Quality Assurance Project Plan

PCB and Dioxin Levels in Resident Fish from Washington Background Lakes and Rivers

by
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January 2008

303(d) Listings Addressed in this Study
Multiple PCB and Dioxin listings

Waterbody Number: Statewide

Project Code: 08-079

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January 2008

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Abstract

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance (QA) Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completion of the study, a final report describing the study results will be posted to the Internet.

This is a QA Project Plan for characterizing PCB and dioxin levels in fish from background lakes and rivers in Washington. Ecology will collect fish from 24 lakes and rivers in four regions statewide during the summer and fall of 2008. A total of 48 composite fillet samples will be analyzed for polychlorinated biphenyls (PCBs) and polychlorinated dioxins and furans (PCDDs/PCDFs) using low-level methods. Ecology will use the results in conjunction with existing data to recommend approaches for addressing 303(d) listings for these compounds.

Acknowledgments

Dale Norton, Ecology Statewide Assessments Unit (SAU) supervisor, developed the concept for this study and obtained grant funding from the U.S. Environmental Protection Agency (EPA). SAU's Keith Seiders helped with many aspects of the study design.

Introduction

There are over 100 listings for polychlorinated biphenyls (PCBs), 2,3,7,8-TCDD (dioxin), and dioxin TEQs[4] in Category 5 of Washington's draft section 303(d) 2004 list of impaired waterbodies. The listings are for edible fish tissue exceeding EPA human health criteria for fish consumption. Approximately one third of the listings are from lakes and rivers with no apparent local sources of these compounds. The Clean Water Act requires Total Maximum Daily Loads (TMDLs) to be established for all waterbodies with Category 5 listings.

Local data and studies in other areas suggest there could be a significant PCB and dioxin background in Washington lakes and rivers. It is, therefore, difficult to determine appropriate approaches for bringing each of the listed areas into compliance with water quality standards for these compounds without better information on what constitutes background levels in fish. The information collected in this project will help prioritize the state's TMDL resources and accelerate cleanup actions related to PCBs and dioxins in freshwater areas statewide. The data will also be useful in evaluating progress toward meeting cleanup targets for waterbodies with TMDLs.

[4] Dioxin TEQs (toxicity equivalents) are a measure of the combined toxicity of a mixture of polychlorinated dibenzodioxins (PCDDs) and –dibenzofurans (PCDFs), based on the toxicity of 2,3,7,8-tetrachlorodibenzodioxin (TCDD), the most toxic of these compounds.

Project Description

The objective of this project is to characterize PCB and PCDD/PCDF levels in fish fillets from background lakes and rivers in Washington. This information will be used in conjunction with existing data to recommend approaches for addressing 303(d) listings for these compounds.

Forty-eight fish samples will be collected from 24 background lakes and rivers in four regions of Washington during summer and fall of 2008. One-to-three species will be sampled in each waterbody, depending on availability. Composite fillets from five-to-ten individuals of each species will be analyzed for PCBs, PCDDs/PCDFs, and percent lipids. High resolution gas chromatography and mass spectrometry (HR-GC/MS) methods will be used to achieve low detection limits for these compounds.

The study will be conducted by the Washington State Department of Ecology (Ecology) Environmental Assessment Program (EA Program). A final report is anticipated by December 2009.

Organization and Schedule

Organization

Following is the organization of project staff and responsibilities.

Name	Ecology Affiliation	Role	Contact Information
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Schedule

Field Work/Laboratory Analyses	
Sample Collection	June – October 2008
Sample Submittal to Laboratory	August – December 2008
Laboratory Analyses Completed	March 2009
Final Report	
Author Lead	Art Johnson
Schedule	
Draft Due to Supervisor	June 2009
Draft Due to Peer Reviewer	August 2009
Draft Due to External Reviewer	October 2009
Final Report Due	December 2009
Environmental Information System (EIM) Data Set	
EIM Data Engineer	Art Johnson
EIM User Study ID	WSTMP07 & WSTMP08
EIM Study Name	PCB/Dioxin Background in Freshwater Fish
EIM Completion Due	December 2009

303(d) Listings

Ecology's 303(d) listing criteria for PCBs and dioxins in edible fish tissue are shown in Table 1. The criteria are derived from EPA bioconcentration factors and human health water column criteria established for fish consumption under the EPA National Toxics Rule (NTR) 31; Federal Register Vol. 57, No. 246; and Vol. 63, No. 63 – Revision of Polychlorinated Biphenyls (PCB) Criteria. The criteria are for a 10^{-6} (one-in-one million) excess life-time cancer risk for average fish consumers among the general public. Washington has adopted the NTR criteria as state human health water quality standards.

Table 1. EPA National Toxics Rule Human Health Criteria for PCBs and Dioxin in Edible Fish Tissue.

Chemical	Units (wet weight)	Human Health Criteria for Fish Consumption
Total PCBs	ug/Kg*	5.3
Dioxin (2,3,7,8-TCDD)	ng/Kg†	0.07

*parts per billion
†parts per trillion

There are currently 92 303(d) listings for PCBs in Washington (2004 list). The individual listings are tabulated in Appendix Table A1; the online version has links to maps and descriptions of the basis for each listing. The freshwater listings are the impetus for the present study.

The locations of the freshwater PCB listings are shown in Figure 1A. Of the 70 listings, approximately half (33) are for the Columbia River, Spokane River, or Yakima River, areas with known PCB sources. Total PCB concentrations reported for these waterbodies often exceed 100 ug/Kg (wet weight). Other listings are based on much lower concentrations. There are, for example, 14 waterbodies where PCB concentrations exceed the human health criterion by less than a factor of three (Table 2). Most of these are in watersheds with no apparent local sources of PCBs, as judged from land-use maps. There are additional waterbodies—Whatcom Lake, Clear Creek, Lake Chelan, and Silver Lake—with higher concentrations (approaching 50 ug/Kg), but where significant sources are also not apparent. Taken together, these waterbodies account for 25% of the freshwater PCB listings.

The locations of the freshwater listings for dioxins are shown in Figure 1B. Dioxins have been analyzed less frequently than PCBs because of the higher cost.

The 2004 listings are based on dioxin or dioxin Toxicity Equivalents (TEQs). There are 19 freshwater listings and one Puget Sound listing, expressed variously on 303(d) as listings for: (1) *2,3,7,8-TCDD*, (2) *Dioxin*, or (3) *Total Dioxins* (Appendix Table A2). Because the EPA human health criteria specify TCDD, Ecology's policy for the 2006 list will be to list solely on basis of TCDD concentrations.

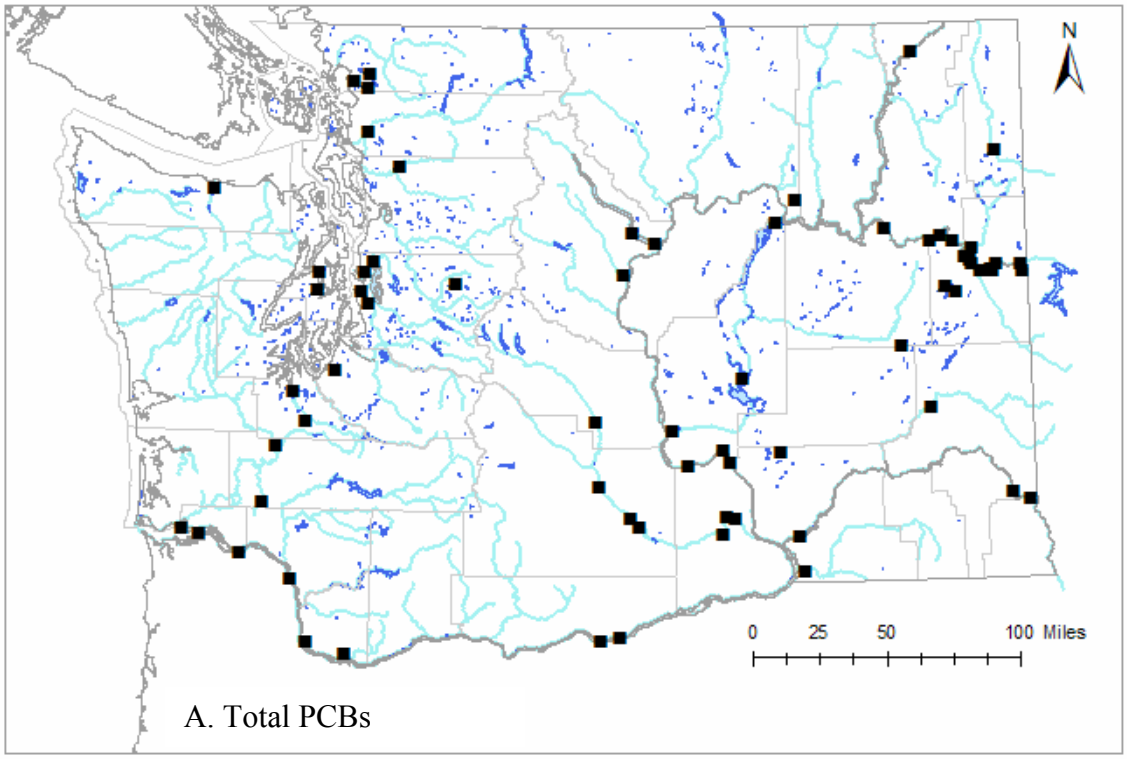
Table 2. 2004 303(d) Listings Based on Total PCB Concentrations that Exceed the NTR Criterion* by Less than a Factor of 3.

Waterbody	Species	Sampling Date	N=	Total PCBs (ug/Kg, wet)
Pend Oreille River	BT	2002	1	5.4
Elwha River	RBT	1999	3	3.0-5.6
Buffalo Lake	LMB	2002	1	5.6
Vancouver Lake	LMB	2002	1	6.0
Calligan Lake	RBT	2002	1	7.0
Ward Lake	LMB, RBT, CTT, KOK	1999	4	4.4-7.1
Keechelus Lake	MWF	2001	1	7.9
Scooteney Reservoir	CAT, WAL, YP	2003	3	7.3-9.8
Lacamas Lake	LMB	2003	1	7.9-9.9
Padden Lake	CTT	2001	1	10.8
Kitsap Lake	LMB, CTT, RBT	2002	1	4.7-11.5
Sprague Lake	CAT, RBT, SMB, WAL	2003	4	2.5-12.1
Samish Lake	CTT	2002	1	13.1
McIntosh Lake	BT	2001	1	13.1

*5.3 ug/Kg, wet

BT=brown trout RBT=rainbow trout LMB=largemouth bass CTT=cutthroat trout KOK=kokanee MWF=mountain whitefish CAT=channel catfish WAL=walleye YP=yellow perch SMB=smallmouth bass

N= number of samples



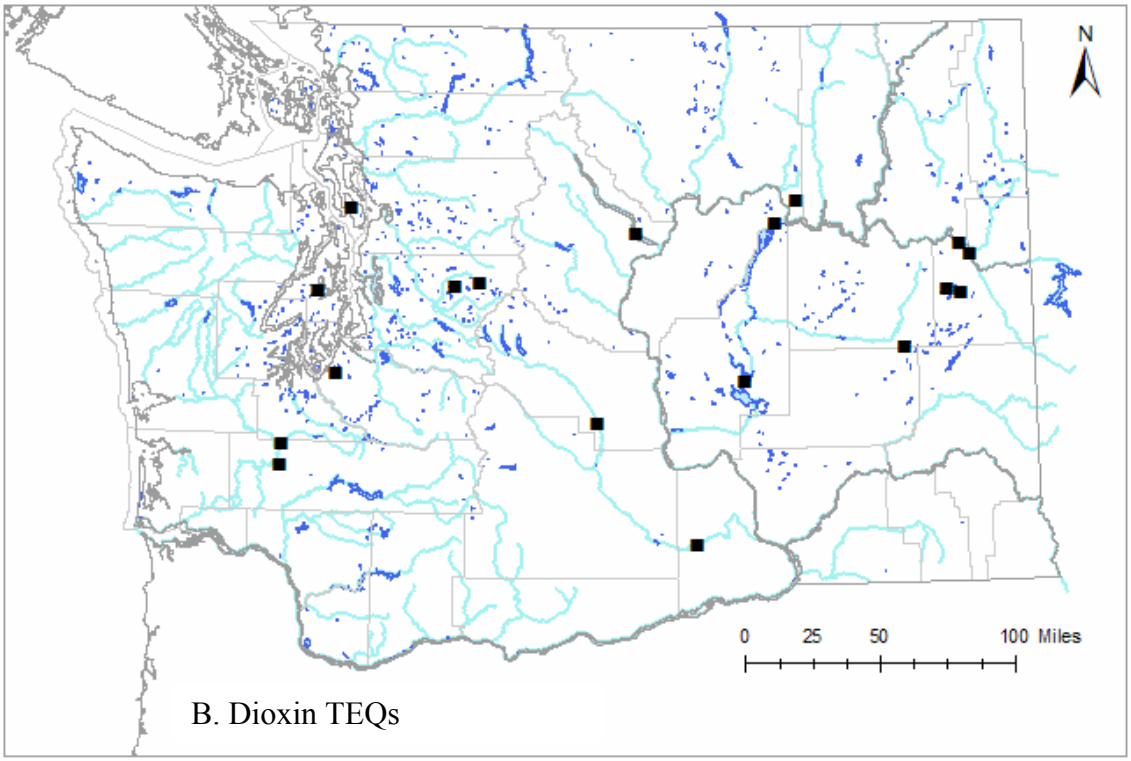


Figure 1. Location of 2004 303(d) Listings for Total PCBs and Dioxin TEQs.

The TCDD and TEQ concentrations behind the 2004 freshwater listings are shown in Table 3. TEQs in a number of these waterbodies are well above the criterion. However, in all but two cases, the TCDD concentrations are either close to the human health criterion or the concentrations are uncertain due to high reporting limits. As with PCBs, many of these waterbodies are in drainages with no obvious sources of dioxins.

Thus, approximately one third of the current 303(d) listings for PCBs and dioxins are based on concentrations that are not substantially above criteria and are for waterbodies without known or apparent sources of contamination.

Table 3. TCDD and TEQ Concentrations in 2004 303(d) Waterbodies Listed For Exceeding the NTR Criterion* for TCDD TEQs [all freshwater listings].

Waterbody	Species	Sampling Date	N=	2,3,7,8-TCDD (ng/Kg wet)	TEQs (ng/Kg wet)
Keechelus Lake	MWF	2001	1	0.04	NR
Yakima River	RBT, LSS	1996	6	<0.02-0.04	0.27-1.2
Dorothy Lake	BT	2000	1	0.06	NR
Calligan Lake	RBT	2002	1	0.07	NR
Lone Lake	RBT	2001	1	0.08	NR
Buffalo Lake	LMB	2002	1	<0.10	NR
Silver Lake	BT	2003	1	<0.13	0.20
Spokane River	RBT	2003	1	<0.13	0.36
Banks Lake	LWF, RBT	2003	2	<0.13-<0.15	0.13-0.45
Chehalis River	MWF	1998	1	0.17	0.51
Yakima River	MWF	1998	6	<0.05-0.18	2.4-4.4
Dillenbaugh Creek	CTT	1998	1	0.26	2.6
Sprague Lake	RBT, WAL, CTT	2003	3	<0.14-<0.31	0.068-0.22
Chelan Lake	LT	2000	1	0.40	1.7
West Medical Lake	RBT	2002	1	<0.52	0.084
American Lake	KOK, RBT	2002	1	<0.72	0.19
Kitsap Lake	CTT	2002	2	<0.68-<0.78	0-0.0702
Moses Lake	RBT	2002	1	<0.49-<0.82	0-0.12
Long Lake (Spokane R.)	MWF	2002	1	<0.96	0.086

*0.07 ng/Kg, wet
NR = not reported in the source document or in EIM
MWF=mountain whitefish RBT=rainbow trout LSS = largescale sucker BT=brown trout
LMB=largemouth bass LWF=lake whitefish CTT=cutthroat trout WAL=walleye
LT=lake trout KOK=kokanee
N = number of samples

Recent Data

The 2004 303(d) list is not representative of PCB and dioxin levels in Washington because it is biased toward contaminated sites and includes studies that go back to the 1980s. A more recent and balanced assessment is provided in the 2004-05 results from Ecology's Washington State Toxics Monitoring Program (WSTMP; Seiders et al., 2007). The bulk of the new fish tissue listings for 2008 will come from these data.

The 2004-05 WSTMP analyzed PCBs, PCDDs/PCDFs, and other chemicals in 105 fish fillet samples from 49 locations in 35 waterbodies statewide (Figure 2). The data are in Appendix Table B1.

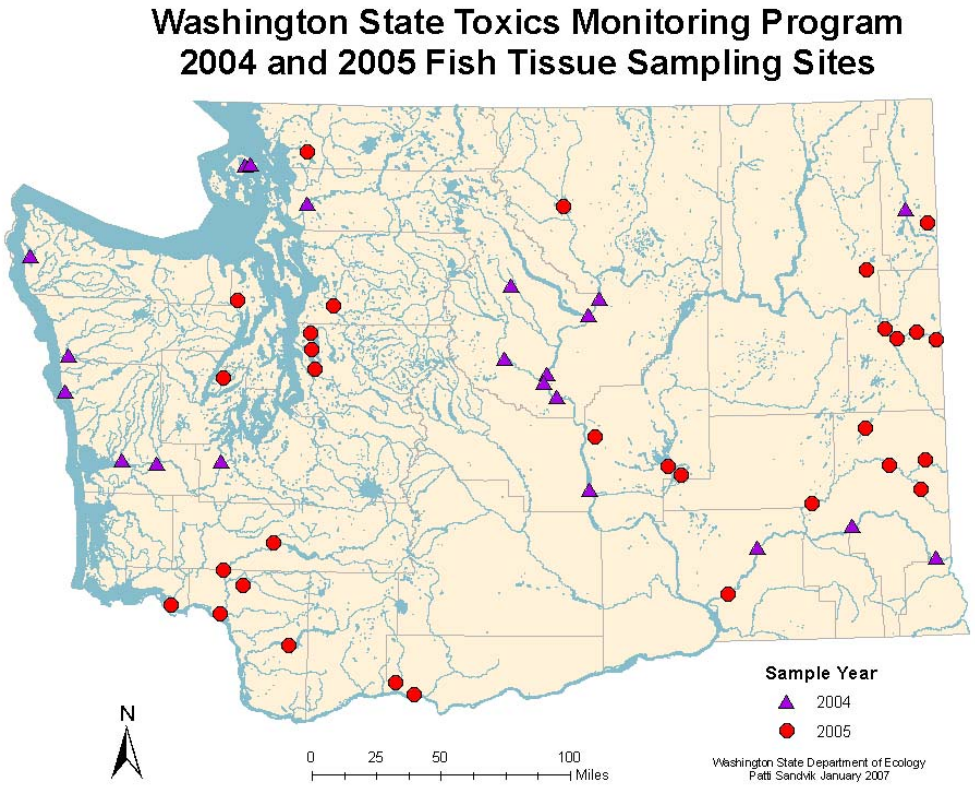
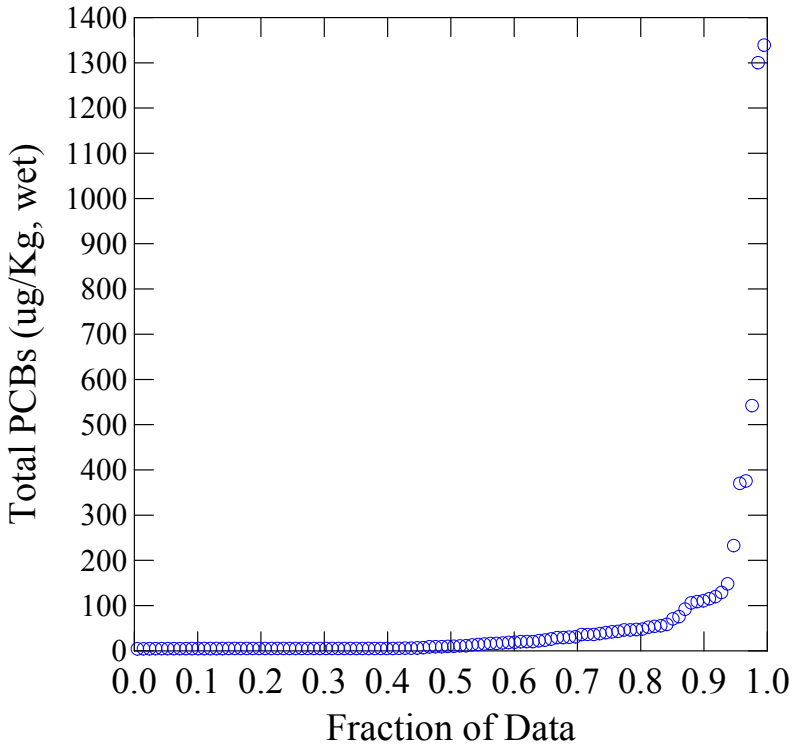


Figure 2. (From Seiders et al., 2007)

The distribution of the total PCB and TCDD values in this data set is shown in Figure 3 (non-detects plotted at the reporting limit). The PCB data are from an Aroclor-equivalents analysis.[7]

[7] PCBs are mixtures of over 150 individual compounds. In the United States, PCBs were primarily manufactured and sold under the trade name Aroclors. PCBs are typically analyzed as equivalent concentrations of commercial Aroclor mixtures (e.g., PCB-1254) or as individual compounds, referred to as PCB congeners. A congener analysis gives lower detection limits and is more expensive. PCB congeners were analyzed in a subset of 2004-05 WSTMP samples (see Appendix B).



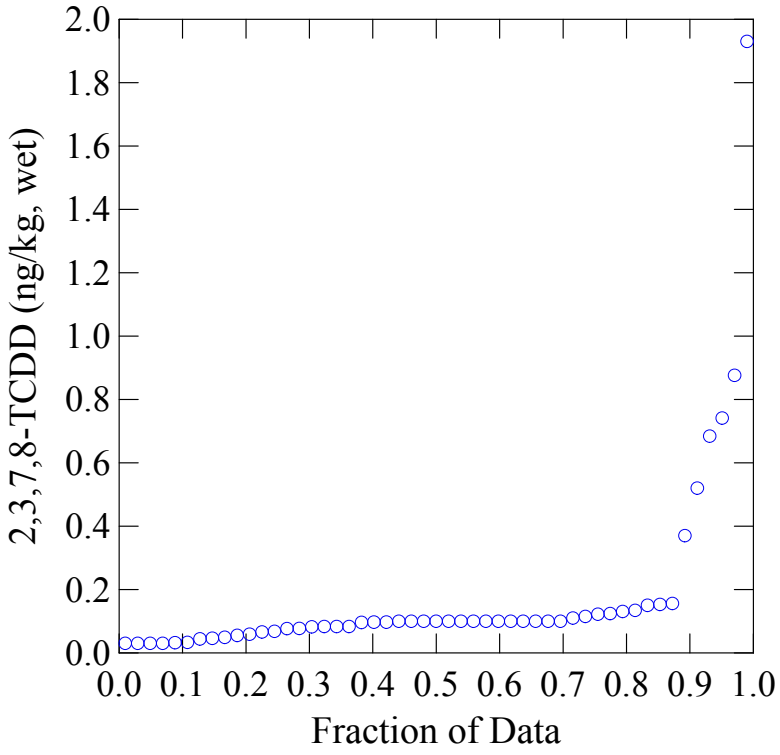


Figure 3. PCB and TCDD Concentrations in Freshwater Fish Fillets Analyzed Statewide for the 2004-05 WSTMP (N = 105 and 51, respectively; Seiders et al., 2007).

Implications of the 2004-05 WSTMP results for future 303(d) listings include the following:

PCBs

- Approximately half the samples have less than 10 ug/Kg total PCBs.
- 37 sites (58% of samples) qualify for 303(d) listing.
- 15 sites (14% of samples) that qualify for listing exceed the criterion by less than a factor of three and have no apparent local sources of PCBs.
- Criterion compliance is uncertain in 30% of the samples due to high reporting limits.

Dioxin

- Approximately two thirds of the samples have less than 0.1 ng/Kg TCDD.
- 18 sites (49% of samples) qualify for 303(d) listing.
- 14 sites (27% of samples) that qualify for listing exceed the criterion by less than a factor of three and have no apparent local sources of TCDD.
- Criterion compliance is uncertain in 27% of the samples due to high reporting limits.

The 2004-05 WSTMP illustrates that PCBs and dioxins continue to be ubiquitous in Washington lakes and rivers. It also demonstrates the need for a better understanding of what constitutes background for these compounds.

Quality Objectives

Quality objectives for this project are to obtain data of sufficient quality so that uncertainties are minimized and the results are comparable to human health criteria and data from previous studies. These objectives will be achieved through careful attention to the sampling, measurement, and quality control (QC) procedures described in this plan.

Measurement Quality Objectives

The chemical analyses for this project will be conducted by an accredited laboratory, through a contract with the Ecology Manchester Environmental Laboratory (MEL). MEL's contractor is expected to meet all QC requirements of the analytical methods being used for this project. Measurement quality objectives (MQOs) are shown in Table 4.

Table 4. Measurement Quality Objectives for PCB and Dioxin Background Study.

Analysis	Laboratory Duplicates (RPD)	Laboratory Control Samples (%)	Calibration Verification (%)	Ongoing Precision and Recovery (%)	Labeled Compound Recovery in Samples (%)	Lowest Concentration of Interest
PCBs	≤ 50	80-120	70 - 130 unlabeled, 50-150 labeled	50-150 unlabeled, 30-140 labeled	25-150	0.05 ug/Kg wet weight
PCDDs/PCDFs*	≤ 50	80-120	78 - 129 unlabeled, 82-121 labeled	67-158 unlabeled, 20-175 labeled	25-164	0.02 ng/Kg wet weight
Percent lipids	≤ 20	80-120	NA	NA	NA	0.1 %

*Method acceptance limits vary with congener; MQOs shown are for 2, 3, 7, 8-TCDD
RPD = relative percent difference
NA = not applicable

Results on duplicate samples (splits) provide estimates of analytical precision. The laboratory control sample for this project will be National Research Council Canada CARP-2 which has reference concentrations for selected PCB and PCDD/PCDF congeners (http://inms-ienm.nrc-cnrc.gc.ca/calserv/crm_e.html). The MQOs for calibration verification, ongoing precision and recovery, and labeled compound recovery correspond to the QC acceptance limits of the analytical methods.

The lowest concentrations of interest shown in Table 4 are the low-end, reporting limits (PCBs) or method detection limits (TCDD) achieved on recent WSTMP samples. For the present study, MEL will request that the contractor report down to their MDL (method detection limit) for TCDD and flag results between the MDL and PQL (practical quantitation limit) as estimates. This should improve the ability to assess compliance with the 0.07 ng/Kg human health criterion. It is anticipated that meeting the MQOs for the lowest concentrations of interest will permit background levels of PCBs and dioxins to be quantified in most samples.

Sampling Design

PCB and Dioxin Sources

PCBs were used in closed industrial systems such as electrical transformers and capacitors, plasticizers, lubricants, and hydraulic fluids, as well as in inks and sealers for gaskets and furnaces. Manufacture and use of PCBs were banned by EPA in the 1970s and 1980s due to ecological concerns.

Dioxins are unintended by-products found in association with certain industrial sites, waste incinerators, and combustion—especially of chlorinated material. Pulp and paper mills using chlorine in their bleaching process, a practice discontinued in the 1990s, were a major historical source of dioxins in the Pacific Northwest. Nationwide, reductions in dioxin emissions have occurred from a combination of regulatory activities, improved emission controls, voluntary actions on the part of industry, and the closing of a number of facilities.

PCBs and dioxins enter waterbodies through a combination of direct discharge, runoff, and atmospheric deposition. Deposition occurs because these compounds are sufficiently volatile to evaporate and they then deposit in cooler regions. In the absence of local sources, PCB and dioxin levels can be elevated solely due to atmospheric deposition from outside sources. Meijer et al. (2003), for example, showed that >80% of the soil burden of PCBs in the northern hemisphere was derived from atmospheric as opposed to local sources. Contamination of polar and mountain lake food webs with PCBs, dioxins, and other organochlorines has been attributed to atmospheric sources (Wania and Mackay, 1993; Gillian and Wania, 2005).

Selection of Background Waterbodies

For purposes of this study, the term *background* denotes a waterbody where the only known or likely PCB and dioxin source of significance is the atmosphere. These are lakes and rivers where there is no reason to suspect past use or sources of PCBs or dioxins in the watershed.

Background sites were selected by examining Washington state maps and GIS coverages showing population density, agricultural land use, public lands, annual precipitation, and wind direction. This exercise identified areas that have a low probability of local sources of contamination.

Fish biologists and resource managers for Washington Department of Fish and Wildlife, National Park Service, U.S. Forest Service, and Ecology were asked to identify potential background lakes and rivers within these areas, using the following criteria:

- Elevation under approximately 3,000 feet.
- Watershed relatively undisturbed or logging only.
- At least two non-planted fish species of catchable size.
- Good accessibility.

Based on the mapping exercise and response to recommendations, four lakes/impoundments and two rivers were selected for sampling in each of four regions: Western Washington, West Slope of the Cascades, East Slope of the Cascades, and Eastern Washington. The location of these regions relative to the Pacific Ocean air mass and atmospheric sources in urban Puget Sound and the barrier to these influences caused by the Cascade Mountains has the potential to result in substantially different rates of chemical deposition.

The appropriateness of the waterbodies recommended as background sites was checked against Ecology's Facility Site Identification System (http://ecyapps3/facilitysite/). This system identifies sites known to Ecology as having an active or potential impact on the environment. Table 5 has the final list of 28 waterbodies proposed for sampling; their locations are shown in Figure 4.

An effort was made to distribute the sampling effort along a north-south gradient within each of the four regions. The waterbodies selected include a mix of impoundments and natural waterbodies of various sizes, as is the case with the 303(d) list. It was difficult to locate appropriate background sites within the major agricultural basins of Eastern Washington; that is, the Yakima, Columbia, Palouse, and Walla Walla.

The sampling effort is weighted toward lakes because of the low diversity of fish species in most rivers that might qualify as background and the greater ability of fish to move into and out of rivers as opposed to lakes. Lakes and impoundments also dominate the 303(d) list.

While pristine, high mountain lakes obviously qualify as background, they are not being included in this study because of enhanced atmospheric deposition due to colder temperatures and larger amounts of precipitation (Gillian and Wania, 2005). High lakes have the additional drawbacks of difficult access and low fish diversity.

The U.S. Geological Survey (USGS) has analyzed PCBs in fish from 14 Washington mountain lakes over 3,000 feet in elevation (Moran et al., 2007). Of the 19 samples analyzed in this study, 78% were non-detected for PCBs because a relatively insensitive gas chromatography-electron capture method was used (50 ug/Kg reporting limit). However, USGS estimated concentrations of 17 – 20 ug/Kg total PCBs in approximately 20% of the samples, higher levels than a number of the waterbodies on the 303(d) list. This finding supports the approach of using lower elevation sites as a reference for 303(d) listed waters.

Table 5. Lakes and Rivers Proposed as Background Sites for PCB and Dioxin Study.

Region and Waterbody Name	Location	Lake Elevation (ft)	Lake Area (acres)	River Drainage Area (mi^2)	Lati-tude	Longi-tude
Western Washington						
Mountain Lake	Moran SP, Orcas Island	914	198	- -	48.66	122.82
Ozette Lake	Olympic NP	29	7,787	- -	48.10	124.64
Quinault River	Quinault Reservation/Olympic NP	- -	- -	264	47.54	123.74
Cushman Lake	Olympic NF	731	4,003	- -	47.47	123.25
North River	Chehalis River drainage	- -	- -	219	46.83	123.59
Radar Ponds	Naselle River drainage	1,125	7.8	- -	46.42	123.83
West Slope Cascades						
Baker Lake	N. Cascade NP/Baker-Snoqualmie NF	724	3,616	- -	48.72	121.66
Sauk River	Baker-Snoqualmie NF	- -	- -	714	48.17	121.47
Spada Lake	Baker-Snoqualmie NF	1,435	1,870	- -	47.97	121.65
Chester Morse Lake	Baker-Snoqualmie NF	1,555	1,682	- -	47.39	121.70
Lewis River	Gifford-Pinchot NF	- -	- -	227	46.18	121.83
Merrill Lake	Lewis River drainage	1,541	344	- -	46.09	122.33
East Slope Cascades						
Patterson Lake	Okanogan NF	2,740	18	- -	48.46	120.24
Entiat River	Wenatchee NF	- -	- -	419	47.93	120.51
Fish Lake	Wenatchee NF	2,257	513	- -	47.83	120.70
Cle Elum Lake	Wenatchee NF	2,224	4,810	- -	47.29	121.11
Bumping Lake	Wenatchee NF	3,426	1,310	- -	46.85	121.32
Klickitat River	Klickitat County	- -	- -	1,297	45.94	121.13
Eastern Washington						
Pierre Lake	Colville NF	2,012	106	- -	48.91	118.13
Kettle River	Colville NF	- -	- -	4,070	48.97	118.22
Omak Lake	Colville Reservation	954	3,244	- -	48.28	119.40
Turnbull NWR	South of Cheney	~2,300	to 361	- -	47.44	117.59
Quincy Wildlife Area	South of Quincy	~1,000	to 235	- -	47.14	119.92
Grande Ronde River	Umatilla NF	- -	- -	3,950	46.04	117.25

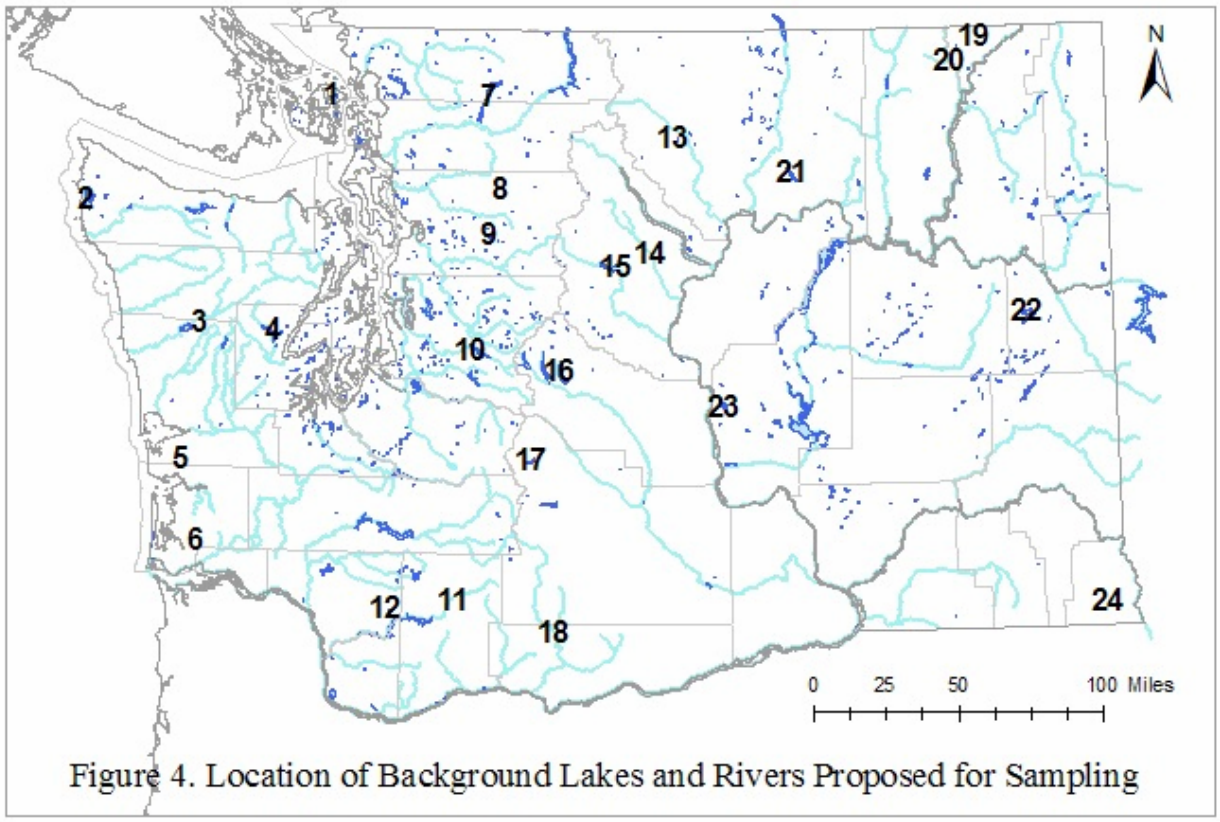


Figure 4. Location of Background Lakes and Rivers Proposed for Sampling

Key to Figure 4:

Western Washington	West Slope	East Slope	Eastern Washington
1 = Mountain Lake	7 = Baker Lake	13 = Patterson Lake	19 = Pierre Lake
2 = Ozette Lake	8 = Sauk River	14 = Entiat River	20 = Kettle River
3 = Quinault River	9 = Spada Lake	15 = Fish Lake	21 = Omake Lake
4 = Cushman Lake	10 = Chester Morse Lake	16 = Cle Elum Lake	22 = Turnbull NWR
5 = North River	11 = Lewis River	17 = Bumping Lake	23 = Quincy Wildlife Area
6 = Radar Ponds	12 = Merrill Lake	18 = Klickitat River	24 = Grande Ronde River

PCB congeners and PCDDs/PCDFs have been analyzed in one fish tissue sample each from five of the proposed background waterbodies (Table 6). Results showed low PCB levels of 0.9 – 10 ug/Kg. An Aroclor analysis of the 10 ug/Kg sample was non-detect at 4.8 ug/Kg. TCDD concentrations in these samples were below detection limits (<0.10 ng/Kg).

Table 6. Existing Data on PCBs and TCDD in Fish Fillets from Background Waterbodies Proposed for Sampling (wet weight).

Region and Waterbody Name	Year Sampled	Species Analyzed	N =	Total PCBs* (ug/Kg)	2,3,7,8-TCDD (ng/Kg)	Reference
Western Washington						
Mountain Lake	2004	KOK	1	10†	<0.10	Seiders et al. (2007)
Ozette Lake	2005	NPM	1	0.9	<0.10	Seiders et al. (2007)
West Slope Cascades						
Chester Morse Lake	2006	PWF	1	<2.0	NA	WSTMP (unpub)
East Slope Cascades						
Patterson Lake	2003	LMB	1	5.6 est.	<0.10	EPA (2005)
Entiat River	2004	RBT	1	3.8	NA	Seiders et al. (2007)
Eastern Washington	no data					

*HR-GC/MS analysis, except Aroclor-equivalents analyzed for Chester Morse Lake
†Total PCB result from an Aroclor analysis of this sample was <4.8 ug/Kg.
NA = not analyzed
KOK=kokanee NPM=northern pikeminnow PWF=pigmy whitefish LMB=largemouth bass
RBT=rainbow trout
N = number of samples

Fish Samples

This study will focus on the larger fish species more likely to be consumed and on which most of the contaminant data for Washington exist. The species of primary interest include: rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*), brook trout (*Salvelinus fontinalis*), kokanee (*Oncorhynchus nerka*), mountain whitefish (*Prosopium williamsoni*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), largescale suckers (*Catostomus macrocheilus*), pike minnow (*Ptychocheilus oregonensis*), and carp (*Cyprinus carpio).* Based on past experience, it is anticipated that one-to-three species of interest could be collected from each waterbody. An effort will be made to collect at least one predator and one bottom feeder from each site, as recommended by EPA (2000). No planted fish will be analyzed, unless planted as fingerlings.

Fish will be collected primarily during the late summer and fall of 2008. Most of 303(d) listings are based on studies conducted around this time frame, most notably the WSTMP and its predecessor the Washington State Pesticide Monitoring Program. These are the source of the majority of the toxics listings. Lipid content of most fish species is highest at this time and PCBs and dioxins are primarily associated with lipids.

Fillets will be analyzed for all fish samples. Each sample will consist of a composite of pooled tissues from five-to-ten individual fish, depending on size. Composite samples provide a more cost efficient estimate of mean contaminant concentrations than single fish samples. There will be one composite per species from each lake. To provide an indication of the potential effect fish size might have on the results, two size ranges of fish will be analyzed for several of the waterbodies, as the opportunity presents itself. Length, weight, age, and sex will be determined for each fish used in the composites.

Chemical Analysis

All samples will be analyzed for PCBs (>150 compounds), PCDDs/PCDFs (17 compounds), and percent lipids. HR-GC/MS methods will be used to give low detection limits. Lipids are being analyzed for use in normalizing contaminant concentrations between samples.

Table 7 summarizes sample size for this project and has an estimate of laboratory costs. The cost estimate includes MEL's 25% surcharge for contract laboratory services.

Table 7. Sample Size and Laboratory Cost Estimate for PCB and Dioxin Background Study.

Number of Waterbodies*	Average Number of Samples per Waterbody	Quality Control Split Samples	Total Samples	Lab Costs (per sample)				
				PCBs	PCDDs/ PCDFs	Percent Lipids	Fish Aging	Total Cost
24	2	6	54	$750	$850	$31	$60	$91,314

*Four lakes and two rivers in each of four regions

A subset of the background samples will be analyzed for PCB Aroclor-equivalents through the 2008 WSTMP.

Representativeness, Comparability, and Completeness

The intent of this sampling design is to obtain representative data on background concentrations of PCBs and dioxins in fish from Washington lakes and rivers, excluding high elevation waterbodies, as previously explained. Steps being taken to ensure representativeness include use of appropriate sampling and sample handling procedures, use of composite samples, and a statewide sampling network where a range of species and waterbody types are being sampled.

The field and laboratory methods being used are the same as or similar to recent Ecology and EPA studies of chemical contaminants in Washington freshwater fish.

The completeness goal for this project is to have valid, defensible data for all samples collected.

Sampling Procedures

Fish Collection

Fish sampling will follow the EA Program's Standard Operating Procedure (SOP) (Sandvik, 2006a at http://www.ecy.wa.gov/programs/eap/quality.html). Fish will be collected by electroshocking, beach seines, gill net, or hook and line. Only legal size fish will be taken. For species with no size limits, only those large enough to reasonably be retained for consumption will be retained. The latitude and longitude of the sampling sites will be recorded from a Global Positioning System receiver.

Fish selected for analysis will be killed by a blow to the head. Each fish will be given a unique identifying number and its length and weight recorded. The fish will be individually wrapped in aluminum foil, put in plastic bags, and placed on ice for transport to Ecology headquarters, where the samples will be frozen pending preparation of tissue samples.

Sample Preparation

Tissue samples will be prepared following the EA Program's SOP (Sandvik, 2006b at http://www.ecy.wa.gov/programs/eap/quality.html). Techniques to minimize potential for sample contamination will be used. People preparing the samples will wear non-talc nitrile gloves and work on heavy duty aluminum foil or a polyethylene cutting board. The gloves and foil will be changed between samples; the cutting board will be cleaned between samples as described below.

The fish will be thawed enough to remove the foil wrapper and rinsed with tap water, then deionized water to remove any adhering debris. The entire fillet from one or both sides of each fish will be removed with stainless steel knives and homogenized in a Kitchen-Aid blender. The fillets will be scaled and analyzed with the skin on. The sex of each fish will be recorded and hard structures saved for age determination (scales, otoliths, opercles, dorsal, and pectoral spines as appropriate for each species). Aging will be done by Washington Department of Fish and Wildlife or a private laboratory.

Five-to-ten individual fish will be used for each composite sample. To the extent possible, the length of the smallest fish in a composite will be no less than 75% of the length of the largest fish. The composites will be prepared using equal weights from each fish. The pooled tissues will be homogenized to uniform color and consistency, using a minimum of three passes through the blender. The homogenates will be placed in glass jars with Teflon lid liners and cleaned to EPA (1990) Quality Assurance/Quality Control specifications.

Cleaning of resecting instruments, cutting boards, and blender parts will be done by washing in tap water with Liquinox detergent, followed by sequential rinses with tap water, de-ionized water, and pesticide-grade acetone. The items will then be air dried on aluminum foil in a fume hood before use.

The tissue samples will be refrozen for shipment with chain-of-custody record to MEL. The samples will be stored frozen at MEL until shipped to the contract laboratory. Excess tissue will be retained for all samples and stored frozen at Ecology Headquarters. The holding time for tissue samples being analyzed for PCBs and PCDDs/PCDFs is up to one year (Methods 1668A, 1613B).

Measurement Procedures

Table 8 shows the numbers of samples to be analyzed, expected range of results, required reporting limits, and sample preparation and analysis methods. Analysis methods were chosen to give reporting limits equal to or less than the lowest concentrations of interest.

Table 8. Laboratory Procedures for PCB and Dioxin Background Study.

Analysis	Number of Samples*	Expected Range of Results	Reporting Limit†	Analytical Method
PCBs	54	0.50- 20 ug/Kg, wet weight	0.02-0.08 ug/Kg, wet weight	EPA 1668A
PCDDs/PCDFs	54	<0.1 - 2.0 ng/Kg wet weight	0.02-1.0 ng/Kg, wet weight	EPA 1613B
Percent lipids	54	0.1-10%	0.1%	MEL SOP #730009

*includes six split samples
†varies with congener; 0.02 ng/Kg for 2,3,7,8-TCDD (see Measurement Quality Objectives)

Quality Control Procedures

Field

No field QC samples are planned for this project.

Laboratory

The QC procedures that MEL routinely requires of its contractors for these analyses will be satisfactory for purposes of this project. Laboratory QC samples to be analyzed are shown in Table 9.

Table 9. Laboratory Quality Control Samples for PCB and Dioxin Background Study.

Analysis	Duplicates	LCS	Method Blanks	OPR Standards	Labeled Compounds
PCBs	2/batch*	1/batch	1/batch	all samples	all samples
PCDDs/PCDFs	2/batch	1/batch	1/batch	all samples	all samples
Percent Lipids	2/batch	1/batch	1/batch	NA	NA

*One batch is $\leq$ 20 samples; project samples will be submitted in three batches
LCS = laboratory control sample
OPR = ongoing precision and recovery
NA = not applicable

For the laboratory duplicates, two composites will be split and analyzed in duplicate with each batch of samples. The duplicates will be prepared by Ecology HQ personnel at the time the samples are homogenized and submitted blind to the contractor. The LCS for this project is CARP-2, as previously mentioned.

Data Management Procedures

Field data and data from preparation of the tissue samples will be recorded in a bound notebook of waterproof paper.

The data package from the contract laboratory will include a case narrative discussing any problems with the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers. The narrative should address condition of the samples on receipt, methods of analysis, sample preparation, instrument calibration, recovery data, and results on QC samples. This information is needed to evaluate the accuracy of the data and to determine whether the MQOs were met.

The contract laboratory will provide the sample results in Excel spreadsheet format and include calculation of PCB homologue totals, total PCBs, and TEQs for PCDDs/PCDFs. TEQs will be calculated using the TEFs (toxic equivalency factors) in Van den Berg et al. (1998).

All project data will be entered into Ecology's Environmental Information Management System (EIM). Data entered into EIM follow a formal data review procedure where the data are reviewed by the project lead, the person entering the data, and an independent reviewer.

Audits and Reports

Audits

MEL participates in performance and system audits of their routine procedures. Results of these audits are available on request.

Reports

The following reports will be prepared for this project:

1. A draft technical report for review by EPA, Ecology Water Quality Program, and other interested parties. The tentative date for the draft is October 2009. The responsible staff member is Art Johnson
2. A final technical report is anticipated in December 2009. The responsible staff member is Art Johnson
3. The project data will be entered into EIM on or before December 2009. The responsible staff member is Art Johnson.

Data Verification

MEL will conduct a review of all laboratory data and case narratives. MEL will verify that:

- Methods and protocols specified in this Quality Assurance Project Plan were followed.
- All calibrations, checks on quality control, and intermediate calculations were performed for all samples.
- Data are consistent, correct, and complete, with no errors or omissions.

Evaluation criteria will include the acceptability of holding times, procedural blanks, calibration, internal standard recoveries, ion abundance ratios, duplicates, laboratory control samples, and appropriateness of data qualifiers assigned. MEL will prepare written data verification reports based on the results of their data review. A case summary will meet the requirements for a data verification report.

To determine if project MQOs have been met, results for laboratory duplicates, laboratory control samples, ongoing precision and recovery, and labeled compounds recovery will be compared to QC limits. The method blanks' results will be examined to verify there was no significant contamination of the samples. To evaluate whether the targets for reporting limits have been met, the results will be examined for *non-detects* and to determine if any values exceed the lowest concentration of interest.

The project lead will review the laboratory data packages and MEL's data verification report. Based on these assessments, the data will be either accepted, accepted with appropriate qualifications, or rejected and re-analysis considered.

Data Usability Assessment

Once the data have been verified, the project lead will determine if they can be used to make the calculations, determinations, and decisions for which the project was conducted. If the results are satisfactory, data analysis will proceed.

Summary statistics will be tabulated for each parameter. The data will be plotted to identify exceedances of human health criteria and to compare contaminant concentrations between sampling sites and species. If a correlation exists between chemical concentrations and lipid content, the data will be normalized to percent lipids and re-examined for site and species differences. Outliers will be identified.

Data sets from other recent fish tissue surveys in Washington will be compiled, including any data resulting in Category 5 listings for the 2008 303(d) list. As previously mentioned, WSTMP will analyze Aroclor-equivalents in a subset of the background samples. The results, along with other paired determinations of PCB congener and Aroclor-equivalents in local freshwater fish samples, will be evaluated to assess the correspondence between these two methods. Many 303(d) listings are based solely on an Aroclor-equivalent analysis. The distribution of values in the total data set on PCBs and PCDDs/PCDFs in Washington freshwater fish will be examined to identify and prioritize concentration levels for TMDLs.

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Appendix A. 2004 303(d) Listings

Table A1. 2004 303(d) Listings for PCBs in Edible Tissue.

Listing ID	Category	WRIA	Waterbody Name	Parameter	Medium	Map Link
17299	5	1	PADDEN LAKE	Total PCBs	Tissue	No Map Link
14025	5	1	WHATCOM LAKE	Total PCBs	Tissue	14025
17366	5	3	SAMISH LAKE	Total PCBs	Tissue	17366
14036	5	3	SKAGIT RIVER	Total PCBs	Tissue	14036
43251	5	7	CALLIGAN LAKE	Total PCBs	Tissue	43251
17383	5	8	GREEN LAKE	Total PCBs	Tissue	17383
43482	5	8	WASHINGTON LAKE	Total PCBs	Tissue	43482
33698	5	9	DUWAMISH WATERWAY AND RIVER	Total PCBs	Tissue	33698
14090	5	9	DUWAMISH WATERWAY AND RIVER	Total PCBs	Tissue	14090
42169	5	12	AMERICAN LAKE	Total PCBs	Tissue	42169
17431	5	13	MCINTOSH LAKE	Total PCBs	Tissue	No Map Link
7022	5	13	WARD LAKE	Total PCBs	Tissue	7022
17161	5	15	CLEAR CREEK	Total PCBs	Tissue	17161
42170	5	15	KITSAP LAKE	Total PCBs	Tissue	42170
7023	5	18	ELWHA RIVER	Total PCBs	Tissue	7023
8741	5	23	CHEHALIS RIVER	Total PCBs	Tissue	8741
8765	5	25	COLUMBIA RIVER	Total PCBs	Tissue	8765
8773	5	25	COLUMBIA RIVER	Total PCBs	Tissue	8773
8772	5	25	COLUMBIA RIVER	Total PCBs	Tissue	8772
17164	5	26	COWLITZ RIVER	Total PCBs	Tissue	17164
8783	5	27	COLUMBIA RIVER	Total PCBs	Tissue	8783
43465	5	28	LACAMAS LAKE	Total PCBs	Tissue	43465
42172	5	28	VANCOUVER LAKE	Total PCBs	Tissue	42172
18802	5	31	COLUMBIA RIVER	Total PCBs	Tissue	18802
18801	5	31	COLUMBIA RIVER	Total PCBs	Tissue	18801
8810	5	32	WALLA WALLA RIVER	Total PCBs	Tissue	8810
8755	5	33	SNAKE RIVER	Total PCBs	Tissue	8755

8820	5	34	PALOUSE RIVER	Total PCBs	Tissue	8820
42412	5	34	SILVER LAKE	Total PCBs	Tissue	42412
42386	5	34	SPRAGUE LAKE	Total PCBs	Tissue	42386
19120	5	35	SNAKE RIVER	Total PCBs	Tissue	19120
19121	5	35	SNAKE RIVER	Total PCBs	Tissue	19121
19390	5	36	COLUMBIA RIVER	Total PCBs	Tissue	19390
19393	5	36	COLUMBIA RIVER	Total PCBs	Tissue	19393
19391	5	36	COLUMBIA RIVER	Total PCBs	Tissue	19391
43385	5	36	SCOOTENEY RESERVOIR	Total PCBs	Tissue	43385
20047	5	37	YAKIMA RIVER	Total PCBs	Tissue	20047
20045	5	37	YAKIMA RIVER	Total PCBs	Tissue	20045
14261	5	37	YAKIMA RIVER	Total PCBs	Tissue	14261
8864	5	37	YAKIMA RIVER	Total PCBs	Tissue	8864
7350	5	37	YAKIMA RIVER	Total PCBs	Tissue	7350
8863	5	37	YAKIMA RIVER	Total PCBs	Tissue	8863
43146	5	39	KEECHELUS LAKE	Total PCBs	Tissue	No Map Link
20219	5	39	YAKIMA RIVER	Total PCBs	Tissue	20219
8953	5	41	LOWER CRAB CREEK	Total PCBs	Tissue	8953
42171	5	41	MOSES LAKE	Total PCBs	Tissue	42171
42269	5	42	BANKS LAKE	Total PCBs	Tissue	42269
42173	5	43	WEST MEDICAL LAKE	Total PCBs	Tissue	No Map Link
14299	5	45	WENATCHEE RIVER	Total PCBs	Tissue	14299
8964	5	47	CHELAN LAKE	Total PCBs	Tissue	8964
14328	5	47	CHELAN RIVER	Total PCBs	Tissue	14328
43215	5	53	BUFFALO LAKE	Total PCBs	Tissue	43215
36441	5	54	LONG LAKE (RESERVOIR)	Total PCBs	Tissue	36441
36440	5	54	LONG LAKE (RESERVOIR)	Total PCBs	Tissue	36440
9015	5	54	LONG LAKE (RESERVOIR)	Total PCBs	Tissue	9015
9021	5	54	LONG LAKE (RESERVOIR)	Total PCBs	Tissue	9021
14385	5	54	SPOKANE RIVER	Total PCBs	Tissue	14385
14400	5	54	SPOKANE RIVER	Total PCBs	Tissue	14400
9033	5	54	SPOKANE RIVER	Total PCBs	Tissue	9033

9027	5	54	SPOKANE RIVER	Total PCBs	Tissue	9027
9051	5	55	LITTLE SPOKANE RIVER	Total PCBs	Tissue	9051
17484	5	57	LIBERTY LAKE	Total PCBs	Tissue	17484
14402	5	57	SPOKANE RIVER	Total PCBs	Tissue	14402
14398	5	57	SPOKANE RIVER	Total PCBs	Tissue	14398
14397	5	57	SPOKANE RIVER	Total PCBs	Tissue	14397
8202	5	57	SPOKANE RIVER	Total PCBs	Tissue	8202
8201	5	57	SPOKANE RIVER	Total PCBs	Tissue	8201
8207	5	57	SPOKANE RIVER	Total PCBs	Tissue	8207
14407	5	61	COLUMBIA RIVER	Total PCBs	Tissue	14407
43383	5	62	PEND OREILLE RIVER	Total PCBs	Tissue	43383

Table A2. 2004 303(d) Listings for Dioxins in Edible Tissue.

Listing ID	Category	WRIA	Waterbody Name	Parameter	Medium	Map Link
42443	5	12	AMERICAN LAKE	2,3,7,8-TCDD	Tissue	42443
42437	5	15	KITSAP LAKE	2,3,7,8-TCDD	Tissue	42437
42431	5	34	SILVER LAKE	2,3,7,8-TCDD	Tissue	42431
42405	5	34	SPRAGUE LAKE	2,3,7,8-TCDD	Tissue	42405
42434	5	41	MOSES LAKE	2,3,7,8-TCDD	Tissue	42434
42440	5	42	BANKS LAKE	2,3,7,8-TCDD	Tissue	42440
42381	5	43	WEST MEDICAL LAKE	2,3,7,8-TCDD	Tissue	No Map Link
42410	5	54	LONG LAKE (RESERVOIR)	2,3,7,8-TCDD	Tissue	42410
42411	5	54	SPOKANE RIVER	2,3,7,8-TCDD	Tissue	42411
43162	5	6	LONE LAKE	Dioxin	Tissue	No Map Link
43233	5	7	CALLIGAN LAKE	Dioxin	Tissue	43233
43094	5	7	DOROTHY LAKE	Dioxin	Tissue	43094
36354	5	23	CHEHALIS RIVER	Dioxin	Tissue	36354
36355	5	23	DILLENBAUGH CREEK	Dioxin	Tissue	36355
34887	5	37	YAKIMA RIVER	Dioxin	Tissue	34887
43128	5	39	KEECHELUS LAKE	Dioxin	Tissue	No Map Link
34889	5	39	YAKIMA RIVER	Dioxin	Tissue	34889
43061	5	47	CHELAN LAKE	Dioxin	Tissue	43061
43197	5	53	BUFFALO LAKE	Dioxin	Tissue	43197
36166	5	9	PUGET SOUND (CENTRAL)	Dioxins, Total	Tissue	36166

Appendix B. WSTMP 2004/2005 Data

Table B-1. Summary of Fish Tissue Sample Results: WSTMP 2004-05 (Seiders et al., 2007).

Site	Species Code	Manchester Environmental Laboratory (MEL) Sample ID	WSTMP Study Year	Date collect	Total PCB aroclors (ug/kg)	Total PCB congeners (ug/kg)	T-DDT (ug/kg)	Total PBDE (ug/kg)	Total Chlordane (ug/kg)	2378 TCDD TEQ (ng/kg)	2378 TCDD (ng/kg)	Mercury (mg/kg)	Lipid - MEL (%)	Lipid - Contract Lab (%)	Mean Total Length (mm)	Mean Weight (g)	Mean Age (years)
Bead Lake	BUR	05514700	2005	10/26/05	5.0 U		1.4	6.2 UJ	1.0 U			0.130	0.4		650	1846	5.6
Bead Lake	KOK	05514701	2005	10/26/05	16		16	2.6	0.95 U			0.030	1.7		267	178	3.0
Bead Lake	NPM	05514702	2005	10/26/05	36	21	29	4.1	0.99 U	1.04	0.134	0.260	8.2	8.1	503	1643	11.0
Bead Lake	PEA	05514703	2005	10/26/05	5.7		2.5	0.29	0.88 U			0.170	1.4		245	107	7.4
Black Lake	RBT	05084284	2004	9/16/04	9.1		1.1	4.8	0.29			0.100	1.9		292	229	1.9
Cascade Lake, Orcas Island	KOK	05084286	2004	9/30/04	4.8 U		0.53	1.6	0.96 U			0.199	2.8		415	686	2.0
Cascade Lake, Orcas Island	KOK	05084285	2004	9/30/04	4.9 U		0.32	2.9	0.97 U			0.241	5.3		205	87	1.0
Cascade Lake, Orcas Island	LMB	05084287	2004	9/29/04	4.7 U		0.33	0.39	0.94 U			0.194	1.0		304	448	2.3
Cascade Lake, Orcas Island	RBT	05084288	2004	9/29/04	4.9 U	1.1	0.49	2.4 UJ	0.94 U			0.201	0.7	1.3	303	280	1.1
Chehalis River, near Aberdeen	CHK	05084289	2004	10/18/04	5.0	5.1	2.6	2.3	0.76	0.089	0.100 U	0.049	3.6	3.3	910	7938	4.8
Chehalis River, near Satsop	CTT	05084280/4290	2004	9/8/04	9.6 m	13 m	8.9 m	0.88 m	0.36 m	0.099 m	0.100 U	0.054 m	4.0 m	5.6 m	330	376	3.0
Chehalis River, near Satsop	NPM	05084291	2004	9/8/04	13	17	4.5	2.7	0.49			0.964	0.6	1.4	415	650	8.9
Columbia River, above Rock Island Dam	NPM	05084292	2004	11/2/04	52	88	415	11	0.78	0.442	0.100 U	0.515	1.8	2.0	400	614	8.4
Columbia River, above Rock Island Dam	PEA	05084293	2004	11/2/04	15		151	6.2	0.23			0.110	2.3		257	159	4.0
Columbia River, above Rock Island Dam	WAL	05084294	2004	11/3/04	46	108	343	22	0.84	0.318	0.100 U	0.644	2.6	6.4	652	3601	9.0
Columbia River, below Rocky Reach Dam	MWF	05084295	2004	11/3/04	36	75	112	10	0.39	0.550	0.100 U	0.022	3.0	3.3	279	187	1.6
Columbia River, below Wanapum Dam	MWF	05084296	2004	11/4/04	54	91	406	50	2.4	0.652	0.150	0.042	6.9	6.7	355	472	3.3
Columbia River, below Wells Dam	MWF	05084281/4297	2004	10/28/04	71 m	92 m	430 m	40 m	1.5 m	0.606 m	0.115 U	0.073 m	4.3 m	5.4 m	353	454	3.6
Columbia River, near Cathlamet, RM 38-42	NPM	06024738	2005	8/30/05	76	46	32	17	2.5	0.345	0.110	0.596	2.0	2.5	466	956	9.2
Columbia River, near Cathlamet, RM 38-42	PEA	05524720	2005	8/30/05	47		27	13	1.0 U			0.140	1.6		275	189	6.4
Columbia River, near Beebe Bridge	NPM	05084298	2004	10/26/04	31	65	509	18	0.51			0.456	2.4	4.6	431	766	7.4
Columbia River, near Beebe Bridge	PEA	05084299	2004	10/26/04	14		197	4.4	0.23			0.130	1.4		259	155	4.3
Cowlitz R, 8 mi N of Castle Rock, RM 24-27	CTT	05514704/4705	2005	8/29/05	55 m	24 m	29 m	5.0 m	0.97 U	0.303 m	0.131 m	0.087 m	4.7 m	5.3 m	360	493	3.0
Cowlitz R, 8 mi N of Castle Rock, RM 24-27	MWF	05514706	2005	8/29/05	46		6.2	24	0.88 U			0.205	6.8		441	859	5.6
Cowlitz R, 8 mi N of Castle Rock, RM 24-27	NPM	05514707	2005	8/29/05	92	56	21	18	0.93 U	0.410	0.124	0.859	1.8	1.7	427	656	10.6
Entiat River, above Entiat Falls	RBT	05084300	2004	10/12/04	4.9 U	3.8	2.8	0.99	0.22			0.037	2.8	5.0	169	42	3.0
Haven Lake	CTT	06054771	2005	11/29/05	5.0 U		1.3	2.5	0.99 U			0.192	2.3		250	137	2.0
Haven Lake	LMB	06054770	2005	11/29/05	4.7 U		1.3	2.3	0.94 U			0.079	1.3		315	528	1.6
Haven Lake	RBT	06054769	2005	11/29/05	5.0 U	6.3	1.2	1.1	1.0 U	0.186	0.068	0.130	1.0	1.1	365	463	1.2

Table B-1 Continued

Site	Species Code	Manchester Environmental Laboratory (MEL) Sample ID	WSTMP Study Year	Date collect	Total PCB aroclors (ug/kg)	Total PCB congeners (ug/kg)	T-DDT (ug/kg)	Total PBDE (ug/kg)	Total Chlordane (ug/kg)	2378 TCDD TEQ (ng/kg)	2378 TCDD (ng/kg)	Mercury (mg/kg)	Lipid MEL (%)	Lipid - Contract Lab (%)	Mean Total Length (mm)	Mean Weight (g)	Mean Age (years)
Leland Lake	BC	06054752	2005	9/14/05	4.7 U		0.95 U	0.43	0.95 U			0.120	0.8		227	185	2.0
Leland Lake	BG	06054753	2005	9/14/05	4.8 U		0.97 U	6.0 UJ	0.97 U			0.130	0.8		168	101	2.0
Leland Lake	LMB	05514708	2005	9/14/05	11	6.2	1.9	1.5	0.96 U	0.181	0.122	0.834	0.9	1.0	481	1776	11.0
Leland Lake	YP	06054754	2005	9/14/05	4.9 U		0.98 U	6.1 UJ	0.98 U			0.196	0.5		217	131	2.2
Liberty Lake	SMB	06054755/4756	2005	10/11/05	24 m	11	23 m	3.2 m	0.99 m	0.048	0.044 J	0.154 m	1.6 m	1.7	375	764	3.8
Long Lake, 8 miles north of Othello	SMB	05514709	2005	8/24/05	4.9 U		3.0	6.1 UJ	0.98 U			0.110	1.0		303	397	3.2
Long Lake, 8 miles north of Othello	WAL	05514710	2005	8/24/05	4.5 U		9.6	0.34	0.90 U			0.207	1.3		437	765	3.4
Loon Lake	LMB	06054757	2005	10/26/05	16	11	5.7	1.7	0.92 U	0.084	0.066	0.280 n	1.4	2.0	455	1767	10.2
Mayfield Reservoir	LMB	05524721	2005	9/15/05	5.5	3.4	0.97 U	2.0	0.97 U	0.050 UJ	0.030 UJ	0.242	0.9	1.0	328	610	4.2
Mayfield Reservoir	NPM	05524722	2005	9/15/05	8.9	5.0	2.5	2.3	0.98 U	0.009	0.030 UJ	0.474	1.5	1.7	312	244	6.4
Mayfield Reservoir	YP	05524723	2005	9/15/05	5.0 U		1.0 U	0.38	1.0 U			0.084	0.5		237	164	4.0
Merwin Lake	KOK	06054758	2005	11/1/05	5.0 U		1.5	5.7	1.0 U			0.078	1.5		370	487	2.0
Merwin Lake	NPM	06054759	2005	11/1/05	20	10	4.9	5.6	0.95 U	0.219	0.059	0.373	2.1	1.4	436	919	6.8
Methow River, 2 mi SE of Winthrop, RM 47-49	CTT	05524724	2005	10/20/05	4.9 U	1.9	9.2	2.6	0.98 U	0.304	0.097	0.028	2.4	2.0	291	241	4.2
Methow River, 2 mi SE of Winthrop, RM 47-49	MWF	06024740	2005	10/20/05	4.9 U	1.3	1.4	11	0.99 U	0.214	0.083	0.037	3.9	2.5	358	505	4.8
Mountain Lake, Orcas Island (natural repro)	KOK	05084301	2004	9/29/04	4.8 U	10	3.4	0.75	0.47	0.627	0.100 U	0.076	3.7	3.8	271	179	3.1
Northwestern Lake	RBT	06054760	2005	11/2/05	8.7	5.7	3.7	0.76	0.98 U	0.133	0.046 J	0.295	1.7	0.9	349	426	2.4
Ozette Lake	CTT	05084302	2004	10/6/04	4.8 U		0.21	6.0 UJ	0.96 U			0.279	1.7		273	171	3.7
Ozette Lake	LMB	05084303	2004	10/6/04	4.9 U		0.98 U	6.1 UJ	0.98 U			0.910	0.7		371	840	4.4
Ozette Lake	NPM	05084304	2004	10/6/04	5.0 U	0.9	0.57	R	1.0 U	0.195	0.100 U	0.724	0.9	3.0	371	464	7.2
Ozette Lake	YP	05084305	2004	10/6/04	4.7 U		0.95 U	5.9 UJ	0.95 U			0.240	0.5		211	108	2.0
Palouse River, Lower	NPM	05514711	2005	6/23/05	20	11	44	7.5	0.97 U	0.128	0.033 J	0.749 p	2.0	1.9	458	940	7.0
Palouse River, Middle	SMB	05514712	2005	6/6/05	5.0 U		7.6	3.8	0.99 U			0.120 p	0.5		178	72	2.0
Palouse River, North Fork	NPM	05514713	2005	6/9/05	22		80	6.9	0.94 U	0.101	0.030 UJ		2.9	3.0	351	419	7.1
Palouse River, South Fork	NPM	05514714	2005	5/24/05	109	35	57	42	0.97 U	0.211	0.055	0.465 p	1.1	0.4	354	442	9.8
Pend Oreille River, south end	NPM	05084319	2004	8/18/04	38	34	8.1	11	0.53			0.825	2.5	4.8	391	758	12.1
Potholes Reservoir	LWF	06024741	2005	10/25/05	17	6.0	60	1.9	6.7	0.326	0.153	0.046	17	18	576	2524	6.2
Potholes Reservoir	SMB	06024742	2005	10/26/05	4.4 U		4.3	0.62	0.88 U			0.118 n	1.9		451	1386	5.8
Potholes Reservoir	WAL	06024743	2005	10/25/05	5.2		18	0.46	1.0 U			0.170	1.7		578	1999	4.2
Queets River	CHK	05084306	2004	10/18/04	5.6	4.7	2.6	0.28	1.3	0.233	0.100 U	0.041	2.8	4.7	932	7983	4.8

Table B-1 Continued

Site	Species Code	Manchester Environmental Laboratory (MEL) Sample ID	WSTMP Study Year	Date collect	Total PCB aroclors (ug/kg)	Total PCB congeners (ug/kg)	T-DDT (ug/kg)	Total PBDE (ug/kg)	Total Chlordane (ug/kg)	2378 TCDD TEQ (ng/kg)	2378 TCDD (ng/kg)	Mercury (mg/kg)	Lipid MEL (%)	Lipid - Contract Lab (%)	Mean Total Length (mm)	Mean Weight (g)	Mean Age (years)
Quinault River	CHK	05084307	2004	10/18/04	6.3	4.4	3.5	0.42	1.7	0.218	0.100 U	0.030	3.5	4.9	868	7892	4.0
Rock Lake	BNT	05524725	2005	8/23/05	4.9 U		8.5	0.60	0.97 U			0.021	4.2		259	187	1.0
Rock Lake	LMB	05524726	2005	8/23/05	4.9 U		2.7	0.58	0.98 U			0.044	1.0		272	346	2.8
Rock Lake	YP	05524727	2005	8/24/05	4.7 U		7.9	0.44	0.94 U			0.160	0.8		316	499	6.0
Rowland Lake	BG	06054761	2005	9/7/05	4.9 U		0.98 U	6.1 UJ	0.98 U			0.044	0.6		175	106	3.1
Rowland Lake	LMB	06054762	2005	9/7/05	4.9 U		3.6	1.1	0.98 U			0.120	0.8		370	740	3.6
Rowland Lake	YP	06054763	2005	9/7/05	4.9 U		0.98 U	6.1 UJ	0.98 U			0.036	0.7		218	119	2.5
Sacajawea Lake at Longview	GC	05514715	2005	9/14/05	30		2.2	0.56	1.0 U			0.017 U	1.2		447	1249	1.0
Sacajawea Lake at Longview	LMB	06024744	2005	9/14/05	29	17	2.3	0.86	0.95 U	0.068	0.049 J	0.059	1.0	0.5	342	692	2.0
Silver Lake, near Castle Rock	BG	06054764	2005	9/22/05	4.8 U		0.96 U	0.28	0.96 U			0.020	1.7		164	95	2.0
Silver Lake, near Castle Rock	CCP	05514716	2005	9/22/05	6.8	5.6	1.3	0.33	0.94 U	0.130	0.083	0.043	2.0	1.8	521	2313	4.8
Silver Lake, near Castle Rock	LMB	06054765	2005	9/22/05	4.8 U	2.7	1.4	0.34	0.95 U	0.094	0.030 UJ	0.079 n	0.7	0.8	352	695	3.6
Skagit River, near Burlington	CTT	05084308	2004	10/4/04	36	22	7.3	14	0.69	0.220	0.100 U	0.140	3.1	6.3	370	501	4.0
Skagit River, near Burlington	MWF	05084309	2004	10/5/04	19	12	6.1	7.8	0.62	0.299	0.100 U	0.076	1.4	6.5	245	103	2.5
Skagit River, near Burlington	PEA	05084310	2004	10/5/04	4.9 U		3.0	2.6	0.99 U			0.241	1.6		250	151	6.2
Snake River, at Central Ferry (L Bryan)	CC	05084311	2004	12/1/04	148	65	389	14	9.9	1.12	0.370	0.283	13	11	565	1842	12.0
Snake River, at Central Ferry (L Bryan)	LMB	05084312	2004	12/1/04	11		9.3	0.47	1.0 U			0.092	0.7		295	399	2.1
Snake River, at Central Ferry (L Bryan)	PEA	05084313	2004	12/1/04	10		29	2.1	0.91 U			0.264	2.2		284	186	5.1
Snake River, at Central Ferry (L Bryan)	YP	05084314	2004	12/1/04	5.0 U		5.9	6.2 UJ	1.0 U			0.196	0.5		258	232	3.3
Snake River, below Lower Monumental Dam	CC	05084283/4315	2004	11/8/04	111 m	165	373 m	26 m	9.1	1.11	0.520 U	0.347 m	7.2 m	7.3	491	1162	11.5
Snake River, downstream of Clarkston at Chief Timothy park	LMB	05084316	2004	11/30/04	4.2 U		22	1.8	0.85 U			0.140	0.7		283	346	1.9
Snake River, downstream of Clarkston at Chief Timothy park	MWF	05084317	2004	11/29/04	106	70	38	9.4	0.98 U	0.413	0.100 U	0.120	2.0	1.4	299	231	2.5
Snake River, downstream of Clarkston at Chief Timothy park	PEA	05084318	2004	11/30/04	26		86	12	0.47			0.296	1.9		273	155	4.3
Snake River, upstream of Ice Harbor Dam, RM 11-12	CCP	06024751	2005	11/14/05	115	65	146	30	5.1	0.417	0.100	0.180	5.4	1.7	675	4207	13.6
Snake River, upstream of Ice Harbor Dam, RM 11-12	PEA	05524731	2005	11/14/05	43		22	2.5	0.98 U			0.190	1.8		286	4207	5.4
Snake River, upstream of Ice Harbor Dam, RM 11-12	YP	05524730	2005	11/14/05	4.9 U		6.7	0.60	0.99 U			0.045	0.6		204	94	1.2
Snohomish River, upstream of Snohomish, RM 15-18	CTT	05524728	2005	9/1/05	42	32	4.7	26	0.99 U	0.304	0.097	0.120	3.6	6.2	375	526	3.4
Snohomish River, upstream of Snohomish, RM 15-18	MWF	06024749/4745	2005	9/1/05	20 m	9.5 m	3.2 m	32 m	0.98 U	0.243 m	0.077 m	0.076 m	4.1 m	3.5 m	304	268	3.8
Snohomish River, upstream of Snohomish, RM 15-18	NPM	06024746	2005	9/1/05	48	30	3.7	12	1.5	0.100	0.077	0.696	2.5	1.8	332	372	4.4

Table B-1 Continued

Site	Species Code	Manchester Environmental Laboratory (MEL) Sample ID	WSTMP Study Year	Date collect	Total PCB aroclors (ug/kg)	Total PCB congeners (ug/kg)	T-DDT (ug/kg)	Total PBDE (ug/kg)	Total Chlordane (ug/kg)	2378 TCDD TEQ (ng/kg)	2378 TCDD (ng/kg)	Mercury (mg/kg)	Lipid MEL (%)	Lipid - Contract Lab (%)	Mean Total Length (mm)	Mean Weight (g)	Mean Age (years)
Spokane River, near Monroe St., RM 75.2	RBT	05524735	2005	9/28/05	120 s			30 s		0.248	0.032 J		1.5	1.8	358	433	3.0
Spokane River, near Ninemile, RM 64.0	MWF	05524736	2005	9/29/05	129 s			1136 s		0.809	0.083		3.4	2.3	335	337	4.7
Spokane River, near Plante Ferry, RM 85.0	RBT	05524737	2005	8/23/05	58 s			102 s		0.448	0.096		3.4	2.2	400	625	2.7
Stan Coffin Lake	CC	06054766	2005	9/6/05	4.6 U	2.4	7.2	0.55	0.92 U	0.175	0.082	0.029	3.5	5.1	548	1589	6.6
Stan Coffin Lake	LMB	06054767	2005	9/6/05	5.0 U		1.8	6.2 UJ	2.0 U			0.150	0.7		349	732	5.0
Stan Coffin Lake	YP	06054768	2005	9/6/05	4.9 U		0.99 U	6.2 UJ	0.99 U			0.042	0.4		187	76	2.6
Washington Lake	CCP	05524717	2005	6/28/05	1339	611	418	54	68	11.9	1.93	0.160	9.0	11	698	5559	17.0
Washington Lake	NPM	05524734	2005	3/9/05	375 w	241	103 w	61 w	37 w	5.75	0.684	0.531 w	3.8	4.8	430	917	5.7
Washington Lake, North	CTT	05524732	2005	3/3/05	233 w	292	117 w	64 w	37 w	4.64	0.741	0.277 w	3.8	4.2	433	934	3.4
Washington Lake, South	CTT	05524733	2005	3/1/05	370 w	384	115 w	102 w	66 w	4.88	0.876	0.308 w	3.1	5.9	437	1027	4.0
Wenatchee River, near Leavenworth	MWF	05084320	2004	11/18/03	1300	1632	43	7.2	3.4 UJ	0.315	0.100	0.028	3.0	3.3	271	182	2.4
Wenatchee River, near Wenatchee	MWF	05084321	2004	11/18/03	542		378	40	0.32			0.050	3.9		297	226	3.4
Whatcom Lake	CTT	06024747	2005	10/12/05	40	23	7.2	13	6.2	0.563	0.156	0.364	2.8	2.7	401	615	4.2
Whatcom Lake	PEA	05524729	2005	10/12/05	18		3.7	1.9	1.6			0.245	2.1		266	183	10.8
Whatcom Lake	SMB	06024750	2005	10/12/05	29		2.3	5.4	4.2			0.425	2.4		417	1178	6.0
Whatcom Lake	YP	06024748	2005	10/12/05	4.9 U		0.97 U	0.17	0.97 U			0.423	0.5		331	496	6.2

U = The analyte was not detected at or above the reported value.

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

R = Rejected (due to poor data quality and apparent spurious value of 31.62 ppb).

m = Mean value from analyses of field duplicates where two results are available. Where analysis was not done on only one sample, that sample result is given. Where both values were non-detect, the highest value was used. Where one duplicate was qualified as a non-detect (U, UJ), the reported value was used in determining the mean value.

n = Mean value of 10 individuals: individual fish results from *Mercury Trends in Fish* project. (Ecology Publication No. 07-03-007)

s = Values from Spokane River study by Serdar and Johnson, Ecology Publication No. 06-03-025. Values are means from multiple samples that were combined to make a WSTMP sample for contract lab analyses of PCB congeners and PCDD/Fs.

p = Values from Palouse River study by Johnson et al. (in preparation). Values are from corresponding samples or from means from multiple samples that were combined to make a WSTMP sample for contract lab analyses of PCB congeners and PCDD/Fs. Value for sample 05514711 is based on result from analyses of 4 of 7 fish used. All fish were of same size and weight range.

w = Values from Lake Washington study by the Washington State Department of Health (DOH; in preparation). Values are means from multiple samples that were combined to make a WSTMP sample for contract lab analyses of PCB congeners and PCDD/Fs.

For completeness, included values for some parameters that were analyzed by MEL for different studies: Spokane River, Palouse River, Lake Washington. These are qualified as "s","p", or "w", and are explained above.

Size and age data obtained from studies that shared fish: 303d Verification Studies (Wenatchee, Pend Oreille), Lake Washington DOH study, Spokane R. study, and Palouse R. study.

Species codes: BC = Black crappie, BG = Bluegill, BNT = Brown trout, BUR = Burbot, CC = Channel catfish, CCP = Common carp, CHK = Chinook salmon, CTT = Cutthroat trout, GC – grass carp, KOK = Kokanee salmon, LMB = Largemouth bass, LWF = Lake whitefish, MWF = Mountain whitefish, NPM = Northern pikeminnow, PEA = Peamouth, RBT = Rainbow trout, SMB = Smallmouth bass, WAL = Walleye, YP = Yellow perch.

RM = river mile.

WSTMP = Washington State Toxics Monitoring Program.