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Columbia River Basin:
State of the River Report for Toxics
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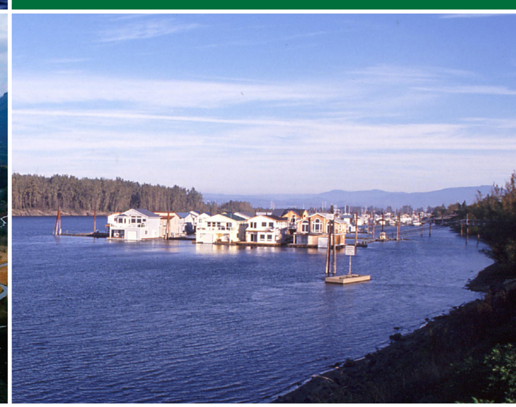

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Acronyms

BMP	best management practice
BPA	Bonneville Power Administration
CRITFC	Columbia River Inter-Tribal Fish Commission
DDD	dichlorophenyldichloroethane
DDE	dichlorophenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
IDEQ	Idaho Department of Environmental Quality
LCREP	Lower Columbia River Estuary Partnership
NOAA	National Oceanic Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPDES	National Pollutant Discharge Elimination System
ODEQ	Oregon Department of Environmental Quality
OSU	Oregon State University
PAH	polycyclic aromatic hydrocarbon
PBDEs	polybrominated diphenyl ethers
PBT	persistent, bioaccumulative, and toxic contaminant
PCBs	polychlorinated biphenyls
PNNL	Pacific Northwest National Laboratory
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PSP	Pesticide Stewardship Partnership
TMDL	total maximum daily load
TRI	Toxics Release Inventory
UC	University of California
U.S.	United States
USACE	U.S. Army Corps of Engineers
USDOE	see DOE
USEPA	see EPA
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WADOE	Washington Department of Ecology
WADOH	Washington Department of Health
WDFW	Washington Department of Fish and Wildlife

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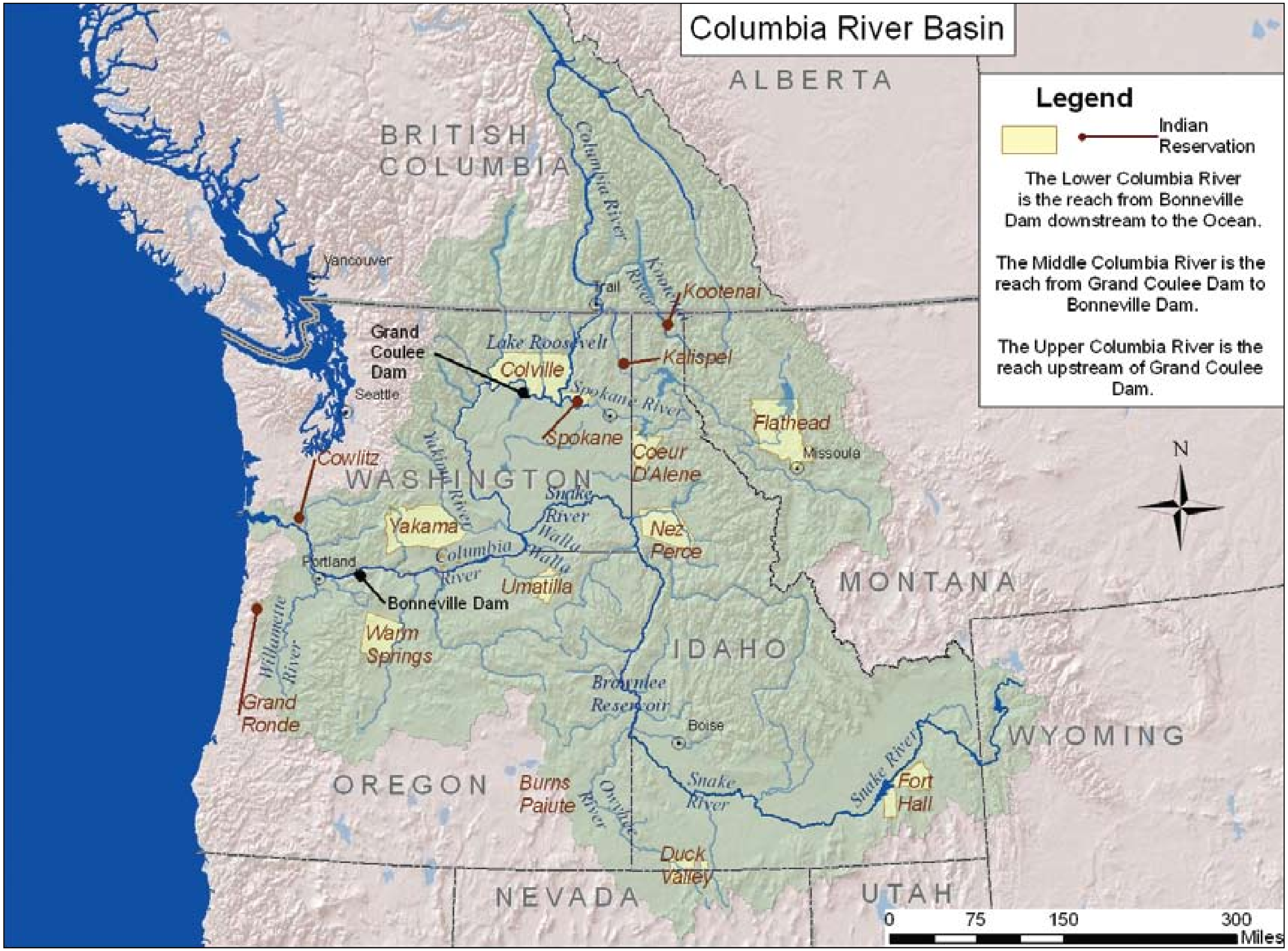


The Columbia River Basin

1.0 Executive Summary

The Columbia River Basin, one of the world's great river basins, is contaminated with many toxic contaminants, some of which are moving through the food web. These toxics in the air, water, and soil threaten the health of people, fish, and wildlife inhabiting the Basin.

In this report, the U.S. Environmental Protection Agency (EPA), Region 10, summarizes what we currently know about four main contaminants in the Basin and the risks they pose to people, fish, and wildlife. We also identify major gaps in current information that we must fill to understand and reduce these contaminants. Current information in the Basin indicates that toxics are a health concern for people, fish, and wildlife, but this information is sparse. In many locations, toxics have not been monitored at all. We do not have enough information in the majority of the Basin to know whether contaminant levels are increasing or decreasing over time. We need to fill these information gaps to understand the impacts on the ecosystem and to plan and prioritize toxics reduction actions.

This report focuses primarily on the following four contaminants: mercury, dichlorodiphenyltrichloroethane (DDT) and its breakdown products, polychlorinated biphenyls (PCBs), and polybrominated diphenyl ether (PBDE) flame retardants. We focus on these contaminants because they are found throughout the Basin at levels that could adversely impact people, fish, and wildlife. Many other contaminants are found in the Basin, including arsenic, dioxins, radionuclides, lead, pesticides, industrial chemicals, and "emerging contaminants" such as pharmaceuticals found in wastewater. This report does not focus on those contaminants, in part because there is a lack of widespread information on their presence in the Basin.

Mercury contaminates the Basin from industrial and energy-related activities occurring within and outside of the Basin. Mercury poses a special challenge because much of the Basin's mercury pollution comes from sources outside of the Basin via atmospheric deposition. At a watershed scale, however, local and regional sources can be significant contributors of mercury to the Basin. Fish consumption advisories for mercury continue to be issued in every state throughout the Basin.

The pesticide DDT and industrial chemicals known as PCBs have been banned since the 1970s, and reduction efforts have lowered their levels in the environment. Unfortunately, these chemicals persist in the environment and continue to pollute the Basin's waterbodies from various sources, including stormwater and agricultural land runoff and hazardous waste releases. In many areas, DDT and PCB concentrations still exceed levels of concern, and fish consumption advisories for these contaminants continue to be issued in every state throughout the Basin.

PBDE flame retardants and other emerging contaminants of concern—such as pharmaceuticals and personal care products—are a growing concern because their levels are increasing in fish and wildlife throughout the Basin. We are just beginning to conduct the research needed to better understand the impacts to the ecosystem from emerging contaminants.

This report provides preliminary information on the presence of mercury, DDT, PCBs, and PBDEs in the following species: juvenile salmon; resident fish (sucker, bass, and mountain whitefish); sturgeon; predatory birds (osprey and bald eagles); aquatic mammals (mink and otter); and sediment-dwelling shellfish (Asian clams). These species can help us understand trends in the levels of toxics in the Basin and judge the effectiveness of toxics reduction efforts.

Some initial steps to address the problem of toxics have already been taken. In 2005, EPA joined other federal, state, tribal, local, and nonprofit partners to form the Columbia River Toxics Reduction Working Group to better coordinate toxics reduction work and share information. The goal of the Working Group is to reduce toxics in the Columbia River Basin and prevent further contamination. This *State of the River Report for Toxics* was identified as a priority by this multi-stakeholder group and was prepared under the leadership of EPA Region 10 with the support and guidance of the Working Group.

Meanwhile, there are many ongoing efforts to reduce toxics in the Basin. Some examples include erosion control efforts in the Yakima Basin; Pesticide Stewardship Partnerships in the Hood River and Walla Walla Basins; PCB cleanup at Bonneville Dam; legacy pesticide collection throughout the Basin;

and investigation and cleanup of the Portland Harbor, Hanford, and Upper Columbia/Lake Roosevelt contamination sites. These and other combined efforts have reduced toxics over the years, but we still need to further reduce toxics to make the Basin a healthier place for people, fish, and wildlife.

To ensure a more coordinated strategy, EPA and our Working Group partners developed a set of six broad Toxics Reduction Initiatives needed to reduce toxics in the Basin. Over the next year, the Working Group will develop a detailed work plan to provide a roadmap for future reduction efforts with input from Basin citizens; local watershed councils; Basin communities and other entities; and tribal, federal, and state governments.

Reducing toxics in the Basin will require a comprehensive, coordinated effort by all levels of government, nongovernmental organizations, and the public. The problems are too large, widespread, and complex to be solved by only one organization. Our hope is that this report and the subsequent toxics reduction work plan will help us make this ecosystem healthier for all who live, work, and play in the Basin.

2.0 Introduction

The Columbia River Basin is one of the world's great river basins in terms of its land area and river volume, as well as its environmental and cultural significance. However, public and scientific concern about the health of the Basin ecosystem is increasing, especially with regard to adverse impacts on the Basin associated with the presence of toxic contaminants. A full understanding of the toxics problem is essential because the health of the Basin's ecosystem is critical to the approximately 8 million people who inhabit the Basin and depend on its resources for their health and livelihood. [1] The health of the ecosystem is also critical to the survival of the hundreds of fish and wildlife species that inhabit the Basin. In this *State of the River Report for Toxics*, we make our first attempt to describe the risks to the Basin's human and animal communities from toxics and to set forth current and future efforts needed to reduce toxics.

The Basin drains about 259,000 square miles across seven U.S. states and British Columbia, Canada. Of that total, about 219,400 square miles, or 85 percent of the Pacific Northwest region, are in the United States; the remaining 39,500 square miles are in Canada. [2] The Basin's rivers and streams carry the fourth largest volume of runoff in North America. The Columbia River begins at Columbia Lake in the Canadian Rockies and travels 1,243 miles over 14 dams to reach the Pacific Ocean a hundred miles downstream from Portland, Oregon. The River's final 300 miles, including the dramatic Columbia River Gorge Scenic Area, form the border between Washington and Oregon. In this report, the Lower Columbia River is considered to be the reach from Bonneville Dam downstream to the Pacific Ocean, the Middle Columbia River is considered to be the reach from Bonneville Dam upstream to Grand Coulee Dam, and the Upper Columbia River is considered to be the reach above Grand Coulee Dam.

Major tributaries to the Columbia River include the Snake, Willamette, Spokane, Deschutes, Yakima, Wenatchee, John Day, Umatilla, Walla Walla, Pend Oreille/Clark Fork, Okanogan, Kettle, Methow, Kootenai, Flathead, Grande Ronde, Lewis, Cowlitz, Salmon, Clearwater, Owyhee, and Klickitat Rivers. The Snake River is the largest tributary to the Columbia River, with a drainage area of 108,500 square miles, or 49 percent of the U.S. portion of the watershed. Another major tributary is the Willamette River, which drains 11,200 square miles and is located entirely within the State of Oregon. [2]

The Basin's salmon and steelhead runs were once the largest runs in the world, with an estimated peak of between 10 million and 16 million fish returning to the Basin annually to about 1 million upriver adult salmon passing Bonneville Dam in recent years. [3] For thousands of years, the tribal people of the Basin have depended on these salmon runs and other native fish for physical, spiritual, and cultural sustenance. Bald eagles, osprey, bears, and many other animals also rely on fish from the Columbia River and its tributaries to survive and feed their young. Historically, the large annual returns of adult salmon and steelhead have contributed important marine nutrients to the ecosystems of the interior Columbia River Basin. The Basin is also economically vital to many Pacific Northwest industries such as sport and commercial fishing, agriculture, transportation, recreation, and tourism. Throughout history, and up to the present day, the Basin has supported settlement and development, agriculture, transportation, and recreation.

There are more than 370 major dams on tributaries of the Columbia River Basin. [4] With its many major federal and nonfederal hydropower dams, the River is one of the most intensive hydroelectric developments in the world. About 65 percent (approximately 33,000 megawatts) of the Pacific Northwest's generating capacity comes from hydroelectric dams. Under normal precipitation, the dams produce about three-quarters (16,200 average megawatts) of the region's electricity. Some of the other major uses of the multi-purpose dams on the Columbia and Snake Rivers include flood control, commercial navigation, irrigation, and recreation. [3]

A National Priority

In 2006, EPA designated the Columbia River Basin as a Critical Large Aquatic Ecosystem in our *2006-2011 Strategic Plan*. [5] The Plan's Goal 4, Healthy Communities and Ecosystems, is "to protect, sustain, or restore the health of people, communities, and ecosystems using integrated and comprehensive approaches and partnerships."

The Columbia River Basin goal states:

> "By 2011, prevent water pollution and improve and protect water quality and ecosystems in the Columbia River Basin to reduce risks to human health and the environment."

The focus of the *2006-2011 Strategic Plan* was achieving more measurable environmental results. Working with state, tribal, and local partners, we selected the following strategic targets for the Columbia River Basin:

- By 2011, protect, enhance, or restore 13,000 acres of wetland habitat and 3,000 acres of upland habitat in the Lower Columbia River watershed.
- By 2011, clean up 150 acres of known highly contaminated sediments in the Lower Columbia River Basin, including Portland Harbor.
- By 2011, demonstrate a 10 percent reduction in mean concentration of contaminants of concern found in water and fish tissue. Contaminants of concern include chlorpyrifos and azinphos methyl in the Little Walla Walla River, DDT in the Walla Walla and Yakima Rivers, and DDT and PCBs in the mainstem.

We selected these targets because historical data were available and each represented measurable outcomes for reduction of toxics in the Basin. Meeting these targets and the overarching goal depends on the states, tribes, local governments, federal government, and nongovernmental agencies working together to improve the health of the Columbia River Basin.

The Story of Contamination in the Columbia River Basin

Fish, wildlife, and people are exposed to many contaminants polluting the water and sediment of the Columbia River Basin. These contaminants come from current and past industrial discharges (point sources) to the air, land, and water and from more widespread sources such as runoff from farms and roads (nonpoint sources) and atmospheric deposition. Some contaminants, such as mercury, also come from natural sources. Even when released in small amounts, some of these contaminants can build up over time to toxic levels in plants and animals.

In 1992, an EPA national survey of contaminants in fish in the United States alerted EPA and others to a potential health threat to tribal and other people who eat fish from the Columbia River Basin. [6] The Columbia River Inter-Tribal Fish Commission (CRITFC) and its four member tribes—the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Umatilla Indian Reservation, and Nez Perce Tribe—were concerned for their tribal members who consume fish.

To evaluate the likelihood that tribal people may be exposed to high levels of contaminants in fish, EPA funded the CRITFC tribes to conduct a Columbia River Basin tribal fish consumption survey, which was then followed by an EPA and tribal study of contaminant levels in fish caught at traditional tribal fishing sites. [7,8] The consumption survey showed that the tribal members were

Human activities have contributed many toxic contaminants to the Columbia River Basin over the last 150 years:

- Dioxins, PCBs, metals, and other toxic chemicals were spilled and dumped in Portland Harbor. The sources: boat-building, steel-milling, and sewer discharges.
- "Legacy pollutants"—chemicals banned in the 1970s such as PCBs and chlorinated pesticides such as DDT—still contaminate the river. The sources: farmland, roads, construction sites, and stormwater runoff.
- Newer chemicals, including modern pesticides, flame retardants such as PBDEs, pharmaceuticals, and personal care products, contaminate the river. The sources: runoff and sewers.
- Metals wash into Lake Roosevelt. The sources: metal smelters in Washington and British Columbia.
- Metals wash into the Spokane River. The source: mines in northern Idaho.

eating six to eleven times more fish than EPA's estimated national average at that time of 6.5 grams per day. The fish contaminant study showed the presence of 92 contaminants in fish consumed by CRITFC tribal members and other people in the Columbia River Basin. Some of these contaminant levels were above the levels of concerns for aquatic life or human health. [8] Contaminants measured in Columbia River fish included PCBs, dioxins, furans, arsenic, mercury, and DDE, a toxic breakdown product of the pesticide DDT.

The Origin and Purpose of the Columbia River Toxics Reduction Working Group

Over the past two decades, much information was collected on the levels of contaminants in water, sediment, and fish in the Columbia River Basin. The result was an accumulation of scattered data that needed to be compiled into a Basin-wide report of the potential impacts from contaminants to people, fish, and wildlife. In 2005, EPA joined other federal, state, tribal, local, and non-profit partners to form the Columbia River Toxics Reduction Working Group to better coordinate this work and share information. Our goal is to reduce toxics in the Basin and prevent further contamination. This goal includes reducing toxics in the plants and animals that people eat and ensuring the survival, reproduction, and growth of fish and wildlife in the Basin.

One of the first actions this multi-stakeholder group identified was the development of a report for the Columbia River Basin describing the state of the River. The Working Group recognized toxics as one of several important factors affecting the health of the Basin's people, plants, and animals. We also recognized that toxics had received less attention than other factors and that a report on the influence of toxics was a good first step in understanding the health of the Basin's ecosystem.

This *State of the River Report for Toxics* was prepared under the leadership of EPA Region 10 with the support and guidance of the Working Group. This report sets in motion the process by which we will address the following questions:

- Which toxics are we most concerned about in the Columbia River Basin, and why? Which toxics are the highest priority for cleanup?
- Where are the toxics coming from? How can they be controlled and cleaned up? How can we prevent contamination in the future?
- What can indicator species tell us about the health of the Columbia River Basin? What indicator species should we use to evaluate the health of the ecosystem? Is the health of the ecosystem improving or declining? What additional information do we need to collect so that we can determine changes over time to better understand and deal with the toxics problem?
- What toxics reduction actions are currently under way? Have they been successful? What actions are planned to further reduce toxics?
- What are the next steps to improve the health of the Columbia River Basin ecosystem? What are the short- and long-term monitoring and research needs?

This report will be used to inform people, communities, and decision-makers in the Basin about the toxics problem and to begin a dialogue to identify potential solutions for improving the Basin's health.

VISIT THE WEB In addition to this report, EPA's Columbia River Basin website (http://www.epa.gov/region10/columbia) will provide more detailed and up-to-date information on the health of the Columbia River Basin as work continues.

3.0 Toxic Contaminants

What are Toxic Contaminants?

Toxic contaminants (or toxics) are chemicals introduced to the environment in amounts that can be harmful to fish, wildlife, or people. Some are naturally occurring, but many of these contaminants were manufactured for use in industry, agriculture, or for personal uses such as hygiene and medical care. These synthetic and naturally occurring chemicals can be concentrated to toxic levels and transported to streams through a combination of human activities such as mining or wastewater treatment and through natural processes such as erosion (Figure 3.1).

The fate of a contaminant is determined by its properties—for example, whether the contaminant mixes readily with water or sediment particles, or whether it changes form when exposed to sunlight, bacteria, or heat. A contaminant's location and level of concentration in a river help determine whether fish, wildlife, and people are exposed to it and, if so, whether they experience harmful health effects.

Why are Persistent Toxics a Concern?

Chemicals with well-known effects are generally those chemicals that remain in the environment for a long time (persistent contaminants), contaminate food sources, and increase in concentration in fish and birds. Animals can take in these contaminants directly while foraging for food or drinking water, or they can eat other animals and plants that have absorbed the contaminants. Many contaminants break down slowly, so they accumulate and concentrate in plants, wildlife, and people. The concentration of persistent contaminants through water, sediment, and food sources and within a plant or animal is called *bioaccumulation*. An example of a persistent chemical in the Columbia River is DDT and its breakdown product DDE, both of which are still present in the River nearly 40 years after DDT was banned.

Contaminants in water and sediment are absorbed by microscopic plants and animals, called phytoplankton and zooplankton, as they take in food and water. Many of these chemicals are not easily metabolized, so they persist in living organisms and concentrations build up in their tissues. Plankton, which are

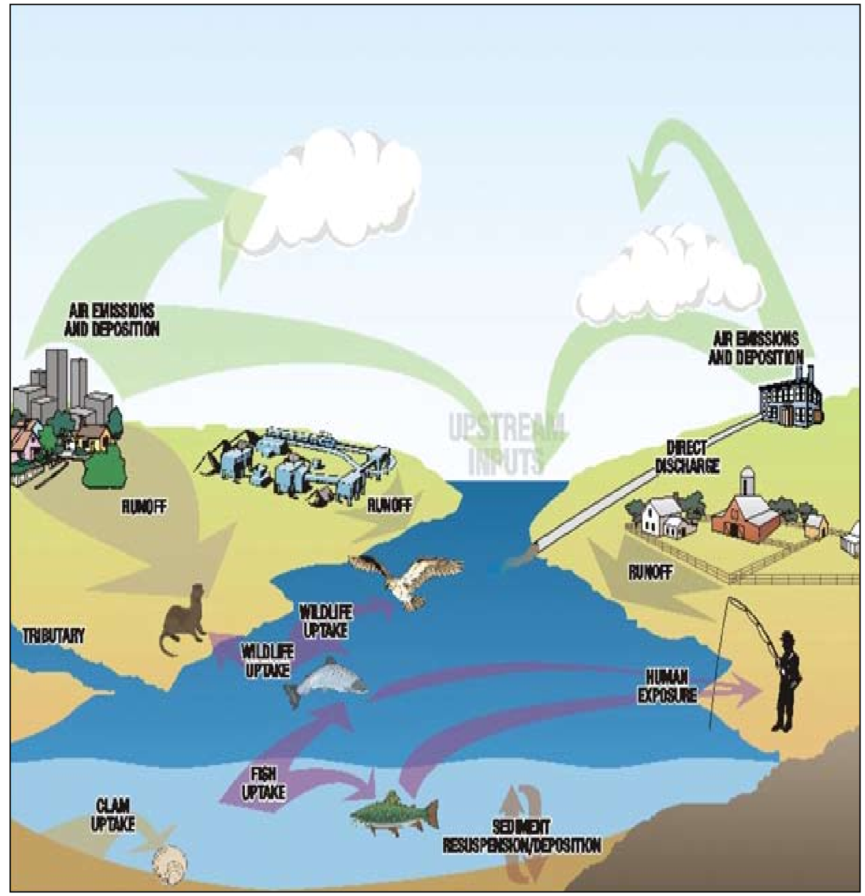


Figure 3.1: Toxic Contaminant Pathways in the Environment

at the bottom of the food web, carry the toxic burden all their lives. As larger animals eat the plankton, the accumulated chemicals are absorbed into each animal's body. Fish and other animals eat the plants, microorganisms, and small fish; the chemical moves into their bodies, and ultimately into larger fish-

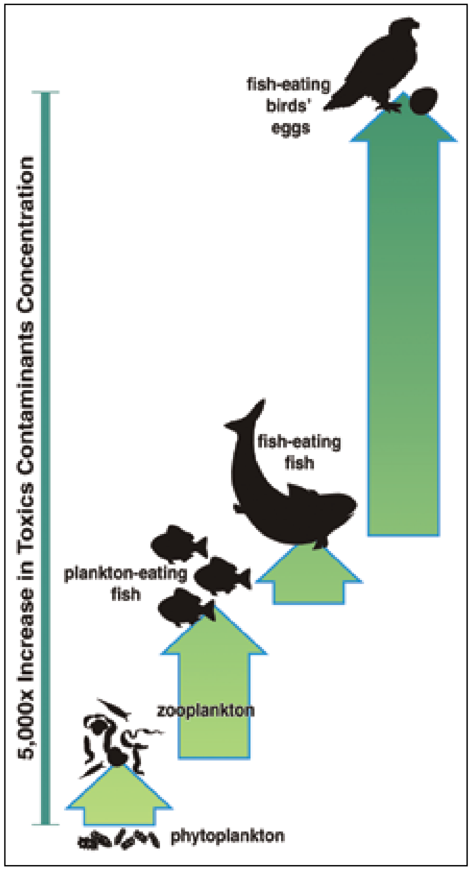


Figure 3.2: Persistent contaminants biomagnify, increasing in concentration up the food web. The highest biomagnification levels can be found in the eggs of fish-eating birds.

eating birds and mammals higher in the food web. This is how contaminant concentrations exponentially increase in fish and fish-eating animals at levels much higher than the concentrations found in the waters the fish live in. Through this *biomagnification* process, top predators, including birds of prey and humans, can accumulate contaminants in higher concentrations than those found in the plants and animals they consume (Figure 3.2). This toxic load builds up in their bodies throughout their lives.

What are the Contaminants of Concern in the Columbia River Basin?

While many contaminants have the potential to be of concern, this report focuses primarily on four contaminants: mercury (including methylmercury); DDT and its breakdown products; PCBs; and PBDEs.

These contaminants are of primary concern because (1) they are widely distributed throughout the Basin; (2) they may have adverse effects on wildlife, fish, and people; (3) they are found at levels of concern in many locations throughout the Basin; and (4) there is an opportunity to build on current efforts to reduce these contaminants within the Basin. [1]

In addition to these four contaminants, many other contaminants of concern were also identified in the Basin. These included metals such as arsenic and lead; radionuclides; several types of pesticides, including current-use pesticides; industrial chemicals; combustion byproducts such as dioxin; and "emerging contaminants" such as pharmaceuticals and personal care products. These contaminants are not the focus of this report, either because there is a lack of widespread information on their presence in the Basin or because they are best suited to more geographically targeted studies within the Basin.

VISIT THE WEB For more information on biomagnification, go to: http://toxics.usgs.gov/definitions/biomagnification.html.

Which Contaminants are Found in People?

Two studies recently investigated the amount and type of toxic contaminants found in people. In 2005, ten Washington residents volunteered to have their hair, blood, and urine tested for the presence of toxics as part of the “Pollution in People” investigative study by the Toxic-Free Legacy Coalition. [2] Each person tested positive for at least 26, and as many as 39, of the 66 toxics tested for, including common pesticides; plasticizers and fragrances found in vinyl, toys, and personal care products; flame retardants found in electronics, mattresses, and furniture; lead, mercury, and arsenic; and both DDT and PCBs.

In 2007, ten Oregon residents representing a diverse group of people from rural and urban areas throughout the state volunteered to have their bodies tested in a study of chemicals in people conducted by the Oregon Environmental Council and the Oregon Collaborative for Health and the Environment. [3] Each person had at least 9, and as many as 16, of the 29 toxics tested for in their bodies. Similar to the Washington study, these toxics included pesticides, mercury, plasticizers, and PCBs. Every participant had mercury, PCBs, and plasticizers in their blood.

While some of these toxics found in people may come from consuming fish or wildlife in the Columbia River Basin, the majority of the toxics found in people come from everyday activities and products such as food, cosmetics, home electronics, plastic products, and furniture. A greater effort to reduce toxics in the products we produce and consume will be needed to limit human exposure and intake of toxics and to reduce the amount of toxics that we put into the ecosystem.

What about Hanford and radionuclides?

For more than 40 years, the U.S. government produced plutonium for nuclear weapons at the Hanford Site along the Columbia River. Production began in 1944 as part of the Manhattan Project, the World War II effort to build an atomic bomb. Plutonium production ended and cleanup began at Hanford in 1989. Over 600 waste sites have been identified in the immediate vicinity of the nuclear reactors. These waste sites have contaminated the groundwater with radionuclides (nuclear waste) and toxic chemicals, above drinking water standards. In certain areas, the contaminated groundwater has reached the Columbia River.

The waste sites and facilities near the River are undergoing an intensive investigation and cleanup effort. One part of that investigation will evaluate the risk to humans and other organisms in the Columbia River ecosystem from Hanford contaminants, including radionuclides, heavy metals, and some organic chemicals. The risk assessment results will be available in 2011. [5] Because of the ongoing investigation and cleanup efforts, this *State of the River Report for Toxics* does not focus on effects on the river from Hanford.

VISIT THE WEB

For more information on the “Pollution in People” studies, visit the Toxic-Free Legacy Coalition: http://www.toxicfreelegacy.org/index.html and the Oregon Environmental Council: http://www.oeconline.org/pollutioninpeople.

VISIT THE WEB

For more information about the Hanford cleanup, go to: http://yosemite.epa.gov/R10/CLEANUP.NSF/sites/Hanford and www.hanford.gov.

What are Emerging Contaminants of Concern?

A growing number of substances that we use every day, including pharmaceuticals, cosmetics, and personal care products, are turning up in our lakes and rivers, including the Columbia River. [4] These "emerging chemical contaminants" often occur at very low levels. With improved detection technologies, we are becoming more aware of their widespread distribution in the environment, and concerns are increasing about their potential impacts on fish and shellfish, wildlife, and human health. Hormones, antibiotics, and other drugs, which are commonly found in animal and human waste sources, are examples of emerging contaminants. Current-use pesticides and perfluorinated compounds—chemicals used in consumer products to make them stain- and stick-resistant—are other examples of emerging contaminants.

Emerging chemical contaminants include pharmaceuticals and other products that are not properly disposed. These contaminants are increasingly accumulating in waterways, including the Columbia River.

Although several of these emerging contaminants have been detected in water and sediment in the Lower Columbia River, information from locations elsewhere in the Basin is extremely limited. In response to these newly recognized contaminants, the U.S. Geological Survey (USGS) is sponsoring a four-year study in the Lower Columbia River addressing the movement of emerging contaminants from water to sediment, and through the food web to fish-eating birds, to evaluate the threat to the environment and human health.

Dioxins: A success story in toxics reductions

A 1987 EPA study showed unsafe levels of dioxin in fish from the Columbia River [6] Dioxins are persistent bioaccumulative toxins that can cause developmental and reproductive problems and potentially increase the risk of cancer. Dioxins are a byproduct of combustion and manufacturing processes, including bleaching paper pulp with chlorine.

In response to the study, in 1991 EPA collaborated with Oregon and Washington to require reductions in the amount of dioxin discharged by 13 paper mills to the Columbia, Snake, and Willamette Rivers. These pulp and paper mills subsequently changed their bleaching process, which reduced releases of dioxins into the Columbia River Basin.

Since 1991, dioxin concentrations in resident fish in the Columbia have decreased dramatically (Figure 3.3). [7,8,9,10,11,12] The dioxin content of osprey eggs has also shown a significant reduction in the lower part of the river. [13] However, dioxin is extremely persistent, and fish consumption advisories are still in place for some locations in the Basin.

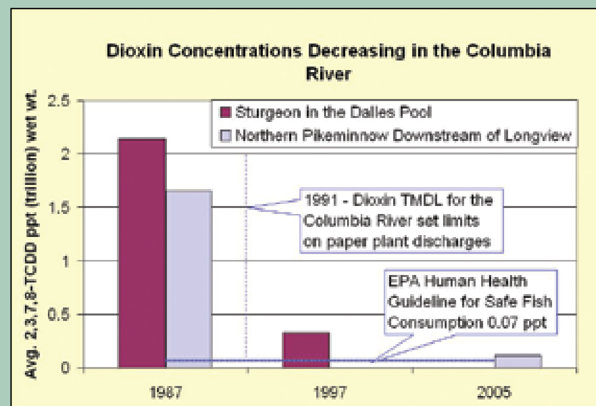


Figure 3.3: Dioxin levels in Columbia River fish have decreased significantly since pulp and paper mills changed their bleaching process, which reduced dioxin discharges in the early 1990s.

VISIT THE WEB For more information about dioxins in the Columbia River Basin, go to: www.deq.state.or.us/wq/TMDLs/columbia.htm and www.ecy.wa.gov/biblio/97342.html.

Fish Consumption Advisories for Toxics are Widespread across the Basin

When a river or lake becomes contaminated, it is not only an ecological loss but also a significant resource loss for people who depend on those fish for their diet. Fish consumption advisories are issued for lakes and rivers where various levels of fish consumption are no longer safe due to toxics in fish.

State health departments have issued public fish consumption advisories about the types and amounts of fish that are safe to eat from specific waters, including waters of the Columbia River Basin (Figure 3.4). In Washington, Oregon, Idaho, and Montana, people are advised to limit meals of fish such as bass, trout, walleye, and bottom fish from certain streams and lakes due to concerns about high levels of mercury, PCBs, and other contaminants. Because testing has shown high mercury concentrations in certain species, and because there is a lack of data from many water bodies, Washington has issued a statewide mercury advisory for consumption of bass and Idaho has issued a statewide mercury advisory for bass and walleye.

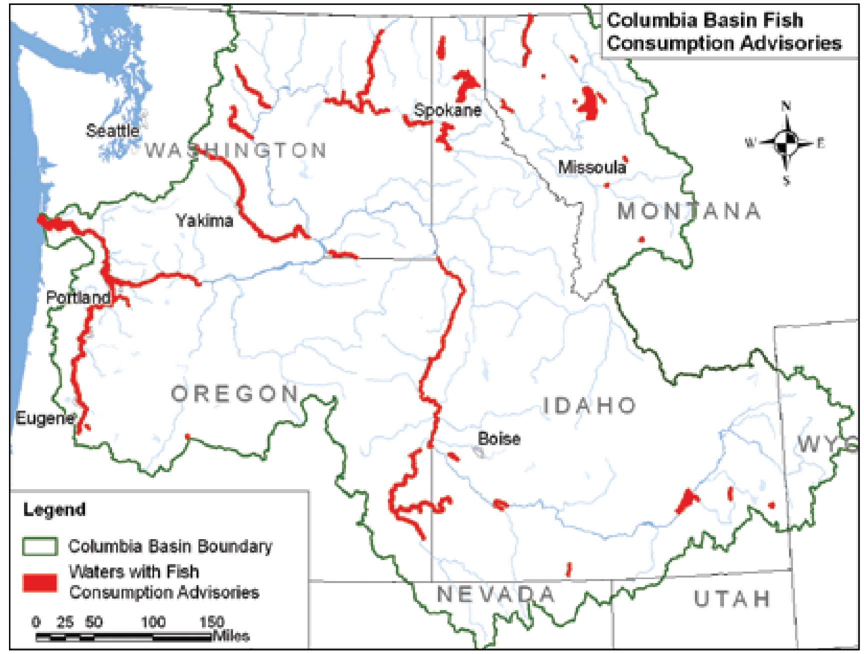


Figure 3.4: State-issued fish consumption advisories are in effect throughout the Columbia River Basin for certain contaminants and species. Not all waters have been tested, so the absence of an advisory does not necessarily mean it is safe to consume unlimited quantities of fish from untested waters.

VISIT THE WEB

Find information about fish consumption advisories for Washington: http://www.doh.wa.gov/ehp/oehas/fish/
Oregon: www.oregon.gov/DHS/ph/envtox/fishconsumption.html
Idaho: www.Idahohealth.org and Montana: www.dphhs.mt.gov/fish2005.pdf.

4.0 Indicators

What are Indicators?

Environmental indicators are tools used to help citizens and decision-makers better understand the health of the environment and whether we are reaching our environmental goals. Indicators may be specific organisms, specific media such as water or sediment, or a specific sampling location or contaminant. The indicators used in this report are animal species living in the Columbia River Basin or dependent on food from the River. Studying these species over time will help scientists track changes in the Basin's ecosystem.

Which Indicator Species are Used in this Report?

For this report, the following indicator species were selected to help assess the health of the Basin ecosystem: juvenile salmon; resident fish, both native and introduced (e.g., sucker, bass, and mountain whitefish); sturgeon; predatory birds (osprey and bald eagle); aquatic mammals (mink and otter), and sediment-dwelling shellfish (Asian clam).

Why were These Species Selected as Indicators for the Columbia River Basin?

The indicator species listed above were chosen for this report because they have some or most of the following characteristics:

- The species has a clear connection with important aspects of the Basin's ecosystem.
- Information is available to describe contaminant status and/or trend information for the species.
- The species can be used to track progress on toxics reduction activities.
- The species represents an important functional level (e.g. predator, prey) of the Basin's food web.
- The species may be compared with the same species living in other aquatic ecosystems.

Juvenile salmon

There are five species of salmon in the Basin: Chinook, coho, sockeye, chum, and pink salmon. Salmon are *anadromous*, meaning their eggs are laid and hatch in freshwater, and their young spend part of their early lives in freshwater before swimming to the ocean to grow and mature (Figure 4.1). Upon returning to their native stream, the adults spawn and then die. Cutthroat trout and steelhead are closely related to salmon. These two species can exhibit both anadromous and resident fish behaviors and are capable of spawning. In the 1990s, the federal fish and wildlife agencies listed several of the anadromous salmon species as threatened and/or endangered.

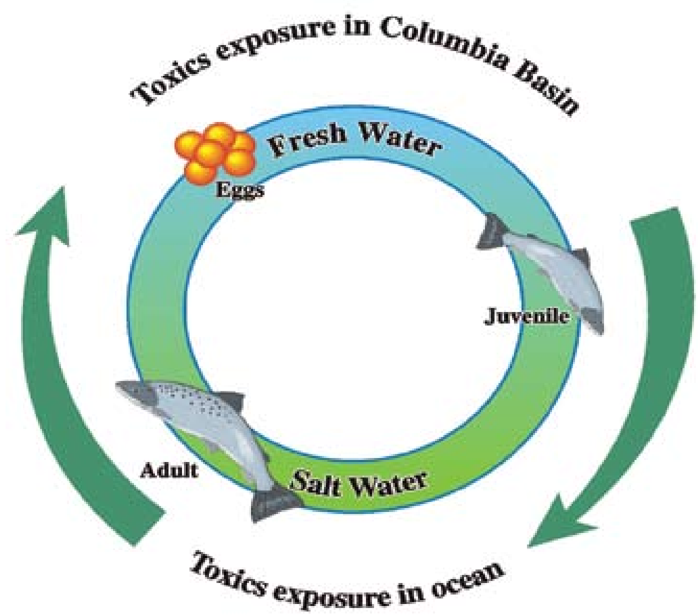


Figure 4.1: Salmon spend a significant part of their adult lives in the ocean. Therefore, it is primarily in their juvenile stages that they are exposed to contaminants in the Columbia River Basin.

Salmon as a Food Source

Because adult salmon spend the majority of their lives in the ocean, the percentage of contaminant accumulation in their tissue from sources in the Columbia River Basin cannot be determined. Regardless of the source, contaminants in adult salmon could pose a threat to people who consume large amounts of salmon, especially Columbia River Basin tribal people for whom the salmon is an important part of their culture and a major food source. In addition, some recreational anglers and their families may consume large amounts of salmon. Given this, it is important to ensure that both tribes and anglers have the most up-to-date information to make informed decisions on how much salmon can be safely consumed.

Pacific salmon die within days of digging their nests, or "redds," and mating. Their remains decompose, releasing nutrients for plants and other animals. Live and dead salmon are also important food for birds and mammals such as bald eagles, otters, and bears. In this way, salmon contribute to the health of freshwater ecosystems.

Juvenile salmon are an important indicator of ecosystem health in the Basin because: (1) they are relatively widespread throughout the Basin; (2) they both forage in the River system and serve as a major food source for larger fish, birds, and mammals; (3) they use many habitat types and therefore provide a means of assessing environmental conditions throughout the River system and estuary; (4) they go through physiological changes from juvenile to adult and therefore can be more susceptible to toxic contaminants; and (5) currently, 13 species of salmon and steelhead in the Basin are listed as either threatened or endangered under the Endangered Species Act.

The National Oceanic and Atmospheric Administration (NOAA) Fisheries and the University of California (UC) Davis are investigating how chemical contaminants affect juvenile salmon health and survival in the Lower Columbia River. In a recently published paper, they concluded that the adverse health effects of chemical contaminant exposure are similar to adverse health effects associated with passage through the hydropower system in the Columbia River. [1]

Resident fish

There are many native and nonnative resident fish species in the Basin, including rainbow trout, cutthroat trout, mountain whitefish, large scale sucker, bass, walleye, and northern pikeminnow. They are a common source of food for people and wildlife and are widely distributed throughout the Basin. Resident fish live their entire lives in the Basin and thus are exposed to contaminants present in the water and sediments through their food, by breathing in oxygenated water through their gills, and by continuous contact with the water and sediments. In many of the Basin's water bodies, these resident species have accumulated levels of some contaminants that are harmful to predators and to people.

Resident fish are useful indicators because: (1) they are widely distributed throughout the Basin; (2) most of the existing data on contaminants in the Basin are from resident fish species; (3) many species of resident fish spend their lives in relatively small areas, so their tissue concentrations are indicative of the contaminant loads in those areas; and (4) they occupy a central place in the food web, are exposed to contaminants through their diet, and in turn expose those who eat them, including people, to any accumulated contaminants.

VISIT THE WEB For more information about salmon in the Columbia River Basin, go to: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Draft-Plans.cfm.

Sturgeon

White Sturgeon (photo courtesy of Gretchen Kruse, Free Run Aquatic Research)

White sturgeon are the largest freshwater fish in North America, occurring in Pacific Coast rivers from central California to Alaska's Aleutian Islands. Some white sturgeon spend their entire life cycle in freshwater, while others use estuarine or coastal saltwater resources for growth and food, only entering freshwater to reproduce.

White sturgeon inhabit the Columbia River and its larger tributaries, such as the Snake and Kootenai Rivers. Sturgeon can live 100 years and grow up to 1,500 pounds and 15 feet long. Sturgeon are primarily bottom-dwelling fish. Juvenile sturgeon feed primarily on plankton and aquatic insects, whereas adults feed mainly on live or decaying fish, aquatic insects, and shellfish (e.g., Asian clams).

Sturgeon are not reproducing successfully throughout the Columbia River system. In Canada's portion of the River, there has been no successful reproduction recorded in the wild over the last decade. For similar reasons, the Kootenai River population of white sturgeon has been listed on the federal endangered species list since 1994.

White sturgeon are a good Columbia River indicator species for several reasons: (1) they are widely distributed in large rivers of the Basin; (2) they are long-lived and thus have prolonged exposure to toxic contaminants; (3) sturgeon migration is curtailed by dams in some portions of the Basin, allowing for evaluation of local toxics effects; (4) they are near the top of the food web; and (5) effects of contaminants on sturgeon are likely similar for other benthic, bottom-dwelling species.

Predatory birds—osprey and bald eagle in the Lower Columbia River

Osprey and bald eagle are large birds of prey that live in much of the Basin, but they are concentrated in the Lower Columbia River. While the bald eagle is found exclusively in North America, the osprey has a nearly world-wide distribution. Bald eagles feed primarily on live or scavenged fish and aquatic birds, while the osprey has a diet almost exclusively of live fish captured near the nest.

Osprey and bald eagles are useful indicators for evaluating the health of an aquatic ecosystem for several reasons: (1) they are widely distributed; (2) they are long-lived (bald eagles, for instance, can live up to 28 years in the wild); (3) they primarily prey on fish and other aquatic predators, usually near their nests; and (4) they are at the top of the food web and are therefore exposed to high concentrations of contaminants through their diet.

Osprey

Bald Eagle

(photos courtesy of NOAA/Dept. of Commerce)

Aquatic mammals—mink and river otter

Mink and river otter are members of the weasel family. They are excellent swimmers and are active predators that feed on fish, frogs, crayfish, and sometimes small mammals and waterfowl. The average lifespan of mink in the

Mink (photo courtesy of U.S. Forest Service)

North American River Otter (photo courtesy of USGS)

wild is three to six years, whereas river otter average over eight years. Both are found throughout the Basin in appropriate habitat; however, mink populations have not recovered from a decline in the 1950s and 1960s, even though suitable habitat is available for them in the Lower Columbia River.

Mink and otter are useful indicators of ecosystem health in the Basin because they: (1) prey on other aquatic species; (2) are particularly sensitive to contaminants which accumulate and can impact their reproduction; (3) have smaller home ranges compared to osprey and bald eagles; and (4) occur throughout the Basin.

Sediment-dwelling shellfish—Asian clam

First found in North America at Vancouver Island, British Columbia, in 1924, the nonnative, freshwater Asian clam is a small, light-colored bivalve now abundant throughout North America. It is widely distributed throughout a large portion of the Basin and has an average life span of three to five years. Located primarily in flat-bottom sand or clay areas, Asian clams feed by filtering particles from the surrounding water. They also routinely bury in the sediment for extended periods and filter sediment pore water.

Asian clams are a good indicator species for several reasons: (1) they are filter feeders and, like other freshwater shellfish, can collect and concentrate contaminants in their bodies; (2) they are not very mobile, so data on clams can be more useful to pinpoint the location where they were exposed to the contaminants than similar or more mobile species; (3) because of their distribution and feeding habits, they are a useful indicator of sediment and water quality conditions in the Basin; and (4) they occupy a lower position in the food web than other indicator species.

Lamprey

Pacific lamprey are scaleless, jawless fish that are culturally important to the Columbia River tribes. Lamprey have declined drastically in the past 20 years and are no longer found in many streams in their traditional range. Pacific lamprey spawn in freshwater streams. Juvenile lamprey (ammocoetes) spend their first five to seven years in the sediment as filter feeders. Adult lamprey migrate to the ocean, where they feed parasitically on other fish for up to three years before returning to freshwater streams to spawn.

Because lamprey spend their developing years in the Basin's streams, there are concerns that toxics may be a contributing factor in their declining numbers. Studies in locations outside the Columbia River Basin have documented the sensitivity of juvenile lamprey to toxics in their environment. [2,3] The unique life cycle of the lamprey with its potential for exposure to Basin contaminants distinguishes it as a potential indicator of ecosystem health. However, very little data have been collected on toxics in lamprey in the Columbia Basin. Because of this lack of data, lamprey are not discussed as an environmental indicator in this report. Given the cultural importance of lamprey to the Columbia River tribes, however, we will evaluate whether lamprey should be added as an indicator species after additional data on toxics in lamprey are collected and evaluated.

5.0
Status and Trends for Mercury, DDT, PCBs, and PBDEs

The contaminants discussed in this report—mercury, DDT, PCBs, and PBDEs—come from a variety of sources and can potentially result in health concerns for wildlife or people. Table 5.1 summarizes the sources and health concerns of these four contaminants.

In order to evaluate whether the toxics reduction efforts currently under way in the Basin are having an impact or if other activities are needed, it is important to understand whether the levels of contaminants are increasing or decreasing over time. While considerable information has been collected over the past 20 years, the data are limited with regard to whether the contaminants are increasing or decreasing Basin-wide. There is some trend information for specific areas of the Basin such as the Lower Columbia. While not comprehensive, this report highlights trend data when such data are available.

Table 5.1: Contaminants of concern summary

Contaminant	Sources/Pathways	Concern
Mercury	Atmospheric deposition from sources inside and outside the region is thought to be a major pathway for mercury. Other possible sources/pathways include releases from past and current mining and smelting activities; erosion of native soils; agricultural activities; discharge of wastewater and stormwater; and resuspension and recirculation of sediments.	Mercury can cause neurological, developmental, and reproductive problems in people and animals.
DDT	DDT was banned in the United States in 1972, but DDT and its breakdown products are still found in the environment in sediments and soil. The main pathway to the River is via runoff from agricultural land.	DDT thins bird eggshells and causes reproductive and development problems. It is linked to cancer, liver disease, and hormone disruption in laboratory-test animals.
PCBs	PCBs were banned in the United States in 1976, but they are still widely found in the environment in fish tissue and sediments. Industrial spills and improper disposal are known sources locally, while incineration and atmospheric deposition bring PCBs from distant sources. Stormwater runoff and erosion may also be important pathways.	PCBs can harm immune systems, reproduction, and development; increase the risk of cancer; and disrupt hormone systems in both people and aquatic life.
PBDEs	PBDE flame retardants are present in many consumer products, including electronics, textiles, and plastics. There is limited information on the transport pathways to the River, but some possible pathways include atmospheric deposition, municipal and industrial wastewater, stormwater discharge, and runoff.	PBDEs accumulate in the environment, harming mammals' reproduction, development, and neurological systems. They can increase the risk of cancer and disrupt hormone systems.

VISIT THE WEB

Additional information and updates about mercury, DDT, PCBs, and PBDEs can be found by visiting EPA's Columbia River website: http://www.epa.gov/region10/columbia.

Mercury: Most Fish Consumption Advisories in the Basin are due to High Concentrations of Mercury

Mercury can affect the nervous system and brain, and even low doses can impair the physical and mental development of human fetuses and infants exposed via the mother's diet. Fish consumption advisories generally discourage the consumption of larger fish and predatory fish, as they typically contain higher concentrations of mercury. Figure 5.1 shows mercury concentrations found in fish from U.S. waters in the Columbia River Basin.

As a metallic element, mercury is never destroyed, but cycles between a number of chemical and physical forms. Mercury in the aquatic environment can be converted by bacteria to a more toxic form, called methylmercury. This process is important because methylmercury can biomagnify, so predators at the top of the food web will have much higher concentrations of mercury in their bodies than are found in the surrounding water or the algae and insects at the base of the food web.

Methylmercury is the dominant form of mercury found in fish, and the concentrations of methylmercury found in fish are directly related to the amount available in the aquatic environment. The rate at which methylation of mercury occurs varies according to water body characteristics such as the amount of organic matter, sulfate, and iron present and the acidity, temperature, and water velocity.

Several pathways introduce mercury into the Columbia River Basin

Mercury enters the Columbia River and its tributaries via several pathways, including atmospheric deposition, runoff, wastewater discharges, industrial discharges, and mines. Based on available data, atmospheric deposition appears to be the major pathway for mercury loading to the Columbia River Basin. [1] Mercury air deposition includes both emissions from industrial facilities within and near the Basin and fallout from the pool of global mercury that has been transported from sources as far away as Asia and Europe.

EPA estimates that the total mercury air deposition in the Columbia River Basin is 11,500 pounds per year. [2] Approximately 84 percent of that load comes from global sources. At a watershed scale, however, local and regional sources

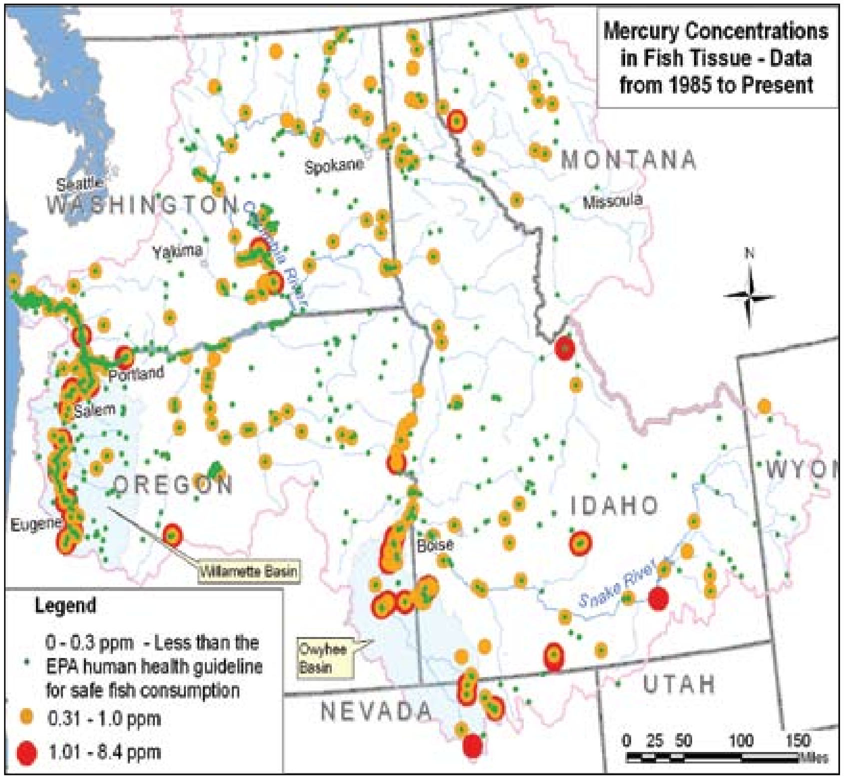


Figure 5.1: Seventy-five percent of fish consumption advisories in the Columbia River Basin are due to mercury contamination. In the fish tested, high levels of mercury have been consistently found downstream of historic mining areas in the Willamette and Owyhee River Basins. There is no information about mercury levels in fish from waters that are unmarked on the map.

can contribute the majority of mercury deposited on the local landscape. For example, a cement plant in Durkee, Oregon, emits more than 2,500 pounds of mercury per year. [3] Although just over 140 pounds of this amount are deposited in the sub-basin in which this plant is located, that deposition constitutes an estimated 62 percent of the air-deposited load in that area. [4]

As for regional sources, in northern Nevada near the Basin's southeast boundary, several gold mines emit mercury from their ore roasters. One of these mines discharges more than 1,700 pounds of mercury per year. [3] Although only part of this load ends up in the Columbia River Basin, almost 160 pounds are deposited in the nearby Upper Owyhee watershed in Idaho, accounting for 58 percent of the atmospheric mercury loading there. [4] In Idaho, the largest source of mercury emissions is an elemental phosphorus plant in Soda Springs. This plant emits more than 900 pounds per year [3] and contributes 36 percent of the mercury deposited in the adjacent watershed. [4]

Across the United States, coal-fired power plants are a major local source, but they are less significant sources in the Northwest because so few are located here. There is a single coal-fired power plant in the Columbia River Basin located near Boardman, in eastern Oregon. This plant emits about 168 pounds of mercury per year. [3] There are also three coal-fired power plants near the boundary of the Basin (one in Washington and two in Nevada) that could contribute some mercury load to the watershed, depending upon their emissions and prevailing wind patterns.

Not all of the mercury that falls onto land gets transported to water bodies. Forests and other undisturbed landscapes can retain mercury for years.

Other point sources directly discharge mercury to rivers and streams. Wastewater treatment plants, industrial discharges, and stormwater runoff from streets and other developed areas are more direct sources of mercury to streams than air deposition or erosion. These sources may be low in concentration, but high in volume. Nine of the 23 largest municipal and industrial wastewater point sources located in the U.S. portion of the Columbia River have reported discharging a total of 33 pounds of mercury per year. [5] This may be an underestimate, however, because mercury reporting is not always required and mercury detection limits are often too high to provide useful information. Although these sources contribute less mercury to the basin than the air pathway, they may be significant at a local scale because they discharge directly to water bodies. A smelter just north of the Canadian border directly discharged an average of 184 pounds of mercury per year to the Upper Columbia from 1994 through 1998. This load was reduced to an average of 38 pounds of mercury per year for the 1999-2007 time period. [6] Historic mercury and gold mining can also be important sources that load mercury directly to streams and have significant impacts at a watershed scale.

Mercury is also still found in several commonly used products such as fluorescent light tubes, compact fluorescent lamps, thermometers, thermostats, switches in vehicles, some batteries and pumps, and medical equipment such as blood pressure measuring devices. Although mercury has been or will be removed from some of these products, many of the older versions still contain mercury. If these older products are not handled and disposed of properly, they can add mercury to the environment.

Regional trends and spatial patterns of mercury levels in the Basin can be difficult to evaluate

Although data on mercury concentrations are available for resident fish species in the Basin from the 1960s to the present, there are few locations with consistent, comparable data from different time periods that can be used to evaluate changes in mercury concentrations over time. Two exceptions, noted in Figure 5.2, are mercury concentrations in northern pikeminnow from the Willamette River Basin and mercury concentrations in osprey eggs in the Lower Columbia River, both of which have been increasing in the last decade. [7,8,9] The osprey egg concentrations, however, were still below levels that are of concern in birds. Another study shows that mercury concentrations increased in pikeminnows (1.12 to 1.91 parts per million [ppm]) from the Upper Willamette River between 1993 and 2001. [10]

The Columbia River sturgeon population living in the pool behind Bonneville Dam has much higher concentrations of mercury in their livers than sturgeon in the estuary or other Columbia River reservoir pools. Sturgeon tissues from the Kootenai, Upper Columbia, and Snake Rivers contained mercury concentrations in the range of 0.02 to 0.6 ppm, but Bonneville pool sturgeon have mean concentrations of 4 ppm. [11,12,13,14] Also, high mercury levels in liver and other organs from Lower Columbia River white sturgeon are correlated with lower physical health indices and reproductive defects in the fish. [15,16,17,18,19]

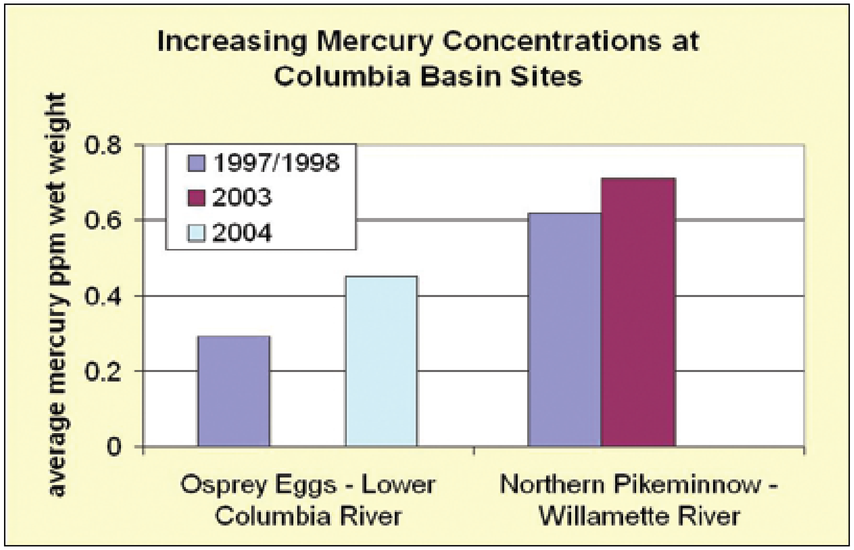


Figure 5.2: Mercury levels in Willamette River northern pikeminnow and Lower Columbia River osprey eggs have increased over the last decade. Mercury level trends have not been studied in other Columbia River Basin organisms over the

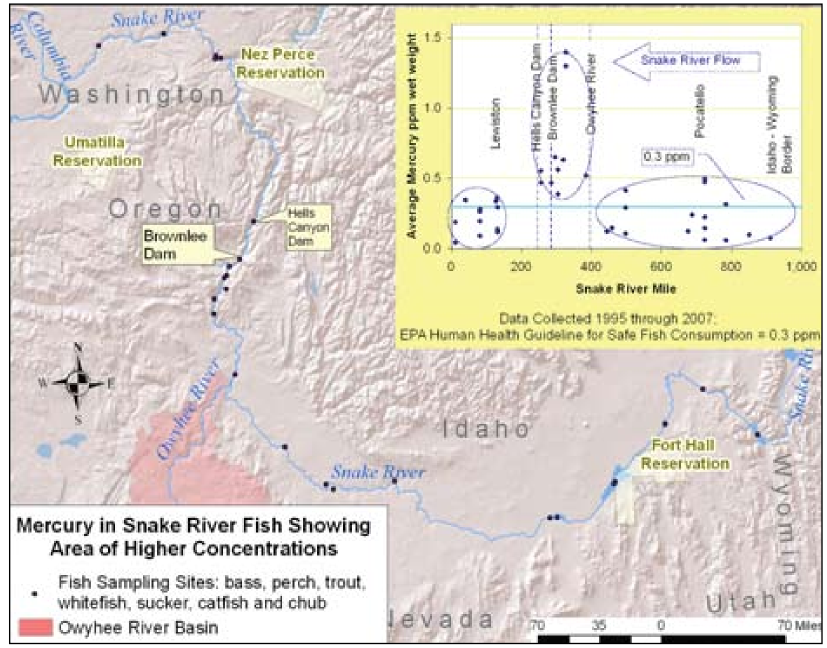


Figure 5.3: Mercury levels are highest in fish collected at Brownlee Dam reservoir, downstream from the Owyhee River inflow. The Owyhee River is contaminated by mercury from historic mining.

Mercury concentrations vary across the basin, but only in some cases are the sources known. For example, in reservoirs in the Owyhee River basin [20,21] and in the Snake River downstream of the Owyhee confluence, mercury levels are found above EPA's 0.3-ppm mercury human health guideline due to mercury used in gold mining there in the 1800s (Figure 5.3). [22,23,24,25,26,27,28,29]

DDT: Banned in 1972, This Pesticide Still Poses a Threat to the Environment

DDT is the most well-known of a class of pesticides that were widely used from the 1940s until EPA banned them in the United States in 1972. However, DDT continues to be used in other parts of the world. DDT and its breakdown products—dichlorophenyldichloroethylene (DDE) and dichlorophenyldichloroethane (DDD)—have been linked to neurological and developmental disorders in birds and other animals. DDT has also been linked to eggshell thinning that caused declines in many bird species and inspired Rachel Carson's 1962 book *Silent Spring*, which documented detrimental effects of pesticides on bird species and ultimately led to the banning of DDT.

The chemical structure of DDT is very stable in the environment, which is why DDT and its breakdown products DDE and DDD continue to be an ecological and human health threat. Figure 5.4 shows DDE concentrations found in fish from U.S. waters in the Columbia River Basin.

Soil erosion from agricultural runoff is the main source of DDT into the Basin

The primary source of DDT to the Columbia River Basin is the considerable acreage of agricultural soils in which DDT accumulated over three decades of intensive use (1940s to early 1970s). DDT reaches the River when the soils are eroded by wind and water. Some irrigation practices increase soil erosion on agricultural lands. Other potential sources of DDT are areas where pesticides were handled or stored, such as barns or agricultural supply sheds, or areas where containers or unused product were disposed. The main pathway for these sources is erosion and runoff. Disturbance of contaminated sediments within the Columbia River and its tributaries may also release DDT to the water column, which can directly or indirectly be taken up by fish.

DDT levels are declining with better soil conservation practices, but DDT still exceeds human health levels of concern

The ban on DDT combined with significant improvements in soil conservation by farmers reduced DDT loading to the Columbia River Basin. [1] A number of state water quality improvement plans currently aim to reduce DDT compounds, and continued monitoring is critical to demonstrating the effectiveness of these actions.

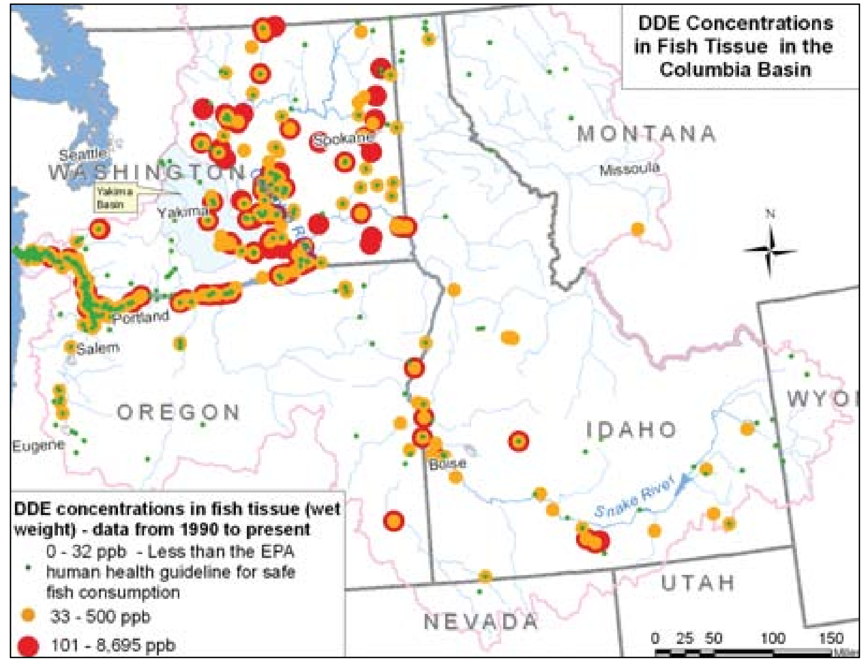


Figure 5.4: High levels of DDE in fish are found in areas where DDT pesticide use was historically high, such as in eastern Washington and the Snake River Plain. There is no information about DDE levels in fish from waters that are unmarked on the map.

Concentrations of DDT compounds in the Columbia River and its wildlife have decreased over the last 20 years. However, DDT is still regularly detected in the fish, plants, and sediments of the River and many of its tributaries, indicating that DDT continues to cycle through the food web. In addition, fish consumption advisories continue to be issued for DDT in Lake Chelan.

DDT levels have declined in several of the key species of resident fish in areas of the Columbia River Basin. DDT contamination has been most intensively studied in the Yakima River, which is a major tributary to the Columbia in Washington State and is in one of the most diverse agricultural areas of the country. [2] Data collected in the 1980s showed that fish in the Yakima River Basin had some of the highest concentrations of DDT in the nation. [3]

In the late 1990s, a partnership of farmers, irrigation districts, the Confederated Tribes and Bands of the Yakama Nation, and many governmental agencies initiated changes in farming and irrigation practices that have dramatically reduced erosion from farmland in the Yakima Basin (see Section 6.0 of this report). Sampling of resident fish conducted between 1996 and 2006 showed an overall decline in DDT levels in several species, including bass and sucker (Figure 5.5). [4,5]

By contrast, liver tissues from Columbia River white sturgeon residing in the pool upstream of Bonneville Dam contained much higher concentrations of DDT than other sub-populations of sturgeon residing in the Columbia River Basin (Figure 5.6). [6,7,8,9,10,11,12,13] The cause of these elevated concentrations is not known.

DDT is also a problem for fish-eating birds such as bald eagles and osprey. Severe declines in eagle populations in the Lower Columbia River occurred from the 1950s to1975. Studies conducted along the Lower Columbia River from 1980 to 1987 found elevated concentrations of DDE in bald eagles. [14] High concentrations of DDE are associated with eggshell thinning and low reproductive success.

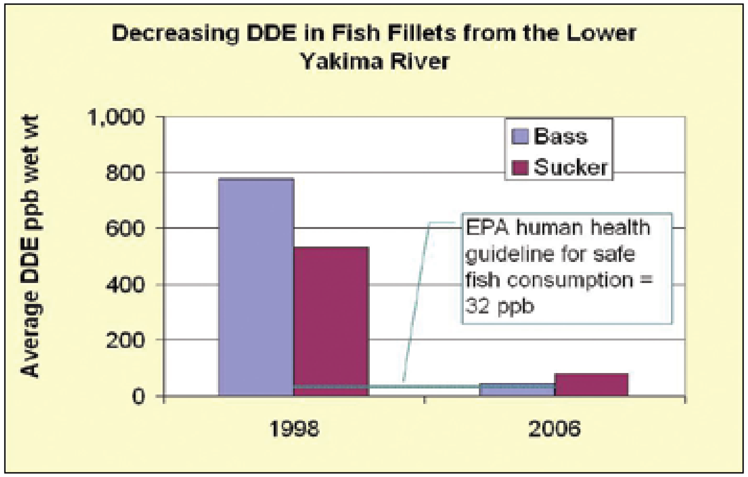


Figure 5.5: DDE levels in Yakima River fish have declined significantly since 1998.

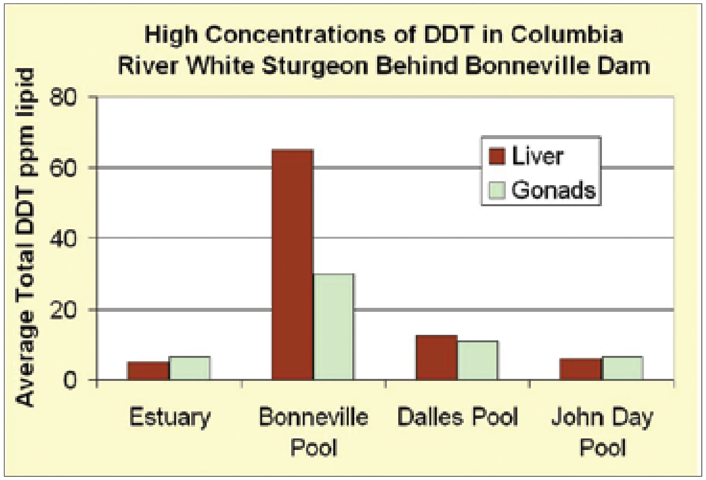


Figure 5.6: Sturgeon in the pool behind Bonneville Dam have much higher levels of DDT and other contaminants (such as mercury and PCBs) than do sturgeon downstream of the dam or sturgeon in pools behind upstream dams.

Successful reproduction of bald eagles along the Columbia River was also found to be considerably lower than the statewide average for Oregon. [15,16] DDE concentrations in Columbia River eagle eggs in the 1980s were the highest recorded for bald eagles in the western United States, surpassed only by levels found in eagle eggs from highly contaminated areas of the eastern United States. [14]

In a similar study in the mid-1990s, researchers found that total DDE concentrations in Columbia River eagle eggs declined significantly in comparison to concentrations found in the mid-1980s (Figure 5.7). [15,16]

Prior to the use of DDT, nesting osprey were common along the Lower Columbia and Willamette Rivers, [17] but populations declined dramatically from the 1950s to the 1970s. As with eagles, DDT was the primary cause of osprey population decline because of eggshell thinning. Figure 5.8 shows the increase in nesting osprey along the Willamette River, an important tributary of the Columbia River, from 1976 to 2001. Similar trends have been found in the Columbia River. A 1976 survey of the 300-mile-long Oregon side of the Columbia River found only one occupied osprey nest. [18,19] In 2004, there were 225 osprey nests in the same area. Scientists recorded a 69 percent decrease in DDT levels in osprey eggs from the Lower Columbia River between 1997 and 2004, coinciding with an increase from 94 to 225 osprey nests. [20]

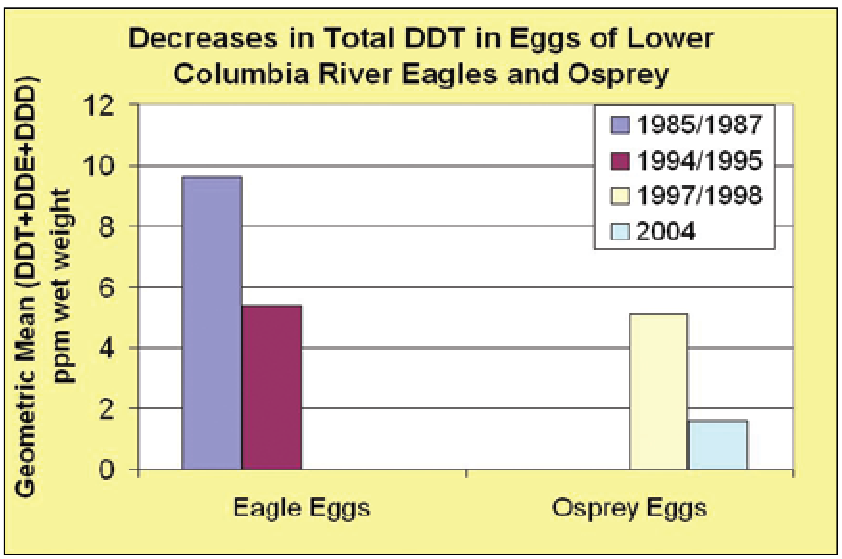
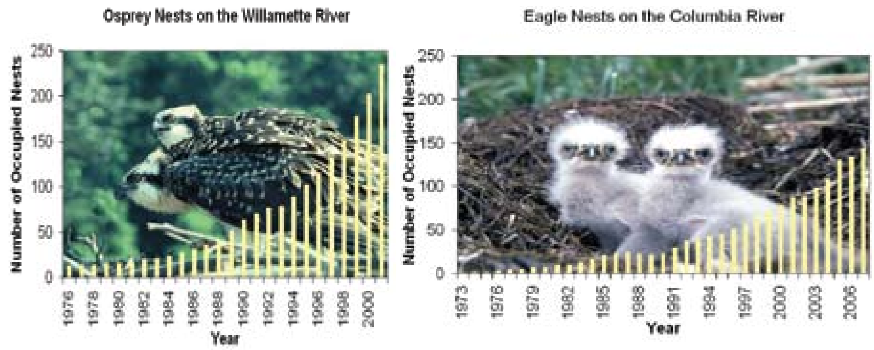


Figure 5.7: DDT levels have decreased significantly in eagle and osprey eggs from the Lower Columbia River over the past 20 years.



(photos courtesy of Peter McGowan, U.S. Fish and Wildlife Service)

Figures 5.8 and 5.9: Nesting pairs of osprey and bald eagle have increased significantly from near-regional extinction in the 1970s, due to reductions of DDT and other contaminants in the environment. [19,21]

Since the late 1970s, the number of bald eagle nesting pairs along the Lower Columbia River also has increased (Figure 5.9). In 2006, there were over 133 nesting pairs of bald eagles, up from 22 in 1980. However, researchers also found that long-established eagle pairs that had been breeding for many years along the Lower Columbia River produced about half the number of young as eagles that had more recently begun nesting there. The greater reproductive success of the newer nesting bald eagle population is attributed in large part to reduced exposure to DDT. [16]

PCBs: Stable PCB Compounds Continue to Persist in the Environment

PCBs are a class of man-made compounds known for their chemical and thermal stability. PCBs were manufactured to take advantage of these properties in such applications as electric transformers and capacitors, heat exchange and hydraulic fluids, lubricants, fluorescent light ballasts, fire retardants, plastics, epoxy paints, and other materials. Before PCBs were banned in the 1970s, approximately 700 million tons of PCBs were produced in the United States, and hundreds of tons remain in service today.

Environmental concentrations of PCBs decrease very slowly because they are stable and persistent. PCBs tend to concentrate in the fatty tissue of fish and other animals and can be passed from mother to young. PCBs have been linked to liver damage, disruption of neuro-development, reproductive problems, and some forms of cancer. PCB levels have triggered fish and shellfish advisories in the Lower Columbia River and several other water bodies in the Basin.

Figure 5.10 shows PCB concentrations found in fish from U.S. waters in the Columbia River Basin.

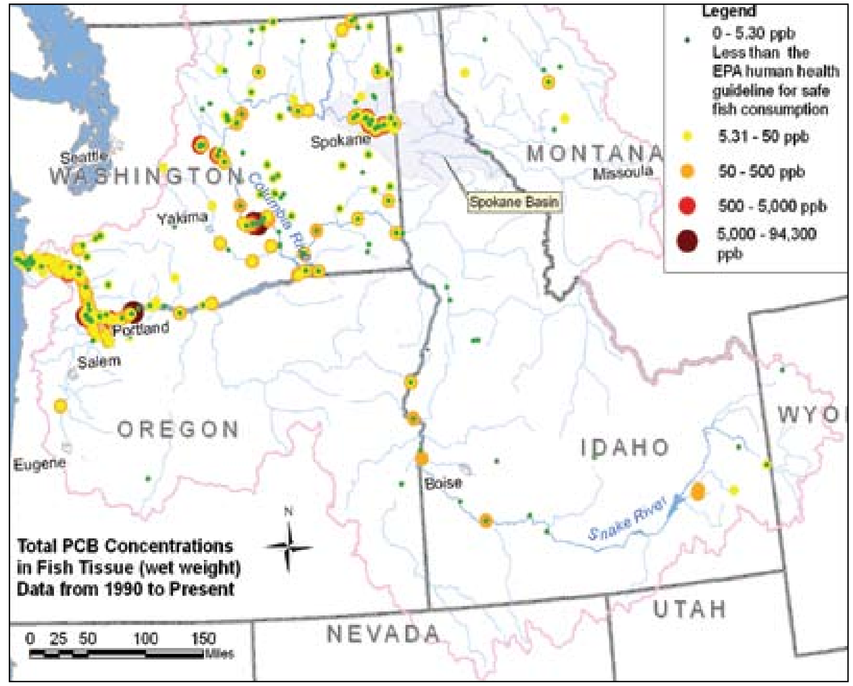


Figure 5.10: A legacy contaminant, PCB hot spots correspond to areas of historic industrial use or disposal sites. There is no information about PCB levels in fish from waters that are unmarked on the map.

PCBs enter the ecosystem from multiple sources and through multiple pathways

PCBs in the Columbia River Basin tend to be associated with industrial locations, where spills or historic handling practices (such as disposing of PCB-contaminated materials in unlined landfills near the River or dumping such materials directly into the River) were more likely to occur. Several examples of known PCB disposal sites in the Lower Columbia River include Bradford Island at Bonneville Dam; Alcoa Smelter in Vancouver, Washington; and Portland Harbor on the Willamette. In addition, historically, many pieces of electrical equipment used to generate power at dams in the Columbia River Basin used cooling and insulating oil that contained PCBs. Past practices such as the use of PCB-laden paint in fish hatcheries and the use of oils tainted with PCBs to control dust on unpaved roads also led to PCB contamination.

Inefficient incineration of PCB-containing materials, followed by atmospheric deposition, is the primary means by which PCBs from other parts of the world reach the Columbia River Basin. Regionally, snowmelt, stormwater runoff and discharge, and soil erosion are pathways by which PCBs deposited on land are transported to water. PCBs entering rivers and streams from stormwater runoff and discharge are a growing concern. PCBs are not very water-soluble, but they do adhere to organic matter and sediment particles, so they have a high potential to be transported when sediment is transported (such as during storms and floods) and then accumulate in pools or reservoirs.

PCBs in fish are declining but still exceed EPA human and ecological health concern levels in some areas

In the early 1990s, the Washington Department of Ecology (WADOE) found high concentrations of PCBs in rainbow trout, mountain whitefish, and large-scale sucker in the Spokane River. [1] The Department took steps to identify and clean up hazardous waste sites and reduce PCB inputs from municipal and industrial wastewater dischargers. As a result, concentrations of PCBs in rainbow trout, mountain whitefish, and sucker have decreased between 1992 and 2005 in almost every reach of the Spokane River (Figure 5.11). [1,2,3,4,5]

As with mercury and DDT, several studies have revealed that Columbia River sturgeon living in the pool behind Bonneville Dam contained much higher concentrations of PCBs in their livers than sturgeon in other areas of the Basin. [6]

Recent studies indicate that juvenile fall Chinook salmon from throughout the Basin are accumulating toxic contaminants, including PCBs, in their tissues. [7,8,9] As shown in Figure 5.12, PCB concentrations in juvenile salmon are higher in out-migrating juveniles sampled in the Lower Columbia River near the confluence of the Willamette River than in juveniles sampled at Warrendale just below the Bonneville Dam. Two studies of PCB

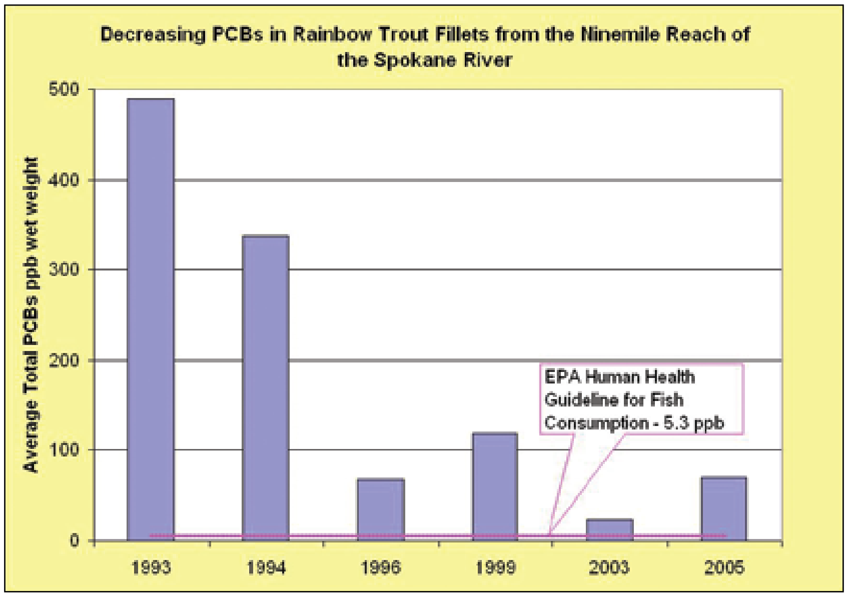


Figure 5.11: PCB levels in rainbow trout from throughout the Spokane River have declined due to hazardous waste cleanup efforts and a reduction in the amount of PCBs discharged in wastewater.

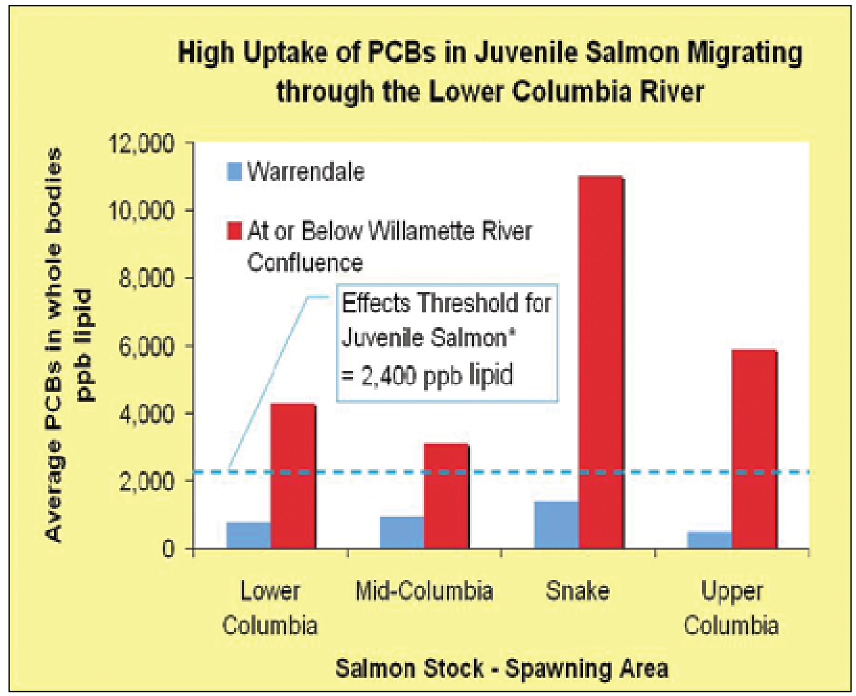


Figure 5.12: Migrating juvenile salmon, regardless of where they began their migration, consistently show higher levels of PCBs when captured in the Lower Columbia River below the Bonneville Dam.

concentrations in water also showed higher dissolved PCBs near the Portland/Vancouver area and downstream of the Willamette River than were found upstream near Bonneville Dam. [7,10] This suggests that there are significant sources of PCBs in the Lower Columbia River.

There are currently no data to indicate whether PCB levels in the mainstem of the Columbia River are increasing or decreasing. However, at some sites PCB concentrations in salmon were as high as or higher than those observed in juvenile salmon from industrial contamination sites in Puget Sound (Duwamish Waterway Superfund site in Seattle, Washington). At several sites in the Columbia River, salmon PCB concentrations were above levels at which juvenile salmon may be harmed (Figure 5.13).

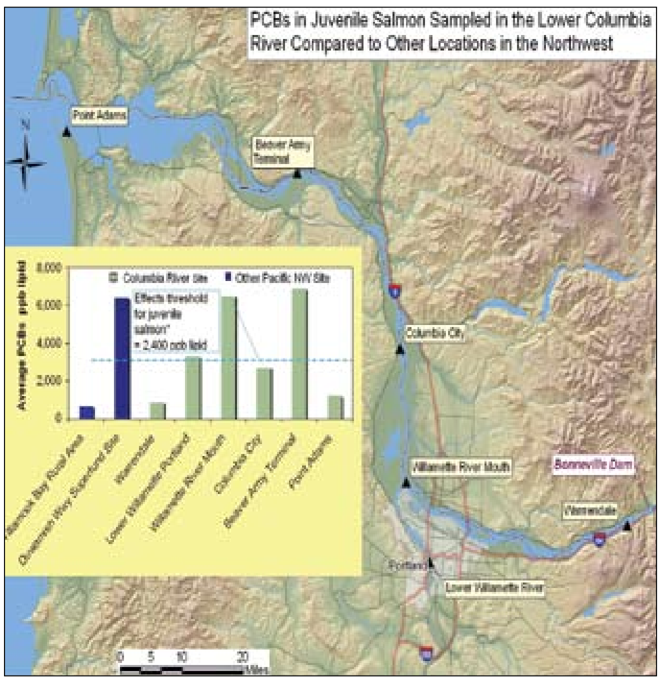


Figure 5.13: PCBs in juvenile salmon from several Lower Columbia River sites are similar to levels found in juvenile salmon at the Duwamish Waterway Superfund site in Seattle, Washington.

PCBs can also adversely affect the ability of mink and otter to reproduce. Mink are especially sensitive to the toxic effects of PCBs. Studies in the late 1970s showed that PCBs in mink from the Lower Columbia River were as high as those levels that are reported to cause total reproductive failure in female mink. [11]

Concentrations of PCBs in mink and otter have declined dramatically since the 1970s (Figure 5.14). [11,12,13] Despite these declines in contaminant concentrations and the presence of suitable habitat, mink remain scarce in the Lower Columbia. While there is a relatively dense otter population distributed throughout the Lower Columbia River, otters there have higher PCB concentrations compared to otters in other areas of Oregon and Washington. [14]

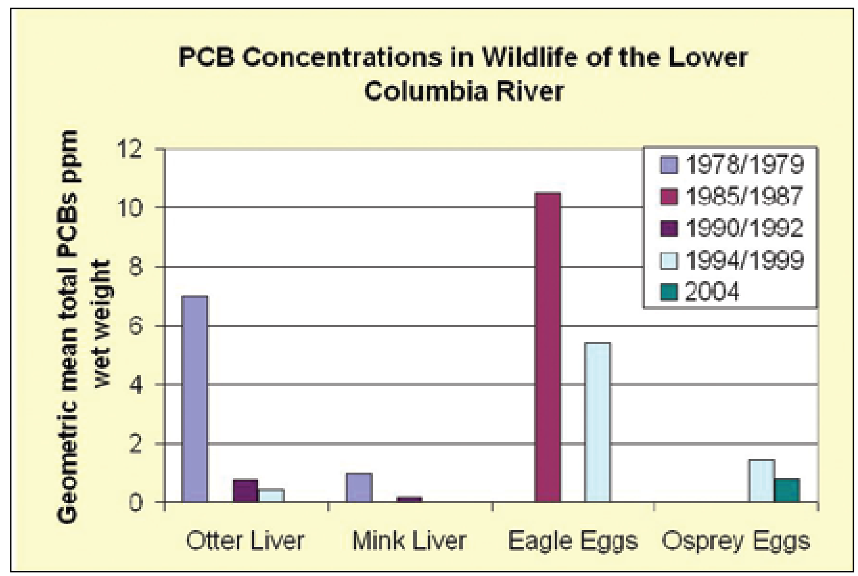


Figure 5.14: PCBs are decreasing in multiple fish-eating predators from the Lower Columbia River, due to decreased PCB use and contaminated site cleanup.

Like DDT, PCBs bioaccumulate in bald eagles and osprey. While PCB concentrations in eagle eggs from the Lower Columbia River were the highest recorded in the western United States in the 1980s, PCB levels are decreasing in both of these top predators (Figure 5.14). [15,16,17]

In 2005, U.S. Army Corps of Engineers (USACE) researchers used the Asian clam to describe distribution patterns of PCBs in the Lower Columbia River. [18] After analyzing samples from 36 stations, the researchers found distinctive spatial patterns related to the specific site from which the clams were collected. All clams collected had detectable levels of PCBs. Especially high levels of PCBs, ranging from 382 to 3,500 parts per billion (ppb), were found downstream of the Alcoa plant, a WADOE hazardous waste cleanup site (Figure 5.15) on the Washington side of the River.

Although "safe" levels for PCB consumption have not been formally established, the Clark County Health Office, State of Washington, recommends that seafood with PCB levels of up to 50 ppb should generally be eaten no more than two or three times per month.

VISIT THE WEB	For more information on PCBs and the Alcoa cleanup, go to: http://www.ecy.wa.gov/programs/swfa/industrial/alum_alcoavan.htm.

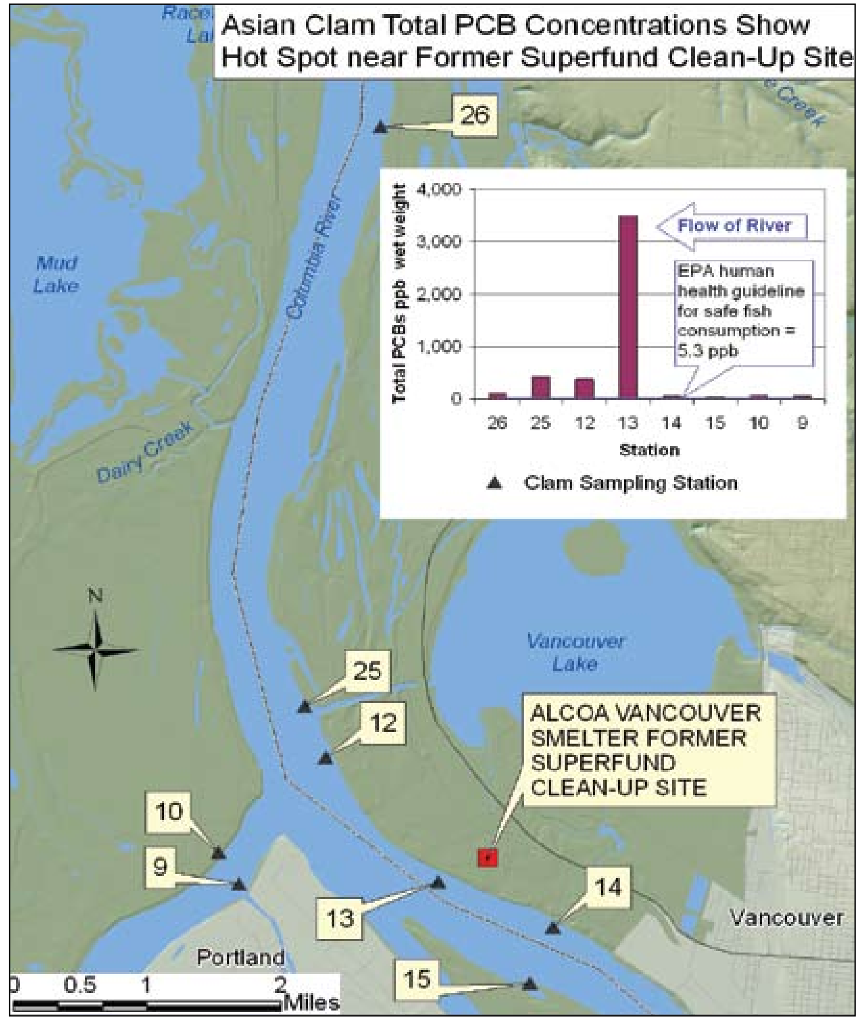


Figure 5.15: Clams collected in the Portland/Vancouver metropolitan area indicate PCB hot spots near the Alcoa plant, a WADOE hazardous waste cleanup site.

PBDEs: Concern over Flame Retardants is Growing

PBDEs are a commonly used flame retardant. Many industries and states, including Washington, are phasing out products containing PBDEs. PBDEs are of concern because their levels have increased rapidly in soil, air, wildlife, and human tissue and breast milk.

The health effects of PBDEs have not been studied in people. Laboratory animal studies show neurological, behavioral, reproductive, and developmental effects and even cancer at very high doses.

PBDEs are in many everyday products

Since the 1960s, PBDEs have been added to plastics and fabrics to reduce the likelihood that these materials will catch fire or burn easily when exposed to flame or high heat. PBDEs are used in electrical appliances; TV sets; building materials; home, auto, and business upholstery; and rug and drapery textiles. They are released slowly to the environment from production, use, and disposal of these products. PBDEs, like PCBs, remain in the environment for a long time. PBDEs accumulate in all animals, but the concentrations continue to increase as an animal ages. However, unlike PCBs, EPA does not currently regulate PBDEs and only recently published a standard method for measuring PBDEs in environmental samples.

Figure 5.16 shows PBDE concentrations found in fish from U.S. waters in the Columbia River Basin.

Information on how PBDEs enter the environment is limited

While there is limited understanding on how PBDEs enter the environment, several studies have indicated that municipal wastewater may be a significant pathway. [1,2,3,4,5] PBDEs in dust and air are a direct pathway of exposure to people, but the importance of air and atmospheric deposition of PBDEs as a source to the Columbia River Basin is unknown. Runoff from municipal sewage sludge placed on land is also being examined as a possible source of PBDEs to surface water. [4,5,6] A study of PBDE contamination in the Canadian portion of the Columbia River found a correlation between high PBDE levels and areas where septic systems were concentrated near the River. [7]

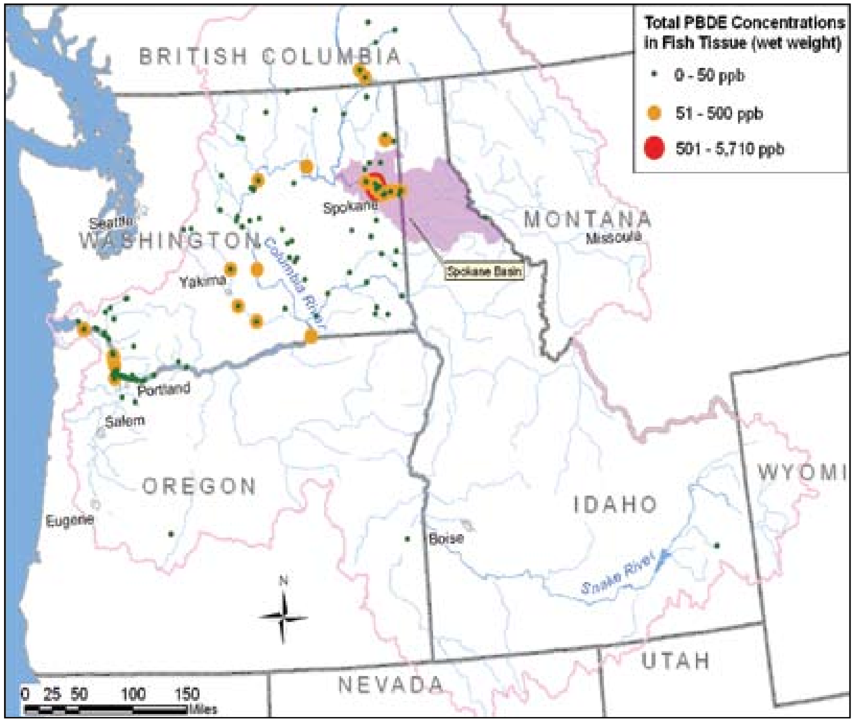


Figure 5.16: PBDEs are being detected and are increasing in fish in the Columbia River Basin. There is no information about PBDE levels in fish from waters that are unmarked on the map.

Levels of PBDEs in the Columbia River are increasing

In 1996, 1999, and 2005, the WADOE studied PBDE concentrations in sucker, mountain whitefish, and rainbow trout in the Spokane River (Figure 5.17). [8,9,10] PBDE levels in these species are increasing in most reaches of the Spokane River. The most dramatic increases were found in mountain whitefish downstream from the Spokane metropolitan area at Ninemile Reach.

Although relatively little PBDE data have been collected in the Columbia River Basin, the studies show that PBDEs are present and are increasing in the waters of the Columbia and several of its tributaries. [7] The studies further show that PBDEs are not only accumulating in larger fish [9] but are being taken up by juvenile salmon as well. [11]

In 2005, PBDEs were detected in all Asian clams collected from 36 stations throughout the Lower Columbia River. [12] The Lower Columbia appears to be an important source of PBDEs for salmon on their migration to the ocean based on the difference in PBDE concentrations in juvenile salmon above and below Bonneville Dam (Figure 5.18).

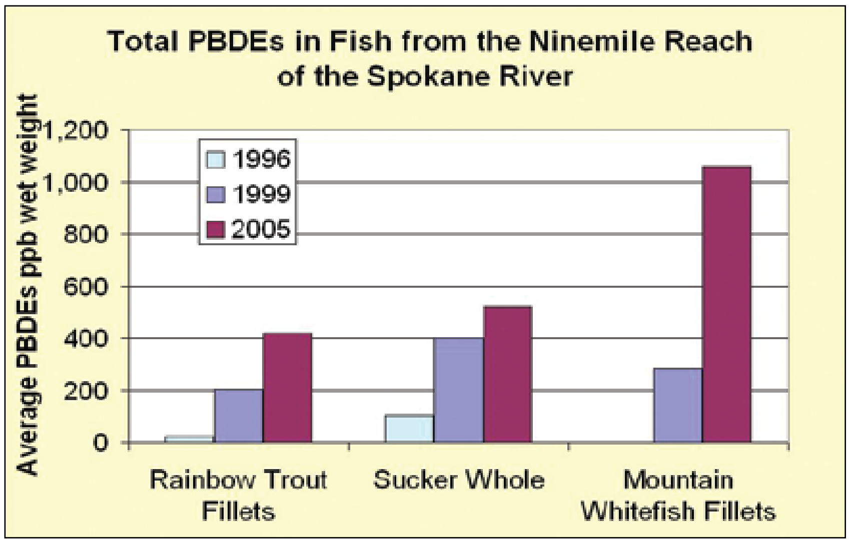


Figure 5.17: PBDE levels in Spokane River fish have increased since 1996.

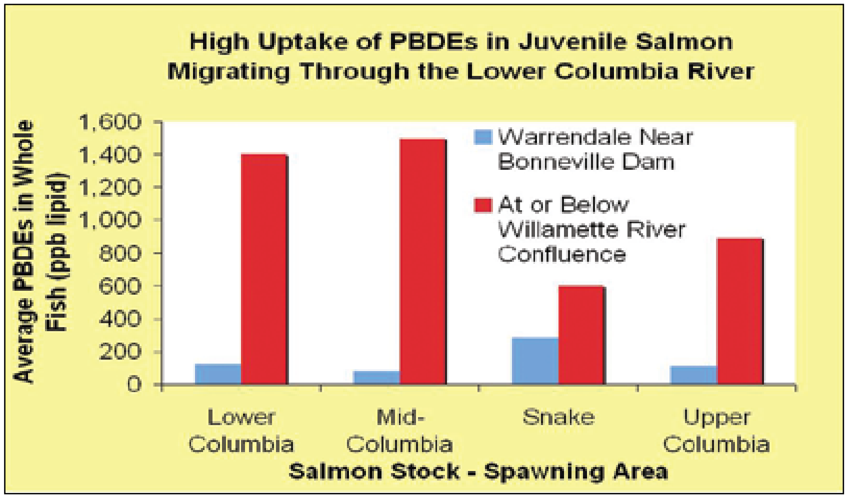


Figure 5.18: Migrating juvenile salmon, regardless of where they began their migration, consistently show higher levels of PBDEs when captured in the Lower Columbia River below the Bonneville Dam.

Summary of Status and Trends for Mercury, DDT, PCBs, and PBDEs

Table 5.2 summarizes the status of concentration levels for the four contaminants discussed in this report and their concentration trends where available.

Table 5.2. Summary of status and concentration trends for the selected indicator species

MERCURY		
Indicator Species	**Status**	**Concentration Trend over Time**
Resident fish - bass, whitefish, sucker, trout, walleye, northern pikeminnow	Increasing concentrations in fish tissue and bird eggs have been seen in the Snake and Willamette River Basins and other locations affected by regional sources compared to other areas within the Basin.	↑
Juvenile salmon		No Trend Data
Sturgeon		No Trend Data
Predatory birds – bald eagle and osprey		↑
Fish-eating mammals - mink and otter		No Trend Data
Sediment-dwelling shellfish - Asian clam		No Trend Data

Note: An upward-pointing red arrow indicates an increasing trend.

DDT AND BREAKDOWN PRODUCTS		
Indicator Species	**Status**	**Concentration Trend over Time**
Resident fish - bass, whitefish, sucker, trout, walleye, northern pikeminnow	The Columbia River Basin received some of the heaviest DDT loadings in the United States prior to the 1972 ban. Levels have decreased dramatically since the 1970s but are still above health effects limits for people, fish, and wildlife in many areas of the Basin.	↓
Juvenile salmon		No Trend Data
Sturgeon		No Trend Data
Predatory birds - bald eagle and osprey		↓
Fish-eating mammals - mink and otter		↓
Sediment-dwelling shellfish - Asian clam		No Trend Data

Note: A downward-pointing green arrow indicates a decreasing trend.

Table 5.2. Summary of status and concentration trends for the selected indicator species (cont)

PCBs

Indicator Species	Status	Concentration Trend over Time
Resident fish - bass, whitefish, sucker, trout, walleye, northern pikeminnow	PCB levels have generally declined since they were banned in the 1970s. Because PCBs are very stable and bioaccumulate in long- lived species and top predators, they are still a concern. Every state in the basin still has areas with fish consumption advisories and levels that exceed species effects levels. Sources are still being discovered.	↓
Juvenile salmon		No Trend Data
Sturgeon		No Trend Data
Predatory birds - bald eagle and osprey		↓
Fish-eating mammals - mink and otter		↓
Sediment-dwelling shellfish - Asian clam		No Trend Data

Note: An upward-pointing red arrow indicates a decreasing trend.

PBDEs

Indicator Species	Status	Concentration Trend over Time
Resident fish - bass, whitefish, sucker, trout, walleye, northern pikeminnow	In areas where data have been collected, levels of these chemicals are showing rapid increases. Though some studies have detected developmental and other impacts for humans and other species, there are currently no established effects levels for human or other species' health.	↑
Juvenile salmon		No Trend Data
Sturgeon		No Trend Data
Predatory birds – bald eagle and osprey		↑
Fish-eating mammals - mink and otter		No Trend Data
Sediment-dwelling shellfish - Asian clam		No Trend Data

Note: An upward-pointing red arrow indicates an increasing trend.

6.0 Toxics Reduction Efforts—Current and Planned

States, tribes, communities, non-profit groups, EPA, and other federal agencies have launched a long-term recovery effort to improve the water, land, and air quality of the Basin. These groups are working together to enhance and accomplish critical ecosystem restoration efforts. A number of toxics reduction efforts are under way throughout the Basin as a part of this recovery effort.

States are Improving Water Quality and Reducing Toxics

State agencies are developing water quality improvement plans

The Federal Clean Water Act requires states to list all water bodies under their control that do not meet water quality standards. The states are then required to develop water quality improvement plans for those impaired waters so they will meet water quality standards. These plans, also known as total maximum daily loads (TMDLs) (Table 6.1), are in place or are being developed throughout the Basin for toxics.

Through implementation of these TMDLs, water quality is improved using a combination of pollution controls on point sources; programs to reduce non-point sources such as urban stormwater and agricultural runoff; and cleanup of known sources of contaminants such as abandoned mines or hazardous waste sites.

Oregon is using human health criteria to limit toxics

In October 2008, the Oregon Environmental Quality Commission recommended that the Oregon Department of Environmental Quality (ODEQ) revise the human health criteria as a part of Oregon's water quality standards. The Commission has asked for a proposed rule with a fish consumption rate of 175 grams per day (instead of the current rate of 17.5 grams per day) and a broader toxics reduction implementation strategy. This recommendation was a result of a two-year collaborative process led by EPA, ODEQ, and the Confederated Tribes of the Umatilla Indian Reservation. The recommended fish consumption rate of 175 grams per day represents approximately the 90th to 95th percentile of Oregon's fish-consuming populations, as indicated by studies of tribes, Asians, and Pacific Islanders in Oregon and Washington. [1]

ODEQ's water quality standards play an important role in maintaining and restoring environmental quality. Human health criteria are used to limit the amount of toxic pollutants that enter Oregon's waterways and accumulate in the fish and shellfish consumed by Oregonians. The criteria also serve as the framework for wastewater permits, nonpoint source reduction activities, stormwater permits, and sediment cleanup efforts. The criteria help ensure that people may eat fish and shellfish from local waters without incurring unacceptable health risks. A final rule on the revised criteria is expected in October 2009.

EPA and States are Using Permits to Control Toxics

The Clean Water Act's National Pollutant Discharge Elimination System (NPDES) program controls the quality of water discharged into the Basin from point sources such as wastewater treatment plants, mines, and pulp and paper plants. Federal, state, and local NPDES permits limit the amount of pollutants from municipal, industrial, and stormwater discharges so that the quality of the water body receiving the discharge is not impacted or further impaired. Facilities that have an NPDES permit must conduct routine monitoring and are fined or required to install pollution controls if their NPDES permit conditions for water quality are not met. However, data on the amounts of many toxics (including DDT, PCBs, and PBDEs) entering the Columbia River from stormwater and from municipal and industrial dischargers are limited.

Combined sewer overflow (CSO) outfall (photo courtesy of WADOE)

Stormwater and erosion controls are increasingly important in urban and developing areas to keep contaminants from reaching lakes, rivers, and streams. This is done through stormwater NPDES permitting and a combination of best management practices (BMPs) and public education. Many communities and industries

Table 6.1: Toxics TMDLs that have been approved or are under development in the Washington, Oregon, and Idaho areas of the Columbia River Basin

State	River	Toxics
Washington	Yakima	Chlorinated Pesticides (e.g., DDT) and PCBs
	Spokane	Metals, PCBs
	Okanogan	DDT, PCBs
	Walla Walla	Chlorinated Pesticides and PCBs
	Palouse	Chlorinated Pesticides and PCBs
	Lake Chelan	DDT, PCBs
	Mission Creek (Wenatchee)	DDT
	Columbia	Dioxins
	Similkameen	Arsenic
Oregon	Columbia	Dioxins
	Columbia Slough	Lead, PCBs, Dioxins, DDT, Dieldrin
	Coast Fork Willamette	Mercury
	Cottage Grove Reservoir	Mercury
	Pudding	DDT, Dieldrin, Chlordane
	Johnson Creek	DDT, Dieldrin
	Willamette	Mercury
	Row River	Mercury
	Snake River	DDD, DDE, DDT, Dieldrin
Idaho	Salmon Falls Reservoir	Mercury
	Jordan Creek	Mercury
	East Fork Eagle Creek (North Fork Coeur D'Alene)	Metals
	Snake River	DDD, DDE, DDT, Dieldrin
	Columbia	Dioxins

are adopting innovative stormwater management techniques that improve the quality of the discharged water before it reaches lakes, rivers, and streams. These include porous pavement to reduce runoff; diversion of runoff from storm sewers into natural systems (e.g., vegetated buffers); retention and treatment wetlands; and filtration through vegetated swales. Such stormwater management practices also reduce flooding, erosion, and direct runoff of contaminants to waterways.

Federal Government and States are Working to Clean up Hazardous Waste in the Basin

Several contaminated sites in the Basin are being cleaned up and managed under EPA Superfund or state toxic cleanup programs. For example, since 1983, EPA has been working with the State of Idaho, the Coeur d'Alene Tribe, and mining companies to clean up the Bunker Hill Mining and Metallurgical Superfund site in the Coeur d'Alene Basin. The area's many mines were once a primary source of our nation's zinc, copper, lead, and precious metals. A comprehensive, integrated approach, using all available regulatory tools such as the Clean Water Act and the Comprehensive Environmental Response, Compensation and Liability Act, has been employed to help protect human health and the environment in this heavily contaminated watershed.

Cleanup of an Idaho mine near the Salmon River (photo courtesy of EPA)

Furthermore, in the Upper Columbia River above Grand Coulee Dam, several investigations and cleanups are ongoing in the areas that drain into Lake Roosevelt. In Montana, cleanup efforts in the upper Clark Fork and Flathead basins have reduced copper, lead, arsenic, and zinc contamination into the Columbia River tributaries. [2] In the Middle Columbia River, the U.S. Department of Energy (DOE) is working to prevent contaminated groundwater on the Hanford Nuclear Reservation from reaching the Columbia River. Work is also under way to clean up contaminated sediment from the Portland Harbor Superfund site, located on the lower Willamette River near its confluence with the Lower Columbia to reduce PCBs, DDT, and many other toxic contaminants.

In addition to the federally listed Superfund sites, each state manages its own list of contaminated site cleanup projects. States work with the federal agencies and with businesses and property owners to develop site assessment and cleanup plans and then conduct cleanup activities. Many contaminated sites in the Basin are in various stages of planning and cleanup for a variety of contaminants. Two examples of PCB-contaminated sites on the Columbia River are the Bradford Island site at the Bonneville Dam and the Alcoa plant in Vancouver, Washington. An accelerated cleanup is planned by the State of Washington at the Alcoa site, where sediment removal is scheduled for November 2008.

Upper Columbia River Investigation and Cleanup

EPA is studying hazardous waste contamination in the Upper Columbia River from the U.S./Canadian border down to Grand Coulee Dam and the surrounding upland areas. The investigation and cleanup site under EPA Superfund authority, located in northeastern Washington, consists of 150 miles of river and lake environment. From about 1930 to 1995, the Teck Cominco smelter in Trail, B.C., located 10 miles north of the U.S./Canadian border, discharged millions of tons of metals-laden slag and other wastes directly into the Columbia River. The waste discharged from the facility was carried downstream into the United States and has settled in the River's low-flow areas, beaches, and stream banks, potentially impacting the ecosystem in and around the Upper Columbia River.

In 2004, EPA began investigating the contamination problems in the Upper Columbia. In the first phase of the investigation, EPA collected over 400 sediment and 1,000 fish samples, along with samples from 15 beaches. Over the next several years, additional sediment, fish, and beach samples will be collected.

Bradford Island PCB Cleanup

In 1997 and 1998, USGS biologists found higher levels of PCBs in osprey eggs collected near Bonneville Dam than in eggs from other reaches of the Columbia River. [3] Also, in the late 1990s, very high levels of PCBs were found in crayfish collected near Bradford Island, which is part of the Bonneville Lock and Dam Complex. Based on this information, the Oregon Department of Human Services issued an advisory cautioning people against consuming crayfish, clams, or other bottom-dwelling organisms between Bonneville Dam and Ruckel Creek, about a mile upstream.

The PCB contamination came from disposal of electrical equipment on Bradford Island and the Columbia River during the 1950s. In response, the USACE removed PCB-containing equipment and some sediments in 2002. In 2007, the Corps completed the removal of PCB sediment "hot-spots" over a one-acre area that was estimated to contain over 90 percent of the PCB contamination on Bradford Island. The Corps continues to work with ODEQ to evaluate and remove the remaining PCB-contaminated sediments.

Portland Harbor Superfund Cleanup Site

The Portland Harbor Superfund site study area is focused on an 11-mile stretch of the lower Willamette River from downtown Portland, Oregon, to the Columbia River. Sediments at the site are contaminated with metals, pesticides (e.g., DDT), polycyclic aromatic hydrocarbons (PAHs), PCBs, and dioxin/furans from a variety of sources. EPA is overseeing a remedial investigation and feasibility study being conducted by a group of potentially responsible parties referred to as the Lower Willamette Group. EPA is the lead agency for investigating and cleaning up contaminated sediment in the Willamette. The ODEQ is the lead agency for investigating and cleaning up the upland sites that are potential sources of contamination to the Willamette. A draft feasibility study, which will evaluate cleanup strategies and methods, is targeted for late 2010. EPA will then issue a proposed cleanup plan for public comment before making a final decision on the harbor-wide cleanup. In addition to the harbor-wide investigation, several early actions are under way to clean up individual sites that need more immediate attention.

VISIT THE WEB

Additional information about the Upper Columbia, Bradford Island, and Portland Harbor investigations and cleanups can be found by visiting EPA's Columbia River Basin website: http://www.epa.gov/region10/columbia.

State and Local Partnerships are Working to Improve Farming Practices

Partnerships and volunteer efforts are reducing runoff from farms

The Columbia River Basin supports some of the most important agricultural regions in the United States. Clean water for food production is critical, but agricultural practices can degrade water quality by contributing eroded soil, nutrients, and pesticides to nearby waters. Agricultural BMPs are used to improve water quality, often with the added benefits of improving water and soil conservation and soil fertility.

BMPs are usually developed and implemented by partnerships between farmers, local conservation districts and university extension services, state and federal agriculture and water quality agencies, tribal governments, and local watershed groups. They have become a critical component of TMDLs in agricultural watersheds such as the Yakima River.

The agricultural community can be leaders in reducing toxics in the Columbia River Basin. Voluntary agricultural activities provide a great opportunity to reduce toxics in the Basin by reducing legacy toxics such as DDT and current-use pesticides, especially organophosphates. Toxic contaminants reach the Columbia River Basin from sediment transport and deposition and have contributed to the long-time degradation of water quality and fish and wildlife habitat. Sediments may transport trace metals (such as arsenic and copper) and organic compounds (such as polycyclic aromatic hydrocarbons [PAHs], PCBs, and pesticides such as DDT, chlordane, and atrazine). Most of these contaminants cling to particles suspended in the water and settle to the bottom; therefore, their concentrations in sediments are typically much higher than in water.

Yakima Valley irrigation ditch before implementation of BMPs (left) and Yakima Valley irrigation ditch with BMPs to control erosion and reduce runoff (right) (photos courtesy of the Confederated Tribes and Bands of the Yakama Nation Environmental Management Program)

Washington is working to control soil erosion and reduce pesticide runoff in the Yakima River Basin

The Yakima River Basin serves as a successful example of sediment cleanup and pesticide reduction efforts. [4] DDT was used extensively in the Yakima Valley from the 1940s until it was banned in 1972, and it persists in Yakima Basin soils. Erosion of these soils allows pesticides to reach the aquatic environment, where they accumulate in fish and in the people and wildlife that eat fish. Recognizing this, the WADOE, Yakima Valley growers, water purveyors, local conservation districts, and the Confederated Tribes and Bands of the Yakama Nation worked together to implement BMPs to reduce DDT and other pesticides by modifying irrigation practices to reduce the amount of soil carried to the Yakima River by irrigation returns.

DDT clings to organic particles in soil; therefore, reducing soil erosion from agricultural fields and the associated sediments should reduce runoff polluted with pesticides like DDT.

After the BMPs were initiated, suspended sediment loading to the Lower Yakima River during the irrigation season was reduced between 67 and 80 percent. Total DDT concentrations in fish were reduced by 30 to 85 percent in the same area after implementation of the BMPs. The accompanying photos show soil eroded by surface irrigation into a return drain before BMPs were implemented; later, with BMPs, the soil is retained by a grass filter strip between crop and drain.

Oregon is working with farmers to reduce pesticide runoff

Another example of toxics reduction from agriculture in the Columbia River Basin is Oregon's Pesticide Stewardship Partnerships. These partnerships are voluntary collaborations to reduce pesticide use and improve water quality. Such collaborations typically include local watershed councils, ODEQ, agricultural growers, Oregon State University (OSU) Extension Service, and tribes. Pilot projects in the Columbia Gorge, Hood River, and Fifteen-Mile Creek near The Dalles, Oregon, showed substantial improvements in water quality due to changes in pesticide management and application practices. In addition, ODEQ has launched Pesticide Stewardship Partnerships in six watersheds in the Basin: the Walla Walla, Clackamas, Pudding, Yamhill, Willamette, and Hood River Basins.

For example, the Walla Walla partnership has reduced pesticide concentrations in Oregon's Walla Walla River Basin. [5] In 2006, high levels of five toxic pesticides were found in tributaries of the Little Walla Walla River. In response, the ODEQ, OSU Extension Service, fruit growers (Blue Mountain Horticultural Society), and Walla Walla Basin Watershed Council worked together to monitor and control current-use pesticides that reach surface water by spray drift and runoff from fruit orchards. To accomplish this, ODEQ and its partners installed vegetated buffers adjacent to surface waters, switched to using less toxic pesticides and mineral oil, provided individualized applicator training, and calibrated sprayers to avoid overspray.

The monitoring results in 2007-2008, after implementation of the practices described above, showed dramatic declines in several pesticides, including large reductions of one of the most toxic pesticides, chlorpyrifos (Figure 6.1).

In addition, ODEQ has worked with partners in the Walla Walla Basin to conduct two agricultural pesticide collection events to remove unwanted waste

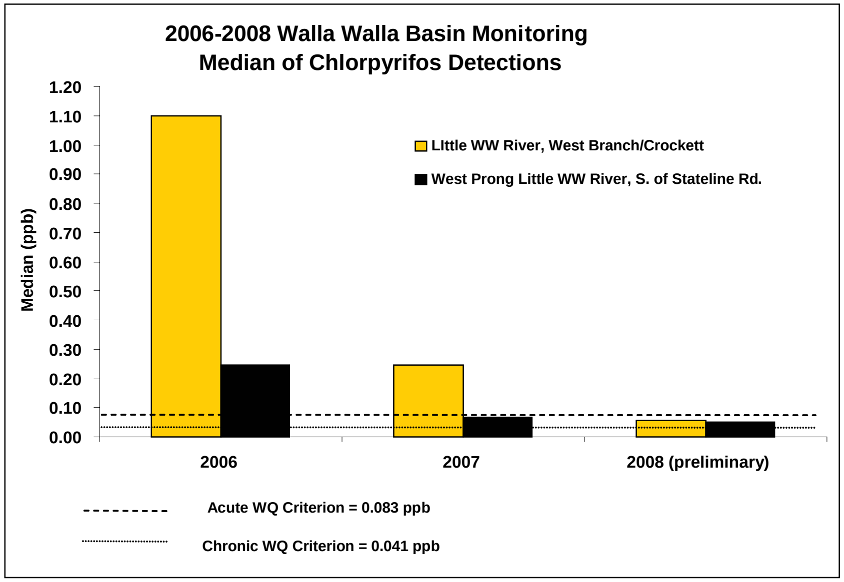


Figure 6.1: Concentrations of chlorpyrifos dropped after measures were implemented to keep pesticides from reaching nearby surface waters in Oregon.

pesticides from the watershed. Over 17,000 pounds of pesticide waste were collected and properly disposed of from these events.

State and Local Governments are Removing Toxics from Communities

The State of Washington passed one of the first state bans on PBDEs in the summer of 2007. This ban is part of the state's overall initiative to reduce the threat from persistent and bioaccumulative toxics (PBTs) by keeping toxics out of products and industrial processes. The ban is being phased in over a two-year period, with an emphasis on finding a safer and feasible alternative. Oregon is also working to reduce and control PBTs, particularly for large municipal wastewater dischargers. All of the Basin states have mercury reduction programs to promote recycling of thermometers and fluorescent lamps containing mercury, and each state works with dentists, hospitals, and vehicle recyclers to capture and recycle mercury. For example, separating mercury from wastewater in dental offices prevents mercury from reaching wastewater treatment plants and the Columbia River. Oregon and Washington also sponsor collection of mercury recovered by small-scale mineral miners from streams and rivers.

State, county, and local toxics reduction programs help businesses and private citizens reduce the use of toxic chemicals and ensure the proper disposal of hazardous wastes such as pesticides, solvents, batteries, electronics, PBDE-containing materials, and pharmaceuticals. For example, Idaho's pesticide disposal program prevents thousands of pounds of unusable pesticides from reaching the environment each year. Under this program, the Idaho State Department of Agriculture assists growers, homeowners, dealers, and applicators with the disposal of pesticides that have become unusable because of expiration, cancellation, deterioration, or crop changes. Individuals can dispose of up to 1,000 pounds of pesticide at no charge. Permanent collection points are established throughout the state; materials are collected annually and taken to a licensed facility for incineration. From 2003 to 2007, 328,000 pounds of unusable pesticides have been collected, and over 870,000 pounds have been collected since the program's inception in 1993 (Figure 6.2). [6] The program also collects and recycles empty pesticide containers. Washington and Oregon are also sponsoring pesticide take-back programs, which have recovered thousands of pounds of banned pesticides such as DDT.

Another Idaho initiative is the Idaho Department of Environmental Quality's (IDEQ's) school laboratory and chemical cleanup project. This project assists schools in understanding and implementing best practices for managing and disposing of their large stockpiles of hazardous chemicals and wastes, including mercury.

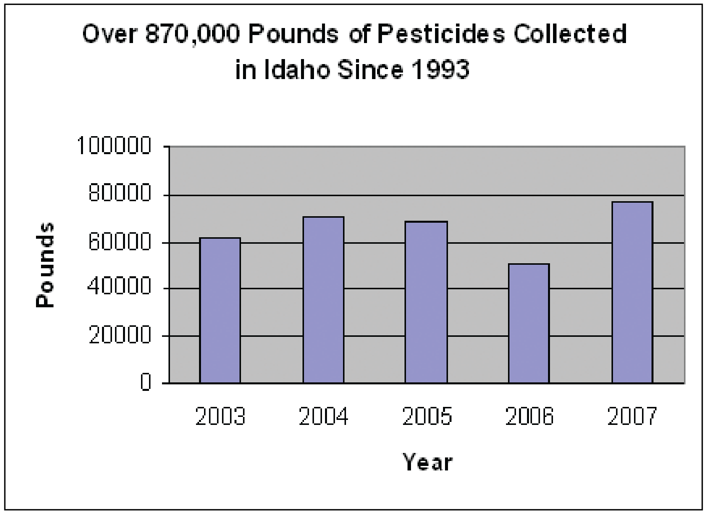


Figure 6.2: Amount of pesticides collected under Idaho's pesticide disposal program (2003–2007).

At the county level, Clark County, on the Lower Columbia River in Washington, recently implemented an unwanted medications take-back program that allows residents to drop off unwanted pharmaceuticals at participating pharmacies. The drugs are then incinerated at a licensed facility. Washington has implemented a pilot pharmaceutical take-back program in King County (through 2008) and plans to expand it to a statewide program. In Oregon, a proposal may be presented to the 2009 legislative session for a pharmaceutical take-back program. These partnerships between state and local governments, pharmacies, medical facilities, and the U.S. Drug Enforcement Administration reduce pharmaceutical pollution in wastewater and unlined solid waste landfills which can contaminate groundwater and surface waterways.

Oregon and Nevada are Reducing Industrial Mercury Emissions

A number of regulatory agencies in the Basin have recently introduced controls on industrial mercury discharges to the air. EPA expanded its Toxics Release Inventory (TRI) reporting requirements in 1999 to include mercury reporting for a variety of industries. The TRI data showed that some of the highest discharges of mercury in the country were in or bordering the Basin and that the single highest emitter of mercury was a cement plant in eastern Oregon. To reduce these emissions, ODEQ worked with the cement plant operators, who, through a 2008 mutual agreement and order, agreed to "…endeavor to meet a goal of 85% reduction in mercury emissions on a rolling 12-month average basis…". The agreement also stipulates that if the goal is not met within a specified timeframe, plant operators will develop an action plan and implement corrective actions in a further effort to achieve the 85 percent reduction. ODEQ will oversee these efforts to determine whether the cement plant "…exhaust[s] all reasonable alternatives…" to meet the goal. [7]

Approximately a dozen mines in the Battle Mountain Mining District in northern Nevada produce 11 percent of the world's gold and 74 percent of the nation's gold. [8] TRI reporting showed that these gold mining operations were releasing a total of over 12,000 pounds of mercury per year. Between 2002 and 2005, EPA and the Nevada Department of Environmental Protection worked with four mining companies to set up a program of voluntary reductions for mercury emissions that resulted in an 82 percent decrease of mercury discharges to air at these mines. In March 2008, the State of Nevada enacted the nation's first regulations limiting mercury air emissions from precious metal mining operations. These regulations set limits on mercury emissions from all the mines in the Battle Mountain District.

The only coal-fired power plant in the Columbia River Basin is located near the Columbia River at Boardman. This plant discharges an average of 168 pounds of mercury to the atmosphere per year. [9] In December 2006, Oregon adopted regulations applicable to coal-fired power plants that require the Boardman plant to control and reduce mercury emissions by 90 percent by 2012 and cap state-wide mercury emissions from coal-fired power plants by 2018. There are also three coal-fired power plants near the boundary of the Basin (one in Washington and two in Nevada) that could contribute some mercury load to the watershed, depending upon their emissions and prevailing wind patterns.

Idaho Agencies and Kootenai Tribe are Monitoring Toxics in Fish, Water, and Air

For several years, the State of Idaho has monitored rivers, lakes, and reservoirs for a number of toxics. In 2006, IDEQ sampled 15 large rivers for mercury in fish. In 2007, IDEQ sampled 50 lakes and reservoirs for arsenic, mercury, and selenium in fish tissue. In 2008, an additional 34 large rivers were sampled for arsenic, mercury, and selenium in both fish and water; the water samples were also tested for methylmercury.

IDEQ has also conducted or supported other local efforts, most notably in support of the Salmon Falls Creek mercury TMDL, submitted to EPA in December 2007 and approved in February 2008. The state's air quality program has also been conducting some mercury deposition monitoring.

Other noteworthy studies include the following:

- The Kootenai Tribe of Idaho has conducted studies of numerous contaminants in sturgeon, fish, water, sediment, and lower food web organisms from the Kootenai River between 1999 and 2007. The tribe has also studied biomarkers in sturgeon for the effects of contaminants.
- The Idaho Department of Fish and Game conducted studies of contaminants and biomarkers in Kootenai River adult and juvenile sturgeon in 1997 and 1998.
- Idaho Power Company has conducted several studies of contaminants in the Snake River area along the Oregon-Idaho state line.

PCBs and Hydroelectric Facilities

Historically, many pieces of electrical equipment used to generate power at dams in the Columbia River Basin used cooling and insulating oil that contained PCBs. In recent years, efforts have been made to reduce the presence of, and risk from, PCBs. These efforts include reducing or removing PCBs from electrical equipment; conducting operator self-assessments and EPA inspections; confirming that turbine oil does not contain PCBs; and reducing the potential for PCB spills. EPA will continue to work with the operators of hydroelectric facilities to better understand the remaining risk of PCBs at dams.

7.0 Conclusions

The Columbia River Basin is a unique and vibrant ecosystem that is at risk from toxic contaminants. Many challenges lie ahead to restore this ecosystem. This *State of the River Report for Toxics* is EPA Region 10's first attempt to understand and describe the current status and trends of toxics in this region of the United States. This report is intended to serve as a starting point for increasing public understanding about the impacts of toxics in the Basin and for finding ways to work in partnership with others to improve and expand current toxics reduction efforts. Specifically, its primary purposes are to inform citizens and decision-makers about the toxics problem and potential solutions; serve as a catalyst for increased citizen involvement and increased action; and inspire additional, more-efficient use of resources for increased toxics reduction and assessment actions.

While several monitoring studies are under way in the Basin to improve our understanding of the toxics problem, we must develop a more comprehensive and collaborative monitoring and research program. In addition, we must expand efforts to identify the sources of toxics in the Basin, characterize the types of contaminants, and quantify the contaminant load from these sources. We must also identify additional effective actions to reduce toxics and protect the health of the Columbia River Basin ecosystem, and we must continue to implement those actions.

This report focused on four contaminants: mercury, DDT and its breakdown products, PCBs, and PBDEs. However, we recognize that other toxics, including additional metals, dioxins, radionuclides, and pesticides as well as pharmaceuticals and personal care products, are also potential contaminants of concern. We know that these other contaminants need to be addressed in the future.

Meanwhile, many groups are conducting pollution prevention and cleanup efforts to reduce toxics overall and to reduce toxics in water, sediment, plants, and animals in the Columbia River Basin. Despite limited resources, these groups are making significant strides in reducing toxics in certain areas, but additional efforts need to be expanded throughout the Basin. The following Toxics Reduction Initiatives represent a first attempt at describing the next steps in the effort to reduce toxics. We look forward to a future public dialogue throughout the Basin as we refine and implement these initiatives.

8.0 Toxics Reduction Initiatives

The Columbia River Toxics Reduction Working Group has developed the following set of six Toxics Reduction Initiatives, which provide a broad overview of major actions needed to further reduce toxics in the Basin. A more in-depth and detailed work plan will be developed over the next year with stakeholder and public input.

Initiative #1: Expand toxics reduction activities

Federal, state, and local agencies have multiple regulatory mechanisms available to reduce toxics. Such mechanisms include TMDLs, NPDES permits, water quality standards, contaminated site cleanup, and programs to control pesticide usage. These programs need to be expanded. For example, additional toxics TMDLs and implementation plans are needed, and additional work is needed to identify other contaminated sites for cleanup.

It is also important to promote voluntary/nonregulatory initiatives. States and tribes have worked to reduce toxics using a variety of voluntary and nonregulatory activities. They have focused much of their work on the tributaries to the Columbia River. Excellent examples of voluntary programs are Oregon's Pesticide Stewardship Partnerships and the Pesticide Take Back Program. Support of local watershed groups in their efforts to complete toxics reduction projects should be continued. In addition, more partnerships should be developed with nongovernmental programs such as Salmon Safe and organizations such as Columbia Riverkeeper, other local nonprofit groups, and area industries.

Initiative #2: Identify, inventory, and characterize the sources of toxics in the Columbia River Basin

There have been past efforts to identify and characterize sources of toxics in the Columbia River and its tributaries,[1] some of which are ongoing (e.g., Upper Columbia River, Hanford, and Portland Harbor investigations; Working Group efforts; and TMDL development in the Basin). However, additional information is needed to better identify, inventory, and characterize the sources of these toxics. This information will be used to prioritize reduction efforts and develop long-term monitoring and research plans.

To fill in these critical information gaps, the Working Group has started to identify important "next steps." These steps include, but are not limited to, (1) identifying, inventorying, and mapping all potential sources of toxics, both within and outside the Basin; (2) determining the contaminants of concern from these sources; (3) collecting information on the concentrations of the contaminants of concern, where available; (4) determining the quantities of contaminants reaching the Columbia River and its tributaries, where possible; (5) evaluating the fate and transport of contaminants and their breakdown products from air and soil into the Columbia River and its tributaries; (6) determining the role of sediments as a source of contamination; and (7) prioritizing those sources where the greatest reduction efforts are needed and can be implemented.

Initiative #3: Develop a regional, multi-agency long-term monitoring program

There is no comprehensive, integrated monitoring plan for the Columbia River and its tributaries. This initiative will allow the Working Group to develop such a plan; ultimately, this plan would provide information on the locations and concentrations of toxics in the Basin, fill in data gaps in our scientific knowledge, evaluate the impact of toxics on the ecosystem, and characterize the information on the status and trends of toxics in the Basin. With this information, the Working Group will be able to target limited resources and tailor the monitoring program to obtain data from areas that have not been previously monitored (such as the mid-Columbia River and the Snake River).

Critical steps in the development of this monitoring plan include (1) completing a data gaps analysis of the Basin's contaminant data collected from 1994 to the present; (2) determining the geographic extent of the areas to be sampled and identifying which contaminants would be monitored; (3) determining the types of media to be sampled (e.g., water, sediments, and/or fish tissue); and (4) determining the frequency, specific locations, and techniques for sampling. Because of limited resources, any monitoring program needs to be coordinated among the different federal, state, tribal, local, and nongovernmental entities to leverage resources and avoid duplication.

Initiative #4: Develop a regional, multi-agency research program

While research is being conducted by different agencies on toxics in the Basin, no coordinated effort has been made to identify the highest priorities for research. A collaborative plan will help the Working Group further understand the Basin's contaminant problems and their relation to the food web, which will allow the Working Group to efficiently leverage resources among agencies. It will also enable us to develop an integrated approach that focuses on issues specific to the Columbia River Basin (for example, PBDE concentrations in osprey eggs) that can be addressed by scientists within the region (NOAA Fisheries, EPA Corvallis Laboratory, USGS Science Center, and others).

Initiative #5: Develop a data management system that will allow us to share information on toxics in the Basin

The ability to access information is critical to effectively evaluating toxics information. It is also necessary when prioritizing which reduction activities will provide the most benefits. Currently, no single database contains all of the data from monitoring efforts within the Basin. In addition, some of the data are not publicly accessible or are often available only in hard copy records. Some records are of unknown quality, and most are in differing formats.

While a single database would be useful, its development would be very expensive and would require dedicated resources to operate and maintain. As an alternative to a single database, the Working Group will explore the possibility of working with existing efforts such as the Northwest Data Exchange Network and the Pacific Northwest Aquatic Monitoring Partnership.

Initiative #6: Increase public education about the toxics problems and resource needs

Public support and concern related to toxics and their impact on human health and the environment are growing. Furthermore, there is a base of support in the Basin among citizens, watershed groups, and other stakeholders associated with local, state, tribal, and federal governments. Many of these groups are interested in working together to better understand and reduce toxics in the Columbia River Basin, with the goal of moving toward a Basin ecosystem that is healthier for all.

It will be important to educate the public further about the Columbia River Basin toxics problem, current efforts, and the need for increased action and resources to reduce toxics. The Working Group intends to work closely with the partners of the Columbia River Toxics Reduction Working Group and with Basin stakeholders to coordinate outreach to the public (including schools, business/industry groups, nonprofit organizations, farm associations, and watershed councils). Outreach efforts will include (1) holding public workshops and other public events throughout the Basin; (2) using multi-media tools, including websites, postcards, and posters, to educate and inform Basin residents about toxics; and (3) encouraging public participation in Columbia River toxics reduction activities.

9.0
A Path Forward

To a great extent, success will depend on a commitment to join forces to make the best use of available resources. This approach will require strong communication and collaboration among Basin agencies, organizations, and the public. We recognize that the citizens of the Northwest place a high value on a healthy Columbia River Basin ecosystem. Therefore, we plan to reach out to those who live, work, and play in the Basin; share information on risks to the Basin posed by toxics; and solicit help in restoring the Basin's magnificent ecosystem.

In 2009, the Columbia River Toxics Reduction Working Group will develop a draft work plan that will build on the successful and numerous toxics reduction efforts already accomplished or under way and will also identify new efforts to reduce toxics in the Basin. We will do this by hosting a number of watershed-based workshops in the Basin. The outcome of these workshops should be a toxics reduction work plan for the Columbia River Basin that will involve citizens; local watershed councils; Basin communities; other entities; and tribal, federal, and state governments in a collaborative partnership.

Columbia River Toxics Reduction Work Plan and Watershed Workshops

Late Winter – Early Spring 2009: The Columbia River Toxics Reduction Working Group develops draft toxics reduction work plan.

Late Spring – Summer 2009: Watershed workshops are held for Basin residents, local watershed councils and communities, tribal governments, and the general public to learn about, and contribute to, the draft work plan. Actions are initiated to evaluate the extent of toxic contamination in the Basin and reduce impacts.

Fall – Winter 2009: The Working Group finalizes a collaborative, watershed-based work plan that focuses efforts on implementation.

VISIT THE WEB

More detailed information, including expanded data and reports, can be found by visiting EPA's Columbia River website: http://www.epa.gov/region10/columbia.

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