Kg), wet weight.
J: The analyte was positively identified. The associated numerical value is an estimate.
NJ: There is evidence that the analyte is present. The associated numerical result is an estimate.
1. - Represents sum of congeners that were detected, expressed as 2,3,7,8-TCDD Toxicity Equivalents.

Criteria for Protection of Human Health

National Toxics Rule

Washington's water quality standards for toxic substances (WAC 173-201A-040[5]) define human-health-based water quality criteria by referencing 40 CFR 131.36, also known as the National Toxics Rule (NTR). Washington's water quality standards further state that risk-based criteria for carcinogenic substances be based on a risk level of 10^{-6}. A risk level is an estimate of the number of cancer cases that would be caused by exposure to a specific contaminant. At a risk level of 10^{-6}, one person in a million would be expected to contract cancer due to long-term exposure to a specific contaminant. These risks are upper-bound estimates, while true risks may be as low as zero. Exposure assumptions include an acceptable risk level and the consumer's body weight, length of exposure, and consumption rate. The NTR criteria are based on a consumption rate of 6.5 grams/day. Table 4 shows the NTR criteria for those contaminants detected in the 2003 WSTMP fish samples.

EPA Screening Values

Screening values (SVs) for carcinogenic and non-carcinogenic substances were developed by EPA in order to aid the prioritization of areas that may present risks to human populations from fish consumption. The EPA SVs are considered guidance only; they are not regulatory thresholds (EPA, 2000).

Assumptions about exposure to contaminants were also used in developing the EPA SVs. The approach is similar to that used for developing the NTR, yet two assumptions differ for SVs: the cancer risk level (10^{-5}) and the consumption rate (17.5 grams/day for recreational fishers and 142.4 grams per day for subsistence fishers). Screening values for non-carcinogenic effects are calculated using toxicological data from a variety of tests. Table 4 shows EPA SVs for those contaminants detected in the 2003 WSTMP fish tissue samples.

Criteria for Mercury

The EPA's recommended water quality criterion for methylmercury is 300 ppb (EPA, 2001). This is the maximum advisable concentration of methylmercury in fish and shellfish to protect consumers among the general population. Methylmercury is a toxic form of mercury that comprises nearly all the mercury in fish tissue (Bloom, 1995). EPA expects the criterion to be used as guidance by states and authorized tribes, and EPA in establishing or updating water quality standards for waters of the United States. While the criterion recommended by EPA in 2001 for mercury in freshwater fish is 300 ppb ww, the NTR criterion of 825 ppb ww remains to be the value used in Washington's water quality standards for regulatory purposes. The various mercury criteria discussed in this report are:

- National Toxics Rule: 825 ppb ww (based on 6.5 grams/day consumption rate).
- EPA's recommended criterion of 300 ppb ww (based on 17.5 grams/day consumption rate).
- EPA screening values which are 400 ppb ww for recreational fishers and 49 ppb ww for subsistence fishers (based on freshwater fish consumption rates of 17.5 and 142.4 grams/day, respectively).

Table 4. NTR Criteria and EPA Screening Values for the Protection of Human Health for Contaminants Detected in Fish Tissue, WSTMP 2003.

Analyte (ppb ww)[1]	National Toxics Rule	EPA Screening Values			
		Subsistence Fishers		Recreational Fishers	
		Non-carcinogens	Carcinogens	Non-carcinogens	Carcinogens
Mercury	825/300 [2]	49	-	400	-
Total PCBs	5.3	9.83	2.45	80	20
2,3,7,8-TCDD TEQ [3]	0.07	-	0.0315	-	0.256
4,4'-DDD	45	-	-	-	-
4,4'-DDE	31.6	-	-	-	-
4,4'-DDT	31.6	-	-	-	-
Total DDT	-	245	14.4	2000	117
Total Chlordanes [4]	-	245	14.0	2000	114
Aldrin	0.65	-	-	-	-
Beta-BHC	5.98	-	-	-	-
Chlorpyriphos	-	147	-	1200	-
Dieldrin	0.65	24	0.307	200	2.5
Endosulfan Sulfate	540	-	-	-	-
Lindane	8.19	147	3.8	1200	30.7
Mirex	-	98	-	800	-
Heptachlor Epoxide	1.232	6.39	0.54	52	4.39
Hexachlorobenzene	6.7	393	3.07	3200	25.0

1 Values in parts per billion wet weight (ug/kg ww) unless otherwise noted.
2 EPA (2001) recommends 300 ppb ww as the criterion for methylmercury yet this has not been adopted by the State of Washington.
3 Values in parts per trillion wet weight (ng/kg ww).
4 NTR criteria are for "Chlordane" only (criterion of 8.3 ppb ww) while the EPA screening values are for "Total Chlordanes" which is a sum of five compounds: cis- and trans-chlordane, cis- and trans-nonachlor, and oxychlordane.

Summing Results from Individual Compounds

Criteria for some analytes in this study are expressed as “total” values in order to compare them to criteria. Total PCBs is the sum of the individual Aroclors. Total DDT is the sum of the 4,4’ and 2,4’ isomers of DDT, DDD, and DDE. Total chlordane is the sum of five compounds: cis- and trans-chlordane, cis- and trans-nonachlor, and oxychlordane. Values qualified as estimates were included in the summing process while non-detect values were assigned a value of zero.

Summary of Fish Tissue Criteria Exceedances

Table 5 lists samples in which contaminants exceeded the NTR criteria and/or EPA’s screening values. Chemicals that exceeded one or more human health criteria included mercury, total PCBs, PCDD/Fs, total DDT, 4,4’-DDE, and dieldrin. Many samples exceeded criteria for multiple contaminants, such as PCDD/Fs and total PCBs. Appendix D (Table D2) shows values for detected contaminants in tissue samples as well as which values exceeded criteria for the protection of human health.

Table 5. Fish Tissue Contaminants Exceeding NTR Criteria or EPA Screening Values for the Protection of Human Health, WSTMP 2003.

Site	Species	Mercury (ppb ww)	Total PCBs (ppb ww)	PCDD/Fs (ppt ww)	Total DDT (ppb ww)	4,4'-DDE (ppb ww)	Dieldrin (ppb ww)	Lipids (%)[1]
Banks Lake	Lake whitefish	61	33	0.4500	35.11	-	-	6.6
	Rainbow trout	83	16.8	0.1340	17.09	-	-	2.6
	Yellow perch	74	-	-	-	-	-	0.67
	Walleye	124	6.7	-	-	-	-	1.7
Lacamas Lake	Largemouth bass	229	7.9	-	-	-	-	1.13
Lake Washington	Largemouth bass	62	10.8	-	-	-	-	0.82
Roses Lake	Largemouth bass	100	-	-	128.2	97	-	1.7
Scooteney Reservoir	Channel catfish	-	7.3	0.0330	26.5	-	2.4	7.53
	Walleye	119	-	-	19.11	-	2.3	1.5
Silver Lake	Brown trout	107	33	0.2015	18.7	-	-	2.2
	Largemouth bass	84	-	-	-	-	-	6.43
Spokane River	Rainbow trout	-	-	0.3620	-	-	-	5.4 [2]
Sprague Lake	Channel catfish	-	12.1	0.2030	10.72	-	-	13.01
	Rainbow trout	-	-	0.2170	-	-	-	1.81
	Smallmouth bass	-	2.8	-	-	-	-	1.23
	Walleye	51	2.5	0.1557	-	-	-	1.24
Twin Lakes	Largemouth bass	154	-	-	-	-	-	0.93
National Toxics Rule Criteria:		825	5.3	0.0700	-	31.6	0.65	-
EPA Screening Value for Subsistence Fishers:		49	2.45	0.0315	14.4	-	0.307	-
EPA Screening Value for Recreational Fishers:		400	20	0.2560	117	-	2.5	-

ppb ww - parts per billion wet weight
ppt ww - parts per trillion wet weight
\- no data available or criteria not exceeded
1 Lipids data from Manchester Environmental Laboratory (MEL).
2 Lipids data from Pace Analytical Services.

Criteria for Protection of Wildlife

There are no federal or Washington State fish tissue standards for the protection of wildlife. This report uses criteria from two sources: the National Academies of Science and Engineering (NAS/NAE, 1972), and the State of New York's Department of Environmental Conservation (Newall et al., 1987). These criteria are shown in Table 6.

Table 6. Fish Tissue Criteria for the Protection of Wildlife.

Analyte (ppb ww) [1]	NAS/NAE [2]	NY DEC [3]	NY DEC [4]
Mercury	500	-	-
Total PCBs	500	110	110
PCDD/Fs [5]	-	2.3	3.0
Total DDT	1000	270	200
Total Chlordanes	100	370	500
Dieldrin	-	22	120
Hexachlorobenzene	-	200	330

1. Values in parts per billion wet weight (ug/kg ww) unless otherwise noted.
2. National Academies of Sciences and Engineering, 1973.
3. Newall et al., 1987. N.Y. Department of Environmental Conservation: One-in-100 cancer risk criteria for piscivorous wildlife.
4. Newall et al., 1987. N.Y. Department of Environmental Conservation: Non-carcinogenic final fish flesh criteria for piscivorous wildlife.
5. PCDD/Fs as 2,3,7,8-TCDD Toxic Equivalent (TEQ); values in parts per trillion wet weight (ng/kg ww).

Data Evaluation by Ecology and the State Department of Health (DOH)

Several federal and state agencies collect and evaluate fish tissue data in Washington State, such as Ecology, DOH, WDFW, EPA, and USGS. Tissue data are evaluated differently by these agencies because their mandates and roles are varied. These multiple evaluations often lead to confusion and misunderstanding among agencies and the public on how fish tissue data are used and interpreted. Most fish tissue contaminant data from Washington fish, regardless of who conducted the study, make their way to DOH for evaluation regarding the safety of consuming contaminated fish. The following is an overview of how Ecology and DOH evaluate fish tissue data to meet different needs.

For the WSTMP, and many other Ecology studies, fish tissue data are evaluated primarily to determine if (1) water quality standards are being met, and (2) potential risks to human health from consuming contaminated fish warrant further study and/or development of a fish consumption advisory. Ecology's role is to determine whether water quality standards are met and to begin the process to correct problems where standards are not met. The DOH and local health departments are responsible for developing fish consumption advisories in Washington. There is some overlap in these evaluations because the water quality standards that fish tissue data are compared to were developed for the protection of human health.

Washington's water quality standards criteria for toxic contaminants were issued to the state in EPA's 1992 National Toxics Rule (NTR) (40CFR131.36). The human-health-based NTR criteria are designed to minimize the risk of effects occurring to humans from chronic (lifetime) exposure to substances through the ingestion of drinking water and consumption of fish obtained from surface waters. *The NTR criteria, if met, will generally ensure that public health concerns do not arise, and that fish advisories are not needed.*

The NTR criteria are thresholds that, when exceeded, may lead to regulatory action. When water quality criteria are exceeded, the federal Clean Water Act requires that the waterbody be put on a list and a water cleanup plan be developed for the pollutant causing the problem. This list is known as the "303(d) list," and the water cleanup plan results from a Total Maximum Daily Load (TMDL) study and public involvement process. Ecology uses the TMDL program to control sources of the particular pollutant in order to bring the waterbody back into compliance with the water quality standards.

While DOH supports Ecology's use of the NTR criteria for identifying problems and controlling pollutant sources so that water quality will meet standards, DOH does not use the NTR criteria to establish fish consumption advisories (McBride, 2006). DOH uses an approach similar to that in EPA's *Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories Vol. 1-4* for assessing mercury, PCBs, and other contaminants (EPA, 2000). These guidance documents provide a framework from which states can evaluate fish tissue data to develop fish consumption advisories based on (1) sound science and (2) established procedures in risk assessment, risk management, and risk communication. Neither the NTR criteria, nor the screening values found in the EPA guidance documents above, incorporate the varied risk management decisions essential to developing fish consumption advisories.

- *Risk Assessment* involves calculating allowable meal limits based on known fish contaminant concentrations. These calculations are conducted for both non-cancer and cancer endpoints using the appropriate Reference Dose (RfD) or Cancer Slope Factor (CSF), if available. These initial calculations are the starting point for evaluating contaminant data to determine whether a fish advisory is warranted. Additionally, known or estimated consumption rates help determine the potential magnitude of exposure and highlight the sensitive groups or populations that may exist due to elevated consumption rates.

- *Risk Management* includes (but is not limited to) consideration of contaminant background concentrations, reduction in contaminant concentrations through preparation and cooking techniques, known health benefits from fish consumption, contaminant concentrations or health risks associated with replacement foods, and cultural importance of fish. Other considerations are the possible health endpoints associated with a contaminant, the strength or weaknesses of the supporting toxicological or sampling data, and whether effects are transient or irreversible.

- *Risk Communication* is the outreach component of the fish advisory. The interpretation of the data from the risk assessment and risk management components drives how and when the fish advisory recommendations are issued to the public dependent on whether the message is targeted toward a sensitive group or a population or the general public. DOH's dual objective is how best to provide guidance to the public to increase consumption of fish low in contaminants to gain the benefits of eating fish, while steering the public away from fish that have high levels of health-damaging contaminants.

This report focuses on comparing fish tissue results to Washington's water quality standards, EPA screening values, and historical data from Washington. This report and the fish tissue data are sent to DOH for their use in determining whether additional sampling is needed for further assessing risks to consumers of contaminated fish.

Mercury

Background

Mercury is widespread in the environment, being released to the atmosphere from varied sources and transported globally. Mercury readily volatilizes such that 95% of atmospheric mercury is in the elemental form. Natural sources of mercury include weathering of mercury-bearing rocks and soil, volcanic activity, forest fires, and degassing from water surfaces. Anthropogenic (human-caused) sources include combustion of fossil fuels, metal production, and industrial processes. Lake sediment records show that atmospheric mercury has tripled over the last 150 years suggesting that two thirds of atmospheric mercury is of anthropogenic origin (Morel et al., 1998). Mercury returns to earth mainly via precipitation, settling in waters and land surfaces and cycling through these environments.

In humans, mercury primarily affects the nervous system, particularly in developing fetuses and children (EPA, 2000). Concern with these health risks resulted in the 2002 Washington State Legislature directing Ecology and DOH to develop a plan targeting mercury as the first priority pollutant in the state's *Proposed Strategy to Continually Reduce Persistent, Bioaccumulative Toxins (PBTs) in Washington State* (Gallagher, 2000). The *Washington State Mercury Chemical Action Plan* (Peele, 2003) identifies sources of mercury in Washington, current institutional structures related to mercury, and strategies for reducing mercury in the environment.

Human Health Criteria Exceedances

Mercury was detected in all 2003 WSTMP fish samples, with no samples exceeding EPA's recommended criterion of 300 ppb ww (Table 5 and Table D2). The highest value, 229 ppb ww, was found in largemouth bass from Lacamas Lake near the city of Camas. EPA's screening value for subsistence fishers, 49 ppb ww, was exceeded by 12 of 25, or 48%, of the samples. No samples exceeded the NTR criterion of 825 ppb ww or EPA's screening value for recreational fishers of 400 ppb ww.

Wildlife Criteria Exceedances

None of the 2003 WSTMP samples exceeded National Academies of Sciences and Engineering (NAS/NAE, 1972) recommended criterion for the protection of wildlife (Table 6). This criterion suggested that fish-eating birds should be protected if mercury levels in fish do not exceed 500 ppb ww. The NAS/NAE recognized that the 500 ppb ww criterion provided little or no safety margin for fish-eating wildlife and recommended that the criterion be updated. There has yet to be an update to this criterion, and scientific literature on the effects of mercury on wildlife was not reviewed for this report.

Statewide Comparison

For a statewide perspective, mercury levels in freshwater fish from various studies are ranked in Figure 2 as cumulative percentiles with the results from 2003 indicated for each sample. The highest mercury levels found in 2003 were in largemouth bass from Lacamas Lake and Twin Lakes (upper lake); each of these samples exceeded the 50th percentile of all mercury values. Fish from the other sites ranked below the 50th percentile.

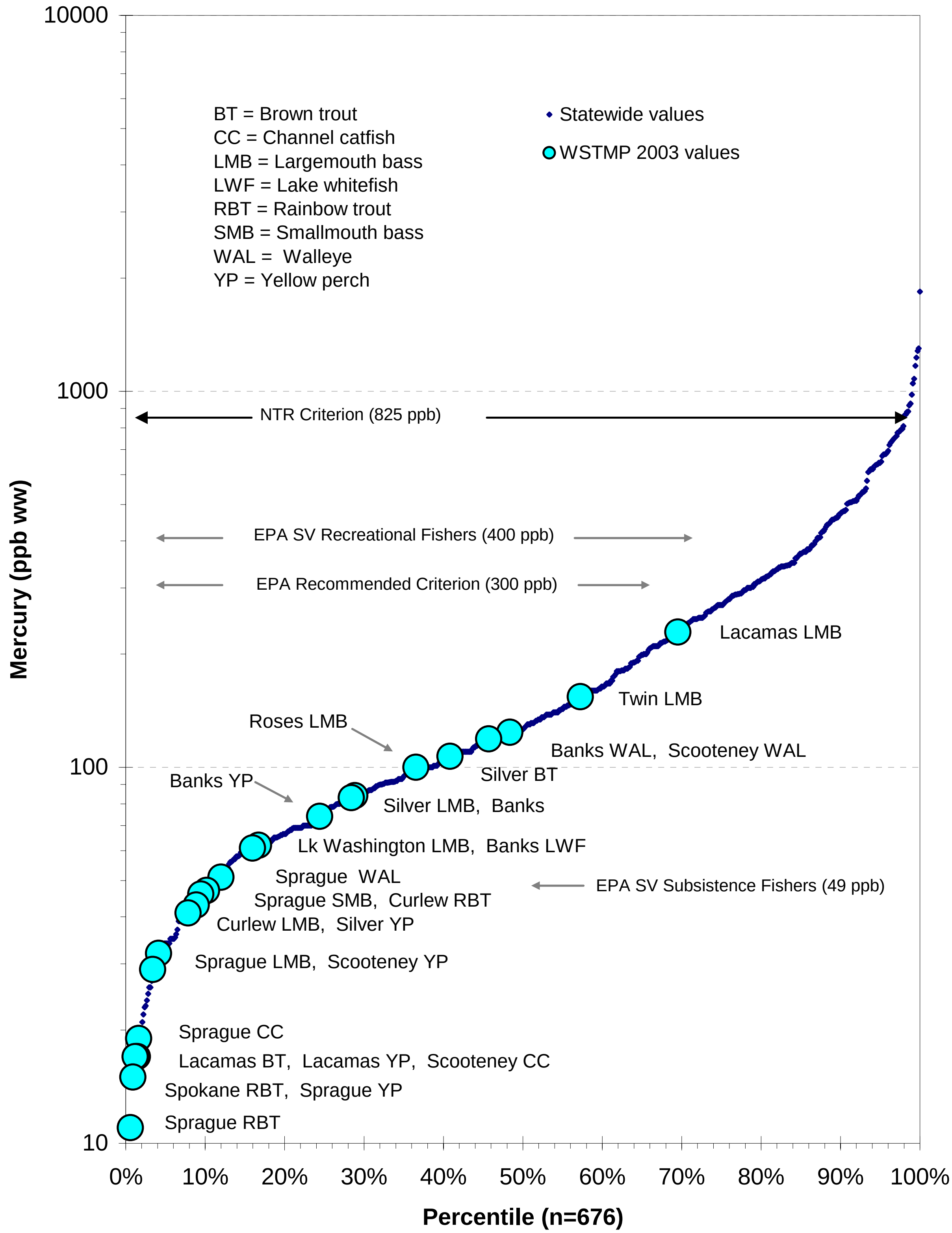

Figure 2. Cumulative Frequency Distribution of Mercury in Edible Fish Tissue.

The 676 values used in Figure 2 are from monitoring conducted by Ecology, EPA, and USGS (EPA, 1992, 2002a, 2005; Fischnaller et al., 2003; Hopkins et al., 1985; Hopkins, 1991; Johnson and Norton, 1990; Seiders, 2003, 2004; Serdar et al., 1994a, 1994b, 2001; Serdar and Davis, 1999; and Munn et al., 1995). These studies determined mercury levels in edible tissue from multiple species using individual fish as well as composite samples of a single species.

PCBs

Background

Polychlorinated biphenyls (PCBs) are a group of 209 synthetic chemicals whose production in the United States was banned in 1979 due to their toxicity and persistence in the environment. PCBs were manufactured in complex mixtures to attain desirable properties for varied applications such as fire retarding properties for lubricating and electrical transformer oils. The major source of PCBs in the environment is from historical manufacturing, storage, use, and disposal practices. Throughout the world, PCBs are found in air, soil, waters, and biota. PCBs have low solubility in water yet have a high affinity for sediments and animal fats; they readily bioaccumulate in the aquatic food chain (EPA, 1999a).

A broad range of adverse health effects have been associated with exposure to PCBs. These include toxic effects on the nervous, endocrine, digestive, immune, and reproductive systems. PCBs are classified as a probable human carcinogen by the EPA. Thirty-seven states have issued 679 fish consumption advisories due to PCB levels. PCBs are responsible for about 27% of fish consumption advisories in the United States (EPA, 1999a).

Human Health Criteria Exceedances

Levels of total PCBs from eight of 24 tissue samples exceeded (did not meet) the NTR criterion of 5.3 ppb ww, and many samples exceeded one or more of EPA's screening values (Table 5 and Table D2). Results from 13 samples could not be adequately compared to the NTR criterion because reporting limits were higher than the criterion.

Brown trout from Silver Lake and lake whitefish from Banks Lake had the highest level of total PCBs (33 ppb ww), each followed by rainbow trout from Banks Lake (16.8 ppb ww). These samples exceeded the NTR criterion of 5.3 ppb ww by factors of about 6 and 3, respectively.

The largemouth bass sample from Lake Washington had a total PCBs concentration of 10.8 ppb ww which exceeded the NTR criteria for total PCBs. A more comprehensive study of Lake Washington fish tissue contaminants is being conducted by DOH due to high levels of PCBs and mercury found in fish during research in 2003 by the University of Washington and the King County Department of Natural Resources (Hardy and McBride, 2004). An Interim Fish Consumption Advisory was issued in 2004 (DOH, 2004). Additional sampling was conducted in 2005 (Carr, 2005) in order to better evaluate potential risks to people eating fish from the lake. A report on the 2005 sampling and a revised Fish Consumption Advisory are expected in 2006.

Wildlife Criteria Exceedances

The 2003 WSTMP fish tissue samples did not exceed criteria for the protection of wildlife. The levels of total PCBs found in most samples were roughly three to 50 times less than several criteria developed for the protection of wildlife (Table 6). Recent scientific literature on the effects of PCBs on wildlife was not reviewed for this report.

Statewide Comparison

PCBs are commonly found in freshwater fish due to PCB's persistence and its widespread historical use. For a statewide perspective, total PCBs in edible fish tissue were compiled from historical studies in Washington and plotted in Figure 3. Most results from the 2003 WSTMP sampling effort fell below the 20th percentile while two samples ranked at the 36th percentile.

The 409 results depicted in Figure 3 represent more than 25 species and include fillet and muscle tissue from individual fish as well as composite samples of multiple fish. More than 95% of edible tissue sampled for PCBs in the state exceed the NTR criterion of 5.3 ppb ww for the protection of human health. The total PCB values in most fish also exceed EPA's screening values for subsistence fishers (2.45 and 9.83 ppb ww).

The historical data represented in Figure 3 were from the following studies: Davis and Johnson, 1994; Davis et al., 1995, 1998; Davis and Serdar, 1996; Ecology, 1995; EPA, 1992, 2002a, 2005; Hopkins et al., 1985; Hopkins, 1991; Jack and Roose, 2002; Johnson and Norton, 1990; Johnson, 1997a, 2000; Seiders, 2003, 2004; Serdar et al., 1994a, 1994b; Serdar, 1998, 1999, 2003; and Serdar and Davis, 1999.

PCDD/Fs

Background

Dioxins and furans are unintentional byproducts of combustion processes, chlorine bleaching in paper production, and contaminants in some chlorinated pesticides. Like PCBs, they are persistent and widely distributed in the environment. Adverse health effects have been associated with the digestive, endocrine, immune, nervous, and reproductive systems. The dioxin compound, or congener, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is the most potent animal carcinogen EPA has evaluated. EPA classifies this congener as a probable human carcinogen (EPA, 1999b).

The 17 PCDD/F congeners have different levels of toxicity compared to 2,3,7,8-TCDD, the most toxic form. To assess the cumulative risks to human and environmental health, the congener concentrations are expressed as Toxic Equivalents (TEQs). The TEQ is calculated by multiplying each congener result by its congener-specific Toxicity Equivalent Factor (TEF) and then summing these to obtain the overall TEQ. Various TEFs have been developed over time as a result of research into the toxicity of individual congeners. The 1998 World Health Organization TEFs are used in this report because they are based on more recent research, are internationally accepted, and preferred by EPA (2002b). These TEFs are described by Van den Berg et al.

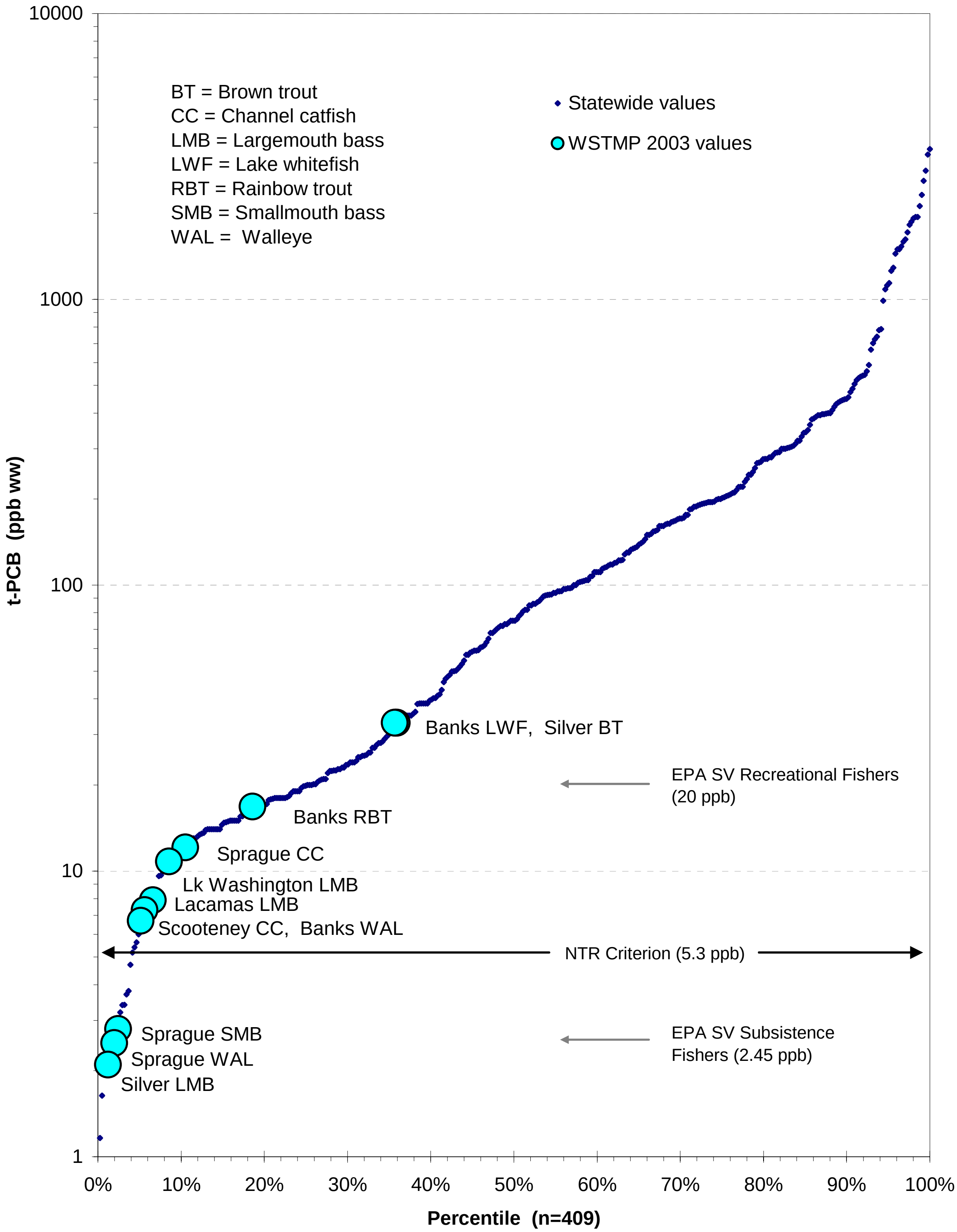

Figure 3. Cumulative Frequency Distribution of Total PCBs in Edible Fish Tissue.

(1998). In calculating the TEQs, non-detects were assigned a value of zero, and results qualified as estimates were used at the reported value. Results for individual congeners, TEFs, and TEQs are included in Appendix D (Table D3).

Human Health Criteria Exceedances

Seven of 11 tissue samples exceeded the NTR criterion of 0.07 parts per trillion wet weight (ppt ww) for PCDD/Fs by factors from about 2 to 6 (Table D3). PCDD/Fs were detected in the remaining four samples yet did not exceed NTR criteria. Eight of the 11 samples exceeded one or more of EPA's screening values (Table 5 and Table D2). Three species from Sprague Lake exceeded NTR criteria for PCDD/Fs: rainbow trout, channel catfish, and walleye.

The highest values of PCDD/Fs were found in lake whitefish from Banks Lake (0.4500 ppt ww) and rainbow trout from the Spokane River (0.3620 ppt ww). The higher level of PCDD/Fs in whitefish from Banks Lake may be related to their age, lipids content, and the source of Banks Lake water. Banks Lake whitefish were the oldest fish sampled in 2003 with a mean age of 10 years. Two individuals were 19 years old with another at 16 years old. These whitefish had a relatively high lipids content of 6.6%. The source water for Banks Lake is Franklin D. Roosevelt reservoir which has historically produced fish contaminated with PCDD/Fs due to pulp mill discharges in the upper Columbia River (Serdar et al., 1991 and 1994a).

Wildlife Criteria Exceedances

Levels of PCDD/Fs in fish tissue were below the two criteria developed by the New York DEC for the protection of wildlife (Newell et al., 1987). These criteria are 2.3 and 3.0 ppt ww for carcinogenic (a 1 in 100 cancer risk) and non-carcinogenic effects, respectively (Table 6). Recent scientific literature on the effects of PCDD/Fs on wildlife was not reviewed for this report.

Statewide Comparison

Tissue data on PCDD/Fs were compiled from historical studies in Washington State and plotted in Figure 4 (Johnson and Yake, 1989; Johnson et al., 1991a, 1991b; Seiders, 2003, 2004; Serdar et al., 1991, 1994a; Era et al., 2002; and EPA, 1992, 2002a, 2005). The 75 results represent numerous species and include results from whole fish and edible tissue from both individual fish and composite samples of multiple fish. Many data used in Figure 4 are from the early 1990s sampling of Lake Roosevelt and the upper Columbia River; this was a period when the Columbia River was receiving untreated pulp mill effluent from a Canadian mill. PCDD/F levels in fish from the area have decreased since the pulp mill began treating their wastewater (Serdar et al., 1994a).

Figure 4 shows that the 2003 WSTMP results range below the 52nd percentile of values found in Washington fish. About 80% of fish sampled for PCDD/Fs in the state since about 1990 exceed the NTR criterion of 0.07 ppt ww for the protection of human health. The EPA's screening values for subsistence fishers (0.032 ppt ww) and recreational fishers (0.256 ppt ww) have also been frequently exceeded.

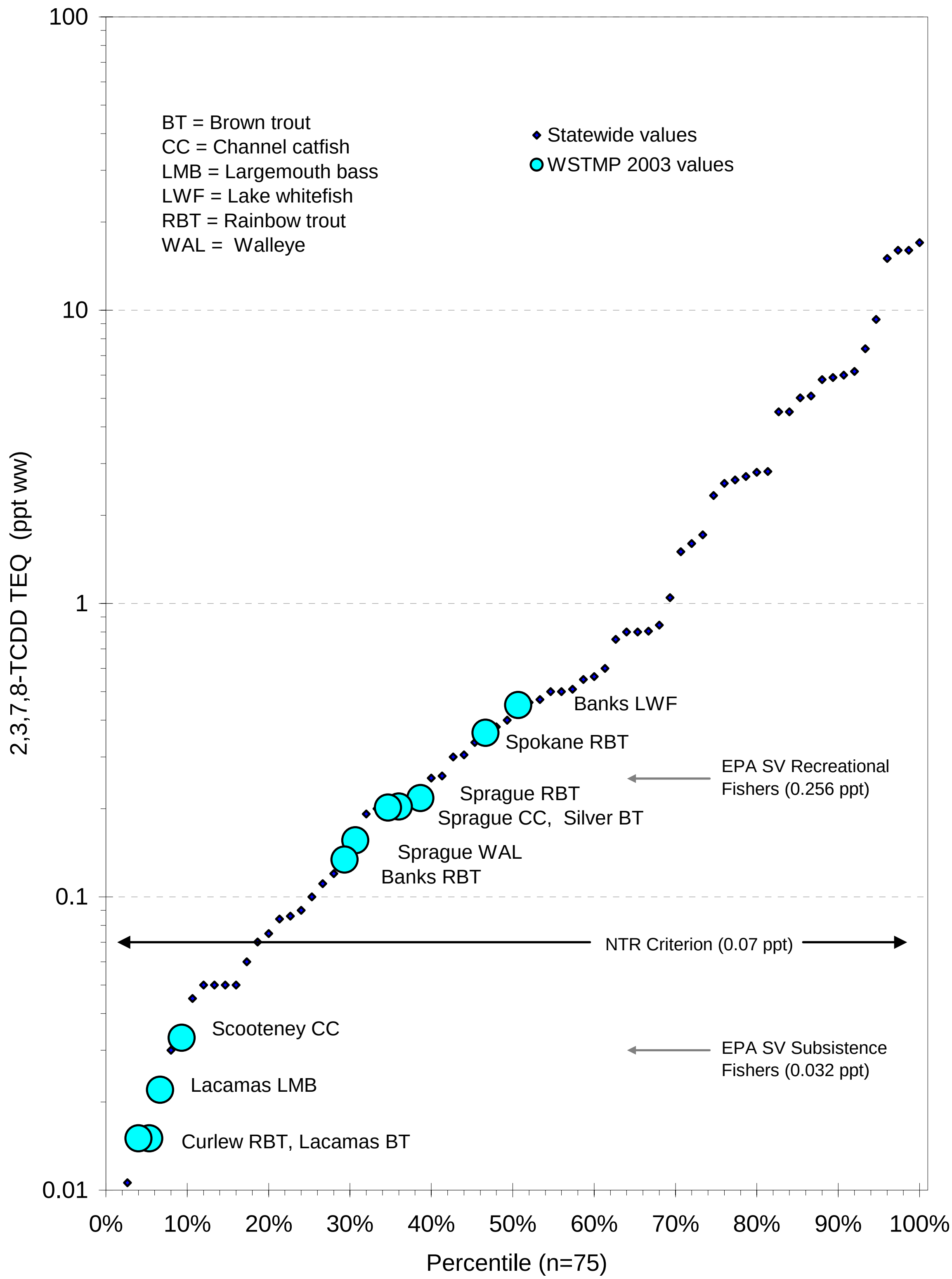

Figure 4. Cumulative Frequency Distribution of 2,3,7,8-TCDD TEQs in Fish Tissue.

Chlorinated Pesticides

Background

Chlorinated pesticides have been used for decades as an insecticide in agricultural and home environments. These compounds have low solubility in water, are not readily metabolized or excreted, are readily stored in fat tissue, and biomagnify to high concentrations in the food web. Many are neurotoxins and are suspected or known carcinogens (EPA, 2000). Many of these compounds (e.g., DDT, chlordanes, and dieldrin) were banned from use in the United States during the 1970s and 1980s as their hazards became evident. Due to their high persistence, chlorinated pesticides continue to be found in fish and wildlife throughout the world.

Human Health Criteria Exceedances

Chlorinated pesticides that exceeded criteria for the protection of human health were total DDT, 4,4'-DDE, and dieldrin (Table 5 and Table D2). Largemouth bass from Roses Lake near Lake Chelan had the highest levels of 4,4'-DDE (97 ppb ww) and total DDT (128 ppb ww). Roses Lake was included in a TMDL study of Lake Chelan (Coots and Era-Miller, 2005) and has been known for high levels of DDT compounds since sampling was conducted in 1992 by Serdar et al. (1994b). Higher levels of total DDT were also found in rainbow trout from Banks Lake, brown trout from Silver Lake, and Scooteney Reservoir walleye and channel catfish. Dieldrin in walleye and channel catfish from Scooteney Reservoir also exceeded NTR criterion.

Several other pesticides were detected with none exceeding any criteria for the protection of human health. These include chlordane compounds, aldrin, Beta-BHC, chlorpyrifos, endosulfan sulfate, heptachlor epoxide, hexachlorobenzene, lindane, and mirex.

Scooteney Reservoir was sampled by Ecology in 1995 (Davis, et. al, 1998) as part of the Washington State Pesticide Monitoring Program. Chlorinated pesticides were found in fillets from large- and smallmouth bass, and in whole carp sampled in 1995. Dieldrin in all species sampled in 1995 exceeded NTR criterion, which was the case for two species sampled in 2003. While levels of total DDT in the 1995 fish were higher than those found in the walleye, yellow perch, and channel catfish fillets sampled in 2003, any assertion of changes in levels would be tenuous because different species and tissue types were sampled during the two studies.

Wildlife Criteria Exceedances

Pesticide concentrations in fish tissue were well below several criteria developed for the protection of wildlife (Table 6). The NAS/NAE (1972) criteria were not exceeded by any samples for any contaminant, nor were criteria developed by the New York DEC for protecting fish-eating wildlife in the Niagara River basin (Newell et al., 1987). Most pesticides were detected at levels well below these criteria with one exception: The total DDT level of 128 ppb ww in largemouth bass from Roses Lake was more than half the 200 ppb ww criterion for the protection of piscivorous wildlife (Newell et al., 1987). Individually, the pesticides detected in fish tissue likely pose little risk to most wildlife; yet it is uncertain what the effects of combinations of pesticides would have since little is known about the synergistic effects of these contaminants.

Statewide Comparison

Many of the pesticides found during this 2003 study are also among the most commonly detected pesticides found in Washington fish during past efforts of the Washington State Pesticide Monitoring Program (WSPMP) (Davis et al., 1998). For example, total DDT in tissue was detected at 97% of the 29 freshwater sites monitored during the WSPMP. Total chlordane was detected in tissues from 93% of the WSPMP sites. Hexachlorobenzene and DDMU were detected in fish tissue at 62% and 66%, respectively, of the WSPMP sites.

To gain a statewide perspective on total DDT, 295 results were compiled from historical studies in Washington (Figure 5). These studies were conducted by Ecology and EPA: Davis and Johnson, 1994; Davis et al., 1995, 1998; Davis and Serdar, 1996; EPA, 1992, 2002a, 2005; Hopkins et al., 1985; Hopkins, 1991; Johnson and Norton, 1990; Johnson, 1997b; Rogowski, 2000; Seiders, 2003, 2004; Serdar et al., 1994b; Serdar, 1998, 2003; and Serdar and Davis, 1999.

Most results from the 2003 WSTMP fall in the lower 45th percentile of statewide results with the exception of Roses Lake largemouth bass whose result ranks at the 68th percentile.

PBDEs

Background

Polybrominated diphenyl ethers (PBDEs) are a group of chemicals used as flame retardants in electronics, plastics, building materials, and textiles. Like PCBs, PBDEs appear to be persistent, are transported throughout the global environment, are lipophilic, and some forms bioaccumulate in aquatic environments. Research on the potential health risks from PBDEs is limited. Animal toxicity studies indicate that PBDEs are associated with developmental neurotoxicity, thyroid hormone disruption, reproductive effects, and liver changes (Darnerud et al., 2001; Birnbaum et al., 2004). Recent studies estimate diet as the main route of exposure to PBDEs for the general public (Harrad et al., 2004).

PBDEs are the focus of Washington's second Chemical Action Plan developed under the state's PBT Initiative (Ecology, 2006). One effort of this PBT Initiative is a statewide assessment of PBDEs in Washington's fish and waters; this study is currently underway and results should be available in the summer of 2006 (Johnson and Seiders, 2005). There are no regulatory criteria for PBDEs for the protection of human health or wildlife.

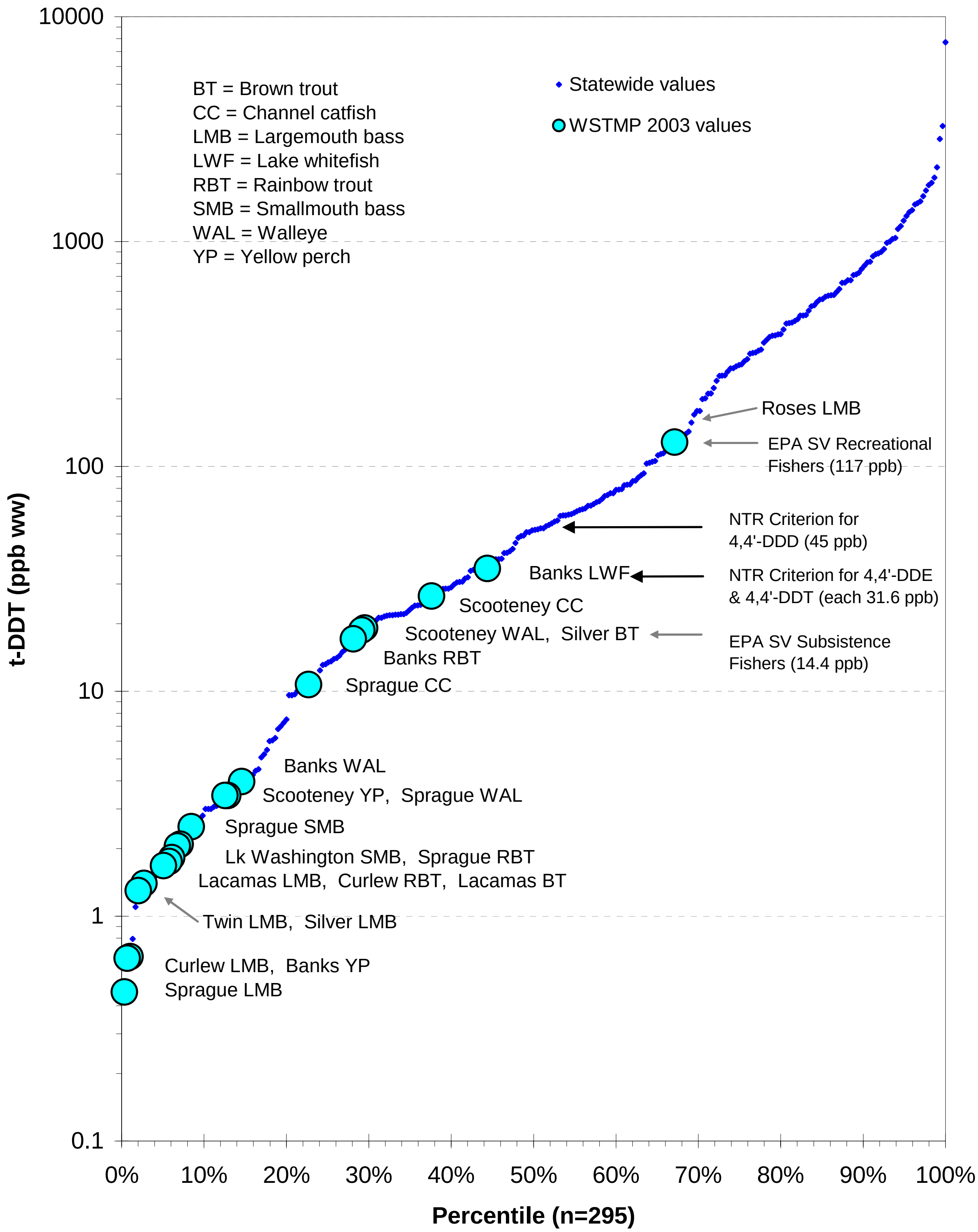

Figure 5. Cumulative Frequency Distribution of Total DDT in Edible Fish Tissue.

PBDE Detections and Statewide Comparison

PBDE congeners were detected in eight of 17 tissue samples. Concentrations of the congeners PBDE-47, PBDE-99, PBDE-100, PBDE-153, and PBDE-154 ranged from 0.19 ppb ww to 4 ppb ww. Summing the values for each site yields total PBDE values that range from 0.19 to 10.01 ppb ww (Table 3 and Table D2).

To gain a statewide perspective on PBDEs, 82 results were compiled from historical studies in Washington (Figure 6). These studies by Ecology were conducted by Johnson and Olson (2001) and Seiders (2003, 2004). Total PBDE values found during the 2003 WSTMP are in the lower 36^{th} percentile of values found statewide (Figure 6). Johnson and Olson (2001) reported results from 16 freshwater fish tissue samples which showed a range of total PBDEs from 1.4 ppb ww in whole rainbow trout from an undeveloped watershed, to 1,250 ppb ww in whole mountain whitefish from the Spokane River. Fish from the Spokane River have the highest values of PBDEs found in Washington to date.

The levels of PBDEs found during the 2003 WSTMP were also lower than PBDE levels found in salmon from the Lake Michigan area. Manchester-Neesvig et al. (2001) analyzed steaks from 16 coho and 5 chinook salmon from two tributaries to Lake Michigan. Concentrations ranged from 44.6 to 148 ppb ww with a mean of 80.1 ppb ww.

Site Ranking by Number of Contaminants

Table 7 is a simple ranking of sites, based only on the numbers of contaminants detected in individual fish species and the number of times that NTR water quality criteria or EPA screening values for the protection of human health were exceeded. The arrangement of sites and species in Table 7 does not account for the magnitude of contamination found in samples or the many factors that influence contaminant levels in fish tissue (e.g., differences among species, size and ages of fish, lipids content, and trophic level).

The most contaminated sites are those in the upper half of Table 7: Banks Lake, Sprague Lake, Scooteney Reservoir, and Silver Lake. The lesser contaminated sites are Lacamas Lake, Curlew Lake, and the upper lake of Twin Lakes.

Fish tissue data from the 2003 WSTMP study on the Spokane River, Roses Lake, and Lake Washington are limited. Historical and ongoing studies show that fish tissue from these three sites contain high levels of PCBs, DDTs, and/or other chemicals (Serdar, 2005; Coots and Era-Miller, 2005; Carr, 2005). It seems likely that the inclusion of data from other studies into this ranking would put these three sites in among the more contaminated sites.

Fish contaminant data from all sites appear to reflect the land uses and water sources associated with each site. Agriculture is the dominant land use associated with Banks Lake, Sprague Lake, Silver Lake, Roses Lake, and Scooteney Reservoir. Silver Lake may also be influenced by nearby residential development and Fairchild Air Force Base. Lake Washington is influenced by the greater Seattle urban area.

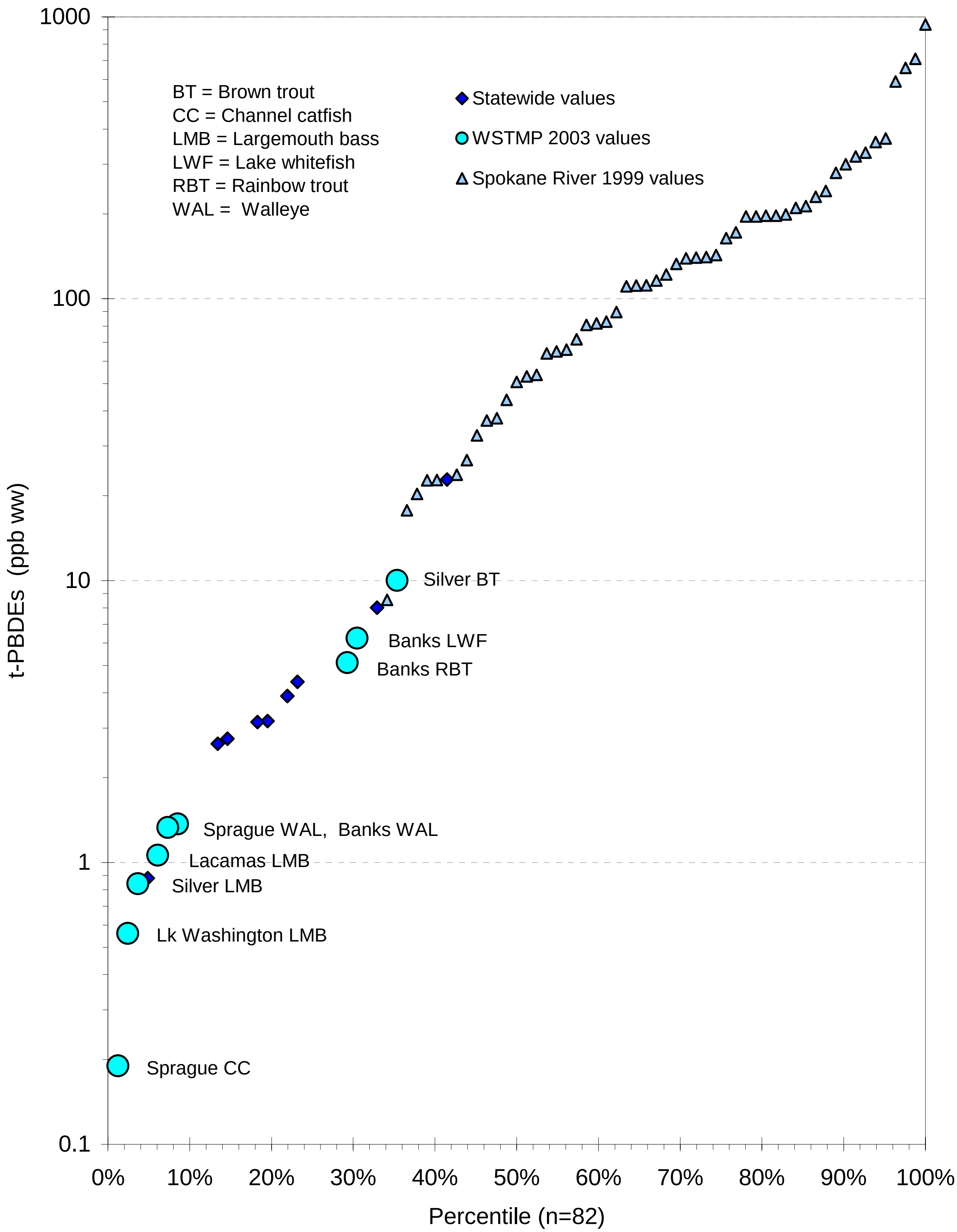

Figure 6. Cumulative Frequency Distribution of Total PBDEs in Edible Fish Tissue.

Table 7. Ranking of Sites and Fish Tissue Samples with Number of Contaminants Detected and Exceedances of NTR Criteria and EPA Screening Values, WSTMP 2003.

Site	Species	No. of Contam-inants Detected	Mercury		Total PCBs		PCDD/Fs		Dieldrin		4,4'-DDE	Total DDTs
			NTR	EPA SV	NTR	EPA SV	NTR	EPA SV	NTR	EPA SV	NTR	EPA SV
Banks Lake	Lake whitefish	19		x	X	x	X	x				x
	Rainbow trout	15		x	X	x	X	x				x
	Walleye	8		x	X	x						
	Yellow perch	2		x								
Sprague Lake	Walleye	21		x			X	x				
	Channel catfish	12			X	x	X	x				
	Rainbow trout	5					X	x				
	Smallmouth bass	3										
	Largemouth bass	2										
	Yellow perch	1										
Scooteney Reservoir	Channel catfish	13			X	x			X	x		x
	Walleye	10		x					X	x		x
	Yellow perch	5										
Silver Lake	Brown trout	19		x	X	x	X	x				x
	Largemouth bass	4		x								
	Yellow perch	1										
Lake Washington	Largemouth bass	10		x	X	x						
Lacamas Lake	Largemouth bass	9		x	X	x						
	Brown trout	4										
	Yellow perch	1										
Roses Lake	Largemouth bass	4		x							X	x
Spokane River	Rainbow trout	2					X	x				
Curlew Lake	Rainbow trout	5										
	Largemouth bass	2										
Twin Lakes	Largemouth bass	2		x								

NTR – National Toxics Rule
EPA SV – U.S. Environmental Protection Agency screening value

A more thorough discussion of land use and potential sources of contaminants is beyond the scope of this screening study. More detailed studies, such as those for developing water cleanup plans on the Spokane River (Serdar, 2005) and Lake Chelan and Roses Lake (Coots and Era-Miller, 2005), examine the likely pathways of contaminants from their sources to their fate of being found in fish.

Water Samples

Results

Results for conventional water quality parameters appeared typical for Washington waters except for instances of high temperatures and high suspended solids (Appendix E, Table E1). High water temperatures measured at seven sites exceeded Washington's water quality standards (WAC 173-201A-040) for Class AA (16.0°C), A (18.0°C), or B (21.0°C) waters depending on the site. Sites exceeding temperature standards were Burnt Bridge Creek, Colville River, Crab Creek, Lacamas Creek, Mill Creek, Rocky Coulee, and the Washougal River.

Some results for total suspended solids seemed high for Chewelah Creek, Colville River, Crab Creek, and Mill Creek. High values (from 10 to 111 mg/L) may have been due to the influence of irrigation return flows or other disturbance upstream of the sampling site. Some sites on Crab Creek had no water in them during sample events so were not sampled. Reasons for lack of water in the streambed were not pursued.

Only six pesticides were detected in water, with all detected at low levels (Table 8). Burnt Bridge Creek had seven detections, Rocky Coulee had three detections, and Crab Creek and Lacamas Creek each had one detection (Table E-2). Pesticides that were most frequently detected included bromacil, dichlobenil, atrazine, and terbacil.

Table 8. Summary of Pesticide Levels Detected in Water, WSTMP 2003.

Analyte	Minimum Value	Maximum Value	Median Value	Number of Detections	Frequency of Detection
Atrazine	0.0032 J	0.013 J	0.0081 J	2	7%
Bromacil	0.013 NJ	0.027 J	0.0145 J	4	15%
Dichlobenil	0.0082 J	0.013 J	0.0106 J	2	7%
Diuron	0.042 J	0.042 J	0.042 J	1	4%
Hexazinone	0.019 J	0.019 J	0.019 J	1	4%
Terbacil	0.015 J	0.057 J	0.036 J	2	7%

J - The analyte was positively identified. The associated numerical value is an estimate.
NJ - There is evidence that the analyte is present. The associated numerical result is an estimate.

Both the 2002 (Seiders, 2004) and the current 2003 WSTMP water sampling efforts had few pesticide detections. When detected, pesticides were found at low frequencies and low levels. Such low rates of detection are likely a consequence of an inadequate sampling strategy, such as: a low frequency of sampling; poor timing of sample collection in relation to pesticide applications; lack of knowledge about the timing, amounts, and types of pesticide applications; and analytical methods that may not be adequately sensitive. Substantial effort would be needed to improve the sampling design and to gain knowledge about pesticide applications at target sampling sites. Such an effort is likely beyond current resources available to the WSTMP.

Aquatic Life Criteria Exceedances

Washington State has no water quality criteria for the pesticides that were detected. For pesticides having water quality criteria, comparisons could not be done because quantitation limits were higher than the criteria. Analytes that were not found at detection limits below water quality criteria include DDT and chlordane compounds, aldrin, chlorpyrifos, dieldrin, endrin, endosulfan, heptachlor, lindane, and parathion.

Conclusions

Conclusions as a result of this 2003 Washington State Toxics Monitoring Program study are as follows:

- During the 2003 monitoring, 25 composite samples of edible fish tissue were analyzed, representing eight species collected from ten sites. Data from the collection of multiple species of fish gives a better assessment of contaminant levels than data from only one or two species.

- Contaminants detected in fish tissue included mercury, PCBs, PCDD/Fs, DDTs, dieldrin, chlordane compounds, aldrin, Beta-BHC, chlorpyrifos, endosulfan sulfate, heptachlor epoxide, hexachlorobenzene, lindane, mirex, and flame retardants (PBDEs).

- PCBs and PCDD/Fs in fish tissue exceeded (did not meet) Washington's water quality criteria for the protection of human health in 33% and 64% of samples, respectively. DDT and/or its metabolites were detected in 88% of samples yet only 4,4'-DDE exceeded criteria in one sample. Dieldrin exceeded criteria in two samples. Mercury was detected in all samples yet did not exceed criteria in any sample. No fish tissue samples exceeded criteria for the protection of wildlife.

- Table 7 summarizes fish tissue samples that exceeded National Toxics Rule (NTR) criteria or EPA screening values for the protection of human health:
  - Total PCBs in eight samples – both NTR criteria and EPA screening values
  - PCDD/Fs in seven samples – both NTR criteria and EPA screening values
  - Dieldrin in two samples – both NTR criteria and EPA screening values
  - 4,4'-DDE in one sample – NTR criteria
  - Total DDTs in six samples – EPA screening values
  - Mercury in 12 samples – EPA screening values

- Water quality samples were collected and measured three times from ten sites. Samples were analyzed for 115 chlorinated, organophosphorous, and nitrogen pesticides. Six pesticides were detected at low levels and low frequencies: bromacil, dichlobenil, atrazine, diuron, hexazinone, and terbacil. The sampling design and available resources were insufficient to characterize pesticides in water.

- Water temperatures measured at eight stream sites exceeded water quality standards for the protection of aquatic life. Suspended solids measured at three sites were unusually high and appeared to be due to the influence of irrigation returns or other upstream disturbances.

Recommendations

Recommendations as a result of this 2003 Washington State Toxics Monitoring Program (WSTMP) study are as follows:

- Ecology should consider additional fish tissue sampling at sites where criteria for the protection of human health were exceeded. The Washington State Department of Health and local health jurisdictions should be consulted about sampling designs that would help determine whether a fish consumption advisory is warranted.

- The following eight waterbodies should be reviewed for placement on the state's 303(d) list, Category 5, for contaminants in fish species (described in Table 7): Banks Lake, Lacamas Lake, Lake Washington, Roses Lake, Scooteney Reservoir, Silver Lake, Spokane River, and Sprague Lake.

- The water sampling component of the WSTMP should be discontinued, with resources shifted to improving the fish tissue sampling component.

- Future analyses of fish tissue data should characterize spatial patterns for selected contaminants and fish species to provide a more comprehensive view of fish tissue contamination across the state. Such analyses will be possible as more fish tissue data are collected in future years.

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Appendices

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Appendix A

Sample Site Descriptions

Table A-1. Sample Site Descriptions, WSTMP 2003.

Site Name	Matrix	Latitude Decimal Degrees [1]	Longitude Decimal Degrees [1]	WBID [2] WA-	WRIA Number	County	EIM "User Location ID" [3]
Banks Lake	Fish	47.8770	-119.1652	42-9020	42	Grant	Banks-F2
Curlew Lake	Fish	48.7455	-118.6651	60-9010	60	Ferry	Curlew-F
Lacamas Lake	Fish	45.6179	-122.4266	28-9050	28	Clark	Lacamas-F
Lake Washington	Fish	47.7452	-122.2654	08-9350	8	King	Washington-F
Roses Lake	Fish	47.9012	-120.1490	47-9037	47	Chelan	Outlet
Scooteney Reservoir	Fish	46.7089	-119.0314	36-9110	36	Franklin	Scooteney-F
Silver Lake	Fish	47.5605	-117.6545	34-9310	34	Spokane	Silver-F
Spokane River	Fish	47.7324	-117.5096	54-1020	54	Spokane	Spokane-F
Sprague Lake	Fish	47.2635	-118.0581	34-9330	34	Lincoln	Sprague-F
Twin Lakes	Fish	47.5321	-118.4978	43-9280	43	Lincoln	Twin-F
Burnt Bridge Creek at Alki Rd., city of Vancouver	Water	45.6614	-122.6721	28-1040	28	Clark	BURNT BR
Chewelah Creek at Alm Lane, city of Chewelah	Water	48.2677	-117.7209	59-6000	59	Stevens	CHEWELAH
Colville River (RM 9.2) at Greenwood Loop Rd., 3 miles east of city of Kettle Falls	Water	48.5886	-117.9923	59-1010	59	Stevens	CR24
Crab Creek 5 miles east of Sylvan Lake on Downs Rd, 13 miles north of city of Ritzville	Water	47.3132	-118.4225	43-4000	43	Lincoln	CRAB CR1
Crab Creek at Hwy 28, 3 miles west of town of Wilson Creek	Water	47.4207	-119.1648	43-1010	43	Grant	CRAB CR2
Crab Creek at 7th NE, 5 miles north of city of Moses Lake	Water	47.1898	-119.2661	41-1030	41	Grant	CRAB CR3
Lacamas Creek at Goodwin Rd., 4 miles NW of city of Camas	Water	45.6387	-122.4567	28-2020	28	Clark	LACAMAS CR
Mill Creek nr mouth, 3 miles northwest of city of Colville	Water	48.5729	-117.9453	59-2000	59	Stevens	COLV-21
Rocky Coulee Wasteway near mouth, 2 miles north of city of Moses Lake	Water	47.1628	-119.2566	41-1130	41	Grant	ROCKY COUL
Washougal River near mouth, city of Washougal	Water	45.5868	-122.3744	28-2010	28	Clark	WASHOUG

1 North American Datum 1983 is horizontal datum for coordinates. Coordinates for fish tissue samples are in central part of lake even though fish were usually collected from many areas of the lake.

2 Ecology's Water Body Identification Number (WBID).

3 Site identification as used in Ecology's Environmental Information Management (EIM) system.

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Appendix B

Field Sampling Procedures

Fish Tissue Samples

Methods for the collection, handling, and processing of fish tissue samples for analysis were guided by methods described in EPA (2000). Fish were collected using gill nets, fyke nets, and/or electrofishing with a 16' Smith-Root electrofishing boat. Fish were collected by the Washington Department of Fish and Wildlife (WDFW) crews at Scooteney Reservoir and Banks, Curlew, Sprague, and Silver lakes. Ecology crews assisted WDFW at most sites. Ecology collected fish from the Spokane River and Lacamas, Twin, Roses, and Washington lakes.

Captured fish were identified to species and target species were retained while non-target species were released. Retained fish were inspected to ensure that they were acceptable for further processing (e.g., proper size – smallest fish at least 75% the length of largest fish in the sample, no obvious damage to tissues, skin intact).

Field preparation of individual fish involved:

- Sacrificing the fish by a blow to the head with a dull object.
- Rinsing in ambient water to remove foreign material from their exterior.
- Weighing to the nearest gram.
- Measuring the total length to the nearest millimeter.
- Double-wrapping individuals in foil with a tag identifying the date and location of capture, species, and fish identification number.
- Placing foil-wrapped fish into plastic zip-lock bags.
- Placing the bagged fish on ice in the field and transporting iced fish to the Ecology facilities in Lacey, Washington within 72 hours of collection.
- Transferring fish to dedicated freezer and freezing to -20°C.

Frozen fish were processed at Ecology's Lacey facility on a later date to form samples to be sent to the laboratory for analysis. The edible portion of target species was used for individual and composite samples. For analysis of organic compounds, at least five fish were used to create a composite sample for each site sampled.

The processing of fish was as follows:

- Fish were removed from the freezer and partially thawed.
- Scales were removed using the dull side of a fillet knife.
- One or two fillets were removed from the fish, depending on the fish size and sample mass required for analysis; fillets from all species included the skin except for catfish where the skin was removed.

- Fillets were cut into 1-2 cm pieces and passed through a decontaminated Kitchen-Aid model FGA food grinder two times to allow thorough grinding and homogenization of fillets from individual fish.
- Equal amounts of the ground and homogenized tissue from each fillet were combined and homogenized by mixing in a stainless steel bowl, passing this through the grinder once more, then homogenized a final time.
- At least 90 grams of the composite sample was put into a pre-cleaned, 4-oz, I-Chem series 200 or 300 jar.
- For duplicate samples, a second jar was filled in the manner above, assigned a different sample ID, and submitted to the lab as a "blind" field duplicate. This processing split sample was termed a "field" duplicate in order to distinguish it from a "lab" duplicate – which is a split of the sample from one jar at the time of lab analysis.
- Sample jars were identified with a sample ID code and pre-assigned a lab sample number; extra tissue was archived.
- Sample jars ready for analysis were returned to the freezer until transported to the laboratory.

After fillets were removed from the fish, scales and otoliths were removed for determining the age of individual fish. Scales were mounted on acetate scale cards provided by WDFW biologists while otoliths were stored in plastic trays designed for such work. All aging structures were identified, packaged according to WDFW directions, and then sent to WDFW staff in Olympia. WDFW later reported the age of individual fish on a spreadsheet or on the returned scale cards. The gender of each fish was determined by opening the abdominal cavity and identifying gonads as testes or ovary.

Water Samples

Water samples for organic contaminant analyses were a composite sample from aliquots collected from three points along a transect in streams. At each quarter-transect point, a US DH-81 rod-mounted sampler with a pre-cleaned, one-liter jar was lowered slowly from the water surface and back to the surface multiple times until filled. The collected sample was then transferred to a pre-cleaned, one-gallon I-Chem jar (Series 200 or 300), and the process was repeated at each transect point until the gallon jar was filled using approximately 1/3 gallon from each quarter-transect point. Samples for total suspended solids (TSS) and total organic carbon (TOC) were collected similarly. Filled sample containers were placed on ice and delivered to the laboratory within 24 to 72 hours.

After water samples were collected, temperature, pH, and conductivity were measured in-situ, and streamflow was measured. Temperature and pH were measured with a handheld Orion Model 250A portable pH meter with a Model 9107 low maintenance triode electrode. Conductivity was measured with a Beckman RB-5 portable conductivity meter. Streamflow was determined by measuring depth with a top-set wading rod and measuring velocity with a March-McBirney Model 201 Flowmeter at more than ten points across the stream. Streamflow at the 102nd Street site culvert was determined with either a bucket and stopwatch method, or by measuring velocity and depth at three points along the cross-section at least two feet upstream of the culvert's discharge lip. All instruments were calibrated and operated according to the manufacturer's instructions.

Field duplicate samples and measurements were collected by repeating the entire sample collection and measurement processes described above. Duplicate field samples were assigned a different sample ID and submitted to the lab as a "blind" field duplicate.

Decontamination Procedures

All utensils used for processing tissue samples were cleaned to prevent contamination of the sample. Utensils include bowls, knives, and tissue grinding appliances having plastic and stainless steel parts. Equipment contacting water samples during collection included glass jars and Teflon nozzles. All utensils for fish tissue and water sampling were cleaned using the following procedure:

- Soap (Liquinox) and hot water wash.
- Tap water rinse.
- 10% nitric acid rinse (omitted for water sampling devices).
- Deionized water rinse (omitted for water sampling devices).
- Solvent rinses with pesticide-grade acetone followed by hexane and/or methanol.
- Utensils air-dried and then packaged in aluminum foil and plastic bags to prevent contamination.

The live well on the electrofishing boat, used to temporarily store fish when captured, was rinsed and scrubbed with ambient water prior to collecting and holding fish. The live well and retrieval nets were cleaned several times during the collection season at Ecology's Lacey facilities using a general boat washing soap followed by thorough rinsing with tap water.

Field Records

Information about each sampling event was recorded in field notebooks. Notes included:

- Date and time.
- Sampling personnel.
- General sampling location.
- Latitude/longitude coordinates of sample site sometimes taken using a Magellan Model 320 Handheld GPS.
- General weather conditions.
- Method of sampling.
- Fish species collected.
- Weights and lengths for individual fish specimens.
- Results from field measurements such as temperature, pH, conductivity, and streamflow data.

Additional information was recorded at the time fish tissue samples were processed and submitted for laboratory analysis:

- Fish identification number.
- Preassigned laboratory sample number.
- Date of resection.
- Types of aging structures retained and their identification data.
- Sex of specimen.
- Which fillet(s) removed.
- Weight of fillet before grinding.
- Weight of sample transferred to sample jar.
- Whether an archive sample was retained and stored at Ecology’s Lacey facility.
- Other observations or notes about processing the sample.

Appendix C

Data Quality Assessment

Data Quality for Fish Tissue Sample Results

Lipids

The precision estimates for most field and laboratory duplicate samples for lipids analyzed by Ecology's Manchester Environmental Laboratory (MEL) met measurement quality objectives described in the project plan as well as objectives set by MEL (Donegan, 2003). Inter-laboratory precision was estimated using results from MEL and Pace Analytical, Inc. Precision estimates for these results were good and ranged from less than 2% to 51% relative standard deviation (RSD). The poor precision of duplicate results were likely the result of poor homogenization and/or low lipids values. Table C1 shows results from duplicate samples with precision expressed in terms of RSD and as relative percent difference (RPD).

Pesticides/PCBs/PBDEs

Quality control and quality assurance data from laboratories were reviewed, and indicated that analytical systems performance was adequate with most data meeting objectives for quality control. Some data were qualified due to challenges encountered in analyses of the samples, and all results were useable as qualified. Quality control procedures included analysis of method blanks, calibration standards, control standards, matrix spikes, matrix spike duplicates, surrogate spikes, laboratory duplicates, and field duplicates. Holding times for all analyses were met.

The case narrative for the pesticide and PCB analyses describes in detail which samples were affected by problems with poor recovery performance for some calibration standards, control standards, surrogates, and matrix spikes (Mandjikov, 2004). Some PCB Aroclors detected in the samples were described as weathered because of poor matching to reference standards; these results were qualified as estimated values (NJ). Unfortunately, the reporting limit for PCBs in 14 of 24 tissue samples was too high to allow comparison of water quality criteria to PCB results. Some reporting limits ranged from 9-10 ppb ww, whereas other reporting limits ranged from 2-3 ppb ww.

Table C-1. Intra- and Inter-laboratory Duplicate Results for Lipids in Fish Tissue, WSTMP 2003.

Intra-laboratory duplicate sample results									
Site	Species	MEL sample ID (40-)	MEL sample result (% lipids)	Field dup result (% lipids)	Lab dup result (% lipids)	RSD For field dup	RSD for lab dup	RPD for field dup	RPD for lab dup
Roses	LMB	64292	1.70	1.89 [1]	1.50 [1]	7%	16%	11%	23%
Scooteney	WAL	64294	1.48	1.45 [4]	-	1%	-	2%	-
Sprague	CC	64299	13.01	11.19 [2]	10.91 [2]	11%	2%	15%	3%
Sprague [5]	CC	64299	13.3	13.2 [3]	11.8 [3]	1%	8%	1%	11%

Inter-laboratory duplicate sample results (MEL and Pace Analytical, Inc.)						
Site	Species	MEL sample ID (40-)	MEL sample result (% lipids)	Pace result (% lipids)	RSD for inter-lab results	RPD for inter-lab results
Banks	LWF	64283	6.60	6.4	2%	3%
Banks	RBT	64284	2.58	2.2	11%	16%
Curlew	RBT	64288	2.33	2.4	2%	3%
Lacamas	LMB	64289	1.13	0.7	33%	47%
Lacamas	BT	64290	1.70	0.8	51%	72%
Scooteney	CC	64293	7.53	7.9	3%	5%
Silver	BT	64296	2.16	1.9	9%	13%
Sprague	CC	64299	13.01	13.3	2%	2%
Sprague	RBT	64301	1.81	1.9	3%	5%
Sprague	WAL	64303	1.24	1.0	15%	21%

MEL - Manchester Environmental Laboratory
RSD - relative standard deviation
RPD - relative percent difference
dup - duplicate

BT - Brown trout (Salmo trutta)
CC - Channel catfish (Ictalurus punctatus)
LMB - Largemouth bass (Micropterus salmoides)
LWF - Lake whitefish (Coregonus clupeaformis)
RBT - Rainbow trout (Oncorhynchus mykiss)
WAL - Walleye (Stizostedion vitreum)

1. - MEL sample ID 4064281
2. - MEL sample ID 4064280
3. - MEL sample ID 4064280
4. - MEL sample ID 4064282
5. - Analyzed by Pace Analytical Inc.

Matrix spike recoveries of most analytes were within limits for two different samples (Tables C2a and C2b). For analytes where recoveries exceeded limits, results were qualified as estimated values (J, NJ, or UJ). Results from the matrix spike duplicates showed good precision with RSDs ranging from 0% to 40%, with a mean RSD of 9%.

Table C-2a. Matrix Spike and Spike Duplicate Results for Pesticides, PCBs, and PBDEs in Fish Tissue, WSTMP 2003: MEL Sample ID 4064296, Silver Lake Brown trout.

Analyte	Matrix Spike 1 (% recovery)	Matrix Spike 2 (% recovery)	RSD of recovery	RPD of recovery
Chlorinated Pesticides				
2,4'-DDD	74	67	7%	10%
2,4'-DDE	66	59	8%	11%
2,4'-DDT	60	56	5%	7%
4,4'-DDD	81	61	20%	28%
4,4'-DDE	66	66	0%	0%
4,4'-DDT	56	48	11%	15%
Aldrin	30	36	13%	18%
Alpha-BHC	50	45	7%	11%
Beta-BHC	75	68	7%	10%
Chlorpyriphos	35	39	8%	11%
Cis-Chlordane (Alpha-Chlordane)	65	57	9%	13%
Cis-Nonachlor	70	62	9%	12%
Dacthal (DCPA)	43	69	33%	46%
Delta-BHC	13	11	12%	17%
Dieldrin	67	70	3%	4%
Endosulfan I	45	51	9%	13%
Endosulfan II	76	77	1%	1%
Endosulfan Sulfate	33	33	0%	0%
Endrin	52	57	6%	9%
Endrin Aldehyde	13	13	0%	0%
Endrin Ketone	65	69	4%	6%
Heptachlor	9	16	40%	56%
Heptachlor Epoxide	68	64	4%	6%
Hexachlorobenzene	30	29	2%	3%
Lindane	65	59	7%	10%
Methoxychlor	86	82	3%	5%
Mirex	80	92	10%	14%
Oxychlordane	60	52	10%	14%
Pentachloroanisole	42	39	5%	7%
Trans-Chlordane (Gamma)	68	53	18%	25%
Trans-Nonachlor	62	56	7%	10%
Toxaphene	36	27	20%	29%
mean value	54	53	9%	13%
PCBs				
PCB-1016	75	82	6%	9%
PCB-1260	67	83	15%	21%
mean value	71	83	11%	15%

Analyte	Matrix Spike 1 (% recovery)	Matrix Spike 2 (% recovery)	RSD of recovery	RPD of recovery
PBDEs				
PBDE- 47 (2,2',4,4'-tetraBDE)	67	49	22%	31%
PBDE-99 (2,2',4,4',5-pentaBDE)	69	45	30%	42%
PBDE-100 (2,2',4,4',6-pentaBDE)	67	47	25%	35%
PBDE-153 (2,2',4,4',5,5'-hexaBDE)	59	45	19%	27%
PBDE-154 (2,2',4,4',5,6'-hexaBDE)	57	43	20%	28%
mean value	64	46	23%	33%

Table C-2b. Matrix Spike and Spike Duplicate Results for Pesticides, PCBs, and PBDEs in Fish Tissue, WSTMP 2003: MEL Sample ID 4064300, Sprague Lake Largemouth bass.

Analyte	Matrix Spike 1 (% recovery)	Matrix Spike 2 (% recovery)	RSD of recovery	RPD of recovery
Chlorinated Pesticides				
4,4'-DDD	74	72	2%	3%
4,4'-DDE	73	71	2%	3%
4,4'-DDT	60	59	1%	2%
mean value	69	67	2%	2%
PCBs				
PCB-1260	66	72	6%	9%
mean value	66	72	6%	9%

Most results from duplicate analyses met precision criteria defined by MEL and the project plan. Laboratory precision, expressed as the RPD, met MEL’s criteria of being less than 20%. The field duplicate for tissue was a split of the field-processed tissue of the composite sample and not an entirely different group of fish collected from the same location. Eighty-five percent of results from the field duplicate sample met the project plan’s target of 28% RSD for the compounds that were detected. Two of the three RSDs exceeding 28% were artificially high due to low levels of analyte detected. The RSD of 38% for 4,4’-DDD may have resulted from poor homogenization of tissue, or simply reflect sample processing and analytical variation. Tables C3a-C3c show results for laboratory and field duplicate analyses for pesticides, PCBs, PBDEs, and mercury.

Results from analysis of Standard Reference Material (SRM) 1946 (Lake Superior Fish Tissue) for 14 chlorinated pesticides showed that the lab met the Measurement Quality Objective for Accuracy as described in the project plan. Analysis of the SRM obtained results that ranged from 25% to 118% of the mean value of the SRM (Table C4).

Table C-3a. Duplicate Analyses Results for Mercury, Pesticides, PCBs, and PBDEs in Fish Tissue, WSTMP 2003.

Analyte	Sample 4064294 result ug/kg ww)		Field dup 4064282 result (ug/kg ww)		RSD of field dup	RPD of field dup	Lab dup 4064282 result (ug/kg ww)		RSD of lab dup	RPD of lab dup
Mercury	119		114	J	3%	4%	122	J	5%	7%
Chlorinated Pesticides										
2,4'-DDD	0.98	U	1.0	U						
2,4'-DDE	0.98	U	1.0	U						
2,4'-DDT	0.21	NJ	1.0	U						
4,4'-DDD	2.4		3.0		16%	22%				
4,4'-DDE	15		26		38%	54%				
4,4'-DDT	1.5	J	1.8	J	13%	18%				
Aldrin	0.98	UJ	1.0	UJ						
Alpha-BHC	0.98	UJ	1.0	UJ						
Beta-BHC	0.98	U	1.0	U						
Chlorpyriphos	1.5	J	2.6	J	38%	54%				
Cis-Chlordane (Alpha-Chlordane)	0.98	U	0.26	NJ						
Cis-Nonachlor	0.25	J	0.33	J	20%	28%				
Dacthal (DCPA)	0.98	UJ	1.0	UJ						
DDMU	1.1	UJ	1.2	J						
Delta-BHC	0.98	UJ	1.0	UJ						
Dieldrin	2.3		2.9		16%	23%				
Endosulfan I	0.98	UJ	1.0	UJ						
Endosulfan II	0.98	U	1.0	U						
Endosulfan Sulfate	1.4	J	1.4	J	0%	0%				
Endrin	0.98	U	1.0	U						
Endrin Aldehyde	0.98	UJ	1.0	UJ						
Endrin Ketone	0.98	UJ	1.0	U						
Heptachlor	0.98	U	1.0	U						
Heptachlor Epoxide	0.98	U	1.0	U						
Hexachlorobenzene	0.98	UJ	0.42	J						
Lindane	0.98	U	1.0	U						
Methoxychlor	0.98	U	1.0	U						
Mirex	0.98	U	1.0	U						
Oxychlordane	0.98	U	1.0	U						
Pentachloroanisole	0.98	UJ	1.0	UJ						
Toxaphene	9.8	UJ	9.9	UJ						
Trans-Chlordane (Gamma)	0.98	U	1.0	U						
Trans-Nonachlor	0.41	J	0.70	NJ	37%	52%				
PCBs										
PCB-1016	9.8	U	9.9	U						
PCB-1221	9.8	U	9.9	U						

Analyte	Sample 4064294 result ug/kg ww)	Field dup 4064282 result (ug/kg ww)	RSD of field dup	RPD of field dup	Lab dup 4064282 result (ug/kg ww)	RSD of lab dup	RPD of lab dup
PCB-1232	9.8 U	9.9 U					
PCB-1242	9.8 U	9.9 U					
PCB-1248	9.8 U	9.9 U					
PCB-1254	9.8 U	2.4 NJ					
PCB-1260	9.8 U	2.1 J					
PCB-1262	9.8 U	9.9 U					
PCB-1268	9.8 U	9.9 U					
PBDEs							
PBDE-47 (2,2',4,4'-tetraBDE)	0.98 UJ	1.0 UJ					
PBDE-99 (2,2',4,4',5-pentaBDE)	0.98 UJ	1.0 UJ					
PBDE-100 (2,2',4,4',6-pentaBDE)	0.98 UJ	1.0 UJ					
PBDE-153 (2,2',4,4',5,5'-hexaBDE)	0.98 UJ	1.0 UJ					
PBDE-154 (2,2',4,4',5,6'-hexaBDE)	0.98 UJ	1.0 UJ					

U - The analyte was not detected at or above the reported result.
UJ - The analyte was not detected at or above the reported estimated result.

Table C-3b. Duplicate Analyses Results for Mercury, Pesticides, PCBs, and PBDEs in Fish Tissue, WSTMP 2003.

Analyte	Sample 4064292 result (ug/kg ww)	Field dup 4064281 result (ug/kg ww)	RSD of field dup	RPD of field dup	Lab dup 4064281 result (ug/kg ww)	RSD of lab dup	RPD of lab dup
Mercury	100 J	113 J	9%	12%	89.0 J	17%	24%
Chlorinated Pesticides							
4,4'-DDD	26	25	3%	4%	25	0%	0%
4,4'-DDE	97	92	4%	5%	90	2%	2%
4,4'-DDT	3.2	3.0	5%	6%	2.7	7%	11%
PCBs							
PCB-1248	9.9 U	10 U			9.7 U		
PCB-1254	9.9 U	10 U			9.7 U		
PCB-1260	9.9 U	10 U			9.7 U		

Duplicate analyses for MEL Sample IDs 4064292 and 4064281, Roses Lake Largemouth bass.
U - The analyte was not detected at or above the reported result.
J - The analyte was positively identified. The associated numerical result is an estimate.

Table C-3c. Duplicate Analyses Results for Mercury, Pesticides, PCBs, and PBDEs in Fish Tissue, WSTMP 2003.

Analyte	Sample 4064299 result (ug/kg ww)	Field dup 4064280 Result (ug/kg ww)	RSD of field dup	RPD of field dup	Lab dup 4064281 result (ug/kg ww)	RSD of lab dup	RPD of lab dup
Mercury	19	18	4%	5%			
Chlorinated Pesticides							
2,4'-DDD	0.93 U	0.88 U			0.96 U		
2,4'-DDE	0.93 U	0.88 U			0.96 U		
2,4'-DDT	0.93 U	0.88 U			0.96 U		
4,4'-DDD	0.82 J	0.81 NJ	1%	1%	0.86 J	4%	6%
4,4'-DDE	9.9	11	7%	11%	8.4	19%	27%
4,4'-DDT	0.93 UJ	0.88 UJ			0.96 UJ		
Aldrin	0.93 UJ	0.88 UJ			0.96 UJ		
Alpha-BHC	0.93 UJ	0.88 UJ			0.96 UJ		
Beta-BHC	0.93 U	0.88 U			0.96 U		
Chlorpyriphos	0.93 UJ	0.88 UJ			0.96 UJ		
Cis-Chlordane (Alpha-Chlordane)	0.22 NJ	0.20 NJ	7%	10%	0.23 NJ	10%	14%
Cis-Nonachlor	0.93 U	0.88 U			0.96 U		
Dacthal (DCPA)	0.93 UJ	0.88 UJ			0.96 UJ		
DDMU	1.1 UJ	1.2 UJ			1.1 UJ		
Delta-BHC	3.2 UJ	0.88 UJ			0.96 UJ		
Dieldrin	0.93 U	0.88 U			0.96 U		
Endosulfan I	0.93 UJ	0.88 UJ			0.96 UJ		
Endosulfan II	0.93 U	0.88 U			0.96 U		
Endosulfan Sulfate	0.93 UJ	0.88 UJ			0.96 U		
Endrin	0.93 U	0.88 U			0.96 U		
Endrin Aldehyde	0.93 UJ	0.88 UJ			0.96 UJ		
Endrin Ketone	0.93 UJ	0.88 U			0.96 U		
Heptachlor	0.93 U	0.88 U			0.96 U		
Heptachlor Epoxide	0.23 J	0.25 NJ	6%	8%	0.96 U		
Hexachlorobenzene	0.90 J	1.1 J	14%	20%	0.94 J	11%	16%
Lindane	0.93 U	0.88 U			0.96 U		
Methoxychlor	0.93 U	0.88 U			0.96 U		
Mirex	0.93 U	0.88 U			0.96 U		
Oxychlordane	0.93 U	0.88 U			0.96 U		
Pentachloroanisole	0.93 UJ	0.88 UJ			0.96 UJ		
Toxaphene	9.3 UJ	8.8 UJ			9.6 UJ		
Trans-Chlordane (Gamma)	0.24 NJ	0.25 J	3%	4%	0.34 J	22%	31%
Trans-Nonachlor	0.45 NJ	0.46 J	2%	2%	0.31 NJ	28%	39%

Analyte	Sample 4064299 result (ug/kg ww)		Field dup 4064280 Result (ug/kg ww)		RSD of field dup	RPD of field dup	Lab dup 4064281 result (ug/kg ww)		RSD of lab dup	RPD of lab dup
PCBs										
PCB-1016	9.3	U	8.8	U			9.6	U		
PCB-1221	9.3	U	8.8	U			9.6	U		
PCB-1232	9.3	U	8.8	U			9.6	U		
PCB-1242	9.3	U	8.8	U			9.6	U		
PCB-1248	9.3	U	8.8	U			9.6	U		
PCB-1254	3.9	J	3.2	NJ	14%	20%	1.9	NJ	36%	51%
PCB-1260	8.2	J	8.9		6%	8%	7.1	J	16%	23%
PCB-1262	9.3	U	8.8	U			9.6	U		
PCB-1268	9.3	U	8.8	U			9.6	U		
PBDEs										
PBDE-47 (2,2',4,4'-tetraBDE)	0.93	UJ	0.88	UJ			0.96	U		
PBDE-99 (2,2',4,4',5-pentaBDE)	0.19	J	0.88	UJ			0.96	UJ		
PBDE-100 (2,2',4,4',6-pentaBDE)	0.93	UJ	0.88	UJ			0.96	UJ		
PBDE-153 (2,2',4,4',5,5'-hexaBDE)	0.93	UJ	0.88	UJ			0.96	UJ		
PBDE-154 (2,2',4,4',5,6'-hexaBDE)	0.93	UJ	0.88	UJ			0.96	UJ		

Duplicate analyses for MEL Sample IDs 4064299 and 4064280, Sprague Lake Channel catfish.
U - The analyte was not detected at or above the reported result.
UJ - The analyte was not detected at or above the reported estimated result.
NJ - There is evidence that the analyte is present. The associated numerical result is an estimate.
J - The analyte was positively identified. The associated numerical result is an estimate.

Table C-4. Results from Analysis of Standard Reference Material 1946 by MEL, WSTMP 2003.

Analyte	SRM Certified Value	Approx 95% CI (+/-) of SRM as Value	Approx 95% CI (+/-) of SRM as Percent	Lab Result 1		Result 1 as % of SRM Value	Lab Result 2	Result 2 as % of SRM Value
4,4'-DDE	373	48	13%	190		51%	320	86%
4,4'-DDD	17.7	2.8	16%	11		62%	14	79%
4,4'-DDT	37.2	3.5	9%	31	J	83%	44	118%
2,4'-DDD	2.20	0.25	11%	6.6	UJ	n/a		
cis-Chlordane	32.5	1.8	6%	17	NJ	52%		
cis-Nonachlor	59.1	3.6	6%	38		64%		
Dieldrin	32.5	3.5	11%	17		52%		
Heptachlor Epoxide	5.50	0.23	4%	4.6		84%		
Hexachlorobenzene	7.25	0.83	11%	1.8	J	25%		
Oxychlordane	18.9	1.5	8%	10		53%		
trans-Chlordane	8.36	0.91	11%	6.3	J	75%		
trans-Nonachlor	99.6	7.6	8%	78		78%		
2,4'-DDE	1.04	0.29	28%	8.9	UJ	n/a		
2,4'-DDT	22.3	3.2	14%	20	NJ	90%		
Mean Recovery						64%		94%

MEL – Manchester Environmental Laboratory
CI – confidence interval
All values reported as ug/kg wet weight (ppb).

U - The analyte was not detected at or above the reported result.
UJ - The analyte was not detected at or above the reported estimated result.
NJ - There is evidence that the analyte is present. The associated numerical result is an estimate.

Mercury

Results from quality control and quality assurance practices for fish tissue samples indicate that the analytical system performed adequately with data meeting objectives for quality control. Quality control procedures included analysis of method blanks, control standards, matrix spikes, matrix spike duplicates, and field duplicates. Results from the analyses of blanks, standards, matrix spikes, and matrix spike duplicates met all acceptance criteria established by MEL. The precision of lab duplicate analyses, expressed as RPD, were 7% and 24%. While the high value exceeded lab limits of 20% RPD, no action was taken because all other quality control results were within limits (Momohara, 2004). The precision of field duplicate analyses was good with RSDs of 3% to 9% (Tables C3a-C3c).

Tissue samples were analyzed within three to seven months of collection. Four results were qualified as estimates because analysis took place after the six-month holding time established by MEL (Momohara, 2004). Bloom (1995) states that biota samples for mercury analysis may be stored indefinitely when frozen. The USGS's NAWQA program uses six months as a holding time (Crawford and Luoma, 1993). Ecology's 28-day holding time appears to be based on water and sediment matrices, and may be overly conservative for fish tissue kept frozen at -20°C.

PCDD/Fs

The analytical report and data generated by Pace Analytical Incorporated, of Minneapolis, Minnesota, were reviewed by MEL and then forwarded as part of the case narrative to the project manager (Feddersen, 2004). The data review included examination of holding times, blank results, calibration, internal standard recoveries, ion abundance ratios, and precision and recovery limits. Quality controls indicated the analytical system performed well with few data needing qualification.

Some of Pace Analytical's data qualifiers were amended by MEL in order to remain consistent with MEL's reporting conventions (e.g., qualifiers used for estimated values or non-detects). Lab results for PCDD/Fs were reported as wet weight for fish tissue samples. Samples were prepared and analyzed according to EPA Method 1613b; the lipid content of each sample was also determined.

Results from laboratory and field duplicate samples are shown in Table C5. Three congeners were detected in the duplicate analyses of Sprague Lake catfish. The RSDs for field duplicate analyses met the precision target defined in the project plan (RSD less than or equal to 28%).

Table C-5. Duplicate Analyses Results for PCDD/F in Fish Tissue, WSTMP 2003.

Site & species: / MEL Lab ID: / Analyte	Sprague Lake CC (field dup) 4064299 (ppt ww)		Sprague Lake CC (field dup) 4064280 (ppt ww)		RSD for field dup	RPD for field dup	Sprague Lake CC (lab duplicate) 4064280 (ppt ww)		RSD for lab dup
2,3,7,8-TCDF	0.58	U	0.29	J			0.25	J	10%
2,3,7,8-TCDD	0.30	U	0.150	U			0.180	UJ	
1,2,3,7,8-PeCDF	0.34	U	0.150	U			0.230	U	
2,3,4,7,8-PeCDF	0.32	NJ	0.150	U			0.230	U	
1,2,3,7,8-PeCDD	0.19	U	0.180	U			0.230	U	
1,2,3,4,7,8-HxCDF	0.17	J	0.140	U			0.130	U	
1,2,3,6,7,8-HxCDF	0.14	U	0.130	U			0.140	U	
2,3,4,6,7,8-HxCDF	0.16	U	0.088	U			0.120	U	
1,2,3,7,8,9-HxCDF	0.22	U	0.15	NJ			0.18	NJ	13%
1,2,3,4,7,8-HxCDD	0.20	U	0.10	J			0.110	U	
1,2,3,6,7,8-HxCDD	0.26	J	0.13	NJ	47%	67%	0.17	NJ	19%
1,2,3,7,8,9-HxCDD	0.20	U	0.096	U			0.100	U	
1,2,3,4,6,7,8-HpCDF	0.23	UJ	0.099	U			0.081	U	
1,2,3,4,7,8,9-HpCDF	0.22	U	0.110	U			0.100	U	
1,2,3,4,6,7,8-HpCDD	0.43	UJ	0.28	UJ			0.35	UJ	
1,2,3,4,6,7,8,9-OCDF	0.34	UJ	0.073	U			0.14	UJ	
1,2,3,4,6,7,8,9-OCDD	0.68	UJ	0.55	UJ			0.62	UJ	

CC – channel catfish
RSD – relative standard deviation
RPD – relative percent difference
dup – duplicate
ppt ww - part per trillion wet weight; PCDD/Fs as 2,3,7,8-TCDD toxic equivalent (TEQ)

UJ - The analyte was not detected at or above the reported estimated result.
NJ - There is evidence that the analyte is present. The associated numerical result is an estimate.
J - The analyte was positively identified. The associated numerical value is an estimate.

Data Quality for Water Sample Results

Results from quality control practices for water samples indicate that the analytical system performed adequately in most cases and that data are useable as qualified. Quality control procedures included analysis of method blanks, matrix spikes, surrogate recoveries, and field duplicates. Laboratory duplicate analyses were performed only for total suspended solids. Measurement quality objectives described in the project plan were met in most cases.

Case narratives for organic compounds for each batch of samples described analytical performance and reasons for qualifying some sample results as estimates (Perez, 2003). Holding times for all analyses were met. No target analytes were found in blank samples. MEL noted some problems with calibration, surrogate recoveries, and matrix spike recoveries that resulted in several results to be qualified as estimated values while other results were rejected. Results for dicofol, methoxychlor, 2,4'-DDE, and 2,4'-DDT sampled in late May 2003 from all sites were rejected because of unacceptable calibration. Results for nitrogen-containing pesticides in a field duplicate sampled August 6, 2003 from Burnt Bridge Creek (Lab ID 03324610) were rejected because of unacceptable surrogate recoveries.

Results from matrix spikes and spike duplicates for organic compounds (Table C7) indicate good precision with an average RSD of 9% and 12% for nitrogen and organophosphorous compounds, respectively. Results from the field duplicate samples are inconclusive: results for many of the field duplicate analytes were rejected as described above, and other analytes were not detected (Table C8).

Case narratives for conventional parameters indicated that the analytical system performed adequately (Momohara, 2003). Precision for field and laboratory duplicates was good (Table C6).

Table C-6. Field and Lab Duplicate Results for Water Sample Conventional Parameters, WSTMP 2003.

MEL Sample ID	Sample result (mg/L)	Lab dup result (mg/L)	Field dup result (mg/L) [1]	RSD		RPD		Site
				lab dup	field dup	lab dup	field dup	
Total Organic Carbon (TOC)								
3324600	2.8	-	2.7	-	3%	-	4%	Burnt Bridge Creek
Total Suspended Solids (TSS)								
3324600	2	-	2	-	0%	-	0%	Burnt Bridge Creek
3224600	9	9	-	0%	-	0%	-	Burnt Bridge Creek
3274611	9	9	-	0%	-	0%	-	Crab Creek 3
3324611	8	9	-	8%	-	12%	-	Crab Creek 3
3224607	111	127	-	10%	-	13%	-	Crab Creek 2

1 - Field dup was MEL sample ID 3324610

Table C-7. Matrix Spike and Spike Duplicate Results for Pesticides in Water, WSTMP 2003.

Analyte	Matrix Spike 1 (% recovery)	Matrix Spike 2 (% recovery)	RSD	RPD
Nitrogen Compounds				
Ametryn	32	24	20%	29%
Benefin	93	44	51%	72%
Butylate	76	79	3%	4%
Chlorothalonil (Daconil)	55	56	1%	2%
Chlorpropham	80	84	3%	5%
Cyanazine	4	-	-	-
Cycloate	63	61	2%	3%
Eptam	115	93	15%	21%
Hexazinone	4	4	0%	0%
Molinate	61	60	1%	2%
Pebulate	115	120	3%	4%
Prometon (Pramitol 5p)	41	28	27%	38%
Propargite	78	85	6%	9%
Propazine	69	63	6%	9%
Terbutryn (Igran)	19	19	0%	0%
Triallate	75	73	2%	3%
Vernolate	80	85	4%	6%
mean value	62	61	9%	13%
Organophosphorus Compounds				
Azinphos Ethyl	88	95	5%	8%
Carbophenothion	107	107	0%	0%
Chlorpyriphos	95	107	8%	12%
Demeton-O	77	84	6%	9%
Demeton-S	6	6	0%	0%
Disulfoton (Di-Syston)	102	111	6%	8%
EPN	76	83	6%	9%
Ethion	100	111	7%	10%
Fenitrothion	77	88	9%	13%
Fonofos	96	107	8%	11%
Malathion	105	117	8%	11%
Merphos (1 & 2)	87	98	8%	12%
Methyl Chlorpyrifos	7	39	98%	139%
Sulfotepp	91	96	4%	5%
mean value	80	89	12%	18%

Matrix spike done on MEL Sample ID 03324600, Burnt Bridge Creek site.

Table C-8. Field Duplicate Results for Pesticides in Water Samples, WSTMP 2003.

Analyte	Result 3324600 (ug/L)		Result 3324610 (ug/L)		RSD	RPD	Analyte	Result 3324600 (ug/L)		Result 3324610 (ug/L)		RSD
2,4'-DDD	0.082	U	0.79	UJ	-	-	Fluridone	0.20	UJ	0.19	REJ	-
2,4'-DDE	0.082	U	0.79	UJ	-	-	Fonofos	0.020	U	0.019	U	-
2,4'-DDT	0.082	U	0.79	UJ	-	-	Heptachlor	0.082	U	0.079	UJ	-
4,4'-DDD	0.082	U	0.079	UJ	-	-	Heptachlor Epoxide	0.082	U	0.079	UJ	-
4,4'-DDE	0.082	U	0.079	UJ	-	-	Hexachlorobenzene	0.82	U	0.79	UJ	-
4,4'-DDT	0.082	U	0.079	UJ	-	-	Hexazinone	0.049	UJ	0.048	REJ	-
Alachlor	0.12	U	0.11	REJ	-	-	Imidan	0.036	U	0.035	U	-
Aldrin	0.082	U	0.079	UJ	-	-	Kelthane	0.33	U	3.2	UJ	-
Alpha-BHC	0.082	U	0.079	UJ	-	-	Lindane	0.082	U	0.079	UJ	-
Ametryn	0.033	UJ	0.032	REJ	-	-	Malathion	0.026	U	0.025	U	-
Atraton	0.049	U	0.048	REJ	-	-	Merphos (1 & 2)	0.039	U	0.038	U	-
Atrazine	0.033	U	0.032	REJ	-	-	Metalaxyl	0.20	U	0.19	REJ	-
Azinphos (Guthion)	0.052	U	0.051	U	-	-	Methoxychlor	0.082	U	0.79	UJ	-
Azinphos Ethyl	0.052	U	0.051	U	-	-	Methyl Chlorpyrifos	0.026	UJ	0.025	UJ	-
Benefin	0.049	U	0.048	REJ	-	-	Methyl Parathion	0.023	U	0.022	U	-
Beta-BHC	0.082	U	0.079	UJ	-	-	Metolachlor	0.13	U	0.13	REJ	-
Bolstar (Sulprofos)	0.023	U	0.022	U	-	-	Metribuzin	0.033	U	0.032	REJ	-
Bromacil	0.016	J	0.13	REJ	-	-	MGK264	0.26	U	0.25	REJ	-
Butachlor	0.20	U	0.19	REJ	-	-	Mirex	0.082	U	0.79	UJ	-
Butylate	0.066	U	0.063	REJ	-	-	Molinate	0.066	U	0.063	REJ	-
Captafol	0.41	U	4.0	UJ	-	-	Napropamide	0.098	U	0.095	REJ	-
Captan	0.22	U	2.1	UJ	-	-	Norflurazon	0.066	UJ	0.063	REJ	-
Carbophenothion	0.033	U	0.032	U	-	-	Oxychlordane	0.082	U	0.79	UJ	-
Carboxin	0.20	U	0.19	REJ	-	-	Oxyfluorfen	0.13	UJ	0.13	REJ	-
Chlorothalonil (Daconil)	0.079	U	0.076	REJ	-	-	Parathion	0.026	U	0.025	U	-
Chlorpropham	0.13	U	0.13	REJ	-	-	Pebulate	0.066	U	0.063	REJ	-
Chlorpyriphos	0.026	U	0.025	U	-	-	Pendimethalin	0.049	U	0.048	REJ	-
Cis-Chlordane (Alpha-Chlordane)	0.082	U	0.079	UJ	-	-	Pentachloroanisole	0.82	U	0.79	UJ	-
Cis-Nonachlor	0.082	U	0.79	UJ	-	-	Phorate	0.023	U	0.022	U	-
Cyanazine	0.049	UJ	0.048	REJ	-	-	Profluralin	0.079	U	0.076	REJ	-
Cycloate	0.066	U	0.063	REJ	-	-	Prometon (Pramitol 5p)	0.033	U	0.032	REJ	-

Analyte	Result 3324600 (ug/L)		Result 3324610 (ug/L)		RSD	RPD	Analyte	Result 3324600 (ug/L)		Result 3324610 (ug/L)		RSD
Delta-BHC	0.082	U	0.079	UJ	-	-	Prometryn	0.033	U	0.032	REJ	-
Demeton-O	0.023	U	0.022	U	-	-	Pronamide (Kerb)	0.13	U	0.13	REJ	-
Demeton-S	0.023	UJ	0.022	UJ	-	-	Propachlor (Ramrod)	0.079	U	0.076	REJ	-
Di-allate (Avadex)	0.23	U	0.22	REJ	-	-	Propargite	0.066	U	0.063	REJ	-
Diazinon	0.026	U	0.025	U	-	-	Propazine	0.033	U	0.032	REJ	-
Dichlobenil	0.013	J	0.063	REJ	-	-	Ronnel	0.023	U	0.022	U	-
Dieldrin	0.082	U	0.079	UJ	-	-	Simazine	0.033	U	0.032	REJ	-
Dimethoate	0.026	UJ	0.025	UJ	-	-	Sulfotepp	0.020	U	0.019	U	-
Diphenamid	0.098	U	0.095	REJ	-	-	Tebuthiuron	0.049	U	0.048	REJ	-
Disulfoton (Di-Syston)	0.020	U	0.019	U	-	-	Terbacil	0.098	U	0.095	REJ	-
Diuron	0.20	U	0.19	REJ	-	-	Terbutryn (Igran)	0.033	UJ	0.032	REJ	-
Endosulfan I	0.082	U	0.079	UJ	-	-	Trans-Chlordane (Gamma)	0.082	U	0.079	UJ	-
Endosulfan II	0.082	U	0.079	UJ	-	-	Trans-Nonachlor	0.082	U	0.79	UJ	-
Endosulfan Sulfate	0.082	U	0.079	UJ	-	-	Treflan (Trifluralin)	0.049	U	0.048	REJ	-
Endrin	0.082	U	0.079	UJ	-	-	Triadimefon	0.085	U	0.083	REJ	-
Endrin Aldehyde	0.082	U	0.079	UJ	-	-	Triallate	0.098	U	0.095	REJ	-
Endrin Ketone	0.082	U	0.079	UJ	-	-	Vernolate	0.066	U	0.063	REJ	-
EPN	0.033	U	0.032	U	-	-						
Eptam	0.066	U	0.063	REJ	-	-						
Ethalfluralin (Sonalan)	0.049	U	0.048	REJ	-	-						
Ethion	0.023	U	0.022	U	-	-						
Ethoprop	0.026	U	0.025	U	-	-						
Fenamiphos	0.049	UJ	0.048	U	-	-						
Fenarimol	0.098	U	0.095	REJ	-	-						
Fenitrothion	0.023	U	0.022	U	-	-						
Fensulfothion	0.033	U	0.032	U	-	-						
Fenthion	0.023	U	0.022	U	-	-						

MEL Sample IDs 03324600 and 03324610 were from the Burnt Bridge Creek site.
J - The analyte was positively identified. The associated numerical value is an estimate.
U - The analyte was not detected at or above the reported result.
UJ - The analyte was not detected at or above the reported estimated result.
REJ - The data are unusable for all purposes.

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Appendix D

Fish and Tissue Sample Data

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Table D-1. Field Processing Information and Length, Weight, Sex, and Age Data for Fish Collected During the 2003 WSTMP.

Waterbody	Field ID (Ecy)	Species	Total Length (mm)	Weight (gm)	Collect Date	Process Date	Fillet Weight (gm)	Fillet Taken (L, R, or B)	Skin Status	Sex	Fish Age (yrs)	Mel Lab ID (40-)	Sample Weight	Collector
Banks Lake	1	LWF	500	1145	10/16/03	12/23/03	250	L	on	F	4	-	-	DFW
Banks Lake	2	LWF	515	1208	10/16/03	12/23/03	255	R	on	M	19	-	-	DFW
Banks Lake	3	LWF	510	1274	10/15/03	12/23/03	270	L	on	M	10	-	-	DFW
Banks Lake	4	LWF	503	1300	10/15/03	12/23/03	270	L	on	F	10	-	-	DFW
Banks Lake	5	LWF	473	882	10/15/03	12/23/03	204	L	on	M	10	-	-	DFW
Banks Lake	6	LWF	483	1091	10/15/03	12/23/03	255	L	on	M	6	-	-	DFW
Banks Lake	7	LWF	498	1044	10/15/03	12/23/03	200	L	on	M	19	-	-	DFW
Banks Lake	8	LWF	478	1038	10/16/03	12/23/03	200	R	on	M	4	-	-	DFW
Banks Lake	9	LWF	502	1061	10/16/03	12/23/03	210	L	on	M	16	-	-	DFW
Banks Lake	10	LWF	448	1030	10/16/03	12/23/03	190	L	on	F	2	-	-	DFW
Banks Lake	**BANKSLWF**	**LWF**	**491.0**	**1107.3**	**10/16/03**	-	**230.4**	-	-	-	**10.0**	**64283**	**159g/fish**	DFW
Banks Lake	1	RBT	421	775	10/16/03	12/31/03	150	L	on	-	2	-	-	DFW
Banks Lake	2	RBT	446	918	10/16/03	12/31/03	185	L	on	-	2	-	-	DFW
Banks Lake	3	RBT	360	488	10/13/03	12/31/03	110	L	on	-	1	-	-	DFW
Banks Lake	4	RBT	444	921	10/16/03	12/31/03	185	L	on	-	2	-	-	DFW
Banks Lake	5	RBT	507	1224	10/13/03	12/31/03	236	L	on	-	4	-	-	DFW
Banks Lake	6	RBT	455	1070	10/17/03	12/31/03	112	L	on	-	2	-	-	DFW
Banks Lake	7	RBT	457	946	10/16/03	12/31/03	165	L	on	-	2	-	-	DFW
Banks Lake	8	RBT	451	929	10/13/03	12/31/03	170	L	on	-	2	-	-	DFW
Banks Lake	9	RBT	452	980	10/16/03	12/31/03	160	L	on	-	2	-	-	DFW
Banks Lake	10	RBT	471	1022	10/16/03	12/31/03	170	L	on	-	2	-	-	DFW
Banks Lake	**BANKSRBT**	**RBT**	**446.4**	**927.3**	**10/16/03**	-	**164.3**	-	-	-	**2.1**	**64284**	**100g/fish**	DFW
Banks Lake	1	WAL	555	1315	10/15/03	1/8/04	269	L	on	-	5	-	-	DFW
Banks Lake	2	WAL	550	1601	10/15/03	1/8/04	352	L	on	-	4	-	-	DFW
Banks Lake	3	WAL	567	1941	10/15/03	1/8/04	366	L	on	-	5	-	-	DFW
Banks Lake	4	WAL	595	2355	10/15/03	1/8/04	487	R	on	-	5	-	-	DFW
Banks Lake	5	WAL	578	1705	10/15/03	1/8/04	336	L	on	-	5	-	-	DFW
Banks Lake	6	WAL	521	1450	10/15/03	1/8/04	292	L	on	-	5	-	-	DFW
Banks Lake	7	WAL	493	1044	10/15/03	1/8/04	227	L	on	-	5	-	-	DFW
Banks Lake	8	WAL	506	1281	10/15/03	1/8/04	277	L	on	-	5	-	-	DFW
Banks Lake	9	WAL	508	1335	10/15/03	1/8/04	287	R	on	-	4	-	-	DFW
Banks Lake	10	WAL	440	817	10/15/03	1/8/04	186	L	on	-	3	-	-	DFW
Banks Lake	**BANKSWAL**	**WAL**	**531.3**	**1484.4**	**10/15/03**	-	**307.9**	-	-	-	**4.6**	**64285**	**185g/fish**	DFW
Banks Lake	1	YP	242	195	10/15/03	12/24/03	70	B	on	F	2	-	-	DFW
Banks Lake	2	YP	239	164	10/15/03	12/24/03	60	B	on	-	2	-	-	DFW
Banks Lake	3	YP	245	174	10/15/03	12/24/03	68	B	on	F	2	-	-	DFW
Banks Lake	5	YP	245	209	10/15/03	12/24/03	71	B	on	F	2	-	-	DFW
Banks Lake	6	YP	251	197	10/15/03	12/24/03	72	B	on	-	2	-	-	DFW
Banks Lake	7	YP	312	420	10/15/03	12/24/03	155	B	on	-	6	-	-	DFW
Banks Lake	8	YP	250	186	10/15/03	12/24/03	68	B	on	F	2	-	-	DFW
Banks Lake	9	YP	282	319	10/15/03	12/24/03	110	B	on	-	5	-	-	DFW
Banks Lake	10	YP	262	225	10/15/03	12/24/03	72	B	on	-	3	-	-	DFW
Banks Lake	**BANKSYP**	**YP**	**258.7**	**232.1**	**10/15/03**	-	**82.9**	-	-	-	**2.9**	**64286**	**55g/fish**	DFW
Curlew Lake	1	LMB	266	281	7/15/03	12/30/03	52	L	on	F	4	-	-	DFW
Curlew Lake	3	LMB	289	390	7/16/03	12/30/03	77	L	on	M	5	-	-	DFW
Curlew Lake	4	LMB	265	275	7/16/03	12/30/03	53	L	on	M	5	-	-	DFW
Curlew Lake	5	LMB	270	327	7/16/03	12/30/03	66	L	on	M	5	-	-	DFW
Curlew Lake	6	LMB	255	246	7/16/03	12/30/03	48	L	on	F	4	-	-	DFW
Curlew Lake	7	LMB	257	254	7/16/03	12/30/03	52	L	on	F	4	-	-	DFW
Curlew Lake	8	LMB	254	238	7/16/03	12/30/03	49	L	on	F	4	-	-	DFW
Curlew Lake	9	LMB	268	297	7/16/03	12/30/03	61	L	on	F	4	-	-	DFW
Curlew Lake	**CURLLMB**	**LMB**	**265.5**	**288.5**	**7/16/03**	-	**57.3**	-	-	-	**4.4**	**64287**	**43g/fish**	DFW
Curlew Lake	1	RBT	278	264	7/16/03	9/23/03	66	L	on	M?	1	-	-	DFW
Curlew Lake	2	RBT	278	302	7/16/03	9/23/03	72	L	on	F	1	-	-	DFW
Curlew Lake	5	RBT	269	244	7/17/03	9/23/03	57	L	on	F	1	-	-	DFW
Curlew Lake	6	RBT	292	311	7/17/03	9/23/03	67	L	on	F	1	-	-	DFW
Curlew Lake	7	RBT	252	178	7/17/03	9/23/03	38	L	on	F	2	-	-	DFW
Curlew Lake	8	RBT	329	443	7/17/03	9/23/03	103	L	on	F	1	-	-	DFW
Curlew Lake	9	RBT	313	381	7/17/03	9/23/03	83	L	on	F?	1	-	-	DFW
Curlew Lake	10	RBT	247	189	7/17/03	9/23/03	35	L	on	U	1	-	-	DFW
Curlew Lake	**CURLRBT**	**RBT**	**282.3**	**289.0**	**7/17/03**	-	**65.1**	-	-	-	**1.1**	**64288**	**19g/fish**	DFW
Lacamas Lake	2	BT	300	236	8/28/03	9/23/03	56	L	on	M?	1	-	-	ECY
Lacamas Lake	3	BT	320	292	8/28/03	9/23/03	67	L	on	M?	1	-	-	ECY
Lacamas Lake	4	BT	323	319	8/28/03	9/23/03	76	L	on	F	1	-	-	ECY
Lacamas Lake	5	BT	339	350	8/28/03	9/23/03	78	L	on	M	1	-	-	ECY
Lacamas Lake	6	BT	300	248	8/28/03	9/23/03	61	L	on	F	1	-	-	ECY
Lacamas Lake	7	BT	337	305	8/28/03	9/23/03	69	L	on	M?	1	-	-	ECY
Lacamas Lake	8	BT	329	323	8/28/03	9/23/03	81	L	on	M?	1	-	-	ECY

Table D-1. (cont.)

Waterbody	Field ID (Ecy)	Species	Total Length (mm)	Weight (gm)	Collect Date	Process Date	Fillet Weight (gm)	Fillet Taken (L, R, or B)	Skin Status	Sex	Fish Age (yrs)	Mel Lab ID (40-)	Sample Weight	Collector
Lacamas Lake	9	BT	320	265	8/28/03	9/23/03	62	L	on	F	1	-	-	ECY
Lacamas Lake	10	BT	305	248	8/28/03	9/23/03	61	L	on	F	1	-	-	ECY
Lacamas Lake	11	BT	295	226	8/28/03	9/23/03	51	L	on	F	1	-	-	ECY
Lacamas Lake	**LACABT**	**BT**	**316.8**	**281.2**	**8/28/03**	-	**66.2**	-	-	-	**1.0**	**64290**	**33g/fish**	ECY
Lacamas Lake	1	LMB	450	1546	8/19/03	1/5/04	280	L	on	F	8	-	-	ECY
Lacamas Lake	2	LMB	408	1025	8/19/03	1/5/04	160	R	on	M	9	-	-	ECY
Lacamas Lake	3	LMB	475	1805	8/19/03	1/5/04	300	L	on	F	9	-	-	ECY
Lacamas Lake	4	LMB	360	683	8/19/03	1/5/04	136	L	on	M	6	-	-	ECY
Lacamas Lake	5	LMB	482	1607	8/19/03	1/5/04	277	L	on	F	9	-	-	ECY
Lacamas Lake	6	LMB	478	1551	8/19/03	1/5/04	262	L	on	F	9	-	-	ECY
Lacamas Lake	7	LMB	368	790	8/19/03	1/5/04	138	L	on	M	7	-	-	ECY
Lacamas Lake	8	LMB	453	1424	8/19/03	1/5/04	255	L	on	F	8	-	-	ECY
Lacamas Lake	9	LMB	471	1737	8/19/03	1/5/04	304	L	on	F	9	-	-	ECY
Lacamas Lake	10	LMB	402	955	8/19/03	1/5/04	174	L	on	F	7	-	-	ECY
Lacamas Lake	**LACALMB**	**LMB**	**434.7**	**1312.3**	**8/19/03**	-	**228.6**	-	-	-	**8.1**	**64289**	**114g/fish**	ECY
Lacamas Lake	1	YP	214	109	8/19/03	1/7/04	42	B	on	M	6	-	-	ECY
Lacamas Lake	6	YP	186	87	8/19/03	1/7/04	36	B	on	F	2	-	-	ECY
Lacamas Lake	7	YP	190	87	8/19/03	1/7/04	36	B	on	F	2	-	-	ECY
Lacamas Lake	9	YP	186	87	8/19/03	1/7/04	36	B	on	F	2	-	-	ECY
Lacamas Lake	12	YP	195	107	8/28/03	1/7/04	42	B	on	F	2	-	-	ECY
Lacamas Lake	13	YP	190	92	8/28/03	1/7/04	39	B	on	F	2	-	-	ECY
Lacamas Lake	14	YP	191	93	8/28/03	1/7/04	35	B	on	F	2	-	-	ECY
Lacamas Lake	16	YP	188	85	8/28/03	1/7/04	35	B	on	F	2	-	-	ECY
Lacamas Lake	17	YP	195	91	8/28/03	1/7/04	40	B	on	F	2	-	-	ECY
Lacamas Lake	19	YP	187	89	8/28/03	1/7/04	42	B	on	M	2	-	-	ECY
Lacamas Lake	**LACAYP**	**YP**	**192.2**	**92.7**	**8/28/03**	-	**38.3**	-	-	-	**2.4**	**64291**	**25g/fish**	ECY
Lake Washington N	1	LMB	238	204	10/13/03	1/8/04	71	B	on	F	1	-	-	ECY
Lake Washington N	2	LMB	250	260	10/13/03	1/8/04	95	B	on	M	1	-	-	ECY
Lake Washington N	3	LMB	261	298	10/13/03	1/8/04	107	B	on	F	1	-	-	ECY
Lake Washington N	4	LMB	310	466	10/13/03	1/8/04	96	R	on	F	1	-	-	ECY
Lake Washington N	5	LMB	287	434	10/13/03	1/8/04	79	L	on	F	1	-	-	ECY
Lake Washington N	6	LMB	332	730	10/13/03	1/8/04	145	L	on	F	1	-	-	ECY
Lake Washington N	**WASHLMB**	**LMB**	**279.7**	**398.7**	**10/13/03**	-	**98.8**	-	-	-	**1.0**	**64306**	**70g/fish**	ECY
Roses Lake	1	LMB	438	1587	8/12/03	12/11/03	302	L	on	F	7	-	-	ECY
Roses Lake	2	LMB	444	1641	8/12/03	12/11/03	314	L	on	F	7	-	-	ECY
Roses Lake	3	LMB	426	1489	8/12/03	12/11/03	281	L	on	F	7	-	-	ECY
Roses Lake	4	LMB	440	1454	8/12/03	12/11/03	253	L	on	F	6	-	-	ECY
Roses Lake	5	LMB	391	1025	8/12/03	12/11/03	180	L	on	M	7	-	-	ECY
Roses Lake	**ROSESLMB**	**LMB**	**427.8**	**1439.2**	**8/12/03**	-	**266.0**	-	-	-	**6.8**	**64292**	**150g/fish**	ECY
Scooteney Res.	1	CC	543	1575	9/29/03	12/23/03	185	L	off	F?	4	-	-	DFW
Scooteney Res.	2	CC	562	2032	9/29/03	12/23/03	215	L	off	F?	5	-	-	DFW
Scooteney Res.	3	CC	420	646	9/29/03	12/23/03	100	L	off	F?	3	-	-	DFW
Scooteney Res.	4	CC	455	1014	9/29/03	12/23/03	120	L	off	M	3	-	-	DFW
Scooteney Res.	5	CC	443	780	9/29/03	12/23/03	110	L	off	M	3	-	-	DFW
Scooteney Res.	6	CC	448	960	9/29/03	12/23/03	115	L	off	F?	3	-	-	DFW
Scooteney Res.	7	CC	413	635	9/29/03	12/23/03	100	L	off	M	3	-	-	DFW
Scooteney Res.	8	CC	440	878	9/29/03	12/23/03	130	L	off	M	4	-	-	DFW
Scooteney Res.	9	CC	445	770	9/29/03	12/23/03	100	L	off	M	3	-	-	DFW
Scooteney Res.	10	CC	448	935	9/29/03	12/23/03	125	L	off	M	4	-	-	DFW
Scooteney Res.	**SCOOTCC**	**CC**	**461.7**	**1022.5**	**9/29/03**	-	**130.0**	-	-	-	**3.5**	**64293**	**77g/fish**	DFW
Scooteney Res.	2	WAL	516	1322	9/29/03	1/12/04	291	R	on	M	3	-	-	DFW
Scooteney Res.	3	WAL	511	1470	9/29/03	1/12/04	295	R	on	F	3	-	-	DFW
Scooteney Res.	4	WAL	588	2054	9/29/03	1/12/04	365	L	on	F	6	-	-	DFW
Scooteney Res.	5	WAL	510	1391	9/29/03	1/12/04	254	R	on	F	3	-	-	DFW
Scooteney Res.	6	WAL	518	1528	9/29/03	1/12/04	214	L	on	F	3	-	-	DFW
Scooteney Res.	7	WAL	485	1134	9/29/03	1/12/04	152	L	on	M	3	-	-	DFW
Scooteney Res.	8	WAL	536	1207	9/29/03	1/12/04	183	R	on	F	3	-	-	DFW
Scooteney Res.	9	WAL	583	1917	9/29/03	1/12/04	285	R	on	F	3	-	-	DFW
Scooteney Res.	10	WAL	623	2855	9/29/03	1/12/04	420	R	on	M	6	-	-	DFW
Scooteney Res.	11	WAL	588	2020	9/29/03	1/12/04	321	R	on	M	6	-	-	DFW
Scooteney Res.	**SCOOTWAL**	**WAL**	**545.8**	**1689.8**	**9/29/03**	-	**278.0**	-	-	-	**3.9**	**64294**	**152g/fish**	DFW
Scooteney Res.	1	YP	286	375	9/29/03	12/10/03	79	L	on	M	6	-	-	DFW
Scooteney Res.	2	YP	239	182	9/29/03	12/10/03	37	L	on	F	3	-	-	DFW
Scooteney Res.	3	YP	243	210	9/29/03	12/10/03	42	L	on	M	4	-	-	DFW
Scooteney Res.	4	YP	272	273	9/29/03	12/10/03	47	L	on	F	3	-	-	DFW
Scooteney Res.	5	YP	273	275	9/29/03	12/10/03	54	L	on	F	3	-	-	DFW
Scooteney Res.	6	YP	235	179	9/29/03	12/10/03	39	L	on	F	2	-	-	DFW
Scooteney Res.	7	YP	239	186	9/29/03	12/10/03	43	R	on	F	2	-	-	DFW

Table D-1. (cont.)

Waterbody	Field ID (Ecy)	Species	Total Length (mm)	Weight (gm)	Collect Date	Process Date	Fillet Weight (gm)	Fillet Taken (L, R, or B)	Skin Status	Sex	Fish Age (yrs)	Mel Lab ID (40-)	Sample Weight	Collector
Scooteney Res.	8	YP	253	200	9/29/03	12/10/03	40	L	on	F	3	-	-	DFW
Scooteney Res.	9	YP	235	171	9/29/03	12/10/03	33	L	on	M	3	-	-	DFW
Scooteney Res.	**SCOOTYP**	**YP**	**252.8**	**227.9**	**9/29/03**	-	**46.0**	-	-	-	**3.2**	**64295**	**22g/fish**	DFW
Silver Lake	1	BT	502	1407	9/17/03	9/23/03	295	R	on	F	6	-	-	DFW
Silver Lake	2	BT	510	1104	9/19/03	9/23/03	230	R	on	F	5	-	-	DFW
Silver Lake	3	BT	480	1302	9/19/03	9/23/03	233	R	on	F	8	-	-	DFW
Silver Lake	4	BT	528	1322	9/19/03	9/23/03	248	R	on	M	6	-	-	DFW
Silver Lake	5	BT	529	1295	9/19/03	9/23/03	222	R	on	F	7	-	-	DFW
Silver Lake	6	BT	620	2540	9/19/03	9/23/03	545	R	on	M	6	-	-	DFW
Silver Lake	7	BT	560	1785	9/19/03	9/23/03	346	R	on	F	5	-	-	DFW
Silver Lake	**SILVR1BT**	**BT**	**532.7**	**1536.4**	**9/19/03**	-	**302.7**	-	-	-	**6.1**	**64296**	**200g/fish**	DFW
Silver Lake	1	LMB	308	428	9/17/03	12/9/03	79	L	on	M	4	-	-	DFW
Silver Lake	2	LMB	342	599	9/17/03	12/9/03	101	L	on	F	6	-	-	DFW
Silver Lake	3	LMB	346	647	9/17/03	12/9/03	115	L	on	M	6	-	-	DFW
Silver Lake	4	LMB	340	685	9/17/03	12/9/03	114	L	on	F	5	-	-	DFW
Silver Lake	5	LMB	392	1075	9/17/03	12/9/03	175	L	on	F	6	-	-	DFW
Silver Lake	6	LMB	380	837	9/17/03	12/9/03	139	L	on	F	6	-	-	DFW
Silver Lake	7	LMB	348	641	9/17/03	12/9/03	115	L	on	M	4	-	-	DFW
Silver Lake	8	LMB	292	402	9/17/03	12/9/03	80	L	on	M	3	-	-	DFW
Silver Lake	9	LMB	358	695	9/17/03	12/9/03	130	L	on	M	6	-	-	DFW
Silver Lake	10	LMB	281	409	9/17/03	12/9/03	80	L	on	M	3	-	-	DFW
Silver Lake	**SILVR1LMB**	**LMB**	**338.7**	**641.8**	**9/17/03**	-	**112.8**	-	-	-	**4.9**	**64297**	**60g/fish**	DFW
Silver Lake	1	YP	236	168	9/17/03	12/29/03	65	B	on	F	2	-	-	DFW
Silver Lake	2	YP	202	106	9/17/03	12/29/03	40	B	on	M	2	-	-	DFW
Silver Lake	3	YP	210	124	9/17/03	12/29/03	48	B	on	M	2	-	-	DFW
Silver Lake	4	YP	216	131	9/17/03	12/29/03	50	B	on	F	2	-	-	DFW
Silver Lake	5	YP	240	177	9/17/03	12/29/03	68	B	on	F	2	-	-	DFW
Silver Lake	6	YP	212	112	9/17/03	12/29/03	41	B	on	F	2	-	-	DFW
Silver Lake	7	YP	237	187	9/18/03	12/29/03	65	B	on	F	2	-	-	DFW
Silver Lake	8	YP	211	145	9/18/03	12/29/03	54	B	on	F	2	-	-	DFW
Silver Lake	9	YP	236	163	9/18/03	12/29/03	65	B	on	F	2	-	-	DFW
Silver Lake	10	YP	228	141	9/18/03	12/29/03	58	B	on	F	2	-	-	DFW
Silver Lake	**SILVR1YP**	**YP**	**222.8**	**145.4**	**9/18/03**	-	**55.4**	-	-	-	**2.0**	**64298**	**37g/fish**	DFW
Spokane River	NM15	RBT	283	268	9/16/03	2/3/04	87	B	on	M im?	1	-	-	ECY
Spokane River	NM14	RBT	289	257	9/16/03	2/3/04	110	B	on	M	1	-	-	ECY
Spokane River	NM13	RBT	296	266	9/16/03	2/3/04	120	B	on	M im?	1	-	-	ECY
Spokane River	NM18	RBT	296	320	9/16/03	2/3/04	129	B	on	M	1	-	-	ECY
Spokane River	NM6	RBT	300	289	9/16/03	2/3/04	120	B	on	M im?	1	-	-	ECY
Spokane River	NM10	RBT	328	380	9/16/03	2/3/04	145	B	on	M	3	-	-	ECY
Spokane River	NM1	RBT	334	413	9/16/03	2/3/04	184	B	on	M im?	1	-	-	ECY
Spokane River	NM12	RBT	342	421	9/16/03	2/3/04	185	B	on	M im?	1	-	-	ECY
Spokane River	NM5	RBT	350	471	9/16/03	2/3/04	154	B	on	F	3	-	-	ECY
Spokane River	NM23	RBT	362	503	9/16/03	2/3/04	212	B	on	F	2	-	-	ECY
Spokane River	**SPOKRBT**	**RBT**	**318.0**	**358.8**	**9/17/03**	-	**144.6**	-	-	-	**1.5**	**64307**	13g/fish	ECY
Sprague Lake	1	CC	680	4770	10/22/03	12/11/03	672	R	off	F	6	-	-	DFW
Sprague Lake	2	CC	625	3050	10/22/03	12/11/03	470	R	off	F	7	-	-	DFW
Sprague Lake	4	CC	501	1400	10/22/03	12/11/03	180	R	off	M	3	-	-	DFW
Sprague Lake	5	CC	610	3104	10/23/03	12/11/03	400	R	off	M	7	-	-	DFW
Sprague Lake	6	CC	665	3495	10/23/03	12/11/03	470	R	off	F	6	-	-	DFW
Sprague Lake	7	CC	671	4780	10/23/03	12/11/03	660	R	off	F	7	-	-	DFW
Sprague Lake	8	CC	650	3430	10/23/03	12/11/03	550	R	off	F	7	-	-	DFW
Sprague Lake	**SPRAGCC**	**CC**	**628.9**	**3432.7**	**10/23/03**	-	**486.0**	-	-	-	**6.1**	**64299**	**125g/fish**	DFW
Sprague Lake	2	LMB	250	261	10/21/03	1/9/04	98	B	on	M?	1	-	-	DFW
Sprague Lake	3	LMB	250	263	10/21/03	1/9/04	51	L	on	F	1	-	-	DFW
Sprague Lake	4	LMB	267	326	10/21/03	1/9/04	67	L	on	F	1	-	-	DFW
Sprague Lake	5	LMB	270	343	10/21/03	1/9/04	67	L	on	F	1	-	-	DFW
Sprague Lake	6	LMB	202	115	10/21/03	1/9/04	44	B	on	F	1	-	-	DFW
Sprague Lake	7	LMB	231	168	10/21/03	1/9/04	66	B	on	F?	1	-	-	DFW
Sprague Lake	8	LMB	210	126	10/21/03	1/9/04	54	B	on	M?	1	-	-	DFW
Sprague Lake	11	LMB	257	297	10/22/03	1/9/04	67	L	on	F	1	-	-	DFW
Sprague Lake	**SPRAGLMB**	**LMB**	**242.1**	**237.4**	**10/22/03**	-	**64.3**	-	-	-	**1.0**	**64300**	**47g/fish**	DFW
Sprague Lake	1	RBT	401	588	10/22/03	12/29/03	145	L	on	M?	1	-	-	DFW
Sprague Lake	2	RBT	378	678	10/22/03	12/29/03	142	R	on	F?	1	-	-	DFW
Sprague Lake	3	RBT	399	735	10/22/03	12/29/03	165	R	on	F?	1	-	-	DFW
Sprague Lake	4	RBT	386	663	10/23/03	12/29/03	153	L	on	F?	1	-	-	DFW
Sprague Lake	5	RBT	380	625	10/23/03	12/29/03	140	L	on	F?	1	-	-	DFW
Sprague Lake	6	RBT	396	741	10/23/03	12/29/03	142	L	on	M	1	-	-	DFW
Sprague Lake	7	RBT	405	775	10/23/03	12/29/03	175	L	on	M	1	-	-	DFW

Table D-1. (cont.)

Waterbody	Field ID (Ecy)	Species	Total Length (mm)	Weight (gm)	Collect Date	Process Date	Fillet Weight (gm)	Fillet Taken (L, R, or B)	Skin Status	Sex	Fish Age (yrs)	Mel Lab ID (40-)	Sample Weight	Collector
Sprague Lake	**SPRAGRBT**	**RBT**	**392.1**	**686.4**	**10/23/03**	-	**151.7**	-	-	-	**1.0**	**64301**	**115g/fish**	DFW
Sprague Lake	1	SMB	298	425	10/21/03	1/7/04	78	L	on	M	2	-	-	DFW
Sprague Lake	2	SMB	270	325	10/21/03	1/7/04	63	L	on	F	2	-	-	DFW
Sprague Lake	3	SMB	298	432	10/21/03	1/7/04	84	L	on	M	2	-	-	DFW
Sprague Lake	5	SMB	369	890	10/22/03	1/7/04	180	L	on	M	5	-	-	DFW
Sprague Lake	6	SMB	300	426	10/23/03	1/7/04	87	R	on	M	2	-	-	DFW
Sprague Lake	**SPRAGSMB**	SMB	**307.0**	**499.6**	**10/23/03**	-	**98.4**	-	-	-	**2.6**	**64302**	**64g/fish**	DFW
Sprague Lake	1	WAL	458	1282	10/22/03	1/7/04	243	L	on	M	7	-	-	DFW
Sprague Lake	2	WAL	465	1050	10/22/03	1/7/04	206	L	on	M	5	-	-	DFW
Sprague Lake	3	WAL	431	857	10/22/03	1/7/04	161	R	on	M	5	-	-	DFW
Sprague Lake	4	WAL	401	660	10/22/03	1/7/04	135	L	on	M	3	-	-	DFW
Sprague Lake	5	WAL	451	891	10/22/03	1/7/04	188	L	on	M	5	-	-	DFW
Sprague Lake	6	WAL	537	1740	10/22/03	1/7/04	327	L	on	F	6	-	-	DFW
Sprague Lake	7	WAL	482	1256	10/22/03	1/7/04	276	L	on	M	5	-	-	DFW
Sprague Lake	8	WAL	430	905	10/22/03	1/7/04	181	L	on	M	5	-	-	DFW
Sprague Lake	9	WAL	482	1247	10/22/03	1/7/04	246	L	on	F	5	-	-	DFW
Sprague Lake	10	WAL	472	775	10/22/03	1/7/04	222	L	on	M	6	-	-	DFW
Sprague Lake	**SPRAGWAL**	WAL	**460.9**	**1066.3**	**10/22/03**	-	**218.5**	-	-	-	**5.2**	**64303**	**135g/fish**	DFW
Sprague Lake	1	YP	316	453	10/22/03	1/5/04	72	R	on	F	5	-	-	DFW
Sprague Lake	3	YP	311	426	10/22/03	1/5/04	70	L	on	F	5	-	-	DFW
Sprague Lake	4	YP	320	496	10/22/03	1/5/04	86	L	on	F	5	-	-	DFW
Sprague Lake	5	YP	314	415	10/22/03	1/5/04	71	L	on	F	5	-	-	DFW
Sprague Lake	9	YP	323	478	10/23/03	1/5/04	85	L	on	F	5	-	-	DFW
Sprague Lake	10	YP	306	436	10/23/03	1/5/04	95	L	on	M	5	-	-	DFW
Sprague Lake	11	YP	303	379	10/23/03	1/5/04	75	L	on	F	3	-	-	DFW
Sprague Lake	12	YP	345	464	10/23/03	1/5/04	85	L	on	F	5	-	-	DFW
Sprague Lake	13	YP	310	447	10/23/03	1/5/04	95	L	on	M	5	-	-	DFW
Sprague Lake	14	YP	300	416	10/23/03	1/5/04	79	L	on	F	5	-	-	DFW
Sprague Lake	**SPRAGYP**	YP	**314.8**	**441.0**	**10/23/03**	-	**81.3**	-	-	-	**4.8**	**64304**	**60g/fish**	DFW
Twin Lakes (upper)	1	LMB	434	1402	10/21/03	12/10/03	240	L	on	F	8	-	-	DFW
Twin Lakes (upper)	2	LMB	446	1500	10/21/03	12/10/03	224	L	on	M	10	-	-	DFW
Twin Lakes (upper)	3	LMB	436	1567	10/21/03	12/10/03	280	L	on	F	6	-	-	DFW
Twin Lakes (upper)	4	LMB	431	1411	10/21/03	12/10/03	244	L	on	F	9	-	-	DFW
Twin Lakes (upper)	5	LMB	443	1656	10/21/03	12/10/03	265	L	on	F	8	-	-	DFW
Twin Lakes (upper)	6	LMB	402	1141	10/21/03	12/10/03	182	R	on	F	6	-	-	DFW
Twin Lakes (upper)	7	LMB	390	1032	10/21/03	12/10/03	183	L	on	F	6	-	-	DFW
Twin Lakes (upper)	8	LMB	340	620	10/21/03	12/10/03	120	L	on	M	5	-	-	DFW
Twin Lakes (upper)	9	LMB	348	628	10/21/03	12/10/03	115	L	on	F	5	-	-	DFW
Twin Lakes (upper)	10	LMB	336	587	10/21/03	12/10/03	105	L	on	M	5	-	-	DFW
Twin Lakes (upper)	**TWIN1LMB**	**LMB**	**400.6**	**1154.4**	**10/21/03**	-	**195.8**	-	-	-	**6.8**	**64305**	**80g/fish**	**DFW**

Bold Field ID samples are composite samples of the preceding fish of the same species.

Data for composite samples is the average value of individual fish that make up the composite.

Species Codes:		Fillet and Sex Codes:	
BT	Brown trout (Salmo trutta)	L -	left side fillet
CC	Channel catfish (Ictalurus punctatus)	R -	right side fillet
LMB	Largemouth bass (Micropterus salmoides)	B -	both fillets
LWF	Lake whitefish (Coregonus clupeaformis)	M -	male, conclusive
RBT	Rainbow trout (Oncorhynchus mykiss)	M? -	male, inconclusive
SMB	Smallmouth bass (Micropterus dolomieui)	F -	female, conclusive
WAL	Walleye (Stizostedion vitreum)	F? -	female, inconclusive
YP	Yellow perch (Perca flavescens)	U -	undetermined or undeterminable

Table D-2. Fish Tissue Results for Mercury, PCBs, PCDD/Fs, Pesticides, and PBDEs with Comparison to Criteria for Protection of Human Health, WSTMP 2003.

Site:	Banks Lake	Banks Lake	Banks Lake	Banks Lake	Curlew Lake	Curlew Lake	Lacamas Lake	Lacamas Lake	Lacamas Lake	Roses Lake	Scooteney Res.	Scooteney Res.	Scooteney Res.	Silver Lake
Species:	Lake whitefish	Rainbow trout	Walleye	Yellow perch	Largemouth bass	Rainbow trout	Largemouth bass	Brown trout	Yellow perch	Largemouth bass	Channel catfish	Walleye	Yellow perch	Brown trout
Mel Lab ID (40-):	64283	64284	64285	64286	64287	64288	64289	64290	64291	64292	64293	64294	64295	64296
Analyte [1]														
Mercury	**61**	**83**	**124**	**74**	43 J	46 J	**229**	17	17	**100** J	17	**119**	29	**107**
PCB-aroclor 1254	17	8.3 J	3.1 J				3.5 NJ				3.8 NJ			15 NJ
PCB-aroclor 1260	16	8.5 J	3.6 J				4.4 J				3.5 J			18 NJ
Total PCBs	**33**	**16.8**	**6.7**	9.9 U	10 U	9.7 U	**7.9**	9.9 U	9.8 U	9.9 U	**7.3**	9.8 U	9.2 U	**33**
PCDD/Fs [2]	**0.4500**	**0.1340**				0.0150	0.0220	0.0150			**0.0330**			**0.2015**
2,4'-DDE	0.44 NJ	0.23 NJ												
2,4'-DDT	0.37 J											0.21 NJ		
4,4'-DDD	6.7	3.2	0.87 NJ			0.35 NJ	0.22 J	0.28 J		28	2.5	2.4	0.44 NJ	3.6
4,4'-DDE	26	13	3.1 J	0.65 NJ	0.66 NJ	1.4 J	1.6 J	1.4		97	24	15	3 J	14
4,4'-DDT	1.6 J	0.66 J								3.2		1.5 J		1.1 J
Total DDTs	**35.11**	**17.09**	3.97	0.65	0.66	1.75	1.82	1.68		**128.2**	**26.5**	**19.11**	3.44	**18.7**
Cis-Chlordane (Alpha-Chlordane)	0.2 NJ													0.19 NJ
Cis-Nonachlor	0.44 J	0.26 J										0.25 J		0.59 NJ
Oxychlordane														0.33 J
Trans-Chlordane (Gamma)	0.19 NJ													0.42 J
Trans-Nonachlor	1.2 NJ	0.5 NJ					0.21 J				0.58 NJ	0.41 J		1
Total Chlordanes	2.03	0.76					0.21				0.58	0.66		2.53
Aldrin											0.25 J			
Beta-BHC														
Chlorpyriphos	0.24 J										5.2 J	1.5 J	0.91 J	
DDMU [3]	1.2 J	1.4	0.41 J			0.23 J							0.25 J	1.8 J
Dieldrin											**2.4** J	**2.3**		
Endosulfan Sulfate											0.86 J	1.4 J		
Heptachlor Epoxide														
Hexachlorobenzene	0.44 J	0.19 J									0.64 J			0.72 J
Lindane														
Mirex											0.23 J			
PBDE-047 (2,2',4,4'-tetraBDE)	4 J	3.1 J	1.1 J				0.65 J							4 J
PBDE-099 (2,2',4,4',5-pentaBDE)	1.6 J	1.4 J	0.23 J				0.41 J							3.7 J
PBDE-100 (2,2,4,4',5,6-hexaBDE)														0.45 J
PBDE-153 (2,2',4,4',6-pentaBDE)	0.64 J	0.61 J												1.4 J
PBDE-154 (2,2'4,4'5,5'-hexaBDE)														0.46 J
Total PBDEs	6.24	5.11	1.33				1.06							10.01
Percent Lipids (MEL)	6.6	2.58	1.65	0.67	0.54	2.33	1.13	1.7	0.5	1.7	7.53	1.48	0.44	2.16
No. of Contaminants Detected	19	15	8	2	2	5	9	4	1	4	13	10	5	19
No. of NTR Exceedances	2	2	1				1			1	1			2
No. of EPA SV Exceedances	4	4	2	1			2			2	4	3		4

Shaded value: exceeds National Toxics Rule criterion.
Bold value: exceeds EPA 2000 SVs.
Blank cells: analysis not performed or result was less than reporting limit.
J: The analyte was positively identified. The associated numerical value is an estimate.
NJ: There is evidence that the analyte is present. The associated numerical result is an estimate.

1 - Values in parts per billion wet weight (ug/kg ww) unless otherwise noted.
2 - PCDD/Fs as 2,3,7,8-TCDD TEQ; values are in parts per trillion wet weight (ng/kg ww).
3 - DDMU is a breakdown product of DDE: 1-Chloro-2,2-bis(4'-chlorophenyl)ethylene.
4 - EPA (2001) recommends 300 ppb ww as the criterion for mercury.
5 - Result from Pace Analytical Services, Inc

Table D-2. (cont.)

Site: Species: Mel Lab ID (40-): Analyte [1]	Silver Lake Largemouth bass 64297	Silver Lake Yellow perch 64298	Sprague Lake Channel catfish 64299	Sprague Lake Largemouth bass 64300	Sprague Lake Rainbow trout 64301	Sprague Lake Smallmouth bass 64302	Sprague Lake Walleye 64303	Sprague Lake Yellow perch 64304	Twin Lakes (upper) Largemouth bass 64305	Lake Washington N Largemouth bass 64306	Spokane River Rainbow trout 64307	National Toxics Rule	EPA SVs: Subsistence Fishers Non-carcinogenic	EPA SVs: Subsistence Fishers Carcinogenic	EPA SVs: Recreational Fishers Non-carcinogenic	EPA SVs: Recreational Fishers Carcinogenic
Mercury	**84**	41	19	32	5.8	47	**51**	11	**154**	**62**	15	825, 300 [4]	49		400	
PCB-aroclor 1254			3.9							5.5 J						
PCB-aroclor 1260	2.1 J		8.2			2.8 J	2.5 J			5.3 J						
Total PCBs	2.1	9.9 U	**12.1**	9.8 U	9.7 U	**2.8**	**2.5**	10 U	9.3 U	**10.8**		5.3	9.83	2.45	80	20
PCDD/Fs [2]			**0.2030**		**0.2170**		**0.1557**				**0.3620**	0.07		0.0315		0.256
2,4'-DDE							0.36 NJ									
2,4'-DDT																
4,4'-DDD			0.82 J		0.25 NJ		0.38 NJ			0.59 J		45				
4,4'-DDE	1.3 J		9.9	0.46 NJ	1.8	2.5 J	2.7 J		1.4	1.5 J		31.6				
4,4'-DDT												31.6				
Total DDTs	1.3		10.72	0.46	2.05	2.5	3.44		1.4	2.09			245	14.4	2000	117
Cis-Chlordane (Alpha-Chlordane)			0.22 NJ				0.34 J			0.49 NJ						
Cis-Nonachlor							0.32 NJ			0.35 J						
Oxychlordane							0.3 J									
Trans-Chlordane (Gamma)			0.24 NJ				0.19 J									
Trans-Nonachlor			0.45 NJ				0.33 NJ			0.69 NJ						
Total Chlordanes			0.91				1.48			1.53			245	14	2000	114
Aldrin												0.65				
Beta-BHC							0.33 J									
Chlorpyriphos							0.35 J						147		1200	
DDMU [3]					0.3 J					0.3 NJ						
Dieldrin												0.65	24	0.307	200	2.5
Endosulfan Sulfate												540				
Heptachlor Epoxide			0.23 J				0.33 NJ									
Hexachlorobenzene			0.9 J				0.24 J					6.7	393	3.07	3200	25
Lindane							0.24 J					8.19	147	3.8	1200	30.7
Mirex													98		800	
PBDE-047 (2,2',4,4'-tetraBDE)	0.84 J						0.42 J			0.56 J						
PBDE-099 (2,2',4,4',5-pentaBDE)			0.19 J				0.28 J									
PBDE-100 (2,2,4,4',5,6-hexaBDE)							0.22 J									
PBDE-153 (2,2',4,4',6-pentaBDE)							0.24 J									
PBDE-154 (2,2'4,4'5,5'-hexaBDE)							0.21 J									
Total PBDEs	0.84		0.19				1.37			0.56						
Percent Lipids (MEL)	6.43	0.43	13.01	0.84	1.81	1.23	1.24	0.67	0.93	0.82	5.4 [5]					
No. of Contaminants Detected	4	1	12	2	5	3	21	1	2	10	2					
No. of NTR Exceedances			2		1		1			1	1					
No. of EPA SV Exceedances	1		2		1	1	3		1	2	1					

Shaded value: exceeds National Toxics Rule criterion.
Bold value: exceeds EPA 2000 SVs.
Blank cells: analysis not performed or result was less than reporting limit.
J: The analyte was positively identified. The associated numerical value is an estimate.
NJ: There is evidence that the analyte is present. The associated numerical result is an estimate.

1 - Values in parts per billion wet weight (ug/kg ww) unless otherwise noted.
2 - PCDD/Fs as 2,3,7,8-TCDD TEQ; values are in parts per trillion wet weight (ng/kg ww).
3 - DDMU is a breakdown product of DDE: 1-Chloro-2,2-bis(4'-chlorophenyl)ethylene.
4 - EPA (2001) recommends 300 ppb ww as the criterion for mercury.
5 - Result from Pace Analytical Services, Inc

Table D-3. Results of PCDD/PCDF Congeners from Composite Fish Tissue Samples, WSTMP 2003. (units ppt - ng/kg ww)

Site:		Banks Lake			Banks Lake			Curlew Lake			Lacamas Lake			Lacamas Lake			Scooteney Reservoir			Silver Lake			Spokane River @ 7Mile Bridge		
Species:		LWF			RBT			RBT			LMB			BT			CC			BT			RBT		
lipids %:		6.4			2.2			2.4			0.7			0.8			7.9			1.9			5.4		
MEL Lab ID:		04064283			04064284			04064288			04064289			04064290			04064293			04064296			04064307		
Analyte	1998 TEF	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)
2,3,7,8-TCDF	0.1	4.20		0.42	1.20		0.12	0.15	J	0.015	0.100	J	0.01	0.15	J	0.015	0.17	J	0.017	0.40		0.04	0.51		0.051
2,3,7,8-TCDD	1	0.130	U	0	0.150	U	0	0.100	U	0	0.090	U	0	0.120	U	0	0.130	U	0	0.130	U	0	0.130	U	0
1,2,3,7,8-PeCDF	0.05	0.180	U	0	0.180	U	0	0.130	U	0	0.130	U	0	0.140	U	0	0.150	U	0	0.29	J	0.0145	0.150	U	0
2,3,4,7,8-PeCDF	0.5	0.190	U	0	0.160	U	0	0.130	U	0	0.120	U	0	0.180	U	0	0.210	U	0	0.170	U	0	0.42	J	0.21
1,2,3,7,8-PeCDD	1	0.250	U	0	0.170	U	0	0.120	U	0	0.180	U	0	0.250	U	0	0.240	U	0	0.13	J	0.13	0.100	U	0
1,2,3,4,7,8-HxCDF	0.1	0.160	U	0	0.130	U	0	0.088	U	0	0.120	U	0	0.110	U	0	0.160	U	0	0.180	U	0	0.64	J	0.064
1,2,3,6,7,8-HxCDF	0.1	0.130	U	0	0.110	U	0	0.092	U	0	0.160	U	0	0.110	U	0	0.190	U	0	0.081	U	0	0.110	U	0
2,3,4,6,7,8-HxCDF	0.1	0.088	U	0	0.077	U	0	0.062	U	0	0.086	U	0	0.087	U	0	0.100	U	0	0.100	U	0	0.14	NJ	0.014
1,2,3,7,8,9-HxCDF	0.1	0.170	NJ	0.017	0.14	NJ	0.014	0.057	U	0	0.12	NJ	0.012	0.099	U	0	0.099	U	0	0.120	U	0	0.23	NJ	0.023
1,2,3,4,7,8-HxCDD	0.1	0.093	U	0	0.092	U	0	0.059	U	0	0.120	U	0	0.150	U	0	0.130	U	0	0.120	U	0	0.077	U	0
1,2,3,6,7,8-HxCDD	0.1	0.13	J	0.013	0.120	U	0	0.063	U	0	0.099	U	0	0.140	U	0	0.16	NJ	0.016	0.17	J	0.017	0.099	U	0
1,2,3,7,8,9-HxCDD	0.1	0.078	U	0	0.110	U	0	0.055	U	0	0.081	U	0	0.140	U	0	0.110	U	0	0.120	U	0	0.095	U	0
1,2,3,4,6,7,8-HpCDF	0.01	0.059	UJ	0	0.081	U	0	0.069	U	0	0.064	U	0	0.110	U	0	0.092	U	0	0.150	U	0	0.380	U	0
1,2,3,4,7,8,9-HpCDF	0.01	0.082	U	0	0.082	U	0	0.079	U	0	0.084	U	0	0.120	U	0	0.170	U	0	0.150	U	0	0.290	U	0
1,2,3,4,6,7,8-HpCDD	0.01	0.32	UJ	0	0.18	UJ	0	0.20	UJ	0	0.190	UJ	0	0.28	UJ	0	0.25	UJ	0	0.30	UJ	0	0.26	UJ	0
1,2,3,4,6,7,8,9-OCDF	0.001	0.087	U	0	0.087	U	0	0.061	U	0	0.081	U	0	0.110	U	0	0.084	U	0	0.120	U	0	0.14	UJ	0
1,2,3,4,6,7,8,9-OCDD	0.0001	0.31	UJ	0	0.31	UJ	0	0.34	UJ	0	0.340	UJ	0	0.47	UJ	0	0.33	NJ	3.3E-05	0.63	UJ	0	0.71	UJ	0
TEQ 2,3,7,8 TCDD				0.4500			0.1340			0.0150			0.0220			0.0150			0.0330			0.2015			0.3620
Exceedance factors for:																									
NTR (0.07 ppt ww)				6.4			1.9			0.2			0.3			0.2			0.5			2.9			5.2
EPA SV Subsistence (0.0315 ppt)				14.3			4.3			0.5			0.7			0.5			1.0			6.4			11.5
EPA SV Recreational (0.256 ppt)				1.8			0.5			0.1			0.1			0.1			0.1			0.8			1.4

Pace Qualifiers not given here, only MELs

TEF	Toxicity Equivalent Factor from Van den Berg et al., 1998	Species Code:
TEQ	Toxic Equivalent (to 2,3,7,8,-TCDD)	BT - Brown trout (Salmo trutta)
RR	Reported Result in ppt ww	CC - Channel catfish (Ictalurus punctatus)
RL	Reporting Limit in ppt ww	LMB - Largemouth bass (Micropterus salmoides)
ppt ww	Parts per trillion, wet weight	LWF - Lake whitefish (Coregonus clupeaformis)
U	The analyte was not detected at or above the reported value.	RBT -Rainbow trout (Oncorhynchus mykiss)
J	The analyte was positively identified. The associated numerical value is an estimate.	SMB - Smallmouth bass (Micropterus dolomieui)
UJ	The analyte was not detected at or above the reported estimated result.	WAL - Walleye (Stizostedion vitreum)
NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.	YP - Yellow perch (Perca flavescens)
Exceedance Factor	The result as a multiple of the criterion or screening value.	

Table D-3. (cont.)

Site:		Sprague Lake			Sprague Lake			Sprague Lake			Sprague Lake (field split)			lab duplicate		
Species:		RBT			WAL			CC			CC			CC		
lipids %:		1.9			1.0			13.3			13.2			11.8		
MEL Lab ID:		04064301			04064303			04064299			04064280			04064280		
Analyte	1998 TEF	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)	RR		TEQ (ND=0)
2,3,7,8-TCDF	0.1	0.30	J	0.03	0.380	U	0	0.58	U	0	0.29	J	0.029	0.25	J	0.025
2,3,7,8-TCDD	1	0.140	U	0	0.310	U	0	0.30	U	0	0.150	U	0	0.180	UJ	0
1,2,3,7,8-PeCDF	0.05	0.150	U	0	0.150	U	0	0.34	U	0	0.150	U	0	0.230	U	0
2,3,4,7,8-PeCDF	0.5	0.27	J	0.135	0.23	NJ	0.115	0.32	NJ	0.16	0.150	U	0	0.230	U	0
1,2,3,7,8-PeCDD	1	0.130	U	0	0.094	U	0	0.19	U	0	0.180	U	0	0.230	U	0
1,2,3,4,7,8-HxCDF	0.1	0.30	J	0.03	0.310	J	0.031	0.17	J	0.017	0.140	U	0	0.130	U	0
1,2,3,6,7,8-HxCDF	0.1	0.11	J	0.011	0.080	U	0	0.14	U	0	0.130	U	0	0.140	U	0
2,3,4,6,7,8-HxCDF	0.1	0.11	J	0.011	0.097	J	0.0097	0.16	U	0	0.088	U	0	0.120	U	0
1,2,3,7,8,9-HxCDF	0.1	0.099	U	0	0.082	U	0	0.22	U	0	0.15	NJ	0.015	0.18	NJ	0.018
1,2,3,4,7,8-HxCDD	0.1	0.100	U	0	0.067	U	0	0.20	U	0	0.10	J	0.01	0.110	U	0
1,2,3,6,7,8-HxCDD	0.1	0.093	U	0	0.090	U	0	0.26	J	0.026	0.13	NJ	0.013	0.17	NJ	0.017
1,2,3,7,8,9-HxCDD	0.1	0.098	U	0	0.080	U	0	0.20	U	0	0.096	U	0	0.100	U	0
1,2,3,4,6,7,8-HpCDF	0.01	0.19	UJ	0	0.25	UJ	0	0.23	UJ	0	0.099	U	0	0.081	U	0
1,2,3,4,7,8,9-HpCDF	0.01	0.140	U	0	0.100	U	0	0.22	U	0	0.110	U	0	0.100	U	0
1,2,3,4,6,7,8-HpCDD	0.01	0.18	UJ	0	0.210	UJ	0	0.43	UJ	0	0.28	UJ	0	0.35	UJ	0
1,2,3,4,6,7,8,9-OCDF	0.001	0.120	U	0	0.16	UJ	0	0.34	UJ	0	0.073	U	0	0.14	UJ	0
1,2,3,4,6,7,8,9-OCDD	0.0001	0.45	UJ	0	0.420	UJ	0	0.68	UJ	0	0.55	UJ	0	0.62	UJ	0
TEQ 2,3,7,8 TCDD				0.2170			0.1557			0.2030			0.0670			0.0600
Exceedance factors for:																
NTR (0.07 ppt ww)				3.1			2.2			2.9			1.0			0.9
EPA SV Subsistence (0.0315 ppt)				6.9			4.9			6.4			2.1			1.9
EPA SV Recreational (0.256 ppt)				0.8			0.6			0.8			0.3			0.2

Pace Qualifiers not given here, only MELs

TEF	Toxicity Equivalent Factor from Van den Berg et al., 1998	Species Code:
TEQ	Toxic Equivalent (to 2,3,7,8,-TCDD)	BT - Brown trout (Salmo trutta)
RR	Reported Result in ppt ww	CC - Channel catfish (Ictalurus punctatus)
RL	Reporting Limit in ppt ww	LMB - Largemouth bass (Micropterus salmoides)
ppt ww	Parts per trillion, wet weight	LWF - Lake whitefish (Coregonus clupeaformis)
U	The analyte was not detected at or above the reported value.	RBT -Rainbow trout (Oncorhynchus mykiss)
J	The analyte was positively identified. The associated numerical value is an estimate.	SMB - Smallmouth bass (Micropterus dolomieui)
UJ	The analyte was not detected at or above the reported estimated result.	WAL - Walleye (Stizostedion vitreum)
NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.	YP - Yellow perch (Perca flavescens)
Exceedance Factor	The result as a multiple of the criterion or screening value.	

Appendix E

Water Sample Data

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Table E-1. Results for Conventional Water Quality Parameters, WSTMP 2003.

EIM "User Location ID"*	Water Class	Date	Time	pH (S.U.)	Temp (°C)	Cond (uS/cm)	Flow (cfs)		TSS (mg/L)	TOC (mg/L)		Sample ID
BURNT BR	A	5/27/03	13:00	7.3	16.4	200	8.46		9.0	1.7		3224600
		6/30/03	10:20	7.8	18.6	215	5.00		4.0	2.0		3274600
		8/6/03	11:45	7.8	17.5	185	5.40		2.0	2.8		3324600
CHEWELAH	A	5/28/03	14:50	7.3	13.8	158	62.3		14	2.7		3224603
		7/1/03	11:10	8.4	13.4	210	30.9		4.0	2.1		3274603
		8/4/03	15:35	8.2	17.5	240	12.3		1.0	1.9		3324603
COLVILLE	A	5/28/03	17:25	8.1	19.1	289	418	gs	16	3.1		3224604
		7/1/03	14:25	8.9	20.3	312	190	gs	9.0	2.5		3274604
		8/4/03	17:55	8.3	22.9	360	71	gs	7.0	2.6		3324604
CRAB CR1	B	5/29/03	11:05	8.0	15.0	340	31.6		3.0	2.1		3224606
		7/1/03	17:38	9.1	17.7	360	13.7		5.0	2.2		3274606
		8/5/03	10:35	8.4	17.3	365	12.0		10	2.5		3324606
CRAB CR2	B	5/29/03	14:15	7.9	25.2	650	nd		111	7.5		3224607
CRAB CR3	B	7/2/03	10:05	8.4	16.8	425	36	gs	9.0	2.5		3274611
		8/5/03	14:15	8.2	22.2	400	51	gs	8.0	3.9		3324611
LACAMAS	AA	5/27/03	15:00	6.6	15.5	110	47.5		4.0	1.6		3224601
		6/30/03	11:45	7.5	19.0	135	20.1		3.0	1.6		3274601
		8/6/03	13:30	7.6	17.8	160	13.4		2.0	1.8		3324601
MILL CR	A	5/28/03	18:15	7.5	16.1	330	89.4		15	1.3		3224605
		7/1/03	13:20	8.7	16.8	390	36.5		3.0	1.2		3274605
		8/4/03	17:05	8.3	20.3	390	12.2		2.0	1.2		3324605
ROCKY COUL	A	5/29/03	15:55	8.7	23.2	365	35.3		1.0	1.8		3224608
		7/2/03	10:45	8.4	18.2	250	110		3.0	1.7		3274608
		8/5/03	14:50	8.3	21.4	150	500	e	3.0	2.0		3324608
WASHOUG	A	5/27/03	17:38	7.1	17.3	32	nd		3.0	1.0	U	3224602
		6/30/03	12:55	8.0	22.4	37	125		1.0	1.0	U	3274602
		8/6/03	15:50	8.8	22.8	44	77.8		1.0	1.0	U	3324602

* - Site identification as used in Ecology's Environmental Information Management (EIM) system.
U - The analyte was not detected at or above the reported result.
nd - not determined
gs - Daily streamflow value from USGS website.
e - Estimated flow based on tapedowns and previous streamflow measurements.

Table E-2. Results for Pesticides Detected in Water Samples, WSTMP 2003.

Analyte	Burnt Bridge Cr.			Crab Cr.2	Lacamas Cr.			Rocky Coulee		
	5/27	6/30	8/6	5/29	5/27	6/30	8/6	5/29	7/2	8/5
Atrazine								0.013 J	0.0032 J	
Bromacil	0.013 J	0.013 NJ	0.016 J				0.027 J			
Dichlobenil	0.0082 J		0.013 J							
Diuron				0.042 J						
Hexazinone								0.019 J		
Terbacil	0.015 J	0.057 J								

All detected pesticides are nitrogen-based herbicides.
J - The analyte was positively identified. The associated numerical value is an estimate.
NJ - There is evidence that the analyte is present. The associated numerical result is an estimate.