Snake River Fish Tested for Chemicals

Overview

Scientists from the Washington State Department of Ecology (Ecology) collected fish from the Washington portion of the Snake River in 2009 to test for levels of toxic chemicals. The effort was part of the Washington State Toxics Monitoring Program (WSTMP: www.ecy.wa.gov/programs/eap/toxics/wstmp.htm). The Snake River testing had two goals:

- Determine the spatial extent of contamination in fish.
- Determine changes in contaminant levels in fish over time.

Fish were collected from six areas shown in Figure 1. Sixty samples from ten species of fish were tested for mercury, chlorinated pesticides, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and polychlorinated dibenzo-p-dioxins and furans (PCDD/Fs).

Results from the 2009 sampling and previous sampling in 2004 and 2005 will help determine where to focus efforts in managing the problem of toxic chemicals in the river. The Washington State Department of Health (DOH) will review this study's data to assess possible health risks to people eating some species of fish from the Snake River.

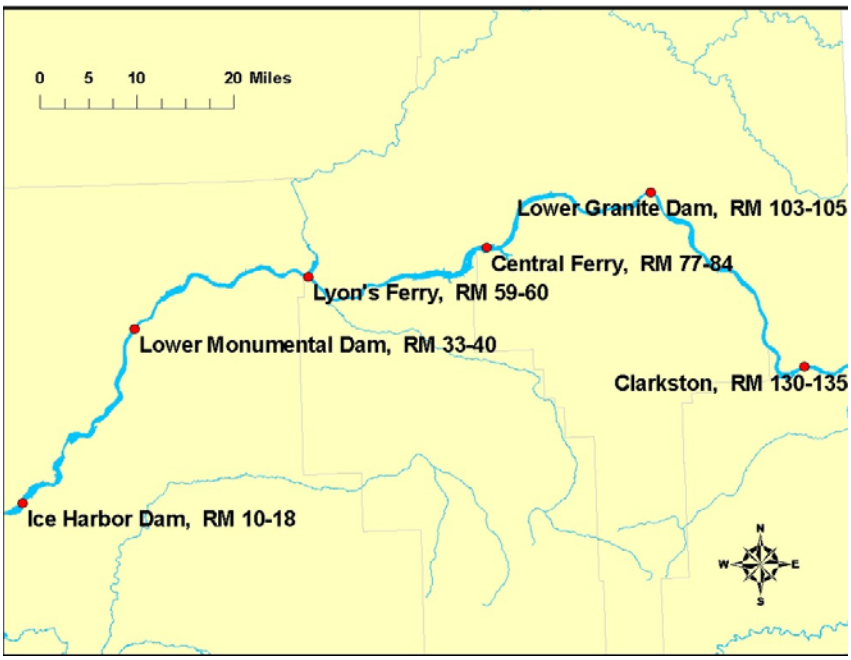

Figure 1. Snake River Fish Sample Sites in 2009.
(RM: river mile)

Processing catfish from Central Ferry for transport to the laboratory.

Why It Matters

Once toxic chemicals such as DDT and PCBs get into the food chain, they persist for decades. Even though these two chemicals were banned more than 30 years ago, they are still present at elevated levels in our environment. Given the persistence of these types of chemicals, the best strategy is to prevent the initial release of chemicals.

Ecology's monitoring programs are designed to protect public health and help decision-makers choose effective strategies to control the sources of toxic chemicals. The WSTMP is one of several efforts in the state to test freshwater fish for chemicals.

Fish can be a very nutritious food. Yet fish can also be one of the biggest exposures people have to environmental contaminants. Be smart and choose fish wisely with advice from the Washington State Department of Health: www.doh.wa.gov/fish

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www.ecy.wa.gov/biblio/1103067.html

Fish from seven other sites in Washington were also sampled yet results are not reported here. These sites and nearest town are: Amber Lake (Cheney), Duck Lake (Ocean Shores), Failor Lake (Aberdeen), Twin Lakes (Odessa), and Black, Leo, and Pierre Lakes (Colville). All results from the 2009 sampling effort can be found in Ecology's EIM database by searching User Study ID WSTMP09: www.ecy.wa.gov/eim/.

Background

The Snake River basin is home to many human activities that create pollution which finds its way into the river: industry, agriculture, forestry, hydroelectric power production, transportation, and settlements such as cities and towns. During a nationwide study in the late 1980s, toxic contaminants such as PCDD/Fs, PCBs, and pesticides were found in fish near Lewiston, Idaho (EPA, 1992). The U.S. Environmental Protection Agency (EPA) later developed total maximum daily loads (TMDLs) to address PCDD/Fs in waters throughout the country, including the Snake River (EPA, 1991). The primary source of PCDD/Fs was believed to be bleaching processes in pulp and paper mills.

Concern about toxic chemicals in the environment prompted Ecology to begin monitoring fish during the 1990s. Results from sampling conducted by Ecology in 1994 in Lake Sacajawea (above Ice Harbor Dam) showed elevated levels of PCBs and chlorinated pesticides in catfish fillets and whole suckers (Davis et al, 1996). Sampling conducted in 1997-1998 by EPA and the Columbia River Inter-Tribal Fish Commission also found elevated levels of PCBs, DDTs, and PCDD/Fs in fillets from suckers and white sturgeon that were collected just downstream of Clarkston (EPA, 2002). Results from sampling conducted by Ecology in 2004 and 2005 showed elevated levels of PCBs, PCDD/Fs, and pesticides such as DDT, dieldrin, chlordane, and toxaphene in fillets of various species of fish (Seiders et al., 2007).

Methods

The sampling plan for 2009 was to collect multiple composite samples of various species of fish from six sites along the Snake River. Collection took place in the fall in order to match the season when historical sampling occurred. Two to three composite samples were collected for many sites and species, yet there were cases where only one composite sample per species was collected (Table 1). Composite samples consisted of skin-on fillets (except catfish) from three to eight individual fish of the same species. Sites were selected based on historical data and accessibility to the public.

Table 1. Number of composite samples analyzed per fish species per site in 2009.

Site	CC	CCP	LMB	MWF	NPM	PEA	SMB	BG	PMP	YP	Sum
Ice Harbor Dam	3		1		1	3	3			2	13
Lower Monumental Dam	3				1	3	2				9
Lyon's Ferry	2	3									5
Central Ferry	3	3				1	3	1	1		12
Lower Granite Dam	3	2		2	3						10
Clarkston		1	3				3	3	1		11
Sum	14	9	4	2	5	7	11	4	2	2	60

Species Codes:
BG=Bluegill, CC = Channel catfish, CCP = Common carp, LMB = Largemouth bass, MWF = Mountain whitefish, NPM = Northern pikeminnow, PEA = Peamouth, PMP=Pumpkinseed, SMB = Smallmouth bass, YP = Yellow perch.

Fish were collected and processed according to standard operating procedures (Sandvik, 2010a.,b.,c). Sample preparations and analytical methods are described in previous reports available at www.ecy.wa.gov/programs/eap/toxics/wstmp.htm.

Overall, the 2009 data met most measurement quality objectives described in the project plan (Seiders and Yake, 2002), and all results were deemed usable as qualified.

Results

No sites met Washington's water quality standards because of elevated levels of contaminants in one or more species of fish. Table 2 shows sites, species, and the water quality standard criterion for each contaminant that fish tissue concentrations exceeded. All sites are recommended for federal Clean Water Act Category 5 (the 303[d] List) and Category 2 (Waters of Concern) assignments for Washington's 2012 Water Quality Assessment process (for more information, visit www.ecy.wa.gov/programs/wq/303d/index.html).

PCDD/F measurements are expressed using the value of the most toxic congener (2,3,7,8-TCDD) and the Toxic Equivalent of all 17 toxic congeners (2,3,7,8-TCDD TEQ).

Table 2. Sites, Species, and Contaminants that Do Not Meet Water Quality Standards Criteria.

Site	Species Exceeding One or More Water Quality Standards Criteria	Total PCBs (5.3 ug/kg)	2378-TCDD (0.065 ng/kg)	4,4'-DDE (31.6 ug/kg)	4,4'-DDD (44.5 ug/kg)	HCB (6.5 ug/kg)	Dieldrin (0.65 ug/kg)	Toxaphene (9.6 ug/kg)	Mercury (770 ug/kg)	TEQ 2378-TCDD (0.065 ng/kg)
Ice Harbor Dam	CC, NPM, PEA	x	x	x			x	x		x
Lower Monumental Dam	CC, NPM, PEA, SMB	x	x	x	x		x	x		x
Lyon's Ferry	CC, CCP	x	x	x		x	x	x		x
Central Ferry	CC, CCP, PEA	x	x	x			x	x		x
Lower Granite Dam	CC, CCP, MWF, NPM	x	x	x			x	x	x	x
Clarkston	CCP	x	x	x			x	x		x
Recommended Category for Water Quality Assessment ->		5								2

See Table 1 for species codes.

Spatial extent of contamination

Results for selected chemicals in the more contaminated species are shown in Figure 2. Catfish and carp consistently had higher levels of contaminants than other species, while northern pikeminnow showed the highest levels of mercury among sites. Smaller and younger species such as yellow perch, pumpkinseed, and bluegill had low to non-detectable levels of contaminants and are not shown. Largemouth bass were also excluded from Figure 2 because results were similar to those for smallmouth bass.

The levels of Total DDT and Total PCB in Snake River catfish and carp rank in the 90th to 100th percentile of levels found statewide, while levels of PCDD/Fs ranked in the 40th to 95th percentile for statewide data.

Levels of mercury in Snake River fish ranged from the 10th to 99th percentile for statewide data, with northern pikeminnow and catfish from the upstream sites having the highest values.

Catfish and carp samples of similar size and lipids were used to test for differences (Kruskal-Wallis single factor ANOVA) among sites for the four analytes shown in Figure 2. Overall, there were no significant differences in contaminant levels among sites. An exception was mercury in catfish which was lower in the three downstream sites compared to samples from the Central Ferry and Lower Granite Dam sites.

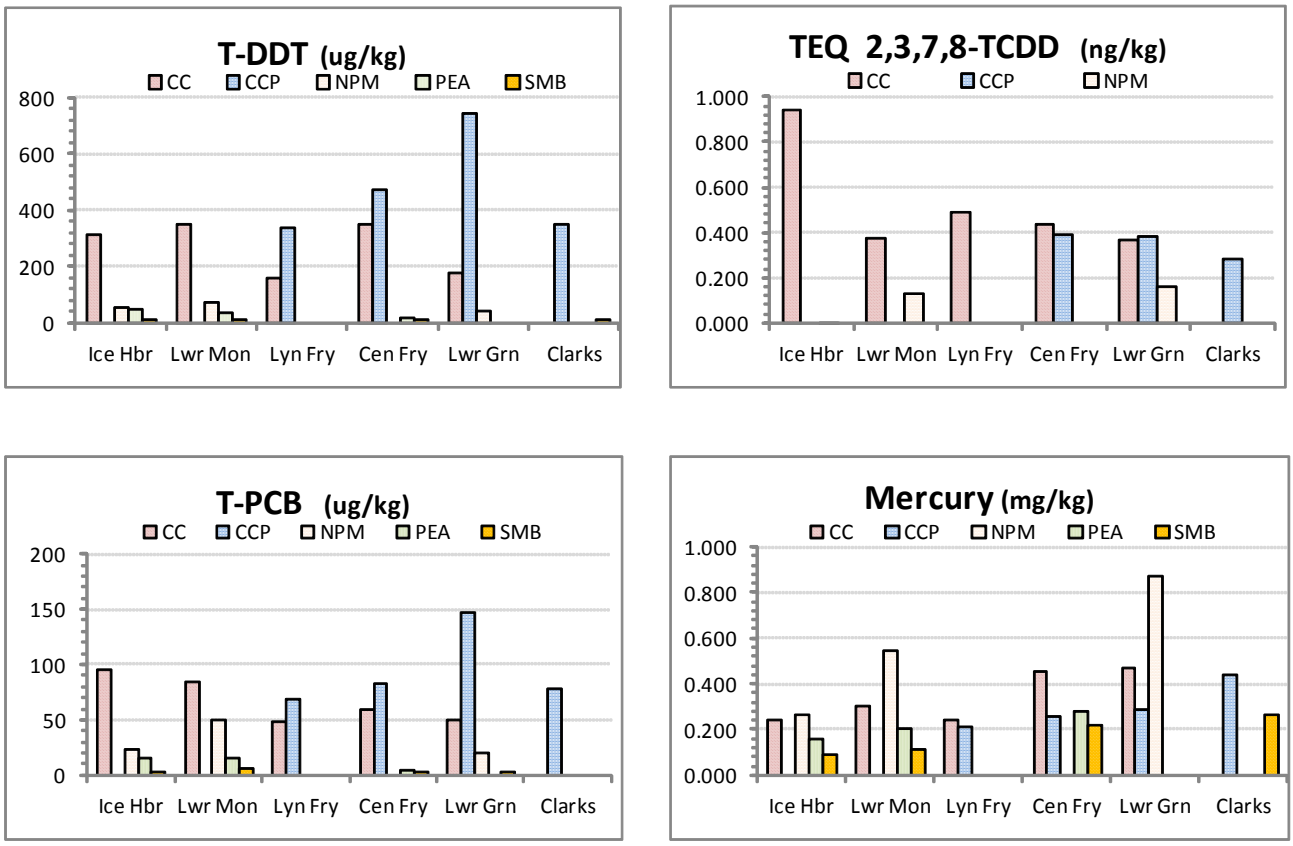

Figure 2. Levels of Total DDTs, Total PCBs, 2,3,7,8-TCDD TEQ, and mercury in fish from six sites. (See Table 1 for species codes).

Have there been changes in contaminant levels over time?

The 2009 results from three sites were plotted with data collected in 2004 and 2005 to qualitatively evaluate changes in contaminant levels over time (Figure 3). These were the only datasets useful for comparison because they had multiple samples of the same species, analytes, and seasons of collections. Samples from 2009 and previous years all contained fish having similar sizes, weights, ages, and lipid content. An exception was the 2004 catfish from Central Ferry which had lipid content of 13%, more than twice the 2009 sample mean of 5.6%.

For peamouth from the Ice Harbor Dam site, it appears that the 2009 fish are higher in Total DDT and lower in Total PCB than in 2005. Whether the results indicate true differences or the high variability typically associated with organic analytes in small sample sizes of fish tissue is unclear. The level of mercury in samples between the two years appears similar.

Figure 3 shows that catfish from the Lower Monumental Dam site appear to have similar levels of Total DDT, Total PCB, and mercury. No differences were found between years for these contaminants when the Mann-Whitney two-sample rank test was used.

The small sample sizes (n=2, n=3) and high variability of results are likely factors in the poor sensitivity of the statistical test to detect any differences between years. For PCDD/Fs in catfish at this site, the levels of 2,3,7,8-TCDD TEQ in 2009 were about one-third of levels found in 2004. It is not clear whether the threefold difference seen in 2,3,7,8-TCDD TEQ is a signal of a true difference in PCDD/Fs or just variability due to small sample size and laboratory analysis of fish tissue. Statistical testing was not done because only one sample from 2004 was analyzed for 2,3,7,8-TCDD TEQ.

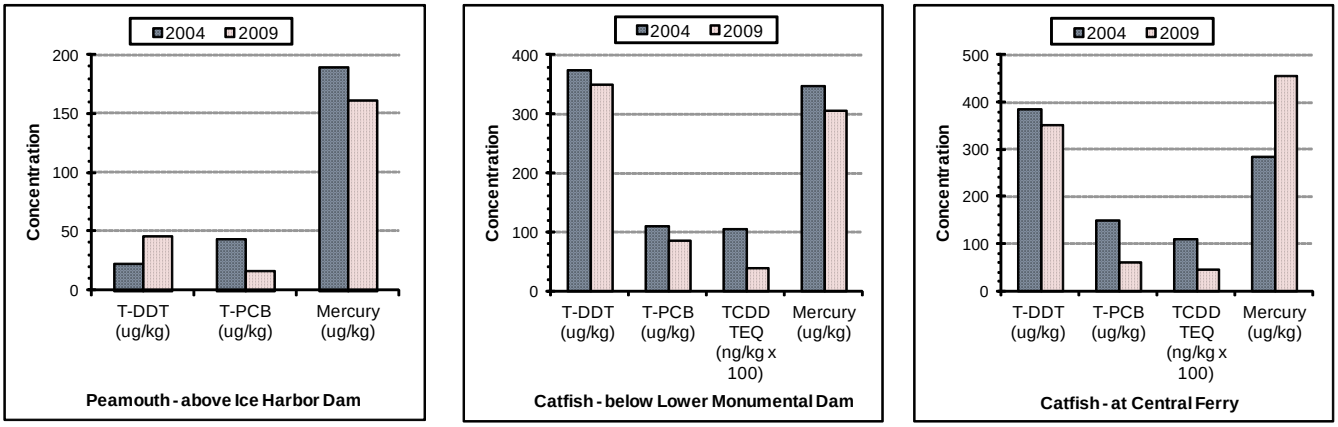

Figure 3. Temporal comparison of Total DDTs, Total PCBs, 2,3,7,8-TCDD TEQ, and mercury in fish from three sites.

Catfish from the Central Ferry site also appear to have similar levels of t-DDT between the two sampling periods. The levels of T-PCB and TCDD TEQ in 2009 were about 40% of the levels found in 2004, while mercury in 2009 was about 140% of that found in 2004. Only one sample from 2004 was analyzed, so statistical testing for differences between years was not performed.

Summary and Recommendations

Summary

- Many species of fish in the Snake River continue to show elevated levels of toxic chemicals in fillet tissue, particularly catfish, carp, and northern pikeminnow.
- All sites had fish with tissue concentrations that exceeded (did not meet) water quality standards for: 4,4'-DDE, 4,4'-DDD, hexachlorobenzene, dieldrin, toxaphene, T-PCB, dioxin/furans, and mercury.
- Differences in contaminant levels in fish among sites or over time could not be detected, likely because of small samples sizes and high variability in the sampled populations.

Recommendations

- DOH should review the 2009 results and determine whether fish consumption advice is warranted.
- Future monitoring efforts should increase sample sizes to improve the ability to discern differences in contaminant levels among sites and over time.
- All sites warrant assignment to Category 5 (the 303(d) list) during Ecology's 2012 Water Quality Assessment for chemicals shown in Table 2.

For more information

Snake River Water Quality

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Ecology Monitoring Efforts

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Local and State Health Departments

Contact local health departments in the six-county area of the Snake River: Franklin, Whitman, Garfield, Asotin, Columbia, and Walla Walla Counties.

Washington State Department of Heath, Fish Consumption Advisory Program, 1-877-485-7316. www.doh.wa.gov/fish

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