CRITFC's Member Tribes Fish Consumption in the Columbia River Basin: Cancer Risk and its Context

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HC 441: Columbia River Ecology
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University of Oregon
Fall, 2005

Introduction

Fish, especially anadromous fish, are an important staple among Native American River Indians in the Columbia River Basin. These fish play and have played a central role in Native American society for centuries. They are of great cultural and economic importance. They also have myriad health benefits. Those of Western society however, in attempts to develop an ever increasingly successful industrial nation, have both intentionally and unintentionally imposed adverse affects on the fish populations of the Columbia River Basin, and in so doing have slowly eroded at the River Indians' way of life.

The most obvious consequence of development is a loss of fish, especially salmon. However, another troubling and less noticeable adverse affect has crept into the limelight, that of the consumption of contaminated fish. Since fish are a primary staple of Native American diets, the health risks associated with fish consumption among this population are of considerable concern. Within this framework, I attempt to evaluate the potential cancer risks this contamination has created for the tribes of the Columbia River Inter-tribal Fish Commission (CRITFC) and explore what regulatory agencies are doing to improve the situation.

The paper will begin with a case study of the history of Hanford and focus on the most studied pollutant emitted—radionuclides. While studying the risks associated with this pollutant

warrant attention, it is but one small piece of the cancer risk associated with CRITFC tribal fish consumption, particularly during the last ten years. In light of this, we should put more emphasis on quantifying *total* cancer risks associated with fish consumption. The importance of this is further underscored by the fact that sources of these cancer risks (all but radionuclides) link inexorably to adverse non-cancerous health risks, thereby increasing the importance of mitigating these pollutants in the environment.[1] Ultimately, if our goal is to try to improve the health of CRITFC tribal members, our analysis of cancer risk through consumption of contaminated fish is a small but important step in the right direction.

Hanford & Tribal Health: Were radionuclides such a big deal back then? Are they now?

The Columbia River Inter-Tribal Fish Commission (CRITFC) is the technical support and coordinating agency for fishery management policies of the four Columbia River treaty tribes. These tribes consist of the Nez Perce, Umatilla, Warm Springs and Yakama tribes of Oregon, Washington and Idaho (CRITFC, "What is CRITFC") whose livelihoods depend upon the fish of Columbia River, especially the salmon. While CRITFC was formed in 1977, health concerns of the tribes began much before then. Perhaps the most well known documented concern has to do with radiation exposure from the Hanford Nuclear project.

Briefly, the Hanford project was created for the production of plutonium for nuclear weapons and operated between 1944 and 1987. During the first several years of production, the Hanford site built six additional reactors to complement the original three from 1944. All except

[1] While radionuclides do have non-cancer health effects, these effects are essentially not present at the low levels of radiation examined in this report; therefore I, as well as the literature I read, ignore them.

one (including the original three reactors), were single-pass reactors, meaning instead of re-circulating their cooling water, they instead discharged it into retention basins. After a set amount of time, they released the radioactively charged water into the Columbia River. By 1971, however, all eight single-pass reactors were closed (Walker and Pritchard 3). Researchers, therefore, have been concerned about the cancer risk caused by exposure to radionuclides primarily during the years of peak production, namely from 1950 through 1971.

The Hanford Environmental Dose Reconstruction (HEDR) Project came about in order to estimate the radiation doses that could have been received by individuals using the Columbia River in the general area of Hanford during this period. Using this model, Walker and Pritchard estimated radiation doses to Yakama tribal fishermen between the Bonneville and McNary dams. The results of this study indicate the importance of fish as an exposure pathway for the radionuclides. Near the McNary dam, the study area closest to Hanford, we find resident fish contributed to 75.5 percent of the exposure, salmon 3.3 percent, drinking water 10.1 percent, and external exposure (from the water) 10.6 percent (41) and the farther one moves from Hanford, the more important the consumption of fish becomes as an exposure pathway (55). The fact that resident fish comprise only 25 percent of the total fish consumption only underscores the importance of resident fish as a source of radionuclides. This is particularly important to note because although the average Yakama Indian fisherman consumes primarily anadromous fish, there is the potential that fishermen who disliked salmon could have eaten a disproportionate amount of resident fish.

Ultimately, Walker and Pritchard determine that for a maximum Yakama tribal fisherman river user, whose consumption of fish they determine to be at about 649 grams per day[2] (11), total cumulative dose of radiation over the 21 year period analyzed amounts to 0.916 rem. They also show the breakdown for three specific organs. Although, they never use their data to attempt a risk analysis for various types of cancers, a study conducted by Hoffman et. al, also based off of the HEDR project does.

Based on their analysis of fish and waterfowl consumption of a certain representative individual based in Richland, Washington, Hoffman et. al. find that the largest excess relative risk for cancer for the individual would be a 7 percent increase in leukemia (37). Ultimately, they came to the conclusion that doses to humans from radionuclides in the Columbia River were not sufficiently high enough to warrant consideration for monitoring of human subjects. Given the fact that their estimates of effective radiation dose for the whole body were considerably higher (uncertainty range of 2.2 to 8.4 rem for Richland, for example) than the radiation dose of Walker and Pritchard, it seems logical at first glance to conclude that the Yakama Fishermen of the 1950's and 1960's really have nothing to worry about.

However, Walker and Pritchard conclude otherwise. They warrant that there is a high enough risk to initiate monitoring to watch for signs of increased diseases resulting from Hanford operations (56) despite the fact that they make no risk assessment. Their conclusion, then, is not very well substantiated. Hoffman's conclusion, on the other hand, appears logical, in light of the fact that the additional cancer risk appears very small when compared with the current lifetime risk of cancer of 1:3 for men and 1:4 for women for the U.S. population in general (McBride, pers. comm.). Nevertheless, the conclusions reached in both studies do not take into account

[2] This consumption rate falls inline with the estimates of CRITFC's 1994 *A fish consumption survey of the Umatilla, Nez Perce, Yakama, and Warm Springs tribes of the Columbia River Basin*, which is the most authoritative source for consumption rates among CRITFC Tribal members.

many factors such as the fact that the CRITFC population eats parts of the fish besides the flesh that may contain higher concentrations of radionuclides such as the skin, bones and scales.[3] They also ignore those Indians who may have fished on the Hanford site. While neither exclusively analyzed fish in their studies, fish were nevertheless the primary pathway for the radionuclides to enter the human body. While multiple pathways should be considered when making the decision to monitor the River Indians for health defects caused from Hanford, special attention should be given to fish.

Since the time of the Hanford operation, evidence by Michael Scott et. al. suggest that radiation exposure through fish consumption and other pathways (dermal, inhalation, direct exposure) has decreased substantially (due to radioactive decay) to levels now deemed safe for lifetime exposure on the Hanford site. In fact, the highest estimated average lifetime exposure for any given reach of the Hanford site was well under 100 mrem (93). Although the risk scenario was not conducted for Indian tribes in particular, if the exposure were multiplied by a factor of ten, it would still be less radiation exposure than during the peak twenty years of Hanford operations.

Further evidence of low risk exposure comes from the U.S. EPA's 2002 *Columbia River Basin Fish Contamination Survey*.[4] Although radiation levels from consuming fish appeared elevated in the Hanford reach as compared to other nearby stretches of the Columbia where CRITFC tribes fish, "considering the number of samples, the mobility of the fish, and the range of results obtained, it does not appear possible to attribute results to specific sources (170)." Furthermore, the study concluded that the risk associated with fish consumption (primarily in the

[3] Interestingly, EPA's 2002 (date of publication) fish contamination survey suggests cancer risk (from all major carcinogens) to be higher from consumption of the entire fish versus just the flesh.
[4] This study (of the fish contamination in general) was confined to the Columbia River Basin below Grand Coulee to the North, the Clearwater River to the East, just below Bonneville Dam to the West and the Willamette River to the South. It sampled fish from CRITFC tribal fishing sites.

Middle Columbia River) was small compared to the estimated risks associated with naturally occurring background sources. In the U.S. the average effective dose equivalent for this background radiation is about 300 mrem, which translates to a lifetime risk of about 1 percent (171). Even with so little risk though, Hanford must continue to be monitored, if for no other reason than to make sure the billions of gallons of contaminated liquids stored there are not escaping into the environment. In addition, other issues such as ground water contamination may affect tribal health.

CRITFC Tribes, Total Cancer Risks and the Culprits

Stepping away from Hanford and radionuclides though, the EPA's fish contamination survey shows the lifetime cancer risks involved with eating exclusively each type of fish[5] for different fish consumption rates of the CRITFC tribes based on the 1994 CRITFC fish consumption survey, where average fish consumption for adults equals 63.2 gpd[6] and high fish consumption equals 389 gpd.[7] At these consumption rates, a diet of only mountain whitefish yields a lifetime cancer risk of about 0.13 percent and 0.8 percent for average and high consumption rates respectively (USEPA 138), which are the highest risk levels for any of the fish analyzed.[8] According to the graphs in appendix N of the contamination survey, however, certain sites yielded higher rates of cancer than other sites. For mountain whitefish, it was the Hanford

[5] Anadromous fish consumed (from most to least consumed): Salmon (including steelhead trout), Lamprey and Smelt (Eulachon); Resident fish consumed (from most to least): Trout, Whitefish, White Sturgeon, Walleye and Largescale Sucker; Other fish consumed by the tribes (to a lesser extent), but not included in the contamination survey: shad, squawfish, bass, black cod and others (CRITFC, "Fish Survey" 43-45; USEPA 145).

[6] EPA uses the average for adults who eat fish, which is slightly higher than the real average of 58 gpd.

[7] Consumption at the 99th percentile of the population

[8] Risk is based Basin-wide average data.

stretch of the river that yielded the highest rates of cancer with about a 3 percent risk for high lifetime consumption among tribal members (9). Since only, about 13.28 percent[9] of CRITFC tribal adults' diets come from whitefish these cancer risks are not representative of the population, but instead show a theoretical risk based on consumption rate. A diet of strictly salmon on the other hand, which in actuality makes up 38.4 percent of the tribal adult fish diet (CRITFC, "Fish Survey" 94) only has lifetime risks of about 0.02 percent and 0.1 percent for average and high consumption rates respectively (USEPA 139). These examples help illustrate a general trend of greater risk of cancer from eating resident fish in general than from eating anadromous fish in the Columbia River Basin (USEPA 145).[10] A cursory look at appendix N of the EPA's survey shows the general trend of higher cancer risk from resident fish in the Hanford stretch of the Columbia River[11] when compared to other Columbia River Basin sites in general. The same cannot be concluded about anadromous fish because the appendices of the survey do not show samples of these fish from this stretch of the river.

As for the average lifetime cancer risk from fish consumption in general, this cannot be measured precisely because the EPA's contamination survey only includes a cancer risk analysis for all except two of the fish consumed by the tribes in the consumption survey. Nevertheless, the EPA's survey created a hypothetical multi-species diet for the average consumption rate of the CRITFC tribes without these two species. Unlike my calculations (see footnote), the EPA

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[9] This results from the weighted mean in gpd of whitefish as a fraction of the sum of all weighted means in gpd of each fish consumed. This is based on the consumption of fish species by adults who eat the particular species. I do not include non-fish consumers in order to be consistent with EPA's use of the statistics in the contamination survey.

[10] According to my calculations based on EPA's hypothetical CRITFC tribal member multi-species diet (described later in the paper), 53 percent of the cancer risk comes from resident fish which makes up about 40 percent of the fish diet. However, I believe this to be an overestimate, based on findings from other literature and the findings from the weighted means method described above, the latter suggesting about 26 percent of CRITFC members' fish diet consists of resident fish.

[11] This is not necessarily statistically significant and is based upon measurements from only three types of fish.

assumes that the data in the CRITFC survey on the percentages of adults consuming different fish species, can be used to estimate the percentage that each fish species contributes to the diet. Specifically, they took the percentage of adults that ate a certain species as a fraction of the sum of the percentages of all species. They repeated this process for each species to create the diet (64). Although this method will not yield a true average representative of the CRITFC survey, the results, I believe, are still more or less indicative of an actual hypothetical diet. Their hypothetical diet finds that the lifetime cancer risk for an average tribal fish consumer is 0.04 percent (145). Assuming, as the EPA does for the purposes of this study, that accumulation of cancer risk is linear based upon consumption rate, we can conclude, using the hypothetical diet, that the lifetime cancer risk for a high consumption tribal adult could be about 0.25 percent. While this cancer risk may not seem too significant in the scheme of things, keep in mind that it is about 52 times higher than the lifetime risk for an average fish consumer of the general public (USEPA 118).

The cause of this significant increased risk in cancer comes primarily from pesticides (especially DDE) in resident fish, arsenic in anadromous fish and PCBs[12] and dioxin in the case of both. (USEPA 125, 133). For resident fish, the greatest single group of chemicals related to cancer risk among CRITFC tribes are PCBs or polychlorinated biphenyls. For anadromous fish PCBs rank second only to arsenic (CRITFC, "Fish Survey" 36, 37; USEPA 125,133). Although the manufacturing of PCBs was banned in the U.S. in 1977, many old electrical transformers and capacitors still contain PCBs. Furthermore, they are very stable compounds that stay in the

[12] EPA's survey combines Aroclors and PCBs into one category. According to Laflamme, PCBs were sold as mixtures of individual cogeners (chemical compounds). In the United States, most of these mixtures were sold under the trade name Aroclor. Essentially, the difference between PCBs PCBs and Aroclors, is that Aroclors are named by the percent chlorine in the total mixture and not by the percent composition of individual congeners (11). For the purpose of this paper, all Aroclors will be considered as PCBs PCBs, since their sources and effects are essentially identical to those of PCBs PCBs.

environment for many years (Laflamme 11). In the general population, the ongoing chronic exposure to this toxin is food; for the Indian tribes that food is primarily fish. Although there is a general trend of decreasing exposure to PCBs, that trend has been slower than many scientists had expected (USEPA 174; Laflamme 11; Stone, pers. comm.). PCBs have a tendency to bioaccumulate in the food chain primarily through absorption in fatty tissues including liver, fat, breast milk and skin. Besides being a probable human carcinogen, PBCs are believed to cause reproductive, developmental, and immunological problems as well (Laflamme 11). In fact, PCBs along with mercury, contributes most to non-cancer hazards among the fish consumed by the CRITFC tribes (CRITFC, "Fish Survey" 36, 37; USEPA 100, 108). In Washington State, concern for PCBs is high among health officials. The safe level for PCBs is deemed at 5.3 parts per billion (ppb), but the state-wide average is currently 65ppb (McBride, pers. comm.). Since PBCs are currently a nonpoint source of pollution and virtually impossible to clean up, the River Indians will likely continue to endure the toxic contributions of PCBs through fish consumption for many years to come.

The second largest contributing group of carcinogenic contaminants for resident fish and the third largest contributing group for anadromous fish are dioxins and furans[13] (CRITFC, "Fish Survey" 36, 37; USEPA 125,133). Of these chemicals, 2,3,7,8-Tetrachlorodibenzo-p-dioxin is the most toxic and EPA currently uses it as a measuring stick for the toxicity of other forms of dioxins and furans (McBride, pers. comm.). These toxic substances are produced as unwanted byproducts of various industrial and combustion processes. According to De Cillo, in the Pacific Northwest, the main known source of dioxin in the environment is from pulp and paper mills due to their chlorine bleaching technologies (33). Foods, particularly fish in the case of tribal exposure, have been identified as the primary source of human exposure to this toxic substance

[13] Henceforth dioxins and furans will simply be called dioxin for simplicity.

(Laflamme 16). Like PCBs, dioxin travels up the food chain through absorption in the lipid stores of plants and animals (De Cillo 34). As of the present, dioxin, a probable human carcinogen, has no known non-cancer endpoints (McBride, pers. comm.), even though mounting evidence suggests dioxin's immunotoxicity and endocrine-disrupting properties may represent the greatest threat to public health (De Cillo 36).[14] This is particularly disturbing when scientists estimate that at background levels alone, dioxin contributes between a 0.1 and 1.0 percent lifetime cancer risk to humans (McBride, pers. comm.).

Fortunately, in the Columbia River basin, paper mills appear to be decreasing the level of dioxin they emit into the environment (Stone, pers. comm.). According to a report by Hansen, between 2000 and 2003 the amount of dioxin emitted by reporting companies in Washington state reduced from over 100 grams to 43.2 grams. However, such a reduction may have more to do with the economy than with regulations or consciousness. For example, between 2002 and 2003 the number of grams reported jumped from 38.3 to 43.2. The number of companies reporting may have increased or decreased as well. In Washington, the threshold for reporting dioxin and dioxin-like compounds is 0.1 gram manufactured, processed or otherwise (28). Dioxin is indeed a problem for Native Americans in the Columbia River Basin. As of the mid 1990's, Oregon had listed all of the Columbia River within its borders as violating the 0.013 ppq[15] water quality standard for dioxin as well as the human health threshold value for fish tissue residue levels of dioxin. In the state of Washington, the Columbia River below Priest Rapids Dam and the entire Snake River, among other locations, were listed as violating the water quality standard for dioxin (De Cillo 26).

[14] Dioxin's non-cancer effects are hard to identify because disruption of the of the immune system leads to a wide range of health effects (De Cillo 36).

[15] Parts per quadrillion

In anadromous fish, the greatest contribution to cancer risk for the tribes (somewhere around 50 percent) came from arsenic, a rather minor contributor to risk for resident fish species (CRITFC, "Fish Survey" 36, 37; USEPA 125,133). Arsenic is a metal that is naturally found in the environment and can occur in high concentrations in rocks in an inorganic form, which is the most toxic form of arsenic. Pesticides and wood preservatives also contribute arsenic to the environment. Most of the arsenic found in fish is in organic form, and not nearly as harmful as the 1 to 10 percent of the total that is inorganic. Classified as a known carcinogen by EPA, arsenic is more likely to be found in planktivorous fish than omnivorous or piscivorous fish, which may help to explain why higher concentrations were found in anadromous fish than resident fish (Laflamme 18; McBride, pers comm.; USEPA 179). While arsenic is thought to contribute to lung, skin, liver and bladder cancers, its non-cancer health effects include muscle weakness, paesthesia, high blood pressure and dry gangrene (Laflamme 18-19).

While pesticides may contribute about 3-4 percent of the total cancer risk among anadromous fish for the tribal populations, they are the third major contributor to risk among resident fish[16] (at around 8 to15 percent) after PCBs and dioxins. Among pesticides, DDT, and in particular its derivative DDE, contribute most to lifetime cancer risk (CRITFC, "Fish Survey" 36, 37; USEPA 125,133). Although DDT was banned in 1972 for use in agriculture, it and its derivatives continue to bioacumulate in fish (Laflamme 13; USEPA 172). Like PCBs, the pervasiveness of DDT and its derivatives is only slowly decreasing in the environment (Stone, pers. comm.). Probable human carcinogens, DDT and its derivatives have been shown to cause liver tumors in rodents and non-cancerous adverse health effects in animals and to a lesser extent in humans, including neurological and developmental problems (Laflemme 13).

[16] This is not surprising considering anadromous spend a considerable amount of their life in the ocean where bioaccumulation of pesticides is considerable less prevalent.

Of all the major carcinogens found in Columbia River Basin fish, only dioxin and radionuclides have not been shown to contribute to non-cancer endpoints in the EPA's 2002 contamination survey.[17] Furthermore, the carcinogens that contribute to non-cancer endpoints contribute to over half the lifetime risks associated with those endpoints. The only other major toxin that contributes to non-cancer risk is mercury[18] (USEPA 100, 108, 125, 133). Unfortunately, comparing cancer risks with non-cancer risk is like comparing apples and oranges because cancer risks are calculated in percent probability while non-cancer risks are compared to a reference dose where that dose is the maximum daily exposure level to a chemical that is unlikely to impact human health. Reference doses are determined by dividing the highest dose level that does not produce an adverse effect in the experimental animal by a safety factor (generally 10) to account for differences in sensitivities within the human population (Laflamme 6).

For risks for both cancer and non-cancer endpoints, there are a myriad of uncertainties and rough approximations. In both cases, scientists extrapolate risk from related human and animal exposures to toxic pollutants. However, the data for non-cancer endpoints is more robust particularly because there is more information available documenting human exposure. On the other hand, cancer risks are based on high levels of exposure, primarily in animals over short periods, and there is great uncertainty when extrapolating risk for humans based on risk for animals, particularly when the exposure is at lower levels for longer periods of time in the case

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[17] Although EPA did not contribute dioxin to non-cancer health risks, there is evidence which suggests otherwise. EPA's omission probably has to due with the difficulty of quantifying the likely non-cancer effects of dioxin.

[18] In addition to natural sources, humans release mercury into the environment from mining, runoff from sanitary landfills, municipal refuse incineration, and direct discharge of industrial wastes (Laflamme 20). Along the Snake River, mining is a particular problem that leads to high concentrations of mercury into the water, ultimately affecting the health of CRITFC's member tribes (Stone, pers. comm.). If mercury is consumed faster than the body can process it, it can cause tremors, lack of coordination, and paralysis among other neurological effects. Children and the elderly are especially susceptible to these adverse health effects (Laflamme 20).

of humans (McBride, pers. comm.). Of course there are other uncertainties as well, not discussed in this paper, that may influence results. For example, the EPA probably overestimated cancer risk by not taking into account cooking methods in their risk assessment. At the same time though, they probably underestimated by not calculating the risk for children and combining that into the lifetime risk assessment, which would probably increase risk. In addition, 12 percent of the tribe's fish now (or at least as of the early 1990's) comes from outside the Columbia River system (45).

Overall, my research uncovered that the tribes of the CRITFC are exposed to a relatively low level of additional lifetime risk to cancer based on adult fish consumption rates of a typical multi-species diet, even at high fish consumption rates. However, if tribal members begin to rely more heavily on resident fish for a livelihood due to a continued decrease in anadromous fish populations or for any other reason, they do increase their risk of contracting cancer. My research further indicates that this cancer risk has likely decreased since earlier years, especially closer to the Hanford Reach. This is due to the discontinuation of Hanford operations, the banning of DDT and PBCs, and the likely decreasing amounts of dioxin released into the environment.

The Bigger Picture

If one were to weigh the net benefits of high CRITFC fish consumption to any probable counterfactual of reducing fish in the diet and eating something else in place of the fish in terms of overall tribal health, I believe the net benefits of the high fish consumption far outweigh the net benefits of the alternative scenario. Nutritionally, the omega-3 fatty acids present in salmon

and other fish lower cholesterol and research further indicates that higher fish consumption leads to lower risk of stroke. Furthermore, fish is an excellent source of protein. Traditionally, the health benefits of eating fish (uncontaminated) helps lead to a longer life. Many Native Americans have lived well into their 90's and beyond probably due in part to a diet high in fish (Smith and Berg 14). In addition, fish, especially salmon, are central to the cultural and spiritual well being of the River Indians. Social gatherings, especially yearly ceremonies, revolve around the consumption of salmon. Fishing, then, is not just a livelihood, but also intricately connected to the quality of life of the CRITFC tribes.

Although the rate of cancer (and diabetes and heart disease) are on the rise among the tribes (Smith 14), my research suggests that this is not caused by increasing carcinogens in salmon. Nor is due to an increase in fish consumption rates; if anything fish consumption rates have decreased since the early 1970's primarily because of fewer fish in the Columbia River (CRITFC, "Fish Survey" 65). Rather, increased cancer rate may have more to do with dietary changes away from traditional foods such as C'lày[19] toward processed foods high in sugars, saturated fats and partially hydrogenated oils with the addition of hormones and chemical residues from pesticides and herbicides.

However, as this paper begins to point out, many of the same toxic substances that cause cancer also pose non-cancer risks that must be considered when consuming large quantities of fish. At the same, the non-cancer risks of mercury must be evaluated when weighing the overall potential benefit of consuming large quantities of fish. While I do not attempt to evaluate both the cancer and non-cancer risks of high fish consumption among the tribes in relation to a probable alternative scenario, I would like to point out the EPA's fish contamination survey, in its hypothetical multiple-fish diet, indicated that about 56 percent of the total non-cancer risk

[19] Pronounced chu-lie, c'lày is made from dried salmon, berries and other oils and foods.

comes from resident fish despite resident fish consisting of about 40 percent of the diet (USEPA 145). Hence, we can infer, if not conclude, that in general, the more anadromous fish the Indians consume in comparison to resident fish, the healthier they will be (disease-wise). This is true in terms of emotional health also because salmon, which are anadromous species, are culturally the most important fish to the tribes. While, this report tends to generalize about fish consumption among the CRITFC tribes, the reader ought to be aware that both cancer and non-cancer risk varies from fishing site to fishing site and that this report primarily points to averages, with the exception of the limited case study of Hanford.

Mitigating the Risk: How best to do it

In order to help mitigate both the cancerous and non-cancerous health effects which are posed by high fish consumption, the EPA recommends preparing and cooking the fish to reduce contaminant levels. This includes removing the skin, cooking the fish for longer periods and cooking the fish in such a way that the fats and oils drip off. The drawback to this however, is that it may also reduce the nutritional value of the fish and impede on cultural traditions of cooking. Also, while cooking methods may reduce contaminants such as PCBs, DDT, dioxins, and furans, it will make little difference for other toxins such as arsenic and mercury that don't primarily accumulate in the fatty parts of fish (Stone, pers. comm.).

As alluded to earlier, many of the pollutants contributing to fish contamination that are already in the environment are dispersed in such a way that cleanup would be costly and not very efficient in most cases. The most efficient method to reduce pollutants in the future is to simply continue to strengthen current regulations for those substances not banned from production

whether naturally occurring or manmade. Another way to help protect the tribes and other fish consumers is to provide fish advisories. Currently the Washington State Department of Health is organizing its office to more effectively and efficiently deal with contaminated fish consumption issues. They recently hired a fish program coordinator to better communicate fish advisories to the public and more specific populations such as Indian tribes. They have also used information technology to better coordinate and streamline their assessments of contamination levels with the Washington State Department of Ecology (McBride, pers. comm.). Currently the state's Department of Health is issuing a fish advisory for large scale and bridgelip sucker, mountain whitefish, common carp, channel catfish, and northern pike minnow along the Yakima River, one of the locations where CRITFC tribes fish. This advisory is simply a suggestion that anglers limit their meals of this group of fish to one 8 ounce meal per week due to high concentrations of DDT and DDE.[20]

Another fish advisory that is for an area where CRITFC tribes fish is along the Snake River. The Oregon Department of Human Services warns that due to moderate levels of mercury in the Snake River, healthy adults should limit fish consumption in general to one 8 ounce meal per week.[21] The Idaho Department of Health and Welfare also lists a fish advisory for a location around where CRITFC member tribes have been known to fish, Brownlee Reservoir, but unlike Oregon and Washington, their website does not say what the advisory is for.[22] At first glance then, it appears that Idaho is not making the same strides as Oregon and Washington are to inform the public and tribes about fish contamination.

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[20] Washington State fish advisories can be found at http://www.doh.wa.gov/ehp/oehas/EHA_fish_adv.htm.

[21] For Oregon fish advisories please see http://oregon.gov/DHS/ph/envtox/fishconsumption.shtml.

[22] For Idaho Fish advisories see http://healthandwelfare.idaho.gov/DesktopModules/ArticlesSortable/ArticlesSrtView.aspx?tabID=0&ItemID=601&mid=10333.

While no fish advisories suggest that CRITFC tribal members need to make drastic changes to their diet, the State of Washington issues advisories only if fish consumption is deemed harmful at 130 gpd or less (McBride, pers. comm.) which is less than the high fish consumption rate of 389 gpd among CRITFC tribal members. For Oregon, the advisories are based on only 20 gpd; however, the state does offer health consultations with tribes (Stone, pers. comm.). I was unable to find information for the state of Idaho in this regard.

However, in the end, advisories may not deter many tribal members from high consumption levels of fish. While this may ultimately not matter for most the tribal population, at least in terms of contracting cancer, certain fishing sites do pose higher risks than others do. Another concern is that if anadromous fish populations continue to decline, tribal members may be more inclined to eat resident fish, which may pose a higher cancer risk for the tribal population. This is one reason to warrant consideration for breaching dams.[23] While there may be some subsistence tribal fishermen that are never informed or disregard all advice for reducing their risk of contracting cancer through fish consumption, there may still be one warning that they adhere to, that of mother nature. While the literature on the national level suggests lower levels of pollution in water bodies nowadays, as compared to the 1970's (USEAP E-8), (a fact that may very well hold true for the Columbia River Basin too) deformed fish are nevertheless a modern day occurrence in certain parts of the Columbia River Basin. In terms of cancer risk, it appears that radionuclides are only one small part of the problem, because they have declined almost to background levels since the years of Hanford's operations.

Since actual cleanup of cancer-causing pollutants may be impractical in most cases, and because precautionary measures may have only limited success among tribal members, more emphasis should be put on decreasing the output of those pollutants that can still be controlled

[23] Of course breaching dams also releases more toxins from built up sediments, especially in the short run.

though regulation.[24] Although the state of Washington doesn't appear to be in the process of updating its water quality standards from 1997, or any process that may lower cancer risk from fish consumption, one look at the state's Department of Ecology website reveals a statewide campaign to lower mercury in the environment, which is still significant in terms of the overall goal of improving tribal health. As of January 1, 2006 for example, it will be illegal to sell products with mercury in them in the state of Washington (Washington State Department of Ecology, "Sale of mercury products illegal") which will reduce the potential leakage of mercury from landfills. Oregon, on the other hand, seems to be focusing its energies on updating its 1991 water quality criteria for toxic pollutants and helping enforce the new, stricter criteria by updating enforced discharge limits (Total Daily Maximum Load) for dischargers at the time they apply for new permits. Another way the state proposes to enforce water quality criteria is by proposing numerical criteria for all pollutants for which EPA has numerical criteria, which will replace less precise and less adequate narrative toxic criterion. However, it was believed as of last year that it would take at least a year for the plan approval, given the fact the EPA was still determining whether or not to approve Idaho's adoption of the national recommended water criteria from 1992 (Hallock 1,2,6).

Ultimately, while Oregon, Washington and Idaho seem to be making regulatory progress on some fronts in an effort to reduce water pollution, it remains to be seen if such efforts will lead to lower cancer overall as well as non-cancer risks through fish consumption in the future. While this paper focuses primarily on cancer risk through CRITFC tribal fish consumption, such risk is nevertheless just one of many factors, some more quantifiable than others, that are

[24] In addition, attacking the problem at its root has the added benefit of cleaning up the environment to create a healthier ecosystem.

necessary to study in an attempt to determine how best to make the people of CRITFC's member tribes healthier and happier.

Bibliography

Alvarez, Robert. "The Legacy of Hanford." *The Nation*. 18 August 2003: 31-35.

Columbia River Inter-Tribal Fish Commission. *A fish consumption survey of the Umatilla, Nez Perce, Yakama, and Warm Springs tribes of the Columbia River Basin*. Technical Report No. 94-3. Portland, Oregon: Columbia River Inter-Tribal Fish Commission, 1994.

Columbia River Inter-Tribal Fish Commission. "What is CRITFC." 4 Nov. 2005 http://www.critfc.org/text/work.html.

De Cillo, Victoria. "Regulatory Injustice. Native American Fish Consumption in the Columbia River Basin." Thesis. The Evergreen State College, 1995.

Hansen, Idell. *Chemicals in Washington State Summary Report 2003*. Washington Department of Ecology Hazardous Waste and Toxic Reduction Program. Publication number 05-04-020. May 2005. 8 Nov. 2005 http://www.ecy.wa.gov/biblio/0504020.html.

Hoffman, F. Owen et. al. *Estimation of health risk based on revised estimates of HEDR doses for maximum representative individuals consuming fish and waterfowl from the Columbia River: an evaluation of HEDR reports on the Columbia River pathway*. Atlanta, Ga.: Dept. of Health and Human Services, Agency for Toxic Substances and Disease Registry, 1997.

Idaho Department of Health and Welfare. "Idaho Fish Consumption Advisory Program." 22 Nov. 2005 http://healthandwelfare.idaho.gov/DesktopModules/ArticlesSortable/ArticlesSrtView.aspx?tabID=0&ItemID=601&mid=10333.

Laflamme, Dennis M. *Health Analysis of chemical contaminants in lower Columbia River Fish*. Olympia, Washington: Washington State Department of Health, May 1996.

McBride, David (toxicologist, Washington Dept. of Health). Personal Interview. 14 Nov. 2005.

Oregon Department of Environmental Quality. "Agenda Item B, Rule Adaption: Water Quality Standards, Including Toxic Pollutants Criteria, OAR Chapter 340, Division 41, May 20-21, 2004, EQC Meeting." Memorandum from Stephanie Hallock to Environmental Quality Commission 29 Apr. 2004. 8 Nov. 2005 http://www.deq.state.or.us/wq/standards/WQStdsToxics.htm.

Oregon Department of Human Services. "Fish Advisories: Consumption Guidelines." 22 Nov. 2005 http://oregon.gov/DHS/ph/envtox/fishconsumption.shtml.

Scott, Michael J. et. al. "Modeling long-term risk to environmental and human systems at the Hanford Nuclear Reservation: Scope and findings from the initial model." *Environmental Management*. 35 (2005): 84-98.

Smith, Yvonne and Laura Berg. "Ancient Tradition Modern Reality: Is there a future for a salmon-based culture?" *Wana Chinook Tymoo*. Issue 1 1998: 10-15.

Stone, David (toxicologist, Oregon Department of Human Services). Personal Interview. 17 Nov. 2005.

United States. Department of the Interior. U.S. Geological Survey. *Suface-Water-Quality Assessment of the Yakima River Basin, Washington*. Overview of Major Findings, 1987-91. Portland, Oregon: USGS, 1999.

United States. Environmental Protection Agency. *Columbia River Basin Fish Contamination Survey*. EPA 910-R-02-006. Seattle, Washington: U.S. Environmental Protection Agency, Region 10, 2002.

United States. Environmental Protection Agency. *Columbia River Basin Fish Contamination Survey*. EPA 910-R-02-006. Volume 1 Appendix N. Seattle, Washington: U.S. Environmental Protection Agency, Region 10, 2002

Walker, Deward E. and Lawrence W. Pritchard. *Estimated Radiation Doses to Yakima Tribal Fishermen: A Test Application of the Columbia River Dosimetry Model Developed for the Hanford Environmental Dose Reconstruction Project*. Boulder, CO: Walker Research Group, Ltd, 1999.

Washington State Department of Ecology. "Sale of mercury-containing products to consumers soon to be illegal." 8 Nov. 2005 http://www.ecy.wa.gov/programs/eap/pbt/hgproductban.html

Washington State Department of Ecology. "Summary of Washington's mercury reduction strategy." 8 Nov. 2005 http://www.ecy.wa.gov/programs/eap/pbt/hgreductionstrategy.html.

Washington State Department of Health. “Fish and Shellfish Consumption Advisories in Washington State.” 23 Mar. 2005. 22 Nov. 2005 http://www.doh.wa.gov/ehp/oehas/EHA_fish_adv.htm.

Welch, Scott. “Hanford again being considered as a national waste depository, meanwhile stored radioactive material threatens ground water.” *Wana Chinook Tymo.* Issue 1 1996: 5-6.