UPPER SNAKE RIVER TRIBES FOUNDATION, INC.

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(208) 331-7880

May 22, 2015

Paula Wilson
IDEQ State Office
Attorney General's Office
1410 N. Hilton Street
Boise, ID 83706

Re: Docket No. 58-0102-1201 – Upper Snake River Tribes Foundation Comments Regarding the Idaho Department of Environmental Quality Recommendations on Criteria Calculation

Dear Ms. Wilson:

The Upper Snake River Tribes (USRT) Foundation is composed of four Indian tribes of the Upper Snake River region in Idaho, Nevada, and Oregon: the Burns Paiute Tribe, Fort McDermitt Paiute-Shoshone Tribe, Shoshone-Bannock Tribes of the Fort Hall Reservation, and Shoshone-Paiute Tribes of the Duck Valley Reservation. The four tribes have common vested interests to protect rights reserved through the United States Constitution, federal treaties, federal unratified treaties (including but not limited to the Fort Boise Treaty of 1864, Malheur Treaty of 1864, Bruneau Treaty of 1866, and Long Tom Creek Treaty of 1867), executive orders, inherent rights, and aboriginal title to the land, which has never been extinguished by USRT member tribes. USRT works to ensure the protection, enhancement, and preservation of the tribes' rights, resources, cultural properties, and practices and that they remain secured. These include but are not limited to hunting, fishing, gathering, and subsistence uses.

USRT appreciates the opportunity to comment on the criteria calculation recommendations that were discussed by the Idaho Department of Environmental Quality (IDEQ) at the April 21, 2015, rulemaking meeting. While USRT seriously disagrees with several of the policy recommendation advanced by IDEQ, we do support the following recommendations presented on April 21st:

- Inclusion of only consumers of fish in the fish consumption distribution. Inclusion of non-consumers would inappropriately skew the fish consumption rate (FCR) lower, which would underestimate the potential risks to fish consumers.

- The use of bioaccumulation factors (BAF) instead of bio-concentration factors (BCF). Moving to the use of BAF will reflect the uptake of contaminants from all sources by fish and shellfish, not just the water column as is the case when using BCF.
- Water quality criteria will not be allowed to become less protective going forward. USRT supports this premise with the caveat that it does not mean that the status quo will be retained. Water quality criteria in Idaho must become more protective moving forward.

As noted, USRT appreciates that IDEQ has stated that water quality criteria will not become less protective in the future. However, several of the policy recommendations that are being considered will ensure that water quality criteria will not be as protective as they should be. It is important to note that the significant lack of detail and description IDEQ provided regarding their policy recommendations at the April 21st rulemaking meeting has made it difficult for USRT to provide detailed comments. It is not clear how IDEQ will implement several of their policy recommendations with such a dearth of detail. In fact, USRT sees no way that IDEQ will be able to resolve all of the inadequacies in a matter timely enough to have a proposed rule adopted and approved under the current time frame. USRT expects that IDEQ will be prepared to fully describe and defend all elements of the preliminary draft rule at the July 8, 2015 rulemaking meeting.

Idaho tribes are significant consumers of fish. This process is of incredible importance to them, as they depend upon healthy waters and clean fish more than any group within the general population (moving forward IDEQ must characterize tribal members as part of the general population and not as a subpopulation). For the last year the Nez Perce Tribe and Shoshone-Bannock Tribes have been engaged in a tribal FCR survey. The draft results for the food frequency questionnaire, released for review by the tribes, Environmental Protection Agency (EPA), and IDEQ on May 13, 2015 illustrate the obvious: tribes of Idaho consume a large amount of fish. At the 95th percentile, the Shoshone-Bannock Tribes consume 768.8 grams/day of species group 1 (all finfish and shellfish). For species group 2 (near coastal, estuarine, freshwater, and anadromous), the Shoshone-Bannock Tribes consume 310.4 grams/day at the 95th percentile. Consumption of fish to this degree by members of the general population, who also hold treaty rights to fish at a subsistence level, clearly puts the onus on IDEQ to implement stringent water quality standards and a protective FCR.

In the following sections USRT will describe those recommendations with which we disagree and believe must be revised.

Probabilistic Risk Assessment

USRT has concerns about the use of the probabilistic risk assessment (PRA) approach in determining criteria selection. IDEQ provided an incredible lack of detail at the April 21st rulemaking meeting on how it would employ PRA in the development of human health ambient water quality criteria. Our main concerns are that IDEQ, with limited resources, will not have the ability to gather enough quality data to construct a distribution or will be able to deal with correlated variables. As the World Health Organization[1] notes:

> Risk analysis is basically a mathematical tool and can only be of practical use if predictive models are available, and quantitative estimates of the probability distribution of input parameters and variables can be made. Results of the analysis depend on the risk assessor being willing and able to invest time and resources in searching for valid and relevant information. The data available about present and past events play a central role, reducing the input from arbitrary judgement. However, the effective use of the Monte Carlo simulation technique depends heavily upon such information being available.

An additional concern of USRT's is that the process of determining and gathering input parameters and variables will lack transparency. Does IDEQ propose to allow for public review and comment on the methods used for the analysis? Analysis methods should include all models used, all data used for assessment, and all assumptions that have a significant impact on the results. Method analysis documentation must be open to tribal and public review, including how data used is representative of the study population, names of the models and software used to generate the analysis, enough information being provided that will allow for the results of the analysis to be independently reproduced, potential sources of bias inherent in the input distributions should be discussed along with the expected impacts on output exposure or risk distributions, and computer code and spreadsheets need to provide adequate documentation and annotation.

Further, EPA guidance on PRA[2] finds that this method is not appropriate for circumstances in which the inputs do not vary independently (e.g. target populations with upper percentile FCR's are also the target populations who live in the same place their entire lives, such as tribal populations).

Exclusion of Market Fish

In June of 2014 USRT submitted comments on IDEQ Discussion Paper #4 – Market (All) or Local Fish. At that time USRT and its member tribes requested that IDEQ include all fish in the FCR calculation. We stand by that determination and disagree with IDEQ's recommendation to include only local fish. Taking into consideration what would be most protective of the health of Idaho Indian tribes, and the target population, USRT asks that IDEQ include market (all) fish in the calculation of the Idaho FCR. By including market fish in the calculation it will ensure that the health of Idaho's Indians, and the rest of the general population, will be protected. As noted in IDEQ Discussion Paper #4, "by including all sources of fish, the cancer risk factor and relative source contribution can be more accurately defined, and human health is protected on a broader scale."

Idahoans are exposed to contaminants through the consumption of both Idaho-caught fish and market fish. While Indians of Idaho prefer to exclusively catch and consume locally-caught fish

[1] http://www.who.int/water_sanitation_health/wastewater/en/wsh0308chap4.pdf
[2] http://www.epa.gov/oswer/riskassessment/rags3adt/

(resident and anadromous) and other freshwater species such as mussels, the ability to do so has been greatly inhibited with European colonization of their historic homelands. As such, tribal members may have to supplement their diet with market fish. Therefore, an Idaho FCR should be set that is reflective of a consumer's intake of both market and locally-caught fish and commensurate pollutant intake such that Indian tribes can safely consume fish from both sources at a level that meets their dietary desires and needs. If an updated Idaho FCR only includes locally-caught fish it will cause uncertainty and potential health risks to fish consumers that eat both local and market fish. The purpose of a state FCR should be to inform and protect fish consumers.

As mentioned, the ability of Indian tribes to consume only locally-caught fish has greatly diminished over the past 150 years for myriad reasons including dams and other diversions, loss of access to historic fishing areas, financial limitations, reduced water quality and quantity, etc. Due to these and other factors, tribes have had to rely more on market fish to meet their subsistence needs. However, in the last several decades Indian tribes have made great strides to increase fish populations in historic areas through legal victories, restoration projects, and supplementation programs. As an example, 2014 saw the largest salmon run returning to the Columbia Basin in the post-dam era. Undoubtedly these efforts will continue in the future, leading to more and more fish in Idaho. With more fish availability in Idaho, tribes will reduce their consumption of market fish and rely more on locally-caught fish. Presumably the same will be true for the general population. Consequently, IDEQ should recognize that in the future Idaho tribes and citizens will eat more locally-caught fish and less market fish. Capturing market fish consumption now will give IDEQ a better understanding of how much locally-caught fish will be eaten in the future, thereby allowing for implementation of a protective FCR now and for years to come.

Currently, at the 95th percentile, Shoshone-Bannock tribal member eat 768.8 grams/day of species group 1. USRT asserts that if Idaho's water were less toxic and the State was not riddled with dams and other diversion structure that impede or even block resident and anadromous species, that this consumption level would be achieved for species group 2, as tribal members would not have to substitute market fish for Idaho-caught fish.

Exclusion of Anadromous Fish

USRT and its member tribes adamantly oppose IDEQ's recommendation to completely exclude anadromous fish from their FCR calculation. USRT believes that IDEQ must reconsider their recommendation and fully include anadromous fish in the calculation of the Idaho FCR. Including anadromous fish in the calculation will ensure that the health of Idaho's Indian tribes, and the general public as a whole, will be protected. What peer-reviewed research is IDEQ relying on to substantiate the claim that "as returning adults almost all the contaminants they (anadromous species) bear are not locally sourced?" It is necessary that IDEQ at the July 8, 2015, rulemaking meeting provide a list of research work that was used in making the determination to fully exclude anadromous species from their FCR. Further, an analysis of the strengths and weaknesses of the research would be useful to fully analyze IDEQ's decision.

USRT recognizes that the EPA considers anadromous fish to acquire the bulk of its contaminant body burden from open ocean feeding. However, there are uncertainties associated with this assumption and it is important to note that EPA does not find that anadromous fish acquire all of their contaminant body burden in the ocean. However, by excluding anadromous fish from their FCR, IDEQ is falsely making the assumption that anadromous fish do acquire all of their contaminant body burden in the ocean. There are clearly uncertainties associated with this assumption, which include:

- Anadromous fish originating in Idaho waters may reside in U.S. coastal waters that fall under the jurisdiction of the Clean Water Act (CWA) and acquire contaminants from feeding in these waters.
- Returning anadromous fish do feed in fresh water, meaning they acquire contaminants from Idaho waters.[3]
- Anadromous fish may, through gill uptake, acquire contaminants during their residency time in Idaho.[4]
- It cannot be denied the high levels of PCB's found in juvenile Snake River salmon.[5]

The importance of anadromous fish to the member tribes of USRT cannot be understated. Not only do anadromous fish provide subsistence to the tribes, they are viewed as culturally and spiritually priceless. Prior to European colonization, the construction of dams and other diversions, and depleted water quality and quantity, millions of anadromous fish returned annually to Idaho rivers and streams. A portion of those anadromous fish were harvested by USRT member tribes and it has been estimated that members of the Shoshone-Bannock Tribes ate as much as 800 pounds of fish per year, the equivalent of 1,000 grams of fish per day.[6] Historic fish consumption estimations for the Northern Paiute vary widely from as little as 143 pounds per year (178 grams/day)[7] to 700 pound per year (871 grams/day)[8].

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[3] http://www.critfc.org/fish-and-watersheds/fish-and-habitat-restoration/restoration-successes/steelhead-kelt-reconditioning/

[4] Qiao P, FAPC Gobas, and AP Farrell. 2000. http://www.researchgate.net/profile/Frank_Gobas2/publication/12373146_Relative_contributions_of_aqueous_and_dietary_uptake_of_hydrophobic_chemicals_to_the_body_burden_in_juvenile_rainbow_trout/links/0fcfd5112a3b20b012000000.pdf

[5] http://www2.epa.gov/sites/production/files/documents/columbia_state_of_the_river_report_jan2009.pdf

[6] Scholz, A., K. O'Laughlin, D. Geist, D. Peone, J. Uehara, L. Fields, T. Kleist, l. Zozaya, T. Peone, and K. Teesatuskie. 1985. *Compilation of Information on Salmon and Steelhead Total Run Size, Catch and Hydropower Related Losses in the Upper Columbia River Basin, above Grand Coulee Dam.* Fisheries Technical Report No. 2. Upper Columbia United Tribes Fisheries Center, Eastern Washington University, Department of Biology. Cheney, Washington 99004. DecemberTooze, J., et. al. 2006. A new statistical method for estimating the usual intake of episodically consumed foods with application to their distribution. Journal of the American Dietetic Association 106:10, 2006, pp. 1575-1587.

[7] United States Senate Committee on Indian Affairs (U.S. Senate). 2007. Shoshone-Paiute Tribes of Duck Valley Water Rights Settlement Act Hearing. One Hundred First Congress, First Session. April 26, 2007.

[8] Upper Snake River Tribes Foundation. 2012. Northwest Power and Conservation Council Presentation. Boise, Idaho. 8 August 2012.

While the number of returning anadromous fish to Idaho is significantly less now than prior to European colonization, USRT member tribes still rely on anadromous fish as a portion of their diet. USRT member tribes, through restoration activities, hatchery production, and participation in issues such as the Columbia River Treaty, Northwest Power and Conservation Council, and dam relicensing, to name a few, are working to increase anadromous fish runs in Idaho and beyond. Those efforts are paying dividends as the Chinook salmon return in 2014 was the largest run in the modern dam era. Undoubtedly these efforts will continue in the future, leading to more and more fish in Idaho. As would be expected, as anadromous fish runs increase, so will consumption of those species by Idaho Indian tribes, as well as the general public.

Idaho tribal communities are the most substantial consumers of anadromous fish in the state and USRT and its member tribes are very disheartened that Idaho proposes to not include anadromous fish in their fish consumption calculation, which will cause significant health risks to the tribes. In its Discussion Paper #5: Anadromous Fish, IDEQ states "to include or exclude anadromous species from the calculation of a state-specific fish consumption rate, used to derive toxics criteria, is a risk management decision." USRT and its member tribes disagree. This is not a risk management decision but about protecting human health and an issue of environmental justice. The mission of IDEQ is very clear: "To protect human health and preserve the quality of Idaho's air, land, and water for use and enjoyment today and in the future." Risking the health of Idaho's tribes, or the additional constituents of the general population, by excluding anadromous fish in a state FCR is antithetical to the mission of IDEQ.

Anadromous fish begin and end their life cycle, which covers several years, in Idaho waters and are an invaluable tribal and state resource. Residency of anadromous fish in Idaho waters varies from one to three years. It is unclear, after reviewing scientific literature, what portion of an anadromous fish's pollutant burden is accrued while living in and traversing Idaho waters. Nor is it evident how Idaho's water quality standards impact water quality in the downstream states of Oregon and Washington, in which anadromous fish exit and enter as they migrate to and from Idaho. Given that anadromous fish do reside in Idaho for a portion of their life history it would be unconscionable to completely remove them from consideration when calculating an updated fish consumption rate for Idaho.

A similar debate whether to include anadromous fish or not recently occurred in Oregon. Their conclusion, as should be the one in Idaho, was that "including Pacific salmon in the fish consumption rate can provide more scientific certainty that Pacific salmon consumption is being accurately accounted for when calculating risk-based water quality criteria."[9] That determination led to Oregon adopting a 175 grams/day fish consumption rate. Similarly, the State of Washington is proposing to include anadromous fish in their FCR. Scientific certainty should drive every decision that IDEQ makes, particularly when human health is at the center of the decision.

[9] State of Oregon Department of Environmental Quality. *Human Health Focus Group Report – Oregon Fish and Shellfish Consumption Rate Project.* June 2008.

Additionally, IDEQ must consider the effects to downstream waters (e.g. Oregon and Washington) if they determine to exclude or only partially account for anadromous fish in their updated fish consumption rate. Without full accounting of anadromous fish in the fish consumption rate, Idaho's water quality criteria will be less protective than those adopted in Oregon and proposed in Washington. As required by federal regulation at 40 CFR 131.10(b), when states adopt water quality standards they "shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters." IDEQ appears to believe they can export their pollution to downstream states and tribes without consequences.

The Burns Paiute Tribe, based in Oregon, and the Fort McDermitt Paiute-Shoshone Tribe, based partially in Oregon, expect IDEQ to protect Oregon waters. As an upstream discharger, Idaho has an obligation to protect downstream waters. Given the significant cultural and subsistence importance of water to the Burns Paiute Tribe and Fort McDermitt Paiute-Shoshone Tribe, IDEQ must implement water quality standards and an FCR that is equal to, or more stringent than, that which are in place currently in Oregon. Anything less is unacceptable to USRT's two Oregon tribes.

Tribal Treaty Rights and Other Rights

The Shoshone-Bannock Tribes exercise a reserved subsistence treaty right. Article 4 of the Fort Bridger Treaty of 1868 states that the Shoshone-Bannock Tribes "shall have the right to hunt on the unoccupied lands of the United States.[10]" The Supreme Court of Idaho has affirmed that the term "hunt" clearly encompasses fishing.[11] IDEQ must protect the Shoshone-Bannock Tribes' treaty rights to fish at a subsistence level. The policy recommendations made during the April 21st rulemaking meeting clearly will not protect these rights. Many of the recommendations being advanced by IDEQ will work to harm the Shoshone-Bannock's treaty fishing rights. The U.S. Supreme Court has avowed tribal treaty rights numerous times and those decisions require federal, state, and local governments to ensure their protection. IDEQ's policy recommendations show complete indifference to the rights endowed in the Fort Bridger Treaty of 1868. IDEQ, in establishing water quality standards and an FCR, must safeguard the right to fish at a subsistence level. To do such means the tribes have access to plentiful fish, free of toxics, and are able to reside and reproduce in clean waters.

USRT's other three tribes do not have treaties, yet they also have a right to fish at a subsistence level. Those rights, which have never been extinguished by the tribes, are reserved through the United States Constitution, federal unratified treaties (including but not limited to the Fort Boise Treaty of 1864, Malheur Treaty of 1864, Bruneau Treaty of 1866, and Long Tom Creek Treaty of 1867), executive orders, inherent rights, and aboriginal title to the land. IDEQ has stated previously

[10] http://www.shoshonebannocktribes.com/treaty.html
[11] 94 Idaho 759, 497 P.2d 1386 (1972)

that they are reviewing tribal treaty rights in Idaho. It is necessary that IDEQ expands their review to tribes that live and/or fish in Idaho waters that do not have treaties but have equal rights through different means.

Risk and Human Health Protection

USRT does not support IDEQ's proposal for setting criteria for carcinogens to achieve a 10^{-6} incremental increase in cancer risk at the mean consumption rate for high consuming subpopulations. One, it is incorrect and inappropriate to characterize tribal populations as "subpopulations." Tribal members and the population as a whole are, and should be considered, a part of the general population. They are not a subpopulation as characterized by IDEQ. While USRT is very supportive of a 10^{-6} cancer risk rate, it must be protective at the 95^{th} percentile consumption rate for high consuming members of the general public (e.g. tribal members). Protecting at the mean consumption rate for high consuming members of the general population will not be protective of individuals or waters.

Suppression

USRT is extremely disappointed and concerned that IDEQ has failed to address suppression in any meaningful way up to this point in the rulemaking process. IDEQ had the unique opportunity during the rulemaking process to evaluate how suppression, both through "contamination (i.e. polluted fish)" and "depletion (i.e. reduced fish numbers)," has affected fish consumption patterns in Idaho. However, to date, it appears that IDEQ has let this opportunity slip away with very little thought or discussion. In our November 4, 2014, comment letter, we requested that IDEQ take serious the matter of suppression and incorporate it into rulemaking decisions. That request was ignored, which is truly a lack of due diligence.

Suppression in Idaho due to contamination is of significant concern not only to the tribes, as elucidated at the October 2, 2014, rulemaking session, but the target population, as well. Idaho's 2012 Integrated Report[12] finds that there are 13,237 river/stream miles in Idaho that are not meeting applicable water quality standards for one or more beneficial uses by one or more pollutants and thus included on the §303(d) list of impaired waters (Category 5 waters). An additional 31,287 miles in Idaho are not supporting one or more beneficial uses (Category 4 waters). Contamination in Idaho waters has caused both diminished fish numbers and bioaccumulation of toxics in living fish to the level where they are unsafe to eat. Whether real or perceived, contaminates in Idaho waters has a significant suppression effect on would be consumers.

Depletion of fish, the other major factor leading to suppression, is certainly attributable to contamination, but in Idaho is largely tied to dams and other diversion structures that impede or prevent fish migration and reproduction, and also add to the pollution problem through

[12] Idaho Department of Environmental Quality. 2014. Idaho's 2012 Integrated Report. Boise, ID: Idaho Department of Environmental Quality.

impoundment. Federal dams on the Columbia and Snake rivers in Oregon and Washington have caused considerable depletion or extirpation of anadromous species in Idaho. There are also dozens of major dams and several hundred smaller dams and diversion structures in Idaho that adversely affect or block fish migration and passage. Without question, fish depletion in Idaho has caused the most harm to the tribes, most notably to their traditional lifeways and in their ability to consume fish at the level and frequency they did historically. To reiterate, it has been estimated that members of the Shoshone-Bannock Tribes ate as much as 800 pounds of fish per year, the equivalent of 1,000 grams of fish per day and historic fish consumption estimations for the Northern Paiute vary widely from as little as 143 pounds per year (178 grams/day) to 700 pound per year (871 grams/day).

Taken together, contamination and depletion in Idaho has led to the suppressed consumption of fish most distinctly for Indian tribes, but also for other portions of the general population. This is a known and substantiated fact. Thus, for IDEQ to devise revised water quality standards based on a current fish consumption rate would not only be harmful to the health of all Idahoans, particularly high fish consumers, but set the state on a never-ending path of diminishing water quality standards and fish consumption rates.

The never-ending path, otherwise known as the "downward spiral," is a concept articulated previously by the EPA and the National Environmental Justice Advisory Council. In *Fish Consumption and Environmental Justice* (2002)[13], it is stated:

> A suppression effect occurs when a fish consumption rate for a given subpopulation reflects a current level of consumption that is artificially diminished from an appropriate baseline level of consumption for that subpopulation . . . When agencies set environmental standards using a fish consumption rate based upon an artificially diminished consumption level, they may set in motion a downward spiral whereby the resulting water quality standards permit further contamination and/or depletion of the fish and aquatic resources.

More recently, EPA reiterated this position in their *Human Health Ambient Water Quality Criteria and Fish Consumption Rates Frequently Asked Questions* (2013)[14]. Under the goals of the human health ambient water quality criteria, EPA states:

> It is also important to avoid any suppression effect that may occur when a fish consumption rate for a given subpopulation reflects an artificially diminished level of consumption from an appropriate baseline level of consumption for that subpopulation because of a perception that fish are contaminated with pollutants.

It is paramount that IDEQ does not take Idaho's water quality standards and fish consumption rate on the downward spiral. Unfortunately, given the minimal emphasis IDEQ has and is placing on the suppression effect, it is difficult to ascertain how the agency will refrain from going down a path

[13] Environmental Protection Agency and the National Environmental Justice Advisory Council. 2002. http://www.epa.gov/environmentaljustice/resources/publications/nejac/fish-consump-report_1102.pdf
[14] http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/upload/hhfaqs.pdf

of accepting diminishing water quality standards and fish consumption rate. IDEQ's engagement in a general population and recreational angler fish consumption survey will provide a statistical estimation of the contemporary level of fish consumption in Idaho. But, of what value is there in knowing what the general population and anglers are currently eating given the condition of Idaho waters? It has already been noted here that there are thousands of miles of impaired rivers and streams in Idaho.

Further, the Idaho Department of Health and Welfare (IDHW) has imposed a statewide mercury advisory for bass (largemouth and smallmouth) in all lakes, rivers, reservoirs, and other water bodies in Idaho.[15] Additionally, there are IDHW-imposed fish consumption advisories on 22 creeks, lakes, reservoirs, and rivers in northern and southern Idaho.[16] The species of fish on the 22 water bodies are varied and include: bluegill, brown trout, bullhead, carp, catfish, crappie, cutthroat trout, kokanee, Lahontan cutthroat trout, lake trout, perch, rainbow trout, redband trout, sucker, Utah sucker, walleye, whitefish, and yellow perch.

If it is IDEQ's strategy to take the results of the contemporary general population/angler survey and use that number to devise Idaho's revised water quality standards and fish consumption rate then the downward spiral has begun. While the Nez Perce Tribe and Shoshone-Bannock Tribes have also completed a contemporary fish consumption survey, they have employed a suite of measures to document the forces of suppression and identify their respective heritage fish consumption rates. This approach, while unique for Idaho tribes, is not unlike what has been done recently by the Lummi, Spokane, Suquamish, and Swinomish tribes. Tribes throughout the country have recognized, as must IDEQ, that contemporary fish consumption rates are not an appropriate baseline for determining water quality standards given the effects of contamination and depletion. For tribes, the baseline is the ability to harvest and consume fish at a level that fully and healthfully fulfills their rights reserved through the United States Constitution, federal treaties, federal unratified treaties, executive orders, inherent rights, and aboriginal title to the land.

As was so eloquently stated by Seattle University law professor Catherine O'Neill, when "we set risk-based standards based on assumptions about exposure measured in this bleak period, we aim for a future that is not improved. That is, we impose a limit on the health of our waters – and a ceiling on the safe consumption of fish from those waters – that reflects not a level of fish intake that is healthful or to which tribes are entitled, but a level that is simply equal to present, constrained practice."[17] EPA's relevant guidance does not restrain agencies to making only present-oriented exposure assessments. Instead, it finds that exposure assessments may be past-, present-, or future-oriented. To realize the restorative goals of the CWA, "it makes sense that exposure

[15] Idaho Department of Health and Welfare. ND. Eat Fish, Be Smart, Choose Wisely: A guide to safe fish consumption for fish caught in Idaho waters.
http://healthandwelfare.idaho.gov/Portals/0/Health/EnvironmentalHealth/FishGuide.pdf
[16] Ibid.
[17] O'Neill, Catherine A. 2013. Fishable Waters. American Indian Law Journal. Vol. I, Issue II.
http://www.law.seattleu.edu/Documents/ailj/Spring%202013/O'Neill-Fishable%20Waters.pdf

analysis is oriented toward a future in which aquatic ecosystems are healthy and whole. And, given the tribal context, it is arguable that exposure analysis not only may but must be oriented toward a future in which the fish resource is robust and tribal members may exercise fully their right to take fish."[18]

In March of 2015, Barbara L. Harper and Deward E. Walker, Jr., published two important papers regarding tribal FCR's: *Columbia Basin Heritage Fish Consumption Rates* and *Comparison of Contemporary* and *Heritage Fish Consumption Rates in the Columbia River Basin*. USRT has attached the peer-reviewed and published articles for your review and consideration.

Relative Source Contribution

IDEQ is proposing to implement a method whereby relative source contribution (RSC) will be adjusted based on changes in the rate of fish consumption. Given that one, IDEQ did not provide a discussion paper on this approach, nor give a comprehensive explanation at the April 21st rulemaking meeting, and two, this approach has not been implemented previously within the U.S., it is difficult for USRT to comment fully on this policy recommendation. However, given that IDEQ is recommending to exclude anadromous fish from their FCR calculation, of which USRT adamantly disagrees, we do not support this proposed approach. As EPA's 2013 *Human Health Ambient Water Quality Criteria and Fish Consumption Rate: Frequently Asked Questions*[19] notes:

> In the absence of scientific data, the application of the EPA's default value of 20 percent RSC in calculating 304(a) criteria or establishing State or Tribal water quality standards under Section 303(c) will ensure that the designated use for a water body is protected. This 20 percent default for RSC can only be replaced where sufficient data are available to develop a scientifically defensible alternative value.

IDEQ provided nothing more than a single PowerPoint slide on their recommendation to use an adjusted RSC based on changes in FCR. If IDEQ is going to move forward with this recommendation it will need to show sufficient data to do so.

Further, the *Human Health Ambient Water Quality Criteria and Fish Consumption Rate: Frequently Asked Questions*, make clear that if a state includes anadromous fish in their FCR they can adjust their RSC from the 0.2 default. However, IDEQ is excluding anadromous fish in the FCR calculation. As such, USRT asserts that an RSC of 0.2 is not only appropriate, but necessary. An RSC value greater than 0.2 will not have the support of USRT.

Drinking Water Intake

IDEQ is recommending, for deterministic calculations, a drinking water intake of 2.4 liters/day. While 2.4 liters/day is higher than EPA's current default rate, USRT requests that IDEQ review EPA's 2014 304(a) recommendations. EPA derived those recommendations by utilizing a drinking

[18] Ibid.
[19] http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/upload/hhfaqs.pdf

water intake rate of 3 liters/day. USRT recommends that IDEQ use the 3 liters/day water intake level when devising water quality criteria.

Dan Opalski Letter to Washington Ecology

On March 23, 2015, Dan Opalski, Director of Office of Water and Watersheds for EPA Region 10, submitted a comment letter to Washington Ecology, regarding their proposed revisions to Washington's Human Health Criteria. USRT believes that this letter is very instructive and will be useful to IDEQ. As such, the letter is attached for your review.

To conclude, while USRT is in agreement with IDEQ on a minority of their policy recommendations, we have significant concerns and strongly disagree with a majority of the policy recommendations. The incredible lack of detail, analysis, and sourcing of many of IDEQ's recommendations is troubling at best. Such unknowns and uncertainties surrounding your policy recommendations have facilitated an inability for USRT to provide detailed comments that we would expect to be incorporated into the preliminary draft rule that will be presented on July 8, 2015. It is expected that on July 8th IDEQ will be fully and comprehensively prepared to describe and defend their draft rule. Anything less is unacceptable.

USRT appreciates the opportunity to comment on IDEQ's Recommendations on Criteria Calculation. If you have questions or remarks following review of these comments, please contact Scott Hauser, USRT Environmental Program Director, at (208) 331-7880 (office) or (208) 995-4872 (cell) and/or by email at scott.hauser@usrtf.org.

Sincerely,

s:/ *Scott Hauser*

Scott Hauser
Environmental Program Director

Attachments:

1. EPA Region 10 Comment Letter to Washington Department of Ecology
2. Harper and Walker, 2015. Columbia Basin Heritage Fish Consumption Rates and Comparison of Contemporary.
3. Harper and Walker, 2015. Heritage Fish Consumption Rates in the Columbia River Basin.
4. Ridolfi, 2014. Review of Heritage Fish Consumption Rates from Idaho Tribal Heritage Fish Consumption Rate Reports for the Coeur d'Alene, Kootenai, Nez Perce, and Shoshone Bannock Tribes

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
WATER AND WATERSHEDS

MAR 23 2015

Ms. Cheryl Niemi
Washington Department of Ecology
Water Quality Program
P.O. Box 47600
Olympia, Washington 98504-7600

Re: EPA's Comments on Proposed Revisions to Washington's Human Health Criteria and New and Revised Implementation Provisions

Dear Ms. Niemi:

I am writing to submit the U.S. Environmental Protection Agency's comments on the Washington Department of Ecology's proposed human health criteria and new and revised implementation provisions issued on January 12, 2015. If adopted, this proposed rulemaking would revise the following sections of Washington's water quality standards:

- Human Health Criteria and Other Narrative Revisions (WAC 173-201A-240)
- Variances (WAC 173-201A-420)
- Intake Credits (WAC 173-201A-460)
- Compliance Schedules (WAC 173-201A-510(4))

The EPA fully supports Ecology's efforts to adopt human health criteria, and we appreciate the leadership that Ecology and the Governor's Office have shown thus far in developing Washington's human health criteria for toxics. Over the last several years, Ecology undertook an extensive public process to discuss options for rule development. The EPA supports Ecology's effort to use regional and local fish consumption data by proposing to adopt human health criteria based on a fish consumption rate of 175 grams per day. As we have previously stated, the best available data includes evidence of fish consumption rates well above 6.5 grams per day among high fish consumers in Washington, including tribal members with treaty-protected rights, which raises concerns that the human health criteria in effect for Clean Water Act purposes in Washington are not sufficiently protective. In fact, the best available data indicates fish consumption rates among some tribal members with treaty-protected fishing rights well above 175 grams per day.

Other elements of Ecology's rule proposal, such as its revision to the state's long-standing cancer risk level from 10^{-6} to 10^{-5}, do not fully reflect the best available science, including local and regional information, as well as applicable EPA policies, guidance, and legal requirements. Specifically, a cancer risk level of 10^{-5} does not provide appropriate risk protection for all Washington citizens, including tribal members with treaty-protected fishing rights, when coupled with a fish consumption rate of 175 grams per day or higher. By using a 10^{-5} cancer risk level, the state has substantially offset the environmental benefits of raising the fish consumption rate for carcinogenic human health criteria. For tribes with treaty-protected fishing rights, this approach to the cancer risk level will not advance health protections consistent with their treaty-reserved right to harvest and eat fish and shellfish. In addition, Ecology has not provided sufficient justification for its proposed 10^{-5} cancer risk level and how it will result in criteria that provide for the attainment and maintenance of the WQS of downstream waters, consistent with the EPA's regulations at 40 CFR 131.10(b). Finally, in addition to the fish consumption rate and cancer risk level, Ecology should use the best available science to derive its human health criteria and, in many instances, EPA's 2014 draft CWA section 304(a) recommended criteria represent that information.

As a result, Ecology should reconsider certain elements of its proposal to ensure that final human health criteria adopted by the state provide appropriate levels of protection for all Washington citizens, including communities that eat higher amounts of fish, specifically tribes with treaty-protected fishing rights. The EPA's concerns are outlined in the enclosed comments. We remain committed to working with the state to ensure that the human health criteria Ecology ultimately chooses to adopt are protective of designated uses and based on a sound scientific rationale, consistent with 40 CFR 131.11(a).

In addition, the EPA appreciates Ecology's efforts to consider implementation of these criteria by proposing new and revised implementation tools. The EPA recognizes that industry and local governments in Washington have raised valid concerns about the challenges of meeting more stringent water quality standards. We believe there is broad recognition that workable, effective implementation will be critical to ultimately realizing the protections that revised human health criteria are intended to provide. The EPA recognizes the importance of implementation tools in making progress toward improved water quality while accounting for the needs of the regulated community. We firmly believe that Ecology can adopt a water quality standards package that offers protective human health criteria while giving industry reasonable time to comply with more stringent water quality-based effluent limits through implementation tools. Such an approach can support a thriving economy while adequately protecting higher fish consuming populations. The EPA remains committed to assisting Ecology during its development and utilization of implementation tools.

As you are aware, the EPA has initiated a federal rulemaking process to amend Washington's existing human health criteria in the National Toxics Rule, which were last updated in 1992. The EPA is encouraged that Ecology proposed its own rule and we hope that Ecology will finalize a scientifically defensible rule that protects the health of Washington's citizens. As stated in Regional Administrator Dennis McLerran's December 18, 2014 letter to Director Maia Bellon, despite our having initiated a federal rulemaking, if Washington submits a final rule to the EPA for Clean Water Act review and action prior to our completion of a federal proposal, the EPA will fulfill its Clean Water Act duty to review and act on the state's submittal.

As previously noted, attached are the EPA's detailed comments for your consideration. We have appreciated our work together throughout this process and remain committed to providing technical assistance as you work on revisions to this proposed rule.

If you have any questions concerning our comments or desire the EPA's assistance, please contact me at (206) 553-1855 or Angela Chung at (206) 553-6511.

Sincerely,

Daniel D. Opalski, Director
Office of Water and Watersheds

Enclosure

U.S. Environmental Protection Agency, Region 10
Comments on Washington Department of Ecology's Proposed Human Health Criteria and Implementation Tools Rule

March 23, 2015

Public Notice of Proposal Dated January 12, 2015

The Washington Department of Ecology (Ecology) provided draft surface water quality standards (WQS) revisions found at Chapter 173-201A WAC to the public for review and comment on January 12, 2015.[1] With these WQS revisions, Ecology is proposing to adopt human health criteria and revise or establish new implementation tools. The EPA reviewed the state's draft rule and associated documents and provides the following comments for Ecology's consideration. The comments are organized as follows:

1. Human Health Criteria and Other Narrative Revisions (WAC 173-201A-240)
    A. Fish Consumption Rate (FCR)
    B. Cancer risk level
    C. Relative Source Contribution (RSC)
    D. Body Weight
    E. Drinking Water Intake
    F. Reference Dose (RfD) and Cancer Slope Factor (CSF)
    G. Bioconcentration Factor (BCF)
    H. Polychlorinated Biphenyls (PCBs)
    I. Arsenic
    J. Methylmercury
    K. Pollutant Scope
    L. Downstream Waters and Other Narrative Revisions

2. Implementation tools and definitions
    A. Variances (WAC 173-201A-420)
    B. Intake Credits (WAC 173-201A-460)
    C. Compliance Schedules (WAC 173-201A-510(4))

Please note that the EPA's positions described in the comments below, regarding the state's proposed WQS, are preliminary in nature and do not constitute an approval or disapproval by the EPA under the Clean Water Act (CWA) Section 303(c). Approval and/or disapproval decisions will be made by the EPA following adoption of the new and revised standards by the state of Washington and submittal of revisions to the EPA. In addition, the EPA's comments do not constitute, and are not intended to be, an Administrator determination under CWA Section 303(c)(4)(B).

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[1] Department of Ecology. 2015. *Proposed Human Health Criteria and Implementation Tools Rule proposal – public review.* http://www.ecy.wa.gov/programs/wq/ruledev/wac173201A/1203inv.html.

1. Human Health Criteria and Other Narrative Revisions (WAC 173-201A-240)

The EPA established Washington's existing human health criteria for toxic pollutants in the 1992 national toxics rule (NTR).[2] Ecology now proposes to adopt human health criteria for 96 different toxic pollutants into the state's WQS. Ecology added these proposed criteria values to Table 240 in the state's WQS, which also contains aquatic life criteria. In most cases, Ecology calculated criteria for each pollutant using the EPA's recommended 304(a) human health criteria equations for carcinogens and non-carcinogens with state-selected inputs. However, in the case of human health criteria for arsenic, copper, and asbestos, Ecology derived those values differently using Safe Drinking Water Act Maximum Contaminant Levels. In addition, the Washington Governor's Office provided a policy overlay that no criterion concentration would become less protective than the corresponding existing NTR criterion concentration, with the exception of arsenic.[3]

Below are the EPA's comments on the individual input parameters that Ecology used to derive its proposed human health criteria along with comments on Ecology's proposed narrative revisions to WAC 173-201A-240. The EPA's comments will assist the state in developing final water quality criteria that protect applicable designated uses and are based on sound scientific rationale consistent with 40 CFR 131.11(a), and protect downstream WQS consistent with 40 CFR 131.10(b).

The EPA would like to point out three overarching themes raised in our comments:

(1) Tribal Treaty Rights. When acting on a state's WQS submission, the EPA must ensure that the WQS comply with the CWA as well as any other applicable law, including federal treaties.[4] In Washington, many tribes hold a treaty-reserved right to take fish for subsistence, ceremonial, religious, and commercial purposes at all usual and accustomed fishing grounds and stations, which cover the majority of waters in the state. These areas cannot directly be protected by the tribal government and, therefore, this responsibility falls to the state and federal governments to ensure their protection.[5] In order to effectuate the rights that these federal treaties afford to those tribes, and to harmonize those treaty rights with the CWA, the EPA and Ecology must interpret the state's designated uses[6] to include subsistence fishing. Therefore, both the EPA and the state need to consider what level of water quality is necessary to allow the tribes to safely consume fish in light of their treaty-reserved rights. In order to protect a subsistence fishing use, the state

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[2] EPA. 1992. *Toxics Criteria for Those States Not Complying with Clean Water Act*, section 303(c)(2)(B). 40 CFR Part 131.36. http://water.epa.gov/lawsregs/rulesregs/ntr/. Amended in 1999 for PCBs. http://water.epa.gov/lawsregs/rulesregs/ntrfact.cfm.

[3] Governor Jay Inslee Policy Brief. July 2014. *Ensuring Safe, Clean Water for Healthy People and a Strong Economy: Updating Washington's Water Quality Standards to Meet Today's Toxic Threats*. http://www-dev.governor.wa.gov/sites/default/files/policy_briefs/pb_CleanWater_2014.pdf.

[4] In addition to treaties, executive orders or federal statutes, such as land claim settlement acts, may also apply to tribal resources.

[5] Note that this analysis does not pertain to trust and reservation lands, where the applicable tribe can obtain treatment in a similar manner to a state (TAS) status and set their own WQS, including human health criteria.

[6] As defined in Washington's WQS (WAC 173-201A-600 and WAC 173-201A-610), these uses include the following: Fresh waters – Harvesting (Fish harvesting); Marine waters – Shellfish Harvesting (shellfish (clam, oyster, and mussel) harvesting) and Harvesting (salmonid and other fish harvesting, and crustacean and other shellfish (crabs, shrimp, scallops, etc.) harvesting).

must adopt criteria that will protect the tribal population exercising the subsistence fishing use as the target general population, not as a high-consuming subpopulation of the state. The data used to determine the fish consumption rate (FCR) also must reasonably represent tribal subsistence consumers' practices unsuppressed by fish availability or concerns about the safety of the fish available for them to consume. In addition, the cancer risk level selected must ensure a minimum level of protection for that tribal target population when consuming fish at unsuppressed levels. If data regarding unsuppressed fish consumption levels are unavailable, consultation with affected tribes is important in deciding, among other things, which fish consumption data should be used and the appropriate cancer risk level.

(2) Best Available Science. Along with using local and regional FCR data, Ecology should use the best available science to derive its human health criteria and, in many instances, the EPA's 2014 draft 304(a) recommended criteria represents that information. If the EPA's criteria recommendations become final before Ecology adopts a final human health criteria rule, the EPA recommends that the state use that information instead of the 2014 draft criteria information.

(3) Protection of Downstream Waters. Ecology has not provided sufficient justification for its proposed 10^{-5} cancer risk level and how it will result in criteria that provide for the attainment and maintenance of the WQS of downstream waters, consistent with the EPA's regulations at 40 CFR 131.10(b). Most of Washington's rivers are in the Columbia River basin and are, therefore, upstream of Oregon's portion of the Columbia River. Approximately 90% of Washington's proposed human health criteria are higher than Oregon's 2011 EPA-approved criteria for the same pollutants.[7]

A. Fish Consumption Rate (FCR)

In Ecology's proposed rule, the state derived human health criteria using a FCR of 175 grams per day (g/day). Ecology stated that this value is representative of state-specific information and was determined through a process that included consideration of EPA guidance and precedent, and input from multiple stakeholder organizations. Specifically, Ecology stated that this value is representative of FCRs for highly exposed populations that consume both fish and shellfish from Puget Sound waters and is considered an "endorsed" value.[8]

In 1992, the EPA used the national default FCR at that time, 6.5 g/day, to derive human health criteria for Washington in the NTR. In 2000, the EPA updated its methodology for deriving human health criteria and associated 304(a) recommendations using a national default FCR of 17.5 g/day.[9] More recently in 2014, the EPA updated the national default FCR to 22 g/day.[10]

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[7] The EPA acknowledges that Washington uses fish tissue equivalent concentrations to trigger waterbody impairments based on the human health criteria in their 303(d) listing methodology.

[8] Department of Ecology. January 2015. *Washington State Water Quality Standards: Human Health Criteria and Implementation Tools. Overview of Key Decisions in Rule Amendment.* Page 17. https://fortress.wa.gov/ecy/publications/publications/1410058.pdf.

[9] EPA. 2000. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.* U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA-822-B-00-004. http://www.epa.gov/waterscience/criteria/humanhealth/method/complete.pdf.

[10] 79 FR 27303. *Updated National Recommended Water Quality Criteria for the Protection of Human Health.*

The EPA's 2000 Human Health Methodology recommends that states use local or regional data over the EPA's national default recommended FCR. Surveys of local residents in the Pacific Northwest, including tribes and recreational anglers, reflect high consumption levels of fish and shellfish – much higher than the national default FCR the EPA used in 1992 to derive Washington's currently applicable human health criteria. Ecology now has sufficient scientifically sound regional and local fish consumption data to consider when choosing an FCR, including:

- *A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin* (Columbia River Inter-Tribal Fish Commission (CRITFC), 1994).
- *A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region* (Toy et al., 1996).
- *Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservations, Puget Sound Region* (Suquamish Tribe, 2000).
- *Asian and Pacific Islander Seafood Consumption Study* (Sechena et al., 1999).

Washington's proposal to use 175 g/day to calculate its revised human health criteria is consistent with the 95th percentile of the 1994 CRITFC study listed above, and is the same FCR that the state of Oregon used to derive its human health criteria, which the EPA approved in 2011.[11] That said, in draft documents, Ecology considered FCRs as high as 267 g/day.[12]

The EPA is encouraged that Ecology is choosing to protect high fish consumers in Washington by deriving the state's human health criteria using local and regional fish consumption data. The EPA is also very supportive of the state's decision to include anadromous fish in the FCR used to derive the criteria, which is appropriate given the species that reside in Washington's nearshore and coastal waters, especially Puget Sound. Ecology's approach is consistent with the EPA's recommendation to use scientifically sound regional and local fish consumption data and is a significant improvement from the FCR used to derive the state's current human health criteria. That said, the EPA recognizes that fish consumption by tribes or other high consumers within the state may be suppressed due to issues including local availability of fish or concerns about the safety of the fish available for them to consume; existing data suggest an unsuppressed FCR would be higher than 175 g/day.[13] As discussed previously, to adequately protect the tribes' treaty-reserved fishing rights, the data used to determine the FCR for the target general population must reasonably represent consumption levels that are unsuppressed. The EPA

[11] EPA. October 2011. *Technical Support Document for Action on the State of Oregon's New and Revised Human Health Water Quality Criteria for Toxics and Associated Implementation Provisions Submitted July 12 and 21, 2011.* http://www.epa.gov/region10/pdf/water/or-tsd-hhwqs-2011.pdf.

[12] Department of Ecology. *Fish Consumption Rates Technical Support Document.* Final issued in January 2013. Draft issued in October 2011. http://www.ecy.wa.gov/programs/tcp/regs/fish/2012/FCR-doc.html.

[13] The EPA is unaware of any data that reliably establish an unsuppressed FCR for all or part of Washington. However, a number of authors have reported heritage average FCRs for the Columbia River Basin Tribes ranging from 401 to 995 g/day (Craig and Hacker (1940) & Hewes (1947); Swindell (1942); Marshall (1977); Walker (1967)). Upper percentile values are not reported in these heritage studies but would be higher than the reported average values. The highest estimated current FCRs in Washington come from a study on the Suquamish Tribe, with reported FCRs as high as 1600 g/day (Suquamish 2000, Table C5). The 95th percentile Suquamish FCR is 767 grams per day (Ecology 2013).

acknowledges, however, that the tribes within the state have generally viewed 175 g/day as a compromise minimum value for current criteria-setting purposes, so long as it is coupled with a cancer risk level of 10^{-6} (see section B). Based on the EPA's review of existing data in Washington, in conjunction with consultation with the tribes, the EPA supports Washington's decision to derive the human health criteria using a FCR of 175 g/day so long as the state also retains a cancer risk level of 10^{-6}. A 10^{-6} cancer risk level is necessary to ensure that the target population of tribal fish consumers exercising their treaty-reserved rights, including those whose consumption is not suppressed, are adequately protected.

B. Cancer Risk Level

The EPA used a cancer risk level of 10^{-6} (1 in 1,000,000) to derive Washington's human health criteria for carcinogens in the 1992 NTR. The EPA selected this cancer risk level with input from Washington, which adopted around the same time a WQS provision that states: *"Risk-based criteria for carcinogenic substances shall be selected such that the upper-bound excess cancer risk is less than or equal to one in a million"* (WAC 173-201A-240(6)), that the EPA approved in 1993. In Ecology's proposed rule, the state derived human health criteria for carcinogens using a cancer risk level of 10^{-5} (with the exception of PCBs), which increases the cancer risk level from 1 in 1,000,000 to 1 in 100,000. Ecology stated that this decision is a state-specific risk management decision that included considerations of engineering, social, economic, and political concerns.[14] Ecology's rationale for this decision includes that the cancer risk level for highly exposed populations is 10^{-5} due to the state's decision to derive its human health criteria using a FCR of 175 g/day.

The EPA's 2000 Human Health Methodology[15] states that use of 10^{-6} or 10^{-5} in the derivation of human health criteria may be an acceptable level of risk for the target general population.[16] Here, the state has not demonstrated how its use of a cancer risk level of 10^{-5} would result in water quality criteria that adequately protect tribal fish consumers as the target general population as opposed to a highly exposed subpopulation within the broader general population in Washington. For example, the cancer risk level for tribal members whose consumption is not suppressed (i.e., greater than 175 g/day), would very likely be higher than 10^{-5}. It should also be noted that the 2000 Human Health Methodology did not consider how CWA decisions should account for applicable treaty-reserved fishing rights, and the treaties themselves may require higher levels of protection. Therefore, the EPA supports the state's decision to derive the human health criteria using a FCR of 175 g/day so long as the state also

[14] Department of Ecology. January 2015. *Washington State Water Quality Standards: Human Health Criteria and Implementation Tools. Overview of Key Decisions in Rule Amendment.* Page 17. https://fortress.wa.gov/ecy/publications/publications/1410058.pdf.

[15] EPA. 2000. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.* U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA-822-B-00-004. http://www.epa.gov/waterscience/criteria/humanhealth/method/complete.pdf.

[16] The Methodology also notes that states and authorized Tribes can always choose a more stringent risk level, such as 10^{-7}. Page 1-12.

retains a cancer risk level of 10^{-6}, which the tribes have generally viewed as a compromise minimum value in tribal consultation.[17]

As further discussed below in section L, Ecology also has not provided sufficient justification for its proposed 10^{-5} cancer risk level and how it will result in criteria that provide for the attainment and maintenance of the WQS of downstream waters, consistent with the EPA's regulations at 40 CFR 131.10(b).

C. Relative Source Contribution (RSC)

The RSC is a factor applied in development of criteria for non-carcinogens and nonlinear carcinogens, to account for sources of exposure other than drinking water and freshwater and estuarine fish consumption (e.g. marine fish, non-fish food consumption, dermal exposure). In Ecology's proposed rule, the state derived human health criteria using a RSC value of 1.0. Ecology stated that this is an appropriate risk management decision due to the limited ability of the CWA to control exposure to sources outside of its jurisdiction. While the EPA commends some of the risk management choices that the state is making with respect to sources of exposure, consistent with the EPA's 2000 Human Health Methodology, the EPA recommends that Ecology derive its human health criteria for non-carcinogens and nonlinear carcinogens using a RSC value between 0.2 and 0.8.

In the 1992 NTR, the EPA did not incorporate a RSC value into the equation to derive Washington's human health criteria for non-carcinogens. The EPA's 2000 Human Health Methodology recommends default RSC values between 0.2 and 0.8 to be used in the calculation of human health criteria. The EPA established a ceiling of 0.8 for the RSC to ensure protection of individuals whose exposure could be greater than indicated by current data and to account for unknown sources of exposure. In the EPA's 2014 draft updated 304(a) recommendations, the EPA applied a RSC for all of the updated national criteria for non-carcinogens and one nonlinear carcinogen.[18]

Again, the EPA commends Ecology for incorporating anadromous fish in the proposed FCR. This is particularly appropriate since data exist that show adult salmon in Washington can accumulate a substantial fraction of their contaminant body burden during their residence time in Puget Sound (O'Neill and West, 2009) and near coastal marine waters (O'Neill 2006) that are under the jurisdiction of the CWA.[19, 20] The EPA's human health criteria FAQs clarify that,

[17] In a July 1, 2014 response letter to Washington Senator Doug Ericksen from Dennis McLerran, EPA Region 10 Administrator, the EPA provided several reasons why Ecology should maintain its current cancer risk level of 10^{-6}, including the protection of reserved fishing treaty rights.
[18] EPA. 2014. *DRAFT: Updated National Recommended Water Quality Criteria – Human Health.* http://water.epa.gov/scitech/swguidance/standards/criteria/current/hhdraft.cfm.
[19] O'Neill, S.M., and J.E. West. 2009. Marine distribution, life history traits, and the accumulation of polychlorinated biphenyls in Chinook salmon from Puget Sound, Washington. Transactions of the American Fisheries Society 138: 616-632.
[20] O'Neill, S.M., G.M. Ylitalo, J.E. West, J. Bolton, C.A. Sloan, and M.M. Krahn. 2006. Regional patterns of persistent organic pollutants in five Pacific salmon species (*Oncorhynchus spp*) and their contributions to

where a state's FCR includes freshwater, estuarine, and all marine fish consumption, states can adjust the RSC to reflect a greater proportion of the reference dose being attributed to marine exposures.[21] Therefore, the EPA recognizes that a default RSC value of 0.2 could be overprotective when anadromous fish are included in the FCR. However, even when accounting for anadromous fish in the FCR, Ecology has not adequately justified using a RSC value of 1.0 to derive human health criteria for all non-carcinogens and nonlinear carcinogens, nor has it adequately explained why it is appropriate to ignore all other routes of exposure, including air, soil, and other marine fish and shellfish. Further, the EPA considers whether there are multiple health-based criteria or regulatory standards for the same chemical in determining the RSC. Therefore, the EPA strongly recommends that Ecology choose an appropriate RSC in the recommended range of 0.2 to 0.8 using the Exposure Decision Tree approach as described in EPA's 2000 Human Health Methodology to calculate human health criteria that are protective of the designated use and based on sound science.

D. Body Weight

In Ecology's proposed rule, the state derived human health criteria using a body weight assumption of 80 kg based on tribal survey data relevant to Washington and EPA's 2011 Exposure Factors Handbook.[22] In general, the EPA is supportive of Ecology assuming a body weight of 80 kg to derive human health criteria.

In the 1992 NTR, the EPA used a body weight assumption of 70 kg in the equation to derive Washington's human health criteria. Although 70 kg is the EPA's current default assumption in its 304(a) recommendations, the EPA derived its 2014 draft 304(a) recommendations using an updated body weight assumption of 80 kg, the national mean based on a more current survey of the U.S. population and described in the EPA's 2011 Exposure Factors Handbook.[23] Consistent with the EPA's guidance, Ecology is using local and regional specific data in deriving this value. In addition, this value is consistent with the national default assumption the EPA will incorporate into its revised 304(a) recommendations for human health criteria.

E. Drinking Water Intake

In Ecology's proposed rule, the state derived human health criteria using a drinking water intake rate of 2 L/day. Ecology states that since data specific to drinking water consumption in Washington are not available, the state cannot compare local data to the available national estimate and, therefore, Ecology proposes to use the EPA's current default rate of 2 L/day. In the absence of reliable local or regional data, the EPA recommends that the state refer to the most current available national data on drinking water intake rates.

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contaminant levels in northern and southern resident killer whales (*Orcinus orca*). 2006 Southern Resident Killer Whale Symposium, NOAA Fisheries Service Northwest Regional Office April 3-5, 2006. Seattle, WA. Extended Abstract. 5pp.

[21] EPA. January 2013. *Human Health Ambient Water Quality Criteria and Fish Consumption Rates: Frequently Asked Questions.* http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/upload/hhfaqs.pdf.

[22] EPA. 2011. EPA Exposure Factors Handbook. 2011 edition (EPA 600/R-090/052F). http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252.

[23] Id.

In the 1992 NTR, the EPA used a drinking water intake rate of 2 L/day in the equation to derive Washington's human health criteria. Although 2 L/day is the EPA's current default rate in its 304(a) recommendations, the EPA derived its 2014 draft 304(a) recommendations using a drinking water intake rate of 3 L/day. This rate represented a *consumer-only* estimate of combined direct and indirect water ingestion for *all sources* of water at the 90th percentile for adults ages 21 and older. [24] In response to public comments that focused on the most current national drinking water data, the EPA will finalize the updated 304(a) criteria using a drinking water intake rate of 2.4 L/day, which represents the *per capita* estimate of combined direct and indirect *community water* ingestion at the 90th percentile for adults ages 21 and older. [25]

If Ecology cannot obtain reliable local or regional data, the EPA encourages Ecology to consider the new information used to update the EPA's national default rate, including EPA's 2011 Exposure Factors Handbook.[26]

F. Reference Dose (RfD) and Cancer Slope Factor (CSF)

New research led to updates of several toxicity values for non-carcinogenic effects (reference doses or RfDs) and carcinogenic effects (cancer slope factors or CSFs) since the EPA promulgated the NTR in 1992. The EPA used updated toxicity factors to recalculate its 304(a) recommended human health criteria for certain pollutants various times since 1992. The EPA's Integrated Risk Information System[27] (IRIS) is the primary recommended source for RfD and CSF information; however, in some cases, more current peer-reviewed and publically-available toxicological data are available from other EPA program offices (e.g., Office of Pesticide Programs, Office of Water, Office of Solid Waste and Emergency Response), other national and international programs, and state programs. The EPA conducted a systematic search of nine peer-reviewed, publicly available sources to obtain the most current RfDs and CSFs to derive the 2014 draft 304(a) recommendations. The criteria are based on the more sensitive endpoint based on cancer or non-cancer assessments, presuming a cancer risk level of 10^{-6}. If a higher cancer risk level is used, it is possible that the non-cancer endpoint becomes the driver for the criterion.

The EPA recommends Ecology consider adopting final criteria that reflect the latest scientific information on toxicity that the EPA used in its draft recommendations or in the final national criteria recommendations if they are available before Ecology adopts a final rule. If Ecology chooses not to use updated toxicity values, the EPA recommends that Ecology provide a rationale for choosing not to integrate the latest science regarding toxicity into its human health criteria.

G. Bioconcentration Factor (BCF)

In Ecology's proposed rule, the state derived human health criteria using BCFs. Ecology's stated rationale is that Bioaccumulation Factors (BAFs) account for uptake from sources other than

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[24] Id.
[25] Id.
[26] Id.
[27] EPA. *Integrated Risk Information System (IRIS).* U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. www.epa.gov/iris.

water (e.g., sediment, other food sources), and, therefore, are overprotective because some of the sources included could have pollutant burdens that come from areas and waters outside of Washington's CWA jurisdiction (e.g., mercury from air deposition). Pollutants from sources other than the water column can accumulate in fish that people consume, particularly if they have chemical properties that cause the pollutants to accumulate in fish dietary items. To account for bioaccumulation, the EPA's 2000 Human Health Methodology recommends use of BAFs that account for uptake of a contaminant from all sources by fish and shellfish, rather than BCFs that only account for uptake from the water column. In the 1992 NTR, the EPA used BCFs in the equation to derive Washington's human health criteria. Although the EPA's current 304(a) recommendations use BCFs, the EPA's 2014 draft 304(a) recommendations replace BCFs with BAFs. The EPA will finalize the updated 304(a) criteria using BAFs, where data are available.

BAFs account for biomagnification in the food chain, which is an essential pathway that Ecology is missing by using BCFs. For example, studies show that dietary uptake is associated with 98% of PCB bioaccumulation in Lake Michigan Lake Trout.[28] The EPA strongly recommends Ecology consider adopting final criteria that reflect the latest scientific information on bioaccumulation that the EPA used in its draft recommendations. If Ecology chooses not to use the latest scientific information on bioaccumulation, the EPA strongly recommends that Ecology provide a rationale for choosing not to integrate the latest science regarding bioaccumulation into its human health criteria.

H. Polychlorinated Biphenyls (PCBs)

For PCBs, Ecology proposed criteria that are the same as those currently in effect under the NTR (as revised in 1999): 0.00017 μg/L for both the criteria for water & organisms and organisms only. In developing the proposed criteria, Ecology used a chemical-specific cancer risk level of 4×10^{-5} or 0.00004, which exclusively applies to PCBs. Ecology states that it chose this cancer risk level for consistency with the level of risk in the toxicity factor that the Washington Department of Health uses to develop fish advisories for PCBs.[29] When Ecology used the 4×10^{-5} cancer risk level along with its other proposed inputs to calculate PCB criteria, the resulting criteria were less stringent than the currently effective 1999 NTR values. Therefore, the state proposed to adopt the 1999 NTR criteria for PCBs.

In general, the EPA does not support Ecology using a chemical-specific cancer risk level for PCBs. Instead, consistent with the EPA's comments related to the need for Ecology to evaluate potential risks to the tribes as a target general population in section B above, the state should calculate human health criteria for all carcinogenic pollutants, including PCBs, using a 10^{-6} cancer risk level.

The EPA recognizes that PCBs provide unique challenges due to the fact that they are pervasive, widespread, long-lasting, and difficult to detect. However, this does not warrant setting the

[28] Thomann R. V., and Connolly, J. P. 1984. Model of PCB in the Lake Michigan lake trout food chain, Environ. Sci. Technol., 18(2), 65-71.

[29] Department of Ecology. January 2015. *Washington State Water Quality Standards: Human Health Criteria and Implementation Tools. Overview of Key Decisions in Rule Amendment.* Page 39. https://fortress.wa.gov/ecy/publications/publications/1410058.pdf.

human health criteria at less stringent levels. Instead, the EPA would like to work with Ecology to further discuss PCBs and how they can be addressed through the state's implementation tools – such as variances – without adjusting the cancer risk level.

I. Arsenic

For arsenic, Ecology proposed to adopt a criterion of 10 µg/L, which is the Maximum Contaminant Level (MCL) for arsenic under the Safe Drinking Water Act. Ecology also proposed requirements relating to arsenic pollution minimization. Arsenic is the only pollutant for which Ecology proposed human health criteria less stringent than the values currently in effect under the NTR (0.018 µg/L for water & organism and 0.14 µg/L for organisms only).

The EPA recognizes that developing human health criteria for arsenic can be challenging, particularly because naturally occurring levels in Washington could exceed the EPA's recommended criteria. The EPA is willing to work with Ecology to explore options for deriving protective arsenic criteria that consider the special circumstances associated with natural levels of arsenic in Washington's waters. The EPA would also like to offer assistance in exploring how arsenic can be addressed using the state's revised implementation tools. However, at this point Ecology has not provided an adequate rationale to depart from its own decision to ensure the newly adopted criteria are no less stringent than the currently effective criteria under the NTR.

J. Methylmercury

Ecology decided to defer the adoption of human health criteria for methylmercury to allow for time to develop a comprehensive implementation plan in a future rulemaking. Therefore, the NTR human health criteria for total mercury would remain in effect for Washington. Ecology has not provided sufficient rationale for why the state is not considering the latest scientific information on methylmercury, beyond the difficulties anticipated in implementation.

In 2001, the EPA updated its 304(a) recommended methylmercury criterion for protection of human health after considering the latest science and data regarding health effects from intake of mercury and the primary routes of exposure. The 2001 methylmercury criterion is expressed as a fish tissue concentration and replaced the EPA's previous recommended water column concentration for total mercury.[30]

As part of the development of the EPA's 2001 recommended methylmercury criterion, the EPA reviewed the sources and forms of mercury that humans are exposed to when eating fish or consuming water from the nation's waters. The EPA found that humans are exposed primarily to methylmercury rather than to inorganic mercury, and the dominant exposure pathway is through consumption of contaminated fish and shellfish rather than from ambient water. The EPA found that a criterion addressing the potential health effects from methylmercury would protect humans from the most toxic form of mercury and the primary route of exposure. Thus, in considering the

[30] EPA. January 2001. *Water Quality Criterion for the Protection of Human Health: Methylmercury.* U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 823-R-01-001. http://water.epa.gov/scitech/swguidance/standards/criteria/health/upload/2009_01_15_criteria_methylmercury_mercury-criterion.pdf.

fate of mercury in the environment and available toxicological data, the EPA concluded that it is more appropriate to derive a water quality criterion for methylmercury rather than inorganic mercury. In addition, the data and science on methylmercury exposure, effects, and environmental fate supported the derivation of a fish tissue residue criterion.

The EPA strongly encourages Ecology to consider adoption of a methylmercury criterion using appropriate input parameters discussed above. Ideally, Ecology would consider adoption of this criterion in this rulemaking. However, if that is not feasible, the EPA recommends that Ecology provide a definitive timeframe for when it plans to adopt a methylmercury criterion.

Regarding implementation of a fish tissue criterion for methylmercury, the EPA published guidance in 2010 to assist states and tribes.[31] The EPA recognizes that there are unique challenges with implementing fish tissue criteria as opposed to water column criteria. The EPA recommends that Ecology consider the information available in the EPA's methylmercury criterion implementation guidance and would like to offer assistance in determining how best to implement a methylmercury fish tissue criterion in Washington.

K. Pollutant Scope

Ecology proposed human health criteria for all CWA Section 307(a) priority toxic pollutants, with the exception of methylmercury. The number of distinct pollutants in Ecology's proposal outnumbers the pollutants in the NTR because Ecology included additional priority pollutants for which the EPA developed 304(a) recommended criteria since last revising the NTR. The EPA also developed 304(a) recommendations for several non-priority pollutants, but Ecology did not propose to adopt criteria for any non-priority pollutants.

The EPA encourages Ecology to consider adopting human health criteria for the non-priority pollutants for which the EPA developed 304(a) recommendations. Although the state's existing narrative criterion for toxic pollutants at WAC 173-201A-240(1) provides coverage for these pollutants, the EPA recommends that states use numeric criteria instead of narrative criteria when available, consistent with 40 CFR 131.11(b). In the event Ecology has data or information suggesting that any of these pollutants do not warrant concern in Washington's waters, the EPA understands that Ecology could choose not to adopt human health criteria for those select non-priority pollutants.

L. Downstream Waters and Other Narrative Revisions

Ecology made several revisions to the provisions at WAC 173-201A-240, which provide background and organize the toxic substances section of Washington's WQS.

The EPA has no comments on Ecology's revisions to WAC 173-201A-240(3), (4), (5), and (5)(a). These revisions help clarify and organize the proposed rule.

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[31] EPA. April 2010. *Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion*. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 823-R-10-001. http://water.epa.gov/scitech/swguidance/standards/criteria/health/upload/mercury2010.pdf.

The EPA has specific comments on WAC 173-201A-240(5)(b). In general, the EPA supports Ecology's revisions to this provision, which explain the purpose of the criteria, criteria derivation, and the format of Table 240. However, the EPA would like to address the proposed language regarding protection of downstream waters in further detail.

Ecology proposed to add the following language:

"All waters shall maintain a level of water quality when entering downstream waters that provides for the attainment and maintenance of the water quality standards of those downstream waters, including the waters of another state."

This is consistent with the EPA's regulation at 40 CFR 131.10(b). In addition, EPA's 2014 guidance on Protection of Downstream Waters states that:

"Adoption of narrative criteria or numeric criteria (or both) that are protective of downstream waters are viable options under 40 CFR 131.10(b). States/tribes have discretion in choosing their preferred approach. The EPA expects that many states/tribes will consider using a combination of narrative and numeric criteria depending on their circumstances." [32]

However, the guidance also suggests that states and tribes can consider a more tailored and specific narrative criterion and/or a numeric criterion in certain situations, such as when more stringent numeric criteria are in place downstream and/or environmental justice issues are relevant.

As mentioned above, most of Washington's rivers are in the Columbia River basin and are, therefore, upstream of Oregon's portion of the Columbia River. In addition, the Columbia River creates most of the Washington–Oregon border. Since approximately 90% of WA's proposed human health criteria are higher than Oregon's EPA-approved criteria for the same pollutants, the EPA strongly encourages Ecology to consider adopting numeric criteria (either in addition to or instead of narrative criteria) that ensure the attainment and maintenance of Oregon's downstream WQS, or to provide additional rationale detailing how the use of a narrative downstream protection criterion alone will protect Oregon's more stringent WQS. For waters flowing into Oregon, criteria that are equally stringent or more stringent than Oregon's human health criteria would better ensure the attainment and maintenance of Oregon's downstream WQS consistent with 40 CFR 131.10(b). This aligns with the EPA's previous statements regarding a desire for regional consistency in human health criteria among Region 10 states.

In addition, as stated in the comments above on the cancer risk level, Ecology should not delete the language at WAC 173-201A-240(6), which pertains to protection from carcinogens at a one in one million cancer risk level.

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[32] EPA. June 2014. *Protection of Downstream Waters in Water Quality Standards: Frequently Asked Questions.* http://water.epa.gov/scitech/swguidance/standards/library/upload/downstream-faqs.pdf.

2. Implementation Tools and Definitions

Ecology proposed to revise procedures/authorizing provisions for two of the state's existing implementation tools (variances and compliance schedules) and added a new tool for intake credits. In addition, the state proposed to adopt a definition for each of these implementation tools at WAC 173-201A-020.

As mentioned in the cover letter to our comments, the EPA recognizes the importance of implementation tools in order to make progress toward improved water quality while accounting for the needs of those affected, such as industry and local municipalities. To that end, the EPA supports use of these tools particularly in instances where more stringent human health criteria would create difficulties for the regulated community.

Below are the EPA's comments on each of the implementation tools Ecology proposed to revise and adopt, to assist the state in ensuring the final implementation tools are approvable under CWA Section 303(c).

A. Variances (WAC 173-201A-420)

Ecology proposed to add a new definition at WAC 173-201A-020 to define variances and substantially revise the state's variance procedures at WAC 173-201A-420. The revised procedures establish minimum qualifications for granting variances for individual dischargers, stretches of waters, and multiple dischargers.

The EPA is in the process of specifying its federal requirements for variances.[33] Keeping in mind the regulatory revisions being considered, below are the EPA's comments on Ecology's revisions to the variance provision and definition of variance:

1. The EPA requests that Ecology clarify that the temporary modification referred to in the variance definition and revised provision is time-limited and does not replace the underlying WQS.

2. Ecology proposed to remove its current five-year term limit on variances. Instead, Ecology expects the timeframe of a variance not to exceed the term of the permit, except under certain circumstances. If a variance term is issued for more than five years, Ecology proposed that the Department will complete mandatory five-year reviews. In general, the EPA supports this revision to the timeframe for variances as it provides flexibility for situations where the term of a permit would not be a reasonable duration for a variance. The EPA will review each variance submittal from Ecology and consider the justification for the term of the variance when making CWA approval/disapproval decisions.

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[33] EPA. September 4, 2013. *Water Quality Standards Regulatory Clarifications; Proposed Rule (40 CFR Part 131).* Federal Register Vol. 78, No. 171. 54518-54546. http://www.gpo.gov/fdsys/pkg/FR-2013-09-04/pdf/2013-21140.pdf.

3. The EPA is supportive of Ecology's proposed language regarding public process, pollutant minimization plans, and conditions in which variances would be considered for renewal (as long as reasonable progress toward meeting the underlying WQS is being made), shortened, or terminated.

4. Ecology also proposed consideration of variances for individual dischargers, multiple dischargers, and waterbodies. The EPA anticipates working closely with the state, especially for multiple discharger variances or waterbody variances, to ensure that each variance meets all applicable federal requirements. The EPA suggests that Ecology review the EPA's FAQs on multiple discharger variances.[34]

5. The EPA requests that Ecology consider adding language into the variance authorizing provision that clearly articulates that any variance adopted by the state must identify the highest attainable condition and interim WQS applicable during the duration of the variance. Even if Ecology chooses not to include this language in its variance authorizing provision, the EPA still expects Ecology to specify this in any variances that it adopts and submits to the EPA.[35]

6. Once Ecology submits its final variance provision, the EPA will review the specified sections of Ecology's variance procedures as a "general policy" under 40 CFR 131.13 and will base its review on whether the procedure is consistent with the CWA and federal regulations. Ecology is still required to submit each individual variance to the EPA for review and action before it is effective for purposes of the CWA because the variances themselves are also WQS. Accordingly, each variance submitted for the EPA's review must include the Attorney General's certification and be consistent with the CWA and the EPA's implementing regulations, including all applicable public participation requirements. Thus, the EPA's review of Ecology's variance procedure need not evaluate each hypothetical variance the state could issue under this regulation and consider whether such a variance would be consistent with the CWA and the EPA's implementing regulation. If the EPA does approve Ecology's variance procedure, the EPA's approval would not be an automatic approval of any future variance the state wishes to grant.

B. Intake Credits (WAC 173-201A-460)

Ecology proposed to add a new provision at WAC 173-201A-460 and an associated definition at WAC 173-201A-020 that addresses situations where a pollutant that a facility discharges also exists in the facility's intake water. The proposed new language provides regulatory relief relative to National Pollutant Discharge Elimination System (NPDES) permit requirements for point sources that do not increase the mass of a background pollutant above their intake water

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[34] EPA. March 2013. *Discharger-specific Variances on a Broader Scale: Developing Credible Rationales for Variances that Apply to Multiple Dischargers. Frequently Asked Questions.* http://water.epa.gov/scitech/swguidance/standards/upload/Discharger-specific-Variances-on-a-Broader-Scale-Developing-Credible-Rationales-for-Variances-that-Apply-to-Multiple-Dischargers-Frequently-Asked-Questions.pdf.

[35] Id. Pages 6-7.

levels. This language is patterned after the language from the EPA's Great Lakes Initiative (GLI) as promulgated at 40 CFR 132, Appendix F, Procedure 5.D and 5.E.

1. Ecology's proposed language at WAC 173-201A-460(2)(a) parallels, in part, the GLI language. Specifically, the rule provides that water quality-based effluent limits (WQBELs) may be established "so there is no net addition of the pollutant in the discharge compared to the intake water" if certain specified conditions are met. This provision is similar to the GLI's "No Net Addition" (NNA), and the conditions are essentially parallel to those included in the GLI provision.

2. However, the GLI regulation also contained an additional intake credit provision (the "reasonable potential procedure"), which allowed the permitting authority to consider intake pollutants in determining whether the discharge had reasonable potential to cause or contribute to an excursion of the water quality criteria. Under the GLI, if the facility did not add any mass of the intake pollutant to its wastewater (e.g. use of intake water for once-through cooling), and met other specified conditions, the permit writer could find that there was no reasonable potential, and thus no WQBEL was required. It is not clear from the existing regulatory text whether Ecology intends to include such a "reasonable potential procedure." Ecology's language states "(t)he department may determine *if there is* [emphasis added] reasonable potential for the discharge," but does not explain how such a determination would be made, and specifically, whether and how intake pollutants would be considered in such determination. To the extent that Ecology intends to include such a provision, the EPA requests that the regulation clarify this by separating out the "reasonable potential procedure" (allowing consideration of intake pollutants in assessing reasonable potential) from the NNA provision (allowing the WQBEL to be set at the level of the intake pollutant).

The EPA does not consider this new implementation tool to be a WQS under CWA Section 303(c) since it is an NPDES permitting implementation provision.

C. Compliance Schedules (WAC 173-201A-510(4))

Ecology proposed to add a new definition at WAC 173-201A-020 to define compliance schedules and revise the compliance schedule authorizing provision at WAC 173-201A-510(4). This revised provision removes the specific time limit for compliance schedules and describes circumstances when a compliance schedule can go beyond the term of a permit and ensures that compliance is achieved as soon as possible. The Washington legislature directed Ecology to extend the maximum length of compliance schedules to more than 10 years when appropriate (RCW 90.48.605). Ecology also added language to describe the interaction with TMDLs.

The EPA considers Ecology's compliance schedule authorizing provision to be a WQS and, therefore, expects to take action on the revisions under CWA Section 303(c). However, unlike individual variances which must be approved by the EPA, the use of individual compliance schedules is not subject to the EPA's approval under CWA Section 303(c). The EPA maintains NPDES permit oversight to ensure that compliance schedules are implemented in a manner consistent with the CWA.

The EPA supports Ecology's new definition for compliance schedules. Below are the EPA's comments on Ecology's revisions to its compliance schedule provision:

1. The EPA requests that Ecology clarify that compliance schedules cannot be established for WQS themselves. Instead, compliance schedules can be authorized for WQBELs that are based on certain WQS.

2. The EPA compared the proposed provision to the language in federal regulations at 40 CFR 122.47(1), which requires "compliance as soon as possible...". Ecology's proposed provision retains language in its current provision, which requires compliance "in the shortest practicable time." By definition, the term "practicable" implies feasible or achievable; therefore, could be implemented in a manner less stringent than "possible." Ecology uses these terms interchangeably throughout the compliance schedule authorizing provision and supporting documentation. The EPA requests clarification to ensure the proposed provision language is as stringent as federal regulations.

3. The EPA acknowledges that Ecology proposed to replace its existing maximum compliance schedule duration of 10 years with language specifying that compliance schedules shall generally not exceed the term of the permit at WAC 173-201A-510(4)(d). This is consistent with applicable guidance[36] and applicable NPDES regulations so long as compliance schedules are authorized to meet a NPDES permit's WQBELs *as soon as possible.*

4. The EPA supports Ecology's decision to delete WAC 173-201A-510(4)(a)(v) from its existing compliance schedule provision. This language regarding "resolution of pending water quality standards issues" is inconsistent with the EPA's guidance and applicable law. In addition, the EPA supports the language Ecology proposed to add to WAC 173-201A-510 (4)(b)(iv). This language clarifies that compliance schedules can be issued for the completion of water quality studies only if such studies are related to implementation of permit requirements to meet WQBELs. Without this clarification, it was unclear if Ecology envisioned such studies to include support for a Use Attainability Analysis (UAA) or a site-specific criteria revision, which would be inconsistent with the EPA's guidance and applicable NPDES regulations.

5. Based on direction from the Washington Legislature, Ecology proposed language regarding how compliance schedules interact with TMDLs at WAC 173-201A-510(4)(e). This new language explains situations in which Ecology can determine a longer time period is needed to come into compliance with applicable WQS beyond the term of a NPDES permit. In any of these situations, the actions specified in the compliance schedule must be sufficient to achieve WQS *as soon as possible* according to WAC 173-201A-510(4)(e)(iv). This is consistent with the EPA's guidance and applicable NPDES regulations.

[36] EPA. May 10, 2007. *Compliance Schedules for Water Quality-Based Effluent Limitations in NPDES Permits.* Memorandum from James A. Hanlon, Director, Office of Wastewater Management. http://water.epa.gov/lawsregs/guidance/wetlands/upload/signed-hanlon-memo.pdf.

6. Lastly, the EPA acknowledges that Ecology constructed the compliance schedule provision to apply to aquatic life uses (WAC 173-201A-510(4)(a)(i)) and uses other than aquatic life (WAC 173-201A-510(4)(a)(ii)). If Ecology adopts this proposed rule language, the state can implement the compliance schedule authorizing provision upon the EPA's approval without ESA consultation for uses other than aquatic life.

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Comparison of Contemporary and Heritage Fish Consumption Rates in the Columbia River Basin

Barbara L. Harper · Deward E. Walker Jr

Abstract Fish consumption rates (e.g., pounds or grams per day (gpd), or meals per week) are used in a variety of regulatory processes such as setting water quality standards. Many Native American tribes eat more fish than the general population, especially in areas such as the Columbia River Basin, which was renowned for abundant fish. However, contemporary fish consumption rates are lower (i.e., they have been suppressed) than baseline heritage rates due to contamination, habitat degradation, loss of access, and legal and physical assault on tribal fishing. Nevertheless, traditional lifestyles are recognized and protected by intergovernmental treaties and/or aboriginal rights. The understanding of heritage rates is gaining importance as tribal cultures are reinvigorated, watersheds are restored, and understanding and respect for tribal lifeways improves. We compare the different methods used to derive Columbia Basin contemporary and heritage fish consumption rates. We highlight the need for caution in selecting a fish consumption rate until the derivation and context of the rate have been considered.

Keywords Fish consumption rates · Columbia Basin · Columbia River · Pacific Northwest · Native American Tribes · Statistical and ethnographic surveys

Introduction

The Clean Water Act, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and other environmental laws use information about how humans interact with the environment in order to protect human health from excessive risk due to contamination in abiotic and biotic natural resources (Grubbs and Wayland 2000; O'Neill 2013). Human dose and risk are estimated using information about (1) the amount of chemical contamination in the water, fish, or other resource and (2) the degree of humans' exposure to the resource (daily water ingestion, daily fish consumption, or other resource contact rates). General environmental contact rates, including fish consumption rates, are published by the United States Environmental Protection Agency (USEPA) in its Exposure Factors Handbook (USEPA 2011) for various activities (e.g., exercise, sleep, recreation, various types of work), various groups of people (e.g., adults or children), and various routes of exposure (e.g., ingestion, inhalation, or dermal contact) based on studies published in the scientific literature. These studies often evaluate specific aspects of the general U.S. lifestyle and can be based on large data sets. However, for lifestyles with little specific data, such as tribal subsistence lifestyles, entire exposure scenarios including traditional diets must be constructed through original research and/or extrapolation (Harper *et al.* 2007, 2012).

One of the key exposure pathways for Native American and Alaskan Native fishing people is fish consumption. Fish intake is the primary route of exposure to several toxic contaminants, including PCBs and mercury. The primary input parameter for evaluating fish-based human health risk is a daily fish consumption rate. Under the Clean Water Act, USEPA guidance recommends that states and tribes base their water quality criteria first on local data regarding fish consumption practices; second, on data reflecting similar geography or population groups; third, on states' or tribes' own analysis of national data; and, lastly, on the USEPA's national default values (USEPA 2000; California OEHHA 2001).

USEPA's guidance on protecting human health and using fish consumption rates is inconsistent; its national default

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values are generally premised on protecting the 90th percentile (USEPA 2000, 2004a; WA State 2009), the 95th percentile (USEPA 2011: Ch. 10), or the 99th percentile (USEPA 2013a) of an exposure distribution. However, under the Clean Water Act USEPA recommends using average fish consumption rates as defaults (USEPA 2000, 2002:32) rather than upper percentiles. USEPA recommends 17.5 g/day for the general public and sport anglers, and 142.4 g/day for subsistence fishers, "which falls within the range of [contemporary] averages for this group" (USEPA 2000:I-13)

The Concept of Heritage Fish Consumption Rates

In addition to the inconsistency of using average or upper percentiles of contemporary fish consumption the USEPA also fails to distinguish between contemporary and heritage rates. The initial methodology for obtaining fish consumption local data was published as a guide for conducting contemporary fish consumption surveys (USEPA 1989, 1992, 1998) that assumes the only desired information is how much fish people might be eating at the time. Current studies on tribal fish consumption often follow this guide even if they recognize that the baseline fish consumption rate is culturally important and higher than at present (Shilling *et al*. 2014). It is clear that this approach oversimplifies the issue and fails to capture information about fish consumption rates that are more relevant to many tribes, namely, heritage or rights-based rates.

In this paper the term 'heritage fish consumption rates' refers to traditional (baseline) tribal fish consumption rates. The concept of the heritage rate has been confirmed as a Treaty-reserved rate for federally recognized Oregon and Washington Tribes through many court cases (Ulrich 1999; O'Neill 2013). The primary cases are (1) *Boldt:* United States v. Washington, 384 F. Supp. 312 (commonly referred to as the "Boldt decision," after its author, Judge George Boldt); (2) *Rafeedie:* United States v. Washington, 873 F. Supp. 1422 (commonly referred to as the "Rafeedie decision," after its author, Judge Edward Rafeedie); (3) *culverts:* Order on Cross-Motions for Summary Judgment, United States v. Washington, 2007 WL 2437166, and (4) Sohappy v. Smith, 302 F. Supp. 899, among others.

Because these rates were codified in treaties between Pacific Northwest Indian Nations and the United States and affirmed in court cases, they are also referred to as rights-based fish consumption rates, both treaty-based and aboriginal. For this paper, the focus of heritage rate data is on the relatively short time between explorer contact and the signing of treaties (1800–1855), although evidence that indigenous populations relied on salmon for many thousand years prior to this is also summarized. The treaties in the lower Columbia Basin were signed in 1855, and established to right to fish for subsistence.

While the data on heritage rates are derived from over a century of information, heritage rates should not be thought of as "historic" because this implies that no one still eats (or wants to eat) at those rates and that they are not relevant to today's regulatory decision processes. On the contrary, the existence of physical or chemical impediments to spawning does not diminish the underlying treaty right, and the right to eat at a heritage rate is still reserved to all citizens of tribes that signed various treaties. In addition, many tribal fisheries programs are making progress in habitat improvement and dam removal, which is increasing run size in some areas (e.g., the Elwha River and the Umatilla River). Further, many tribal health programs are recommending healthier (i.e., more traditional) diets that often include or are based on heritage fish consumption rates.

Although many tribes eat more fish than the general population, a great deal of data shows that contemporary fish consumption rates are nevertheless suppressed from the traditional 'baseline' fish consumption rates (i.e., the amount of fish that would be consumed if fish were clean, available, and accessible). Suppression can be caused by contamination (advisories), loss of access to fishing sites, and reduced fish populations due to habitat degradation, dams, and land development (Donatuto and Harper 2008; O'Neil 2000). Thus, surveys of contemporary fish consumption rates may only confirm that fisheries are currently impaired or that people are heeding any applicable fish advisories.

The number of tribal members able to obtain the full amount of fish has steadily diminished over time and with the construction of dams. However, the right to eat heritage amounts of fish extends to all members of a tribe even if current circumstances prevent many people from doing so. In fact, some tribal members still have access to adequate numbers of fish and still eat close to heritage rates, particularly as fisheries are improved.

It is clear that setting water quality standards using contemporary suppressed fish consumption rates fails to protect traditional fishing practices, to improve water quality, or to reduce contamination enough to enable tribes to safely eat traditional amounts of fish (Wendee 2013). There are many policy questions that arise because current environmental, social, or infrastructure conditions may not support an original baseline quantity of fish. Identifying the heritage treaty-based baseline fish consumption is a separate question from addressing all the ancillary issues involved in recovering fisheries by removing dams, improving habitat, establishing hatcheries, removing legal obstacles to fishing access, cleaning watersheds so fish advisories are not necessary, and changing laws and regulations. This paper summarizes and compares heritage and contemporary rates and empirically determines the original heritage rate, but does not make any policy recommendations.

Applications of Contemporary and Heritage Fish Consumption Rates

Methodology to quantify fish consumption rates includes contemporary statistical surveys and contemporary ethnography to ascertain contemporary rates, and multiple lines of evidence to ascertain heritage rates. Each method has its own utility in describing different aspects of contemporary or heritage fish consumption rates. The differences in methods and results underscore the need to define the consumption question carefully so the most appropriate method is chosen (Table 1).

Table 1 Range of fish consumption rates relevant to the Pacific Northwest

Amount (gpd)	Derivation
4	Estimated contemporary average from the Colville survey (Westat 2012)
6.5	Prior USEPA default national average used in the Clean Water Act; still the basis for many state water quality standards.
17.5	Current USEPA default national average recommended for developing water quality standards.
48.6	FDA recommends two 6-ounce meals per week
63.7	Contemporary 4-tribe average, all finfish, consumers only (CRITFC 2004)
82, 84	Contemporary means, all fish, Tulalip and Squaxin Tribes (Puget Sound, including marine species) (Toy *et al.* 1996)
117	Contemporary mean, Asian and Pacific Islanders (Sechena *et al.* 2003). Reanalyzed by WA Ecology (2013) as 74 gpd.
142.4	USEPA recommendation for subsistence fishing
175	Oregon water quality standards
214	Contemporary mean, Suquamish Tribe, all fish including marine species (The Suquamish Tribe 2000)
389	CTUIR water quality standards; 99th percentile of the CRITFC (2004) survey.
454	Frequent response to the general question of how much fish Tribes consider to be a cutoff between contemporary and heritage rates, based on 1 pound per day.
540	Harris and Harper (1997) average from a survey of contemporary subset of 35 CTUIR traditional tribal fishermen.
620	Boldt decision, 500 pounds per capita per year, Columbia Basin salmonid average (Treaty right)
725	Walker (1985) estimate of average Columbia Basin heritage rate (583 pounds per capita per year)
865	Spokane Tribe water quality standards; heritage rate

1. In the CERCLA (or Superfund) process at contaminated sites, a baseline human health risk assessment (BHHRA) is performed to understand what the human health risk is, or would be, if people used the resources as if they were uncontaminated (i.e., assuming that there are no restrictions on resource use) to justify taking a remedial action. The exposure scenarios used in these assessments are designed to reflect Reasonable Maximum Exposures (RME), a concept that helps define the percentile within an exposed population that is to be used in remedy selection. At sites where tribes use the natural resources, a logical RME would be based on a Tribal exposure scenario, including a heritage fish consumption rate. Using the heritage rate would result in more protective cleanup goals.
2. The CWA includes provisions for setting prospective or aspirational standards to improve water quality, thereby making fish safer to consume, including at healthful levels of fish intake (O'Neil 2000). For the general population, an obvious rate might be equivalent to the recommended two 6-ounce fish meals per week (48.6 gpd, USFDA 2004; USEPA 2004b). For tribes, fish consumption rates might range from a default such as 17.5 gpd, a rate such as 175 gpd as an intermediate rate, or full baseline rates. Knowing the baseline heritage fish consumption rates (i.e., unrestricted or unsuppressed heritage rates) allows tribes, regulators, and the public to track incremental progress toward an ultimate goal.
3. Superfund cleanups generally have a single opportunity to develop a remedy that permanently cleans a site in order to regain unrestricted access and unlimited use, although 5-year reviews provide an opportunity for continued remediation. CERCLA 5-year review criteria include a goal of "unlimited use and unrestricted access" (UU/UA), meaning that there are no restrictions placed on the use of land or other natural resources (USEPA 2003). Information about baseline/heritage resource use, including fish consumption rates, can be used to define UU/UA for a site or region.
4. After CERCLA defines and implements a remedy to reduce contamination and risk, the Natural Resource Damage Assessment (NRDA) process addresses final restoration of the natural resources and the human uses of those resources. In cases where a fishery has been injured, knowing the baseline/heritage fish consumption rate supports the NRDA process by establishing a standard to which the resources and their ecosystem services should be restored. This information can also be used during watershed restoration, dam removal, sediment remediation, and similar situations.
5. Contemporary fish consumption rates are required to understand current risks based on current fish consumption and contamination rates in order to design immediate

intervention strategies such as fish advisories. Although such a snapshot of contemporary intake and the resulting risks is sometimes mislabeled as a "baseline" exposure assessment, it is more accurate and helpful to reserve the term "baseline" for the fish consumption rates provided in an environment that is not degraded. Baseline is the condition to which resource quality should return. In this paper, contemporary conditions are not considered to be 'baseline' unless the resource is un-degraded or uncontaminated. This is a key distinction in setting environmental standards – is the goal to regain a higher environmental quality, or to maintain the status quo?

6. Contemporary fish consumption rates can help identify representative fish consumption rates for contemporary high-end consumers such as tribal peoples who are engaged in traditional subsistence practices. This information might be desired for cultural education, policy development, or research design.
7. Contemporary fish consumption rates can support exposure science and/or ecological research. For example, current fish consumption rates may be needed to develop or validate foodchain models by providing data used to compare uptake models to actual biotic and human exposure data (e.g., tracing Hg from the water and sediment through to foodchain and validating the model with human hair data). An accurate real-time fish consumption rate is required for the last step. Environmental epidemiology also requires information about contemporary fish consumption, such as tracking foodborne illness, evaluating health effects of environmental contaminants, or developing nutritional recommendations.

The framework presented above is not always followed in regulatory contexts. For example, federal and state water quality standards generally use contemporary fish consumption data, although this need not be the case. The water quality standards for the Spokane Tribe of Indians are based on the heritage rate (Harper *et al*. 2002); they are the first tribe to adopt this standard. The USEPA states that "The EPA is approving the majority of the Tribe's revised human health criteria because the methodology used by the Tribe to develop the fish consumption rate, and other variables used in developing the criteria, are scientifically sound and sufficient to protect designated uses, which are designed to protect fish consumption and drinking water rates characteristic of the traditional Spokane lifestyle" (USEPA 2013b). At the time of writing (2014), the Penobscot Nation in Maine is also proposing to use a heritage fish and other aquatic organisms consumption rate of 286 gpd for development of water quality standards.

Survey Methods and Columbia Basin Data

This paper compares the methods used to ascertain contemporary and heritage fish consumption rates; the data for the heritage rates is described in more detail in a companion paper (Walker and Harper this issue). The following section describes methods for obtaining contemporary fish consumption data.

Contemporary Statistical Surveys

Statistical surveys are used to obtain averages and percentiles within an existing defined population. Federal and state agencies have developed guidelines reflecting technical literature that has increasingly recognized the need for culturally appropriate methods needed to derive culture-specific information (USEPA 1989, 1992, 1998; WA State 2013).

Within a tribal population, participants in a statistical survey can be a random cross-section of the entire tribal population (e.g., drawn from enrollment or clinic lists), or a targeted subpopulation (e.g., elders or children with asthma or traditional fishermen). There are many well-recognized difficulties in defining and selecting tribal subpopulations, obtaining trust and participation, and interpreting results (Donatuto and Harper 2008) that apply to both statistical and ethnographic survey approaches.

Statistical surveys often use computer-based questionnaires to solicit information about catch rates (e.g., creel or fishing license surveys) or consumption rates (e.g., dietary history, food frequency questionnaires, or dietary recall surveys) administered by telephone, mail, or interview (Ferro-Luzzi nd.; Block 1982; Bingham *et al*. 1994; Moya 2004). These methods have been validated in various types of populations using multiple methods to correct for the well-recognized and systematic under- and over-reporting of different components of diet (Usher and Wenzel 1987; Kroke *et al*. 1999; Black *et al*. 2000; Tooze et al. 2006; Thompson and Subar 2008; Vucic *et al*. 2009). For validation, dietary surveys can also include food models, diaries, weighing actual food, nutritional analysis of the actual food, measuring or estimating personal energy expenditures, excretory and metabolite analysis, and other methods.

Statistical surveys can be difficult to administer and validate in indigenous populations, particularly in cases where the people continue to use large parts of their traditional territory for subsistence (Wolfe and Walker 1987; Berkes 1990; Berkes *et al*. 1995). Native harvest data are normally obtained by recall survey rather than direct observation, raising typical issues of species identification, precision and uniformity of survey parameters and interview terminology, sampling procedures, non-response bias, and response bias. Most estimates of the fish harvest of northern Native Canadians (Berkes 1990), for example, are recent and were carried out in connection with development proposals, or arose from conflicts between subsistence and commercial use of valuable salmon species (Berkes 1979, 1983; Hopper and Power 1991; Johnson *et al*. 2009). Nobman *et al.* conducted a large dietary survey of Alaska Natives using a food frequency questionnaire validated with 24-h recall interviews, clinical interviews, and food models. Their study documented the amount of different foods eaten differed by age groups within each gender, illustrating a real variability that would have been masked if only the group mean had been determined. Individual tribes also regulate their own harvests and typically work with states to set annual catch limits based on the size of annual runs, although it is problematic to extrapolate this information into fish consumption rates for individuals.

Medical and nutritional studies have provided additional information on Native harvests by documenting what people actually eat. Methods such as keeping personal dietary records are possible, although they are data-intensive and difficult to sustain in the field (e.g., at hunting or fishing camps, or on traditional gathering trips). Personal dietary records can include checklists for individual species and methods of preparation that are specific to a particular population, but are subject to issues with species identification. For example, there are several important roots in the *Lomatium* genus in the Columbia Basin that have different Native names but are not well-speciated by Linnaean classification (Hunn and French 1980), and fish and other animal species may be grouped in Native classification systems according to the role they play in Native diet and culture (Hunn 1980, 1981), rather than by Euroamerican genus and species. Thus, investigators and community members may need to come to an agreement on identification of the particular species of plants and animals consumed (common name, Latin or Linnaean name, and/or native language name), although some of this information may be considered proprietary and names can even vary among individual tribal dialects (e.g., among 15 Sahaptin dialects, Hunn 1980).

One comprehensive contemporary survey has been conducted in the Columbia Basin. During the fall and winter of 1991–1992, the Columbia River Inter-Tribal Fish Commission (CRITFC) surveyed fish consumption among four Native American tribes that reside in the middle Columbia River Basin on or near the Yakama, Warm Springs, Umatilla, or Nez Perce Reservations (CRITFC 1994) (for a summary see Washington State Department of Ecology 2013). A random sampling of fish consumption was conducted using respondents selected from patient registration files of the Indian Health Service. The survey questionnaire included a 24-h dietary recall and questions regarding seasonal and annual fish consumption. Food models were used to help respondents estimate the amounts of fish consumed. The mean fish (all finfish) consumption rate for all surveyed tribal adults (consumers and non-consumers) throughout the year was 58.7 gpd. Excluding non-consumers of fish (7 % of the surveyed adults), the mean fish consumption rate for surveyed tribal adult fish consumers was 63.7 gpd. The 95th percentile was 170 gpd and the 99th percentile was 389 gpd.

Perhaps the largest weakness with statistical surveys is that they imply a definitive answer about "what Tribes eat" and a precision about the surveyed population that may not always be warranted or accurate. This is particularly true for indigenous populations. Donatuto and Harper (2008) described problems in conventional fish consumption survey methods used in widely cited tribal fish consumption reports, including the CRITFC survey. A random sampling technique is employed in most of the surveys to capture a statistical mean. This is appropriate to answer some study questions; however, random sampling through the use of enrollment records may produce flawed results because many people, and especially traditional consumers and elders, are transient even within a reservation or simply wish to remain invisible. This may result in an effective oversampling of the low consumers, creating a downward bias. In addition, outlier data are sometimes eliminated or recoded based on the assumption that the respondents are mistaken about how much fish they eat. Yet traditional subsistence consumers, who represent the highest reported rates, are acutely aware of how much subsistence food they eat and, conversely, how much they are currently prevented from eating (Donatuto and Harper 2008). In the CRITFC survey, for example, the data points for the highest consumers were simply eliminated during compilation, in accordance with statistical convention. It was not recognized that these data points might be accurate, or that these people might represent subsistence fishers.

Within the Confederated Umatilla Tribes, a subset of 35 traditional consumers who adhere more closely to traditional subsistence practices such as harvesting and preparing their own food was surveyed shortly after the CRITFC study and found to consume an average of approximately 540 gpd (Harris and Harper 1997; see below). These results support the suggestion that there may be a definable group of high-consumers following specific traditional lifeways that can be evaluated separately. Simply asking "how much do Tribes eat?" misses the richness of tribal culture even when the purpose of the study is to document contemporary consumption rates.

A large survey of natural resource use was recently completed on the Confederated Tribes of the Colville Reservation (Westat 2012) as part of the investigation related to the Upper Columbia River Superfund site. The Colville Tribe is located along the Columbia River, above Grand Coulee Dam in the northern Columbia Basin. Prior to the construction of the dam, the Colville Tribe had access to the large Kettle Falls fishery. There is a fish advisory for this segment of the Columbia River, known as Lake Roosevelt (Lake Roosevelt Forum 2012).

At the time of the survey (2010–2011), 4783 residents in 1784 households comprised the list of eligible participants (49 % of people living on the reservation were enrolled Colville Tribe members and 51 % were non-enrolled or non-native). From this list, a subset of 2645 people was selected as the target population, with oversampling of "heavy consumers" (undefined, comprising 51 % of the participants) and children, and 1165 people completed the survey process.

Three different types of survey instruments were administered to the Colville survey participants. Two of these focused exclusively on food consumption. A standard USDA interviewer-administered 24-h dietary-recall questionnaire using computer-assisted personal interviewing techniques was customized to include an additional 57 local and indigenous foods. The survey was administered multiple times (up to four) over the data collection period in order to capture seasonal variability in food consumption, although the majority of participants completed only two surveys over the course of a year. Another survey instrument, the Food Questionnaire (FQ), was developed specifically for this survey and included less frequently consumed foods consumed during the previous 12 months, asking where each food was obtained. Food models (plastic replicas) were also used. The third survey instrument, the Resource Use Profile questionnaire, was designed to collect data about non-dietary local practices.

The 1165 participants completed at least two 24-h recall surveys plus the FQ, for a total of 5469 interviews. Of the 1165 respondents, 83 % ate fish at least once during the previous year and 73 % reported eating salmon or kokanee[1] at least once during the 12 months prior to completion of the FQ, 46 % reported eating trout/steelhead, 13 % report consuming walleye, and 11 % reported consuming smallmouth bass. On average, each salmon consumer ate salmon/kokanee 15 times per year, trout 13 times per year, walleye nine times per year, and smallmouth bass 21 times per year. Overall, about half of the respondents, including non-consumers, ate fish once a month or less; those who ate fish more regularly were considered "heavy consumers." These data included repeat sampling (three to five per individual), so they cannot be used to directly calculate fish consumption rates. The average portion size (actually, the amount of fish consumed on a 'fish day' including the potential for more than one meal) was 126 g and the 90th percentile for serving size was 405 g (10.9 oz) to 637 g (22.4 oz) for non-enrolled and enrolled residents, respectively. Thus, the average resident of the Colville Reservation, including non-consumers, eats fish at a rate of around 4 gpd (12 meals month × 126 g/portion). Those who eat fish more frequently and in larger amounts might eat fish on 58 days per year (adding the meal frequency of the top four species), for a total of 63 gpd (58 meals at 405 gpd) to 101 gpd (58 fish days at 637 gpd). Since there is a fish advisory for eating different amounts of various species, the results may reflect adherence to the advisory; however, the potential cumulative health effects if all species were eaten at their recommended rates is not discussed.

Comparing the Umatilla (Harris and Harper 1997) and the Colville (Westat 2012) studies illustrates several points. The Umatilla study targeted traditional tribal fishing families because the goal was to document how much fish this subset of tribal members consumes today, while the Colville study goal was to document cross-sectional averages and ranges rather than a specific segment of the Indian and non-Indian reservation residents. Secondly, the Umatilla survey used a guided conversational ethnographic approach (see below) while the Colville study used a highly statistical approach. Third, the Umatilla study location is on the lower Columbia River where salmon runs still exist, while the Colville study location was primarily above Grand Coulee Dam, which blocked all anadromous salmon runs to the upper Columbia River. Thus, the study goals were quite different, the methods were different, and the results were very different. However both studies have been termed "contemporary tribal studies," and both purport to answer the question "how much fish do tribes eat?" Unless the different study goals, location, context, and methods are recognized, an unwary reader might conclude that upper Columbia River Tribes do not eat fish by choice or circumstance, and therefore water quality standards can be based on inappropriately low fish consumption rates.

Ethnographic Surveys

A suite of methods for collecting contemporary ethnographic data and eliciting expert information to investigate specific research questions has been developed over time (Winterhalder 1981; Meyer and Booker 1991; Hora 1992; Riley *et al*. 2006; O'Reilly 2012; Schensul and LeCompte 2012). Ethnographic methods are structured and systematic ways of gathering data but are more conversational and therefore more suitable than computer-based tools for certain types of communities such as indigenous communities who hold and employ traditional environmental knowledge (Berkes *et al*. 2000; Satterfield *et al*. 2000; Turner *et al*. 2000; Cochran *et al*. 2008; Donatuto *et al*. 2011), and who may prefer to communicate via oral history, conversation, and demonstrations. Ethnographic methods can seek the same general information as computer-based questionnaires to obtain numerical data, as well as broader narrative information.

Traditional ecological knowledge (TEK) represents direct human contact with the environment over thousands of years

[1] Kokanee are land-locked sockeye salmon that live their entire lives above the Grand Coulee dam and never have an ocean phase. The average size of kokanee at maturity is 9–12" long and 0.5 to 1 lb. http://www.fins1.com/kokanee.htm; http://www.env.gov.bc.ca/wld/documents/fishfacts/kokanee.pdf; http://fishandgame.idaho.gov/public/fish/?getPage=85; http://www.spokesman.com/stories/2013/apr/11/2013-is-year-of-the-kokanee-for-area-anglers/ Last accessed 10/20/14.

(Berkes 1983). It is both practical and abstract (Berkes *et al.* 2000) and is based on long and detailed observation of natural processes that systematically builds a working knowledge of the ecology and the interaction of ecological components, including people, that is taught as natural law in indigenous communities. TEK has a growing role in environmental management (Berkes *et al.* 2000) and in international law and policy (Mauro and Hardison 2000).

Within the southern Columbia Plateau, three ethnographic studies have examined traditional fish consumption rates in contemporary settings. Hunn and Bruneau (1989) estimated contemporary but traditional dietary intakes for the periods 1944–1947 (pre-dam) and 1964–1966 (post-dam). They developed percentages of resources in the diet, based on a traditional fish consumption rate of 500 lbs/year for "river Yakima" (those traditional families of the Yakama Nation who retained residence and fishing sites on and near the Columbia River) and 400 lbs/year for the Nez Perce. They estimated that the fisheries had already been about half degraded by the 1940s, but traditional families still had access to traditional fishing sites.

Walker and Pritchard (1999) estimated radiation doses to Yakama tribal fishermen from the releases of radioactivity from the Hanford nuclear site into the Columbia River from the 1940s through the 1960s, based on interviews, maps, and fish consumption rates for the relevant time periods (rates adjusted from Hewes 1947, 1973; Hunn and Bruneau 1989; Harris and Harper 1997; Walker 1997).

Harris and Harper (1997) used ethnographic narrative surveys and interviews (conducted by Harris, a scientist and enrolled CTUIR[2] tribal member) to gather input from 35 traditional CTUIR tribal members and tribal fishermen about activities, seasonal patterns, diets, and other lifestyle elements that are important for preserving the traditional cultural-religious way of life. The interviewees indicated that their responses were more accurate than if they had been asked by nonmembers or non-Native tribal employees or even by other tribal members, and were more accurate than the answers they had provided during the CRITFC survey. Reasons given by the respondents included lack of trust, uncertainty whether information about high rates of fishing would be used to prosecute fishermen, a general reticence to provide traditional information, and a general concern whether an honest answer would indicate they were eating too much or too little fish. For example, some tribal members knowingly eat contaminated fish in order to preserve their treaty rights and because it is part of their religion, yet they are blamed for any resulting adverse health effects.

Cross-cultural relationships require time and effort on the part of the investigator, and this even extends to investigations within the same culture such as research conducted by tribal scientists within their own tribe. In general, any data obtained from communities, and from tribes in particular, may be inaccurate due to mistrust, lack of understanding on both sides (e.g., about goals, terminology, local mores, or local means of communication), a history of misuse of information or lack of promised follow-though, or simple failure to obtain the consent of the informants. However, if trust is built, ethnographic methods can provide more accurate information than other types of surveys including statistical surveys.

We suggest that USEPA and other regulatory agencies consider ethnographic methods as part of the best-practice tools to develop complete and relevant information in indigenous communities (USEPA SAB 2014). While both ethnographic and statistical approaches can be well designed and rigorous and thus be of high quality, USEPA should consider the merits and quality of non-statistical approaches. While statistical data can appear more precise, they can in fact be less accurate if inadequate attention is paid to clarifying objectives and to questionnaire design.

Heritage Rates in the Columbia Basin

When Lewis and Clark explored the region in the early nineteenth century, the Columbia and its tributaries provided 12, 935 miles of river habitat (Craig and Hacker 1940). It is well established that conditions in the Pacific Northwest supported a resilient and sustainable fish-based way of life (Trosper 2002). For thousands of years, and continuing into the living memory of current tribal members, the Columbia Basin has been extremely productive and has supported large populations of people who relied on or included fish in their diets.

Because fish consumption rates are currently suppressed, heritage rates cannot be determined by asking people what they eat today except in areas such as circumpolar regions where most or all nutrition is obtained directly from the environment. Rather, multiple lines of evidence must be evaluated in order to develop a numerical heritage rate. This evidence comes from a wide range of older ethnographic studies, ethnohistory, archaeology, food sale and purchase records, ecological history, oral history, and data about nutrition, paleomedicine, isotope analysis, and DNA analysis. Results can be confirmed with contemporary interviews to ascertain general validity on a qualitative basis.

In the Pacific Northwest, earlier abundance and distribution of salmonid species within the Columbia Basin and ethnographic, ethnohistorical, archaeological, geologic, and biological data on the ecology, harvest, use, and consumption of these species is well established. Ethnohistoric data include journals and diaries of early explorers, traders, missionaries, settlers, artists, photographers, as well as information obtained from the indigenous inhabitants. These accounts extend from the earliest contact through the period immediately before the

[2] Confederated Tribes of the Umatilla Indian Reservation.

major impacts resulting from European contact, and further into the mid-twentieth century (Walker 1967; Northwest Power Planning Council (NPPC) 1986; Schalk 1986; Boyd 1996; Trosper 2002).

There is general consensus that fish, particularly salmon, formed from one-third to one-half of the food supply of Columbia Basin tribes until and even beyond the construction of the Columbia River dams (Walker 1967; Anastasio 1985; Hunn 1981, 1990; Hewes 1998). Before the dams were constructed, full heritage amounts of fish were widely available; after construction and during the era when people were forced off the river at gunpoint, fewer people had access to large amounts of fish, but some still did (and still do). This situation has improved to some degree since the right to obtain fish was adjudicated and since watershed and habitat improvements have been made, hatcheries constructed, research supporting salmon recovery pursued, and dam operations modified. Salmon and steelhead were major staples eaten fresh for as much as 6 months of the year and dried or smoked for the lean winter months. Many authors, starting with Lewis and Clark (Thwaites 1905) have estimated Columbia River fish harvest and consumption.

The earliest fish catch and consumption estimates were developed by Craig and Hacker (1940) and Hewes (1947, 1973). There is currently agreement that Hewes' original total harvest estimates were too low (Walker 1967, 1968; Walker 1985 as cited in Scholz *et al.* 1985; Hunn 1981, 1990; NPPC 1986; Schalk 1986; Schalk 1977).

In 1974, Judge George Boldt reaffirmed the right of most Washington tribes to act as "co-manager" of salmon alongside the State, and continue to harvest them (*United States v. Washington,* 384 F. Supp. 312). Based on the testimony of 49 experts and tribal members, the court cited 500 lbs per capita as a reasonable number for salmon consumption on the Columbia River (in addition to recognizing that resident species were eaten as well). Later, Walker (1985, 1993a, 1993b, 2010) examined available data and concluded that the Columbia Plateau fish consumption range was between 365 lbs and 800 lbs. per capita with the annual average close to 583 lbs (725 gpd); Scholz *et al.* (1985:77) agree that this is the most accurate estimate. While the USEPA recommendation of 142.4 gpd for subsistence fishing may be suitable for inland freshwater areas, it is clearly too low for west coast salmon rivers.

Discussion

The heritage fish consumption rates for tribes located within the Columbia River watershed are one to two orders of magnitude higher than contemporary averages (Fig. 1 and Table 1). Originally, the heritage rate was available to everyone; at present the heritage rate is available to few tribal members, depending on local environmental conditions, presence of dams, membership in a fishing family, access to fishing sites, ability to devote adequate time to fishing within state-regulated seasons, and other factors. This does not mean that heritage rates are no longer relevant or possible; they fluctuate within tribes and within families, and are the subject of many efforts to repair fisheries, practice indigenous cultural and

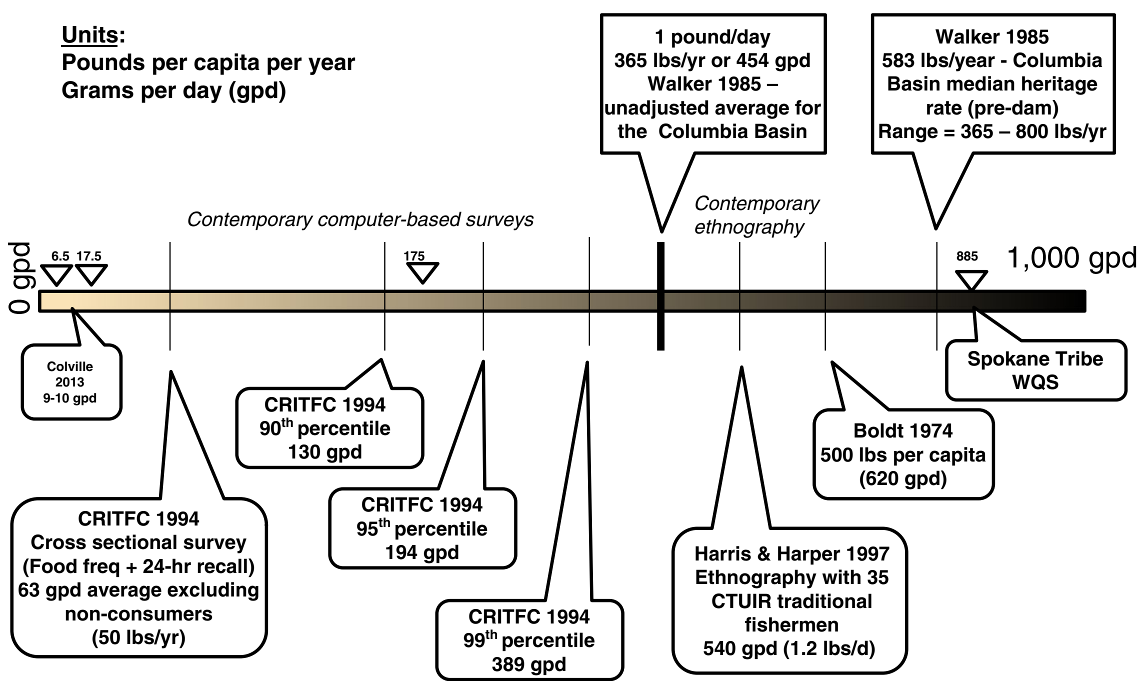

Fig. 1 Columbia Basin fish consumption rates

religious lifestyles, exercise Treaty-reserved rights, and improve diets.

As acknowledged by USEPA in the letter approving the Spokane Tribe's standards, the methodology for using multiple lines of evidence, including ethnographic methods to determine heritage rates are valid and protective of the Spokane Tribe's traditional lifestyle. For contemporary studies, methods include (a) dietary recall and food frequency questionnaires (e.g., the CRITFC and Colville studies) and (b) contemporary ethnography combined with other relevant data (Walker 1985; Harris and Harper 1997). These methods can lead to quite different conclusions. Using dietary recall and food frequency questionnaires, the contemporary average consumption rate of the CRITFC Tribes is 63.7 gpd. However, using ethnographic methods, Harris and Harper (1997) found that traditional CTUIR fishermen still eat 540 gpd. The contemporary CRITFC cross-sectional average is roughly ten times lower than the amount eaten by contemporary traditional fishermen, while the latter is closer to the adjudicated rate of 620 gpd based on the Boldt decision and the 725–1000 gpd estimated by Walker (1985). The 99th percentile of contemporary consumption (389 gpd) measured in the CRITFC study is still less than the lower boundary of the documented range of traditional fish consumption (roughly 454 gpd or 1 lb/day). Similarly, the contemporary average for the residents of the Colville reservation, half of whom were considered to be high consumers, was very low compared to the heritage rate of 800–1200 gpd (Walker 1985) as estimated for upper Columbia River tribes. Thus, while statistical methods can give the appearance of precision, they do not accurately measure either the heritage rate or, we argue, the rate for traditional contemporary fishermen.

Fish consumption rates used in regulatory settings by states or USEPA range from 6.5 gpd (100 times lower than the heritage rate), 17.5 gpd (the current USEPA recommendation), to 175 gpd (Oregon, USEPA 2014), and other numbers in between. Although 175 gpd is much more protective of tribal health than the lower rates, it is not a heritage or full rights-based rate. The Spokane Tribe's water quality standards have recently been approved by USEPA using their heritage fish consumption rate of 865 gpd, making them the only tribe thus far to use a full heritage rate. It is a matter of science to determine fish consumption rates, and a matter of policy to choose the rate on which to base water quality standards, or which segment of the overall population to protect or fail to protect.

Our review describes the range of traditional fish consumption rates that provides general estimates that are reasonable, supportable, and already adjudicated. Additionally, catch estimates have been used by the federal government and the courts to calculate the amount of salmon lost to the tribes due to dam construction. While localized fish consumption rates can vary by local habitat (e.g., Columbia River mainstem, or major and minor tributaries), our review supports Walker's estimate of 583 lbs per capita per year (725 gpd) and the Boldt decision value of 500 lbs per year (620 gpd) as reasonable and supportable fish consumption rates. Further considerations would be whether to use a salmon-only or an all-fish (or finfish plus shellfish) value, and whether the particular application requires a basin-wide average or a tribe-specific value that might require additional intensive research.

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Columbia Basin Heritage Fish Consumption Rates

Barbara L. Harper · Deward E. Walker Jr.

Abstract The distinction between contemporary Native American fish consumption rates and original baseline heritage rates is important as heritage rates have long been recognized as a baseline relevant to the fishing tribes of the Pacific Northwest, and are generally protected by Treaties and case law. This paper reviews two approaches to accurately defining heritage fish consumption rates in the Columbia Basin. One approach is dietary reconstruction based on several lines of evidence (ethnographic, archaeological, historical ecology, nutritional) to estimate overall dietary composition and the caloric contribution of fish, especially salmon. The second approach is review of abundance, harvest, and consumption rates augmented with ethnographic and archaeological evidence over the same geographical area. The two methods independently arrive at the same range for heritage rates, and the wealth of evidence that has accumulated over 75 years of investigation suggests that these are robust conclusions.

Keywords Fish consumption rates · Heritage consumption rates · Columbia Basin · Columbia River · Pacific Northwest · Native American · Ethnographic surveys

The Concept of Heritage Fish Consumption Rates

The primary exposure parameter for evaluating human health risk from contaminants in fish is a daily fish consumption rate, generally expressed as grams per day (gpd). Contemporary fish consumption rates are required if the goal is to understand current risks in order to design immediate intervention strategies such as fish advisories. However, if the goal is to protect Treaty rights or to understand what the human health risks would be if people ate fish as if they were uncontaminated (i.e., assuming that there are no impediments or restrictions on resource use), then a baseline or unrestricted fish consumption rate is needed. More specifically, if the regulatory goal is to improve water quality in order to protect the health of Native Americans whose traditional diets include fish, then the appropriate rate is an unrestricted traditional amount of fish consumption. The objective of the Clean Water Act is to "is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters," thereby making greater amounts of fish safe to consume, so the policy question is where to base water quality standards along the gradient of contemporary suppressed rates to full heritage rates. The scientific question is how to verify the most accurate baseline traditional fish consumption rates.

Baseline traditional fish consumption rates are more appropriately termed heritage or rights-based rates. The concept of the heritage rate has been confirmed as a treaty-reserved rate through many court cases (Newell 1993; Ulrich 1999; O'Neill 2000, 2013; NEJAC 2002). The right to consume heritage amounts of fish extends to all members of a treaty tribe even if current circumstances prevent most from doing so. It is important to emphasize that tribes are not just communities of subsistence consumers or groups of more sensitive subpopulations; they are governments with treaty-protected rights to preserve their health and cultural practices, including eating fish at traditional rates. Treaties remain in force and are relevant to contemporary regulatory decision processes.

The initial methodology for obtaining fish consumption data was published as guidance for conducting contemporary fish consumption surveys (USEPA 1989, 1992, 1998, 2000,

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2011; Moya 2004) and assumed that the only information to be established is how much fish people are eating at present. Although many riverine and coastal tribes still eat more fish than the general population, contemporary fish consumption rates are nevertheless suppressed (O'Neill 2000, 2013; Donatuto and Harper 2008) due to habitat degradation, dams, and land development, as well as contaminant levels in fish that require fish advisories in order to protect human health. Thus, surveys of contemporary fish consumption rates may only confirm that fisheries are currently impaired or that people are heeding applicable fish advisories. The largest contemporary survey in the middle Columbia Basin, the Columbia River Inter-Tribal Fish Commission (CRITFC), surveyed four Native American tribes in 1991–1992 and found that the annual mean fish (all finfish) consumption rate for tribal adults (consumers and non-consumers) was 58.7 gpd. Excluding non-consumers of fish (7 % of surveyed adults), the mean fish consumption rate for surveyed tribal adult fish consumers was 63.7 gpd. The 95th percentile was 170 gpd and the 99th percentile was 389 gpd, and data from the highest consumers were considered outliers and eliminated from the analysis (CRITFC 1994). Reviewing two approaches to establishing baseline heritage fish consumption rates for the Columbia River Basin we show that even the contemporary 99th percentile of the CRITFC survey is lower than the average heritage rates for the Columbia River Basin.

There is a long history of dietary reconstruction in the fields of ethnobiology and nutritional anthropology that provides reasonable and supportable numerical descriptions of heritage food consumption. This work has generally taken one of two approaches: (1) reconstruction of the entire diet to ascertain the role of individual resources such as fish within the context of total caloric and other nutritional needs, generally at a level of detail approximating a food pyramid; or (2) evaluation of a specific resource abundance to ascertain harvest or catchment quantities relative to the amount consumed, traded, or used for other purposes, along with estimates of the population size that could be supported by that quantity of the resource. There are enough data for the Columbia Basin to support both approaches in a manner that is repeatable, verifiable, peer-reviewed, and corroborated by a variety of measures.

Approaches to Dietary Reconstruction

Due to the length of time that tribal fisheries and fish consumption have been blocked or impaired, most heritage rates must be determined through a multi-disciplinary approach that examines a broad range of evidence collected over almost a century. To some extent, contemporary statistical or ethnographic surveys of traditional peoples can inform the derivation of a true heritage rate if the people in question continue to use large parts of their traditional territory for subsistence (Wolfe and Walker 1987; Berkes 1979, 1983, 1990; Berkes *et al.* 1995). But because indigenous fishing was severely impaired by missionaries, laws, fences, assault, and arrest for many generations, personal knowledge of how much fish constitutes a heritage rate has diminished, so heritage rates cannot be determined by asking people what they remember eating as a child or to speculate about how much fish they would like to eat. However, traditional knowledge can help identify species consumed and provide information about their relative importance.

The field of ethnobiology describes general patterns of natural resource use (Anderson 2011) drawing on archaeology, anthropology, ecology, linguistics, nutrition, geology, and many other fields (Kelly 1986, 1995; Anderson 2011). Diets (nutritional requirements and energy budgets) have been a focus of hunter-gatherer studies for over five decades (Jenicke 2001; Boone 2002) and many investigators have reviewed and synthesized information on diet, physical activity and health of hunter-gatherers around the world (e.g., Lee et al. 1968; Winterhalder 1981; Cohen and Armelagos 1984; Cohen 1989; Kelly 1995;, Kuhnlein and Receveur 1996; Kuhnlein *et al.* 1996, 2006; Eaton *et al.* 1997).

A subset of this literature uses foraging theory models that are based on the premise that foragers' decisions are made in order to maximize short-term energy return rates while foraging. In general, labor cost is attained by multiplying minutes spent in a certain activity (e.g., paddling a canoe or digging roots) by standardized measures of energy expenditure from published sources (calorimetry measurement for various activities adjusted for age, weight, and gender). These methods map real non-random subsistence movement across actual landscapes and account for climate variation, knowledge of resource locations and real-time decisions based on needs and local annual conditions, seasonality, species variation, and kinship and trade relationships (Walker 1967).

Ethnobiology research into traditional diets encompasses a wide range of older ethnographic studies, ethnohistory, first-hand historical accounts, archaeology, food sale/purchase records, ecological history, geospatial history (maps, place names; Walker 1993a,b, 2010), family names, oral history, and data about nutrition, paleo-medicine, isotope analysis, and DNA analysis. This range of data can come together in a "convergence of several lines of evidence" (Trigger 1986; White 1999; Galloway 2006). For example, direct observations of fish harvest numbers, numbers of people splitting the harvest, family size, patterns of trade and sharing and other socio-cultural information can be cross-checked with biomedical information about grams of protein per fish and dietary recommendations for calories and nutrients, and further compared to archaeological evidence of nutritional adequacy from examination of skeletal remains and village sites and of seasonal abundance.

In the Pacific Northwest, anthropologists and archaeologists have long recognized Pacific salmon as the crucial food resource that underpinned the complex foraging cultures of the Northwest Coast of North America, equivalent to the bison on the Plains, wild rice or *manoomin* in northern areas, maize and beans in the Southwest, and corn, beans and squash in the eastern woodlands (Coupland *et al.* 2010). As new faunal evidence continues to accumulate, it is increasingly clear that use of salmon was very highly specialized and was a critical component of the 'Developed Northwest Coast Pattern.' Indeed, some indigenous peoples on the Northwest Coast were among the most highly resource-specialized hunter–gatherer groups in the world (Coupland *et al.* 2010).

There are a multitude of studies of Pacific Northwest resource use, many of which examine coastal shellfish use. We describe a few examples in order to demonstrate the robustness of the data for northwest indigenous groups. Some groups made few moves away from their winter villages because resources were available throughout the year, while other groups employed a series of short-term camps, base camps, and summer, winter, and year-round villages, according to richness, degree of specialization, density, accessibility, reliability, and seasonality of local resources (Lepofsky and Lyons 2003). Middens from some coastal village sites indicate stable occupation for 7,000 to 10,000 years (Carlson 1979, 1998; Anderson 1981; Cannon 1991, 2000; Donald and Mitchell 1996; Cannon *et al.* 1999; Erlandson *et al.* 2008; Canon and Burchell 2009; Burchell *et al.* 2013). Along with archaeological context and ethnographic accounts of salmon species use and preference, seasonality of salmon use has been evaluated through analysis of ancient DNA from Pacific salmon vertebrae along with osteometric measurements such as vertebrae size to unambiguously identify individual salmonid species (Yang *et al*. 2004; Speller *et al*. 2005; Ewonus *et al.* 2011; Grier *et al.* 2013).

The general validity of ethnographic and historical research to quantify overall subsistence diets has been corroborated by modern analytical methods. The natural abundance of stable carbon, nitrogen, sulfur, and oxygen in foods varies as a function of the photosynthetic pathway of the floral food sources, the consumption of animal sources (including the animal source's floral diet), and the incorporation of terrestrial or marine foods in the diet (Hedges *et al.* 2004; Privat *et al.* 2007; Salamon *et al.* 2008). Analysis of both animal or human teeth and bone collagen provides evidence of long-term dietary behaviors.

For example, Jones and Quinn (2009) evaluated prehistoric Fijian diet and subsistence by integrating faunal and ethnographic evidence with stable isotopic analysis of human and animal skeletal material. Salamon and colleagues (2008) studied Mediterranean diets by comparing historical and isotopic results, and Petroutsa and Manolis (2010) examined Bronze Age Greek diets through stable isotope analysis in human and faunal remains combined with documentary and archaeological evidence. White (1999) reconstructed Ancient Mayan diets using multiple methods, including traditional archaeology, paleopathology of human remains, paleoecology, social chronologies, and isotopic and elemental analysis. Oeggl and colleagues (2007) reported on the isotopic analysis of strontium, lead, and oxygen in the Iceman's (O'tzi's) teeth that confirmed his place of origin and early childhood, while his last few days were described through analyses of pollen and of the food residues in his intestines, which also provided information about historical plant associations. Williams *et al.* (2005) and Benson *et al.* (2007) used oxygen isotopes in cellulose remains to evaluate the seasonality of the water source used for maize cultivation in the Colorado Plateau.

There are no comparable studies in the southern Columbia River Basin, although stable isotopic evidence from the Kennewick Man (a 9000 year old skeleton found along the banks of the Columbia River near Kennewick, WA) indicated that he ate large amounts of salmon and other fish or animals that fed on the anadromous fish-based food chain (Schwarcz *et al.* 2014). Lovell *et al.* (1986) evaluated the historic utilization of migratory salmon by people who lived along the rivers of interior British Columbia by stable carbon isotope analysis of 44 skeletal samples up to 2,000 years old. They concluded that, on average, those groups with easy access to the salmon obtained about one-half to two-thirds of their protein from salmon.

Heritage Rates in the Columbia Basin

For thousands of years and continuing into the living memory of the current generations of tribal members, the Columbia Basin has been extremely productive and has supported large populations of people. Ethnohistory of the Columbia Basin includes reports of Lewis and Clark and other explorers, settlers, naturalists, artists and photographers, trappers, traders, missionaries, and early ethnographers (Krech 1991). The zone on the Columbia River around the Dalles and Celilo Falls was over many millennia a major trade center for fresh and dried salmon for many tribes (Anastasio 1985; Walker 1992; Boyd 1996). When Lewis and Clark explored the region in the early nineteenth century, huge numbers of salmon returned to spawn every year (Thwaites 1905). At that time, the Columbia and its tributaries provided 12,935 miles of pristine river habitat with abundant spawning areas (Craig and Hacker 1940).

Archaeological data extend the time scale of human resource use in the Columbia Basin back 10,000 years or more, illuminating how indigenous cultures evolved and how the climate and various food sources changed over time (Walker 1967; Cressman 1977; Marshall 1977; Northwest Power Planning Council (NPPC) 1986; Schalk 1986; Hunn 1990; Hewes 1998; Trosper 2002; Lyman 2003; Davis 2007; Gresh 2007 citing Ames and Marshall 1980). Some of the earliest evidence for aboriginal use of salmon has been found at major rapids and falls, such as Five-Mile Rapids (Long Narrows) on the Columbia River near The Dalles, Oregon, and Kettle Falls/Spokane Valley (Cressman 1977; Schalk 1986). Salmon vertebrae have been recovered from The Dalles that are up to 10,000 years old (Butler and O'Connor 2004), and from Kettle Falls from 7,000–9,000 years old. Large seasonal fisheries at Kettle Falls (northern Washington state) were reported to support eight tribes (Walker 1967), with equally large or larger numbers at the Dalles and Celilo Falls.

Peoples of the Pacific Northwest were fishing societies with unusually high population densities, complex social organization, large villages, and other features ordinarily found only among agricultural peoples (Ray 1939, 1977; Ames and Marshall 1980; Schalk 1986). Unlike the Euroamerican commercial fisheries that developed in the latter nineteenth century, the Native American fisheries were dispersed over thousands of rivers, streams, and creeks of the Columbia River watershed (Schalk 1986) in a single overall social and economic system (Schwede 1966, 1970; Walker 1967, 1993a, b, 1998, 2010; Anastasio 1985). As reported by Scholz *et al.* (1985), "Indian fishing activity was spread throughout the Columbia Basin and salmon fishing was as important to upriver tribes as it was to the lower river tribes on both the Snake and Columbia Rivers." In addition to the major harvest areas, many other fishing sites also were noted by Lewis and Clark and other early explorers, trappers, and traders, and included falls, spawning, and passage areas (Swindell 1942).

Salmon and steelhead were a major staple food, eaten fresh for as much as 6 months of the year and dried or smoked to store for the lean winter months, as well as used as a flavoring, thickener, and in other forms (Hunn 1990). The quantitative importance of salmonids in aboriginal subsistence varied from area to area within the Columbia drainage, but there was some degree of dependence upon salmon in virtually all areas of the Basin that provided accessible spawning habitat. Resident fish (sturgeon, suckers, whitefish, others) were also readily available. More broadly, the salmon fisheries from northern California (Hewes 1947, 1973; Baumhoff 1963; McEvoy 1986) northward through British Columbia and Alaska have provided sustained yields for at least several thousand years (Newell 1993; Trosper 2002).

There is a general consensus that fish, particularly salmon, formed from one-third to one-half of the food supply of Columbia Basin tribes (Walker 1967; Hunn 1981, 1990; Anastasio 1985; Hewes 1998). This amount falls in the range of 700–1000 kcal/day per person based on a total of 2000–2500 kcal/day, or approximately 600–850 gpd (1.3 to 1.8 lbs/day) assuming 117 kcal/100 g of smoked chinook salmon (http://ndb.nal.usda.gov/ndb/foods/show/4532). If salmon supplied one-third to one-half of the daily protein, based on a recommendation of 50 g protein/d (http://www.cdc.gov/nutrition/everyone/basics/protein.html) and assuming 19 g protein/100 g of smoked chinook salmon, then a much smaller amount of salmon would have supplied adequate protein, provided that the caloric difference was replaced by much larger quantities of *Lomatium* roots, the other major staple (Hunn 1981).

Per Capita Fish Consumption – Early Estimates Through 1974

There have been many estimates of total salmonid abundance, harvest, and/or consumption for different tribal groups within the Columbia Basin and throughout the entire salmon region from California to Alaska (Craig and Hacker 1940; Griswold 1953; Baumhoff 1963; Walker 1967, 1993a,b, 2010; Hewes 1973; Scholz *et al.* 1985; Schalk 1986; NPPC 1986; Lichatowich 1999; Finney *et al.* 2000; Gresh *et al.* 2000; Meengs and Lackey 2005; Davis 2007).

Gresh *et al.* (2000) estimated the historic biomass of salmon returning annually to the Pacific Northwest (Washington, Oregon, Idaho, and California) to be 350 to 500 million pounds. More recently Meengs and Lackey (2005) estimated the annual aboriginal harvest to have been about 10 million pounds per year, or 1.75 to 5.36 million fish of all anadromous species. The NPPC (1986) estimated that average annual salmon runs before development of the basin ranged from about 10 to 16 million fish. Commercial harvests of spring, summer, and fall chinook salmon, not including aboriginal harvest, reached an all-time high of nearly 43 million pounds in 1883, and varied between 17 and 37 million pounds between 1890 and 1920 (Fulton 1968, 1970). Chapman (1986) estimated peak-period commercial catches from mean catch weights during the five consecutive years of greatest total harvest, and from mean weights of fish reported in the early literature. These catches were 1,700,000 summer chinook salmon (1881–1885), 382,000 steelhead (1892–1896), 1,100,000 fall chinook salmon (1915–1919), 400,000 spring chinook salmon, 476,000 coho salmon (1894–1898), 1,915,000 sockeye salmon (1883–1887), and 359,000 chum salmon (1915–1919).

Most of the earlier authors who considered per capita fish consumption rates assumed 2000 calories per day as the total human requirement. The earliest catch and consumption estimates, developed by Craig and Hacker (1940), posited an average annual per capita consumption rate of 365 lb (1 lb/day or 454 gpd) for the entire region. Hewes (1947, 1973), using ethnographic data from central California to Alaska and the Yukon estimated a total annual salmon catch of 127,775,800 lb for the entire area based on a human requirement of 2,000 kcal/day and 900 kcal/lb of salmon. Within the Columbia Basin, Hewes' estimates of per capita consumption range from 50 to 100 lb on the uppermost reaches of Columbia River tributaries, to 500–600 lb on Columbia River mainstem fisheries, with some areas even higher (Table 1).

In 1974, Judge George Boldt reaffirmed the right of most Washington tribes to act as "co-managers" of salmon

Table 1 Aboriginal fish consumption rate estimates. All units are per capita consumption in pounds/year, as originally reported. gpd = grams per day

Native group or tribe	Hewes 1947, 1973	Adjusted for calorie loss and waste. Schalk 1986	Walker 1985 as cited in Scholz *et al.* (1985)	Other
Klickitat, Yakama, Wanapum, Wishram, Palouse	400	863	1200 of which 900 are anadromous salmonid	
Tenino Umatilla Walla Walla	500	744	1000 of which 750 are anadromous salmonid	
Cayuse	365	564	Not discussed separately	
Wenatchi, Sinkiuse, Methow, Nespelem, Sanpoil. Colville	500	976	1200 of which 1080 are anadromous salmonid	Walker 1967 adjusted Hewes to 950; Scholz adjusted Hewes to 976
Spokane	500	976	Scholz *et al.* (1985)=948 Walker 1967 = 965 Walker 1985=1080 (1200 of which 1080 are anadromous salmonid)	Harper *et al.* (2002)=865 gpd
Kalispel, Coeur d'Alene,	100	219	Scholz *et al.* (1985)=658; Walker 1967 = 584; Walker 1985=750 (1000 total fish of which 750 are anadromous salmonid)	
Pend d'Oeille, Flathead	100	219	Walker 1985=400 (800 total fish of which 400 are anadromous salmonid)	
Okanagon, Lakes	500	1250	Walker 1985=1000 total fish of which 750 are anadromous salmonids	
Kutenai	300	481	Scholz *et al.* (1985)=658 Walker 1967 = 584 Walker 1985=900 (1000 of which 900 are salmonid, and the rest resident fish)	Scholz *et al.* (1985) 300–365; Walker 1967 adjusted Hewes to 584 Walker; Scholz adjusted Hewes to 982.
Nez Perce	300	646	Walker 1985=1000 total fish of which 900 are anadromous salmonid	Walker 1967 = 582 as cited by Hunn 1990 Table 13, the median for Plateau tribes.
Bannock, Northern Paiute, Northern Shoshone	50	179	Shoshone Paiute=400 total fish of which 300 are anadromous salmonids; Shoshone Bannock=800 total fish of which 600 are anadromous salmonids	Walker 1993a, b Shoshone-Bannock Minimum river use average 64 lbs/year Median river user: 282 lbs/year
Average Columbia-Fraser Plateau	365 or 438			Walker 1967 says the average may be 365 lbs but the median (583 lbs.) should be used as more realistic, with a range from 365 to 800 lbs.

Hewes 1947, 1973 labels his tables as consumption (based on population size and calories)

Schalk 1986 cites Hewes table as being catch as well as consumption. Schalk adjusts for migration calorie loss as well as for waste (citing Hunn 1981 that 80 % of the weight of the fish is edible). The total catch would have been larger for dog food and trade with some use for fuel

Walker 1985 as cited by Scholz is labeled consumption, not catch

alongside the State, and to continue to harvest them (*United States v. Washington*, 384 F. Supp. 312). Forty-nine academic and tribal experts testified to the importance of salmon and the amounts caught and eaten. The court cited 500 lb per capita as a reasonable amount for salmon consumption on the Columbia River mainstem, in addition to recognizing that resident species were eaten in addition to anadromous species.

Per Capita Consumption—Improved Estimates

Estimates of Native American fish consumption have continued to improve through the recognition that a primary stimulus to extensive Plateau travel was the quality of salmon at different points on the Columbia River. Although the flesh of salmon is rich and oily in the lower reaches of the river, it becomes less so as they ascend the river since they do not feed during the spawning runs, and expend much energy on the long journey, thus making fishing and trading more attractive in the Celilo area, as well as available earlier in the season. Most Native informants are well aware of this and have different words for salmon quality at various locations (Walker 1967). The indigenous inhabitants selected specific salmon for different purposes; those taken earlier in the spawning run were used for food, fuel, preservation by smoking, making pemmican, and immediate trade, while salmon with lower oil content were easier to air-dry for longer term storage or lighter in weight to carry; different species might be selected for feeding dogs or for other reasons (Walker 1967, 1997).

Two authors (Walker and Hunn) have conducted original and intensive ethnographic field research regarding fish consumption rates, and others (Scholz and Schalk, among others) have compiled and evaluated consumption rates and other evidence. There is agreement that Hewes' total harvest estimates were too low (Walker 1967; Hunn 1981; Walker 1985 as cited in Scholz *et al.* 1985, Schalk 1986; NPPC 1986) because he assumed a caloric content for salmon throughout the entire region based upon fish as they enter freshwater in prime condition. As reported by the Northwest Power Planning Council (1986), a general average per capita consumption rate of 500 lb per capita is a reasonable estimate, but "the total annual per capita estimate for fish consumed rises significantly when a migration calorie-loss factor is included." Several authors have adjusted Hewes' estimates to account for the fact that salmonids lose up to 75 % of their caloric content during migration to the furthest spawning grounds (Idler and Clemens 1959; Hunn 1981) based on the distance traveled upstream (Table 1). Schalk (1986) also concluded that increasing the Hewes per capita estimates was more consistent with the ethnographic and ethnohistoric data.

For the Dalles region, Walker (1967, 1986) raised the Craig and Hacker and Hewes estimates of 365 to 500 lb per capita per year based on river miles and calorie loss. Walker also states that, in light of the known annual dietary dependence on fish among indigenous societies of the Plateau, it seems reasonable to conclude that the Plateau fish consumption range was between 365 and 800 lbs. per capita with the annual average probably close to 583 lbs or 725 gpd.[1]

Conclusion

The approach of dietary reconstruction, augmented with a large variety of ethnographic, archaeological, and biomedical data, and the approach of evaluating abundance and harvest data, augmented with population estimates and migratory calorie loss both support a range of 500 to 583 lb per capita per year (620 to 725 gpd) as the average heritage rate for the Columbia River mainstem. This convergence of conclusions by multiple authors reflects the robustness of the data.

The data compiled for this paper also show that heritage fish consumption rates for the 15 tribes located within the Columbia River watershed are substantially higher than contemporary averages. The average contemporary fish consumption rate for the four CRITFC Tribes is roughly 10 times lower than the amount eaten by some of today's traditional fishermen (540 gpd, from Harris and Harper 2007), the adjudicated rate of 620 gpd, and the 725–1000 gpd estimated by Walker (1985). The 99th percentile of contemporary consumption (389 gpd) measured in the CRITFC study is still somewhat less than the lower end of the documented range of average traditional fish consumption (454 gpd or 1 lb per day).

These methods have also been supported by the US Environmental Protection Agency (USEPA), which approved the Spokane Tribe's water quality standards in 2013 using their heritage fish consumption rate of 865 gpd (Harper *et al.* 2002), the only tribe thus far using a full heritage rate. As acknowledged by USEPA in the letter approving the Spokane Tribe's standards, the methodology for using multiple lines of evidence including both dietary reconstruction and estimates of abundance near the Tribe's location to determine heritage rates are valid and protective of the Spokane Tribe's traditional lifestyle (USEPA 2013).

This review describes the range of traditional fish consumption rates and provides general estimates that are reasonable, supportable, and (through the Boldt decision) already adjudicated. Additionally, these catch estimates have been used by the federal government and courts to calculate the amount of salmon lost due to dam construction. Further considerations for more localized estimates would be selection of a salmon-only or an all-fish (or finfish plus shellfish) value, and whether the particular application requires a basin-wide average or a tribe-specific value that might require additional intensive research. It is our recommendation that deriving a single heritage fish consumption rate for a large area that includes a wide range of salmon habitats (e.g., Columbia River mainstem, or major and minor tributaries) be considered very carefully, although a supportable default assumption for the entire Columbia Basin is in the range of 500 to 583 pounds per capita per year.

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B Harper. *Heritage or Rights-Based Fish consumption Rates in the Columbia Basin*. 2013 Tribal Leaders Summit, October 7–11, 2013. Northern Quest Resort & Casino, Spokane WA. Invited presentation, posted at http://tels.kalispeltribe.com/

[1] Scholz *et al.* (1985:73) comment, "Walker (1967) estimated that the average annual per capita consumption for the Columbia Basin Tribes was 584 pounds. We deliberately used Hewes' [lower] figures to maintain a conservative bias in developing our estimation of consumption, even though Walker's figures are likely more accurate."

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Review of Heritage Fish Consumption Rates from Idaho Tribal Heritage Fish Consumption Rate Reports for the Coeur d'Alene, Kootenai, Nez Perce, and Shoshone Bannock Tribes (Ridolfi 2014)								
Reference	**Methodology**	**Tribes Evaluated**	**Species Evaluated**	**Rate in g/day**	**Rate Derivation**	**Includes (Note: +/-/U indicates whether the way in which a particular factor was addressed causes an increase, decrease, or unknown impact on the FCR)**		
						Uses Besides Consumption	**Migratory Caloric Loss Factor** [1]	**Accounting for inedible portion** [2]
Craig & Hacker 1940	Ethnographic Observation	Columbia Basin Tribes	Salmon, sturgeon, trout	454	Not presented	No (+)	No (-)	Yes (U)
Swindell 1942	Ethnographic Observation	Columbia Basin Tribes, Celio Region	Salmon	401	1611 lb salmon/year ÷ 5 people/family x 454 g salmon/lb salmon ÷ 365 days/year	No (+)	No (-)	Yes (U)
Hewes 1947	Caloric Analysis	Columbia Basin Tribes	Salmon	454	2000 calories/day x 50% of diet as salmon x 1000 calories/lb salmon x lb salmon/454 g salmon	Yes (-)	No (-)	Yes (U)
Griswold 1954	Ethnographic Observation	Columbia Basin Tribes, Celio Region	Salmon	746	30 sacks salmon/year/family x 10 lb salmon/sack x family/5 people x 454 g salmon/lb salmon x year/365 days Griswald cited 40 sacks of salmon per family were obtained with 30 retained for family use and 10 used for other purposes.	No (+)	No (-)	No (U)
Walker 1967	Evaluation of Craig & Hacker 1940 and Griswold 1954	Columbia Basin Tribes	Salmon	725	Average of 454 g/day (from Craig and Hacker, 1940) and 995 g/day (from Griswold 1954). The Griswold value was based on families obtaining 40 bags of salmon, 30 for consumption and 10 for trade. 995 g/day = 40 sacks salmon/year/family x 100 lb salmon/sack x family/5 people x 454 g salmon/lb salmon x year/365 days	Yes (+)	No (-)	No (U)
Boldt 1974	Undocumented, (United States v. Washington, 384 F. Supp. 312	Columbia Basin Tribes	Salmon	622	500 lb salmon/person/year x 454 g salmon/lb salmon x year/365 days	Unknown (U)	No (-)	Unknown (U)
Walker 1967	Ethnographic observation citing Spalding 1936	Nez Perce Tribe	Salmon	373[a] 466[b]	300 fish/peak day/fishing site x 10 peak days/year x 10 lb tissue/fish x 50 fishing sites ÷ 5000 total population (from Spalding 1936) a: assumes population of 5000 b: assumes population of 4000 (Hewes 1947)	Unknown (U)	No (-)	Unknown (U)
Hewes 1973	Caloric Analysis/Ethnographic Observation	Nez Perce Tribe	Salmon	373		No (+)	No (-)	No (U)
Marshall 1977	Ethnographic Observation citing Walker	Nez Perce Tribe	Salmon	701	300 fish/peak day/fishing site x 10 peak days/year x 10 lb salmon/fish x 94 fishing sites x 454 g salmon/lb salmon ÷ 5000 total population Note: fishing sites increased from 50 to 94 based on Schwede 1966	Unknown (U)	No (-)	No (U)
Walker 1985	Ethnographic Observation, unpublished by cited by Scholz 1985	Nez Perce Tribe	Salmon & Resident	1,244	Methodology not presented	Unknown (U)	Unknown (U)	Unknown (U)
Schalk 1986	Ethnographic Observation citing Hewes 1947 and 1973	Nez Perce Tribe	Salmon	804	300 lb salmon/year/person x 454 g salmon/lb salmon x year/365 days ÷ 0.58 caloric loss factor ÷ 0.8 edible fraction. Modified consumption rates of Hewes 1947 and 1973. Hewes (1973) assumed a consumption rate of 300 lb/year. Assumed that caloric content of fish was reduced during migration. For the Nez Perce, there was a 58% reduction in caloric value. Further, not all parts of the salmon are edible. Schalk assumed 80% of the fish was consumed.	Unknown (U)	Yes (+)	Yes (+)

Review of Heritage Fish Consumption Rates from Idaho Tribal Heritage Fish Consumption Rate Reports for the Coeur d'Alene, Kootenai, Nez Perce, and Shoshone Bannock Tribes (Ridolfi 2014)								
Reference	**Methodology**	**Tribes Evaluated**	**Species Evaluated**	**Rate in g/day**	**Rate Derivation**	**Includes (Note: +/-/U indicates whether the way in which a particular factor was addressed causes an increase, decrease, or unknown impact on the FCR)**		
						Uses Besides Consumption	**Migratory Caloric Loss Factor [1]**	**Accounting for inedible portion [2]**
Hunn and Bruneau 1989	Ethnographic Observation, derived from: Craig and Hacker 1950; Hewes 1947 & 1973; Walker 1967	Nez Perce Tribe	Salmon, Steelhead, Lamprey	398	400 lb salmon/year/person x 454 g salmon/pound of salmon x year/365 days x 0.8 edible fraction Based on review of references cited in the methodology column, Hunn and Bruneau estimated the annual salmon harvest per person at 400 lb/year	Unknown (U)	No (-)	Yes (-)
Hewes 1973	Caloric Analysis/Ethnographic Observation	Coeur d'Alene Tribe	Salmon	124		Unknown (U)	Unknown (U)	Unknown (U)
Scholz et al. 1985	Reanalysis of Hewes 1947 and 1973	Coeur d'Alene Tribe	Salmon	818 996	124 g/day estimate of Hewes adjusted upward to 373 to 454 g/day 818 g/day = 373 g/day ÷ 0.57 caloric loss factor ÷ 0.8 waste loss factor 996 g/day = 454 g/day ÷ 0.57 caloric loss factor ÷ 0.8 waste loss factor	Unknown (U)	Yes (+)	Yes (+)
Walker 1985	Unpublished, cited by Scholz et al 1985.	Coeur d'Alene Tribe	Salmon and Resident	1,244	Methodology not presented	Unknown (U)	Unknown (U)	Unknown (U)
Schalk 1986	Reanalysis of Hewes 1947 and 1973	Coeur d'Alene Tribe	Salmon	273	273 g/day = 124 g/day from Hewes ÷ 0.57 caloric loss factor ÷ 0.8 waste loss factor	Unknown (U)	Yes (+)	Yes (+)
Hewes 1973	Caloric Analysis/Ethnographic Observation	Shoshone Bannock	Salmon	62	Methodology not presented	Unknown (U)	Unknown (U)	Unknown (U)
Walker 1985	Unpublished, cited by Scholz et al 1985.	Shoshone Bannock	Salmon and Resident	995	Methodology not presented	Unknown (U)	Unknown (U)	Unknown (U)
Schalk 1986	Reanalysis of Hewes 1947 and 1973	Shoshone Bannock	Salmon	222	222 g/day = 62 g/day from Hewes 1973 ÷ 0.35 caloric loss factor ÷ 0.8 waste loss factor	Unknown (U)	Yes (+)	Yes (+)
Walker 1993	Review of Schalk 1986 for the Northwest Planning Council	Shoshone Bannock	Salmon	790	Reviewed work of Schalk 1986, determining this work was applicable to the Shoshone Bannock Tribe	Unknown (U)	Yes (+)	Yes (+)
Hewes 1973	Caloric Analysis/Ethnographic Observation	Kootenai	Salmon	373		Unknown (U)	Unknown (U)	Unknown (U)
Northcote 1973`	Caloric Analysis/Ethnographic Observation	Kootenai	Salmon and Resident	1,646	NOTE rate is for tribal members fishing from Kootenay Lake in British Columbia 1,646 g/day = 2,500 calories/day x 0.75 salmon diet fraction x 100 g wet wt. fish / 113.9 kcal	Unknown (U)	Unknown (U)	Unknown (U)
Walker 1985	Unpublished, cited by Scholz et al. 1985	Kootenai	Salmon and Resident	1,244	Methodology not presented	Unknown (U)	Unknown (U)	Unknown (U)
Schalk 1986	Reanalysis of Hewes 1973	Kootenai	Salmon	599	599 g/day = 187 g/day (Schalk modification of Hewes 1973 of 373 g/day) ÷ 0.39 caloric loss factor ÷ 0.8 waste loss factor. However, this calculation yields 1,195 g/day NOT 598.	Unknown (U)	Yes (+)	Yes (+)

[1] Includes a migration calorie loss factor (based on Hunn, 1981, citing Idler and Clemens, 1959) to adjust estimates based on caloric intake.

[2] Waste loss may be accounted for either in direct observation (i.e. the author is citing consumption of fish that had been prepared for consumption, as was done by Craig and Hacker and Swindell) or by adjusting the amount of fish harvested by a waste loss factor loss factor (0.8, based on Hunn, 1981) to translate from amount consumed to amount harvested. For consumption rates derived using caloric analysis, waste loss is inherently accounted for, as calories consumed are converted into edible fish mass consumed.

Notes:

Estimates based on ethnographic observation sometimes appear to be based on amounts actually consumed (e.g. Craig and Hacker; Swindell) and sometimes based on amounts harvested (e.g. Walker; Marshall). Those based on the amount harvested would include the inedible (waste loss) portion, and would likely overestimate consumption. They may also include harvest for other uses, although that is not specifically stated in most studies.

Different studies address "waste loss" differently. Most that use the "waste loss factor", like Schalk and Scholz, use the factor to translate from a consumption rate to a harvest rate, so they tend to inflate the consumption rate (by dividing by 0.8). Other studies (e.g. Hunn and Bruneau, 1989) use the same factor to translate from a harvest rate to a consumption rate (by multiplying by 0.8). So both studies "account" for waste loss, but they do so to opposite effect.

Here is an excerpt from Hunn and Bruneau:

> "Based on these educated guesses, I use 500 pounds per person per year as a reasonable traditional gross harvest rate for "River Yakima" and 400 pounds for the Nez Perce (cf. Walker 1973:56) and the Colville. Actual consumption is estimated at 80% for the edible fraction (thus 400 and 320 pounds respectively)."

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