Dioxins in the Willamette

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The Willamette River, flowing from Waldo Lake in central Oregon and emptying into the Columbia, is the 10th largest river in the conterminous United States. Its basin is home to 70% of Oregon's population, nearly two million people in 1990. (Ulrich, 5) It is enjoyed for recreation and used for irrigation, industrial, and municipal needs, and serves as a natural environmental for a variety of fish and aquatic wildlife. However, as human population has increased in the Willamette Valley, the river's floodplain has been "dammed, diked, drained, filled, and confined to the point that it no longer functions as a healthy ecosystem with the capacity to support native fish and wildlife, absorb and reduce the impact of flooding, and filter contaminants" (Allen, et al. 12)

In addition to physical changes made to the Willamette River, the river has been used as a dumping ground for "pesticides, fertilizers, and toxic pollution from agricultural and urban areas" (Allen, et al. 1) Point-source pollution, a huge problem during the early part of the 20th century, has been greatly reduced. However, at the same time, non-point source pollution has amplified. The Willamette River, located in the backyard of many Oregonians, remains a seriously polluted river.

One of the pollutants in the river, illuminated by Bernadine Bonn in her report entitled *Dioxins and Furans in Bed Sediment and Fish Tissue of the Willamette Basin, Oregon, 1992-5,* is the family of toxic polychlorinated compounds called dioxins. Studies find dioxin's presence in both fish and the bed sediment of the Willamette River. This report will focus primarily on the human health effects of dioxin. It will also look at what dioxin is, where it is found in the Willamette River, how it got into the river, and will recommend remediation efforts to reduce the amount of dioxin entering the Willamette River.

Before looking specifically at dioxin's presence in the Willamette River, it is important to understand what dioxins, or polychlorinateddebenzo-p-dioxins, are. First of all, there are 75 different kinds of dioxins, which vary in level of toxicity. They differ in the number of chlorine atoms present, anywhere from one to eight. The most toxic dioxin is 2,3,7,8-tetrachlorodibenzo-p-dioxin, also know as TCDD. (Gibbs, 35).

Dioxins are naturally occurring compounds that are also produced as unwanted results of human activity. They are not "deliberately manufactured, but rather the by-product from two types of reactions" (Bonn, 3). These two types of reaction are "as a chemical contaminant of industrial processes involving chlorine or bromine or by burning organic material in the presence of chlorine." (Gibbs, 35) Processes that produce dioxins include "municipal and medical waste incineration, wood burning, production of chlorinated aromatic compounds, bleaching of kraft pulp, metals production, and chlorination of sewage effluent" (Bonn, 3).

Dioxins are also not very water-soluble, and have a low vapor pressure. (Gibbs, 40) In addition, they "have a high organic carbon coefficient, which means they stick to the organic components of soil and water and tend to stay where they end up in soil or mud, such as at the bottom of a lake or river" (Gibbs, 40). Due to this, dioxins remain for a long time in the sediment of rivers, such as the Willamette.

Another reason dioxins are dangerous is because they are a persistent chemical. Even if all manmade sources of dioxin are cut down, the United States Environmental Protection Agency

(USEPA) notes that "dioxins break down so slowly that some of the dioxins from past releases will still be in the environment many years from now" (USEPA "Frequently") Dioxins also have a fairly long half-life, estimated to be about 7.1 years, according to the USEPA. (EPA, "Dioxin Reassessment, 59) A lot of the threat associated with dioxin is the fact that it is very hard to get rid of.

Dioxins are also harmful to humans because they are a bio-accumulator. The National Institute of Medicine explains how dioxins "accumulate, through the food chain, into the lipid component of animal foods" (1). This means, for example, that dioxins that have settled into the river floor, can be eaten by small aquatic life, later eaten by fish, and then reach humans. The dioxin will stay in each animal's body, and therefore accumulate as it moves up the food chain.

Besides understanding what dioxins are, it is important to understand the risk they impose on humans. The story of dioxins and their history is a complicated one; according to Gibbs in her book Dying from Dioxin, it is also a story that involves "cover-ups, lies and deception, data manipulations by corporations and government as well as fraudulent claims and faked studies" (1).

Dioxins have most likely always existed in some amount, because they can be made via natural sources, such as forest fires. However, the USEPA notes that core sediments taken from lake bottoms find virtually no evidence of dioxin until around 1940. Levels increased from 1940 until 1960, an "increase which parallels the growth of chlorine-using industries" (Gibbs, 10) Between 1986 and 1996, exposure measured in human tissue samples decreased by 75% (Papke, qtd. in Institute, 13). Even so, "public concern persists with regard to the safety of the food supply" (Institute, 13).

Why was there a sharp increase in dioxin around 1940? Extensive production of dioxin began in the mid 20th century, specifically with three chemical companies: Monsanto, BASF, and Dow Chemical. (Gibbs, 2) Both Monsanto and BASF had accidents where workers were exposed to dioxins. The companies maintained that these exposures did not harm employees beyond the skin effect of chloracne, reported by the USEPA to be a common side effect of high dioxin exposure. Chloracne is a skin disorder characterized by acne-like symptoms, including "pus-filled boils….and cysts that sometimes persist for years" (Gibbs, 122). Dow Chemical, located in the Pacific Northwest, did tests on prisoners in Pennsylvania in order to test the toxicity of dioxin. They also concluded that the only side effect was chloracne.

However, further studies on workers at the BASF found "an increase in all cancers" (Gibbs, 8) for those with prolonged exposure. In addition, the EPA did a study of miscarriages in Oregon in 1978. This study found "evidence of increased miscarriages in areas of the Pacific Northwest that were sprayed with the herbicide 2,4,5-T" (Gibbs, 11), a herbicide that includes dioxin as a contaminant.

The health effects of dioxin go beyond chloracne and reduced reproduction capacity. The EPA has found that in animals dioxin causes "changes in hormone systems, alterations in fetal development, reduced reproductive capacity, and immunosuppressant" (USEPA, Persistant..") In addition, the USEPA also acknowledges that dioxins are "likely to be human carcinogens and are anticipated to increase the risk of cancer at background levels of exposure" (USEPA, "Persistent..")

In Dying from Dioxin, Gibbs elucidates these human health effects. She explains how Dioxin is not a "direct" carcinogenic, because it does not mutate DNA. (93) Instead it is an "indirect" carcinogenic, which means it works by "accelerating cell growth, by suppressing the immune system, or by affecting hormone function" (93). All three of these functions can increase the risk of cancer.

Besides increasing the risk of cancer, the Institute of Medicine acknowledges that are also adverse non-cancerous effects of dioxins. These include "possible changes in glucose metabolism and in diabetes risk" (26), "alterations in thyroid function" (26), and "alterations in liver function" (26), among other things.

In addition, a study done with monkeys found that dioxins increase the risk of endometriosis, a condition where the lining of the uterus grows outside the uterus. It is a painful condition, which can also lead to infertility. (Gibbs, 111) Dioxin has also been shown to "inhibit the synthesis of testosterone" (Gibbs, 116), causing lower sperm count, testosterone levels, and decreased size of sex organs in male animals (USEPA, qtd in Gibbs, 116).

Humans who eat high on the food chain are exposed because dioxin is a bioaccumulator. In a Greenpeace report entitled "Achieving Zero Dioxin," Michelle Allsop acknowledges that humans "having a high fish or sea mammal diet are more at risk" (Allsop) to the health effects of dioxins. The Institute of Medicine sees "subsistence fishers, and American Indian and Alaska Native tribes for whom [dioxin]-containing fish and wild game are important cultural food sources" (14) as groups highly exposed to dioxins.

The fact that humans' intake of dioxin increases with fish consumption, specifically of fish carrying dioxin, illuminates the danger to humans of eating contaminated fish. Studies done on the Willamette River show evidence of dioxin, including the toxic 2,3,7,8-TCDD varieties. OSPIRG, the Oregon Student Public Interest Research Group, reports that levels of dioxin in the Willamette exceed the EPA standards (OSPIRG, "Students..")

These findings are illuminated in a 1998 water-resources investigation report for the U.S. Geological Survey, where Bernadine Bonn summarizes the distribution and prevalence of dioxins in the Willamette Basin. This information was gathered from bed sediment in 22 sites and fish tissue in 8 sites, from 1992 to 1995. The sites “were chosen to represent a cross-section of hydrology, basin scale, and land use” (4).

Dioxins were found “in every bed sample collected” (6). However, the 2,3,7,8-TCDD was detected at only six sites. (6) Studies found the highest concentrations “at sites where industrial or urban inputs were most likely” (1). Furthermore, the toxicity at these sites “was high enough to be associated with increased risk to sensitive mammalian wildlife” (1). In one area surveyed, the A-3 channel just north of Eugene, the toxicity equivalents concentration (TEC), “exceeded the U.S. Centers for Disease Control criterion of 100 peq/g for human contact with soil, as well as the high risk criterion for fish” (6).

In addition to Bonn’s study, a study done by the Oregon Department of Environmental Quality of the Newberg Pool, located on the Willamette River, found evidence of dioxins in the pool (Hunsberger). This survey, summarized in The Oregonian article “Newberg Pool Poisons Potent, Study Finds,” concludes that “if you eat fish from the Newberg Pool, you’re boosting your cancer risk” (Hunsberger). Eugene Foster, a DEQ toxicologist, explains that it is likely that the contaminants are also located elsewhere in the Willamette, specifically downstream.

Where did these dioxins come from? It is difficult to pinpoint the exact source of dioxins in the Willamette River. There is no evidence I could find that shows exactly how dioxins have gotten into the Willamette River. Dioxins travel far in the air, so it is most likely that the dioxins in the river come from a variety of sources in the Willamette watershed. Gibbs explains that “the largest source of the dioxin found in water is the wastewater discharged from the pulp and paper industry's bleaching process" (56). Even though the level of dioxin produced from bleaching has reduced in recent years, dioxin from past processes remains in the water supply. (Gibbs, 56)

Dioxins also enter the atmosphere from "municipal and medical waste incineration, wood burning, production of chlorinated aromatic compounds, bleaching of kraft pulp, metals production, and chlorination of sewage effluent" (Bonn, 3). Medical and municipal waste incinerators account for more than 75% of air emissions of dioxins (Gibbs, 55). These air emissions are "either washed out by rain (wet deposition) or [settled] onto the ground (dry deposition)" (Gibbs, 43).

Bonn's report explains that the levels of dioxins found in the forested and agricultural areas of the Willamette watershed were most likely from atmospheric deposition. These levels were also "less than or similar to background concentrations at reference sites elsewhere" (9). However, levels of dioxins in urban and industrial areas were significantly higher. Bonn's report does not explain where this dioxin comes from. It does say that "pentachlorophenol-related inputs [common wood preserving chemical] may be an important source" (10), but there is no hard evidence.

Because no concrete evidence was found regarding how dioxins entered the Willamette, one can only speculate about the possible sources. It may have come from waste burning, sewage treatment plants, pesticide and other chemical manufactures, or industrial plants.

What should be done in order to reduce the amount of dioxins found in the Willamette River? Because there is not one point source for dioxins, the best solution would include a number of different regulations that reduce overall dioxin content in our atmosphere and waterways. New regulations should be imposed on various industries in order to reduce dioxin content.

One way dioxin can be reduced is by creating regulations on both municipal and medical waste incinerators, as well as on hazardous waste incinerators. Oregon has two solid waste incinerators and one hazardous waste incinerator, as well as multiple medical incinerators (Gibbs). These incinerators should be required not to burn plastic. Going a step beyond that, the hospital and other industries should attempt to reduce their usage of PVC's. In the medical industry, plastics "account for 14 to 30 percent of non-infectious medical waste" (Gibbs, 244). If the medical industry specifies to its suppliers that it prefers non-PVC goods, PVC waste can be greatly reduced.

Another suggestion for reducing the amount of dioxins is by targeting the paper and pulp mills. It is possible to create paper without bleaching it; government should move towards eliminating chlorine in paper products. Mills can also use recycled paper, oxygen bleaching, or other forms of chlorine-free bleaching.

In general, if chlorine products are slowly phased out of our industry, dioxin production will be greatly reduced. Consumers should voice their preference for chlorine-free paper, alternatives to PVC products, and chlorine-free pesticides. Backyard, as well as industrial, burning of plastics should be outlawed.

The battle against dioxins still has a long way to go. In order to reduce the amount of dioxins in the Willamette River, the public needs to be educated about both its presence and adverse health effects. Reducing the amount of dioxins in the Willamette River is a step in the right direction, a step towards restoring our river.

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