

Fish Consumption Report Reviews
Idaho Department of Environmental Quality

Reviewers:
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1. Adolfson Associates Inc. 1995. *Technical Memorandum on the Results of the 1995 Fish Consumption and Recreational Use Surveys*. 51 pp.

Both a consumption survey and recreational angler survey. One month of survey from June 3, 1995 through July 3, 1995. Not a random sample, survey was of anglers that visited known fishing and recreational sites at Columbia Slough and Sauvie Island during survey period. Ethnic background of those surveyed was characterized. Survey method described in considerable detail. QA/QC mentioned, but not much detail, but problems encountered in survey are discussed. Information on consumption was based on frequency of fish consumption over year of survey and previous year, and weight of catch for only the fish that were stated to be consumed. This was limited by refusal of some fisherman to have their catch weighed. Consumption was spread among all those the angler said they would share the catch with, thus only consumers of fish included in consumption calculation. Calculated fish consumption rate highly variable, wide confidence bands, in part due to small sample size (21 and 31 for Columbia Slough and Sauvie Island respectively). No peer review is evident.

“Role-playing scenarios were also conducted to improve interview techniques and to prepare for various interview situations.”

“Not every angler answered every question on the survey, and thus the sample size for each analysis is different. Angler information was obtained for consumption if the angler indicated that fish were eaten, whether or not the angler had fish. Because the surveys were random, each summary statistic represents a sample of the total population of anglers” [Emphasis added]

“Twenty-eight people responded that they would eat fish caught from the Columbia Slough.”

“For the Columbia Slough data, we only need 23 valid data points. Currently we have 21 valid data points.” [There is a discrepancy in sample size for fish consumption between two previous statements. Similarly for Sauvie Island, 35 vs. 31.]

“Most of the anglers had difficulties in estimating the quantity of fish they consumed.”

“On numerous occasions the surveyors were unable (or not allowed) to weigh the anglers catch.”

“Thirty percent of the total weight of fish was considered edible.”

“All people that the angler indicated would be sharing the fish with were assumed to eat equal shares of the fish, and were included in the consumption calculations. There were instances where the angler had no fish but indicated that there were people who generally shared the catch. These people were also considered in consumption calculations. This assumption was made to calculate the consumption rate of all fish consumers.” [Emphasis added]

“For both the Sauvie Island data and the Columbia Slough data, the lower 95% confidence limit is negative. The second method is to increase the number of data points.”

2. Agency for Toxic Substances and Disease Registry (ATSDR). 1989. *The Relationship of Human Levels of Lead and Cadmium to the Consumption of Fish Caught in and Around Lake Coeur D’Alene Idaho*. 77 pp.

Both a consumption survey and health risk assessment. Specific to Lake Coeur d’Alene, the Coeur d’Alene River, as well as the adjacent Chain Lakes (residents of Kootenai and Benewah counties). Three

fish consumer groups surveyed: 1) all Coeur d'Alene Tribal members (572 individuals were identified in door-to-door survey conducted over three weeks); 2) 250 randomly selected holders of 1985 fishing licensees who resided in Kootenai and Benewah counties (only 55 consented to participate), and 3) 101 volunteers from those two counties. Study conducted in three phases of which only phase 1 was to obtain fish consumption data. Methods described in great detail, but distinction between purposes, what was done, in each of three phases not real clear, sample numbers do not add up. It is said 933 individuals were "identified" in phase 1, of which "33.8% were volunteers, and 18.4% holders of fishing licenses" but this would suggest 315 volunteers and 171 fishing license holders, as opposed to 101 and 55 stated above. Discrepancy may be those interviewed responding for others in their household, but this is not clear. Those surveyed were asked about consumption of all fish species, plus ducks, water potatoes and wild rice; no anadromous species present. Study limitations are discussed but no real QA/QC section. Since ATSDR lead the study and it was a cooperative effort with several agencies, assumed there was peer review.

Although people were asked about fish consumption, frequency of fish consumption, and number of meals of fish consumed by themselves or members of their household, actual fish consumption rates e.g. g/day or kg/year) are not reported. Some interesting results include: while more people eat salmon species than lake fish or bottom feeders, lake fish are served more often; although a much lower fraction of tribal members ate fish than volunteers and license holders (22.5% versus 97.9% and 92.8%), tribal members that did eat fish tended to eat more fish per meal. Numbers in tables 3-6 don't agree with one another.

"Respondents were asked to refer only to locally caught fish when answering the questionnaires."

"The questionnaire assessed household patterns of fish acquisition and diet (number of fish meals served per week; average number of 8-inch fish eaten per meal; preferred fishing location; preferred catch), as well as dietary patterns for other locally acquired consumables, (ducks and geese; water potatoes; wild rice)."

"In Phase I, 299 households and 933 individuals were identified. Of these 47% were tribal members, 33.8% were volunteers, and 18.4% were holders of fishing licenses."

"Although fewer tribal households served meals containing fish than did fish licensee or volunteer households, the tribal households that did serve fish tended to serve more fish meals per week. The tribal households also served more bottom feeders (catfish, bull heads, suckers) and lake feeders (perch, crappies, bass, pike) and less salmon (kokanee, blue backs, trout, Chinook, whitefish) than did the other groups."

"Current smokers made up 41.5% of the tribal group compared with 15.8% of the volunteers and 21.4% of the fishing licensees (p - 0.02)."

"The population for this study was so selected because it was thought to be at risk for lead and cadmium exposure through high dietary consumption of potentially contaminated fish. However, only 33% of the tribal members indicated that they served meals containing fish. It could not be determined whether this reflected the historical prevalence of fish consumption or whether fewer tribal members fished because of concerns about the highly publicized Lake Coeur d'Alene contamination."

"The purpose of this study was twofold: first, to provide descriptive information about patterns of fish acquisition and consumption for people living around Lake Coeur d'Alene; [Emphasis added]

"The results of this study cannot be used to determine a safe level of fish consumption."

3. Columbia River Intertribal Fish Commission (CRITFC). 1994. *A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin*. 183 pp.

This is a well-designed and documented study specific to determining fish consumption rates. It was targeted at members of the four CRITFC tribes, including Nez Perce Tribe of Idaho. Results were aggregated so as to represent all four tribes as a single population. Methods are clearly explained in detail. QA/QC is specifically addressed with in depth discussion of survey limitations. The report received internal and external technical review as well as independent peer review. Respondents were asked about consumption throughout the year, although the survey was conducted during a three-week period in November. Portion size models were used to better estimate serving size (consumption per meal). Reported months of peak consumption were April-July. Great detail was obtained on species consumed, method of preparation, and source of fish eaten, both harvest and otherwise.

“The objective of the survey was to ascertain individual tribal members’ consumption rates, patterns, habits and preparation methods of anadromous and resident fish species caught from the Columbia River Basin.”

“Monetary incentives (\$40/person) were used to encourage individuals to come to a central location on the reservation to be surveyed.”

“A total of 513 interviews were completed in a three week period.”

“A survey pretest was conducted during October 1991.”

“The peer review panel, selected by CRITFC, consisted of nine individuals from across the country esteemed in the fields of epidemiology, toxicology, survey methodology and statistics.”

“The reported mean consumption rate estimate also includes those respondents that were not fish consumers and thus represents the estimated consumption rate of the entire tribal population sampled.”

“Analysis of the fish consumption rates indicated that the data were not normally or log-normally distributed, nor were any other standard data transforms likely to yield a normal distribution.”

“The average rate of consumption by all surveyed adults throughout the year for all species from all sources was determined to be 58.7 (3.64 SE) gpd. The 90th percentile of consumption was between 97.2 and 130 gpd, the 95th percentile was at approximately 170 gpd;”

“The average rate of consumption of anadromous species for only those respondents who consume fish was 28.8 (1.45 SE) gpd and the average consumption rate of resident species was 10 (0.77 SE) gpd (Figures 7-8, Table 18).”

“In addition, this report does not provide estimates of consumption that take into account varying body weights. Given the differences in body weight and size between ethnic groups, fish consumption estimates in g/kg/day should be calculated.”

4. Harper, BL, Flett, B, Harris, S, Abeyta, C, and Kirschner F. 2002.
The Spokane Tribe's Multipathway Subsistence Exposure Scenario and Screening Level RME.
Risk Analysis Vol 22. No.3.

This paper presents “portions” of a multi-pathway exposure scenario developed by AESE, Inc. in conjunction with the Spokane Tribal Cultural Resources Program.

The exposure scenario serves as a screening-level RME exposure scenario for the Midnight Uranium Mine Superfund site:

“The scenario and resulting RME reflect the subsistence use of original and existing natural resources by a hypothetical but representative family living on the reservation at or near the mine site.”

The fish consumption information presented is not based on dietary surveys. Food consumption is based on an estimated dietary need of 2,500 kcal/day. The original diet of the Spokane Tribe was based on salmon:

“Historically, the Spokane tribe consumed roughly 1,000 to 1,500 grams of salmon and other fish per day.”

The authors question whether a subsistence diet can be constructed solely from the EPA *Exposure Factors Handbook*, because they claim the caloric intake would fall short of an adequate amount (i.e., ~2,500 kcal/day) even if the intake factors for Native Americans were used.

Fish ingestion is not the primary focus of the paper; rather, it is one of multiple exposure routes addressed in the exposure scenario. In the Spokane Subsistence Composite RME Scenario, there are two alternate scenarios considered: a “high fish diet” consisting of 885 g/d fish, 175 g/day other aquatic foods such as crayfish and mussels, and 150 g/day game animals, and a “high game diet,” consisting of 935 g/day large and small game, 75 g/day fish, and 175 g/day other aquatic foods. The rationale for this is that, following construction of the Grand Coulee Dam and destruction of anadromous salmon runs, there was a shift to big game and to Kokanee and resident trout. The intent is “to evaluate exposures that traditional members currently receive and that more members will receive as they regain a traditional diet.”

Regarding consumption of fish and other aquatic organisms:

“The best estimate of original (predam) salmon intake by the Spokane Tribe is the Walker estimate (cited in Scholz et al., 1985) of 1,200 pounds per year of salmon per adult, or 1,426 gpd (about 3 pounds), yielding 2,566 kcal before migration and $2566 \times 0.64 = 1643$ kcal after migration from the ocean to the Spokane area. The current 885 gpd is based on a combination of calories estimates, availability, interviews, and dietary balance. The current Spokane diet relies on Kokanee (landlocked sockeye) and trout (bull or Dolly Varden, rainbow), suckers, whitefish, other species. Salmon and steelhead are obtained whenever possible. Mussels and crayfish were also eaten regularly.” (The source of obtained salmon and steelhead is not given).

Footnote to Table II regarding meat and fish ingestion:

“Exposure Factors Handbook, Volume II, Section 10.10 recommends using 21.1 g/d total fish and shellfish as the mean value for the general population and 70 g/d [or Native American subsistence populations (mean value) or 170 g/d (95th percentile)]. EPA Office of Water (Methodology [or Deriving Ambient Water Quality Criteria for the Protection of Human Health 2000, EPA-822-B-00-004 and Water Quality Standards for Indian Country at www.epa.gov/ost/standards/tribal/tribalfact.html] uses

17.5 g/d as the 90th percentile for the general population and 142.4 g/d for subsistence populations as the 99th percentile, all in uncooked weight. These values are all for adults and are based on current cross-sectional surveys that likely omit traditional tribal members. The Spokane value reflects existing documentation on historical subsistence consumption rates with caloric evaluation, confirmatory interviews with the tribal cultural staff, and tribal policy goals for regaining traditional healthy cultural lifestyles, not on dietary surveys.”

Additionally:

“Thus, developing a subsistence exposure scenario with a traditional diet and cultural practices specific to reservation living needs to rely primarily on ethnographic data and cultural information, and only secondarily on national dietary survey data.”

From the conclusions:

“Existing human-health-based regulatory standards were not developed with subsistence in mind, so tribes are always less protected because they are always more exposed.”

5. IDM Consulting. 1997. *Establishing Alaska Subsistence Exposure Scenarios*. ASPSP #97-0165.

The project was a first step in estimating regional intake rates of subsistence foods in Alaska. Intakes of major subsistence resources in different Ecological-Cultural regions were examined.

“IDM Consulting was contracted by the Alaska Department of Environmental Conservation to evaluate existing subsistence information in an effort to define subsistence regions and develop subsistence consumption parameter distributions for use in human health risk assessment. The project was divided into three parts: 1) Determining appropriate Alaska resource needs areas for the study; 2) Conducting sensitivity analysis on subsistence risk calculations to determine which variables contribute most to the overall risk assessment; and 3) Conducting subsistence research and preparing point estimates and probability density functions for all input parameters for the variables identified in Task 2 for each resource area identified in Task 1.”

“IDM compared the Alaska Department of Fish and Game Community Profile Database (CPDB) harvest survey results and Indian Health Service consumption survey results, where data existed in both databases. Because the CPDB harvest data are available for many more communities than the consumption data, it was preferable to use the harvest data in developing probability distributions to represent dietary subsistence intake. However, it has not been generally established that harvest data provide a good representation of subsistence consumption patterns in Alaska. IDM evaluated both the harvest data and limited consumption data in order to better understand the relationship of these two data sources. Our analysis of 7 Alaska communities for which both harvest and consumption data were available indicates that harvest and consumption are well correlated, although harvest data significantly overestimates consumption for some resources.”

“...it is not appropriate to make inferences regarding regional consumption from the limited consumption data that are available...”

“The findings of this study can serve as an initial screening tool for identifying food resources consumed in greater quantities in a region, for the identification of data needs when performing site-specific risk

assessments, and for preliminary risk estimation for communities when contaminant information is available.”

“Additionally, because the available data were collected for too few days per season per person to adequately quantify annual subsistence harvest or consumption at the individual level, the probability distributions recommended here only represent variation among community per capita (mean) harvest rates.”

Addressing methodology:

“The data from the dietary investigation (Nobmann et al, 1992) provide the latest, most geographically varied direct information on intakes of Alaska Native adults. Intakes from four seasons are included. Information was obtained on total diet in an open-ended format thus, information on consumption of specific foods is included. The design of the dietary investigation attempted to minimize the recognized limitations of all dietary surveys. This was done by conducting standardized training for interviewers, randomly selecting participants, and interviewing participants in their home where portion sizes could more easily be estimated. Approximately 80% of the Alaska Native population live in the regions included in the investigation.”

“The original data are available and were used for verification of the database on the computer when necessary. The principal investigator of the original investigation analyzed the data for the investigation presented here.”

“As with any dietary investigation, there are several limitations to the interpretation of information presented as part of this investigation. Importantly, communities included in the consumption survey do not represent all areas of the state, nor can they be reasonably assumed to represent regional dietary trends because of their limited number. Data were not collected in communities of the North Slope, Interior, or Aleutian Island Chain. Because of the limited number of communities selected, it may be anticipated that had different communities been invited to participate in providing consumption information, different results would have been obtained. For these reasons we did not attempt to extrapolate community consumption to the appropriate Ecological-Cultural region.”

Cited reference:

Nobmann ED, Byers T, Lanier AP, Hankin JH, Jackson MY. *The diet of Alaska Native adults: 1987-1988*. Am J Clin Nutr 1992;55:1024-32.

Seasonal and annual mean consumption rates of a number of subsistence foods, including two fish categories, salmon and non-salmon, were presented for eleven communities. The mean per capita daily fish intakes ranged from 43 g/day to 587 g/day, with a mean of 186 g/day.

6. Landolt, M., et al. *Potential Toxicant Exposure among Consumers of Recreationally Caught Fish from Urban Embayments of Puget Sound*.

This study outlines the first of a two year study to determine potential for exposure to contaminants through the consumption of fish caught by recreational anglers. Two types of data were used: 1) estimates of catch and consumption on a daily basis of fish exposed to these toxins in their urban habitats, 2) an estimate of the concentration of selected organic and inorganic contaminants. The study surveyed anglers at four embayments around the Sound and also did limited chemical analysis on fish caught by survey participants (those who allowed their catch to be examined). The chemicals selected for analysis were arsenic, cadmium, lead and PCBs. Although an objective of the study was to characterize fish

consumption patterns of the anglers, fish consumption rates were not the main focus and are reported based on some very generic assumptions, including: 1) grams of fish taken per species are computed based on quantity of fish taken and lengths using weight length regression coefficients (in cases where more than one fish per species was taken, the mean fish length was used to compute weight and then multiplied by the number), 2) the total weight of fish caught was divided by the # of people reportedly eating fish in the angler's household and by the days elapsed since fish caught at the same site were last eaten, 3) daily consumption/dose rates reflect consumption/dose per day only for the period of time that each species was present in the fishery.

"We do not know how persons who were not interviewed differ from interviewed anglers."

"Lack of species estimates of catch and consumption probably bias our findings downward for those species controlled by bag limits (e.g., trout, salmon)."

"Demographic studies of anglers were conducted over a 13-month period (Nov 1, 1983 – Nov 30, 1984) at each of the four urban embayments."

"By mid-January 1984, we had enough indication of fishing preferences to abandon the random approach, and thereafter field schedules were designed according to expected maximum fishing activity."

"Interviewers wore specially marked caps and carried University of Washington identification cards to avoid being mistaken for state fisheries enforcement officials."

7. Landolt M, Kalman D, Nevissi A, van Belle G, Van Ness K, and Hafer F. 1987. *Potential Toxicant Exposure Among Consumers of Recreationally Caught Fish from Urban Embayments of Puget Sound: Final Report*. National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NOS OMA 33. Rockville, Maryland. 126 pp.

The methods and QA/QC were well described and documented. Study included an investigation into how cooking affects contaminant concentrations in fish tissue. Report recognizes shortcomings of study and makes recommendations for future studies. Focus of report is more on the toxicology of the fish tissue than actual human consumption of those tissues. The study is not representative of the general population, with nearly 92% of the respondents being male, and mostly Caucasian (68.7%). It was noted that many boating fisherman were not cooperative in participating in the survey and in general had a higher number of catch than shoreside anglers, therefore results may have been skewed.

In 1983, this semi-seasonal creel study was initiated to estimate the dosage of key contaminants that recreational anglers (and their families) might ingest through the consumption of Puget Sound seafood. *"High concentrations of organic and inorganic contaminants have been found in the sediments of Puget Sound, Washington embayments, particularly those that are adjacent to urban areas."*

The study was conducted in the 1980's over a 2-year period, with the first year of study focusing on the collection of catch and consumption data through an interview process, spanning a 9-month period. All interviews were conducted shoreside at public boat ramps. All interviews were voluntary and anonymous and the interviewers wore *"specially marked caps and carried University of Washington identification to avoid being mistaken for fisheries enforcement officials"*. The interviewer *"noted the age, sex, and race of each angler,"* but body weight was not considered. The second year study focused more on the contaminant analysis, but a few similar interviews were conducted as well.

Exposure estimates were based on fish consumption rates and contaminant levels in the most commonly caught species in Puget Sound: Chinook* and Coho salmon, walleye Pollock, squid, sablefish, Pacific hake, starry flounder, English sole, Pacific cod, tomcod and lingcod. All specimens were identified to the species level using field guides; but some were not identifiable due to pre-interview processing. *Chinook is the only species relevant to Idaho.

Chemical analyses included the following trace metals: Hg, Cd, Pb, Se, Cu, Zn and Ar. The analysis of more than 20 trace organics revealed that only PCBs were present in ALL species. Other compounds that were frequently encountered included: DDE, DDD, DDT and hexachlorobenzene. It was found that cooking markedly increased the concentrations of arsenic and PCBs (high enough to indicate a potential for cancer risk), although “The study was not designed to assess risk or to set level-of-concern values for contaminants in fish.”

8. Mayfield DB, Robinson S, Simmonds J. 2007. *Survey of Fish Consumption Patterns of King County (Washington) Recreational Anglers. Journal of Exposure Analysis and Environmental Epidemiology. 17:604-612. 9 pp.*

An angler survey in King County, so very much a targeted population, included marine, estuarine, and freshwater locations. Data from these locations was analyzed and presented separately so can pick out fresh water data that may be relevant to Idaho. Freshwater survey appears to have been conducted throughout a year. Survey went beyond just creel information to get at actual fish consumption by those surveyed. Methods reported, interviewers trained, locations and manner of interviews explained, but little on questionnaire details. Consumption rate calculated based on frequency of fishing and limited data on weight of catch, except that for the freshwater lakes survey respondents were shown picture of various meal sizes to aid in their estimation of per meal consumption. Sources of bias mentioned but no real QA/QC information provided. Data was collected on ethnicity of angler, various species consumed, parts of fish consumed, and method of cooking. Published in peer reviewed journal.

Abstract:

“Three fish consumption surveys were conducted in King County, WA during 1997–2003. These surveys were conducted to support environmental analyses of proposed capital improvement projects planned by the King County Department of Natural Resources and Parks. Personal interviews were conducted at marine, estuarine, and freshwater locations throughout King County. Over 1300 anglers participated in the survey and provided consumption information. A majority of the respondents from the surveys (30–71%) were Caucasian, while the remaining respondents comprised various ethnic groups. The mean consumption rates for consumers of marine fish, shellfish, and freshwater fish were 53, 25, and 10 g/day, respectively. Results indicate that the consumption patterns of marine anglers from King County have remained consistent since the mid-1980s. The consumption distribution for marine anglers suggests that some respondents may consume fish as a large portion of their diet. The consumption habits of freshwater anglers are comparable to those of other recreational anglers throughout the United States. The survey results provide distributions of marine and freshwater fish consumption suitable for risk assessments conducted for anglers residing in King County, WA.”

“... the surveys examined the potential for exposure to contaminants through consumption of locally caught fish and shellfish.”

“Surveys of freshwater anglers in Washington state were conducted at locations outside of the

project area (i.e., King County, WA, USA) (CRITFC, 1994; WA DOH, 1997, 2001). More recent studies have focused only on populations with high (i.e., subsistence) consumption patterns (CRITFC, 1994; Toy et al., 1996; Suquamish Tribe, 2000; Sechena et al., 2003)."

"The third survey was conducted at freshwater locations around Lake Sammamish, Lake Washington, and Lake Union from June 2002 to May 2003."

"The consumption rate for the King County Lakes survey was conducted by an alternative calculation method. During this survey, the respondent was presented with visual representations of fish fillets of varying meal sizes (6, 8, 10, and 12 ounce fillets)."

"The mean (median) consumption rate from all freshwater locations was 10(0) and 7(0) g/day for respondents and their children, respectively." [Reported 90th percentiles were 23 & 17 respectively]

"The mean freshwater fish consumption rates were 26, 13, 8, 6 g/day for African American, Asian and Pacific Islander, Caucasian, and Hispanic respondents, respectively."

"Consumption surveys typically contain unavoidable sources of error (US EPA, 1998). For example, the questions on fishing or consumption frequency are subject to recall bias."

"In addition, creel surveys of this type may over-sample frequent anglers (Price et al., 1994) and may lead to over-estimation of the consumption rate for the general population."

9. McCallum M. 1985. *Recreational and Subsistence Catch and Consumption of Seafood from Three Urban Industrial Bays of Puget Sound: Port Gardner, Elliott Bay, and Sinclair Inlet*. Washington Department of Social and Health Services, Division of Health, Olympia Washington. 59 pp.

This study was focused on harvest of marine bottom feeders from polluted bays of Puget Sound. Although an angler survey questions about actual fish consumption were asked. Those out to catch salmon only, and not bottom fish, were excluded from inquiry questions about consumption. This survey, unlike most, was conducted over an entire year. Methods are well described and survey ascertained ethnicity of respondent, species caught and how prepared. Sample size was large (703, 641, and 225) from three bays surveyed. Although the data necessary to calculate a fish consumption rate was obtained, no such results are reported. No peer review is evident.

"... questions concerning the parts of the catch eaten, how it was prepared and how often the person fished, crabbed or clammed were consistently the most troublesome."

"A problem was noted with the question, "How often do you fish/crab/clam here?" Most people tended to respond on the basis of their activity in the recent past. If they had fished every day for the past week, they said they fished every day even though they had not fished before that week or would not fish again for the rest of the year. Also, people probably overestimated how often they actually fished, and responded on the basis of how often they would like to fish or the most often they ever fished."

"Fishing frequencies presented in this report may be inflated."

"A small minority of the interviewees appeared to be fishing with the sole purpose of catching food."

10. Pierce DS, Noviello DT, Rogers SH. 1981. *Commencement Bay Seafood Consumption Study. Preliminary Report.* Tacoma Pierce-County Health Department, Tacoma, WA. 35 pp.

This survey was very similar in nature to McCallum, 1985 - i.e. angler survey of harvest of seafood - but for Commencement Bay to the south. Survey methods are described. Survey was seasonal (July into November), interviews were conducted on just 9 days in that period. Only successful fishermen were interviewed. Information was gathered on race of the angler and species of fish caught. There were follow-up interviews by phone to determine if catch was eaten and how prepared.

“It should be noted that although salmon are a popular food fish caught in Commencement Bay, they have been excluded from this study. Due to their migratory nature, these fish have a minimal amount of contact with pollution sources in Commencement Bay.”

“Persons not having fish were not interviewed.”

“Fishermen tended to respond with how often they fished during the current season, not an annual average.” [Authors present some calculations to illustrate this bias]

“If these edible tissues are divided by 3.74, the average size living group, this works out to, roughly, 0.45 lbs. per person.”

“Repeating the above process, we find the average fishing day produces, roughly, 1 lb. of edible fish tissue per day per person.”

11. Ridolfi. 2007. *Yakama Nation Exposure Scenario for Hanford Site Risk Assessment, Richland WA.*

An exposure scenario was developed for the Confederated Tribes and Bands of the Yakama Nation for use in assessment of risk associated with the Hanford Site. Exposure parameters were estimated for a variety of exposure routes in addition to fish ingestion: inhalation, dermal contact, and ingestion of soil, water, meat, vegetables, fruit and milk.

“Surveys found that the Yakama depend heavily on the harvest and consumption of fish from local rivers, including the Columbia River, which passes through the Hanford Site.”

“Although 16 interviews (from a membership enrollment of over 9,700) is a small sample population, the selected interviewees provided an adequate cross-sectional representation of the population as a whole for the purposes of this study.”

“Interviews were conducted by four Yakama Nation members and a Ridolfi risk assessor.”

“Samples of fish, meat and plants were used for estimating serving sizes, as well as measuring cups.”

“Consumption rates for fish and meat estimated are estimated by the respondents based upon meals; data were converted to raw tissue values.”

“The spring Chinook salmon is considered a “first food,” celebrated with a feast each spring to recognize the availability and abundance of food at the start of each growing season.”

“Based upon maximum values provided by respondents, the adult fish consumption rate ranged from 3 g/day to 451 g/day, with an average of 150 g/day.” (Rationale is presented why the 451 g/day value may be an underestimation - elderly respondents who eat less in general; underestimation of serving size; high fish-consuming subpopulations that might not have been captured by the limited sample size; current rates may reflect suppressed rates that do not represent a subsistence lifestyle.)

12. Spokane Regional Health District (SRHD). 1998. 1998 Fish Consumption Survey, Spokane River, Washington.

Data were gathered on amounts of fish consumed, preparation techniques, and fishing practices. Fishing license holders were sampled to understand the extent to which they fish the Spokane River. Certain ethnic communities that were presumed to use the river as a food source (Russian, Hmong and Laotian communities) were also sampled. As defined by ATSDR guidelines, respondents consume low amounts of fish from the Spokane River. Russian respondents, on average, consumed more of a variety of fish species, used more parts of fish in food preparation, and fished the Spokane River within Spokane city boundaries more regularly. Russian respondents report eating fish one once every two weeks, or about four pounds in a month (**equivalent to 60 g/day**).

“Using triangulation methodology, the qualitative information gathered from focus groups, interviews, and literature reviews served as the basis for the development of the written survey instrument.”

“A focus group was conducted with the Walleye Club during a monthly meeting and casual interviews were conducted at two local tackle shops.”

“The information from the focus group, interviews and a model survey of Lake Roosevelt were used to formulate the questions and fixed answers pertaining to preparation of fish to eat, parts of the fish that are consumed, the frequency with which fish are consumed, and demographics.”

“This survey was designed as a mail survey where two subgroups were sampled, a random sample of fishing license holders and a sample of individuals from the Walleye Club mailing list. The Walleye Club was sampled separately as supplemental information of fishing and consumption practices pertaining to the Spokane River and is treated as such in the forthcoming analysis.”

“The random sample of fishing license holders living in Spokane County was generated from a database obtained from the Washington State Department of Fish and Wildlife.”

A sample of 2,000 of the fishing license holders was selected, out of which 627 (31.35%) returned their surveys. Reminders had been mailed three days after the surveys were mailed. Additionally, surveys were sent to 180 members of the Walleye Club; 56 (31.11%) returned the surveys.

Survey findings – only 70 respondents completed all sections of the survey, including how many and how often fish are eaten in a year. Analysis of this limited subsample indicated a mean consumption of 1-10 fish/year, and a 90th percentile of 21-30 fish. It is not possible to estimate fish consumption rates in g/day from the information presented without making additional assumptions.

Ethnic community findings:

It was determined that the Hmong did not consume fish from the river so the study focused on Russians and Laotians.

“Two contractors, a Russian and a Laotian community member, were hired by the Spokane Regional Health District to coordinate the study pertaining to their specific community. They were contracted to convene a focus group, serve as interpreters, translate the written survey, and coordinate survey distribution within those communities.”

“Fewer than five surveys were returned from either group and therefore were not considered for the analysis.” Thus the ethnic community findings were based on information exchange at facilitated meetings.

Russian Community:

“When asked what they do with the fish they catch (eat it, give it away, or release it) overwhelmingly they responded they either eat it or give it away. They only lose the fish “if it jumps off the hook or it is too small”. On average they report eating the fish from the Spokane River one time in two weeks or about four pounds in a month. One respondent reported that how much he eats depends on how much fish are caught and added it also depends on the fishing limit. Attendees reported they fish primarily in the fall and spring.”

Laotian Community:

“During the months that they fish, they eat about two to three meals of Spokane River fish per month. Generally, with the smaller fish, such as catfish, one person eats two fish per meal. It was mentioned that they eat few trout because they are hard to catch. The fish are frozen, to preserve them. Some species of fish are eaten ten or more months out of the year.”

Discussion:

“People of the Russian community generally catch and eat rainbow trout, brown trout, suckers, catfish, crayfish, pike minnow, smallmouth bass, and perch. They reported eating the fish approximately once every two weeks; about four pounds a month. This population self-reported that they do preserve the fish they catch in the forms of drying and pickling it. The Russian community is also more likely to consume more of the fish they catch. Russian respondents consume, on average, more of a variety of fish than the other populations studied. They also seem to include more parts of the fish in preparing the fish to eat, as well as using diverse methods of preparing the fish. However, using the same measurements as the ATSDR (Agency for Toxic Substances and Disease Registry) in their report “The Relationship of Human Levels of Lead and Cadmium to the Consumption of Fish Caught in and Around Lake Coeur D’Alene, Idaho,” these respondents from the Russian community are classified as low consumers of the fish from the river (< 1 fish meal/week).”

13. Duncan, M. et al. Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region.

This study evaluated the seafood consumption habits of Suquamish Tribal members living on and near the Port Madison Indian Reservation in March 1997. This study also identified cultural practices and attributes which affect consumption rates, patterns and habits of members of the Suquamish Tribe. The population identified was randomly sampled to select adults age 16 and over who are registered members of the tribe. A survey questionnaire was administered by personal interview and was adapted from the Columbia River Inter-Tribal Fish Commission. Models of the various seafood types and portion sizes were used to help respondents provide information on portion sizes and types typically consumed. A mean adult consumption rate of all finfish and shellfish was reported as 2.7 g/kg/day. This was the highest seafood consumption rate reported in studies conducted among the CRITFC, Tualip, Squaxin Island and the Asian/Pacific Island population of King County. Consumption rates for adults and

children under six by individual type of finfish and shellfish as well as by seafood groups are provided for consumers while consumption rates with complete data are provided for participants, including non-consumers, by age and gender.

“The fourth and final part of the questionnaire is devoted to questions concerning changes in consumption over time, fish and shellfish consumed at gatherings, ceremonies or community events and age, weight, height, and household income.”

“The survey was conducted during the months of July, August, and September 1998. Timing coincided with tribal participation in salmon and other finfish and shellfish fisheries for subsistence, ceremonial, and commercial purposes.”

“For a specific type of finfish or shellfish, the consumption for a respondent was calculated by multiplying the portion size typically eaten by the respondent by the ‘frequency’ of consumption (number of times consuming the specific type of fish). The consumption was computed for ‘in season’ and ‘during the rest of the year’, separately. Finally the sum of the consumption for the two time periods yields an annual consumption (in grams) for the specific type of fish. Division of annual consumption by 365 days and the weight of the respondent yielded a weight standardized daily consumption rate in units of grams/kilograms body weight/day.”

“The total seafood consumption rate reported for the day preceding the interview was compared with the rate reported for year-round consumption. // Mean consumption was 1.5 g/kg/day, including respondents with zero consumption the day before, compared with 2.7 g/kg/day from the full survey. The preceding day rates and annual rates were positively correlated (Spearman’s rho = 0.41, p <0.001). The positive and significant correlation indicates some consistency between the dietary recall and the body of the survey results presented in this report.”

14. Toy et al. 1996. A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region.

This fish consumption survey determines the fish and shellfish consumption rates of the Tulalip and Squaxin Island tribes of Puget Sounds. The target population was well defined and sampled at random. Participants in the survey were mailed a questionnaire to fill out and bring to their interview. This Gladys Block Food Frequency Questionnaire was used to help compare the rates reported by a self-administered test to those determined during an interview-based test. The questionnaire and subsequent interview gathered information on the source of fish (market vs. caught), species, preparation methods, and consumption of fish parts. This study also evaluated the consumption rate for children under 6 years of age (n=69). Weight adjusted consumption rates were calculated and evaluated by tribe, age, gender, income and species consumed. Fish species were combined into five groups as defined by life history and distribution in the water column (anadromous, bottom, pelagic and shellfish). Quality assurance and control procedures were well thought out, defined in text and followed throughout the survey and analysis, e.g., when it was discovered that one of the four interviewers for the Tulalip tribe did not consistently follow the specified survey procedures, all results from that interviewer were discarded (n=73).

“The survey questionnaire was designed to focus on frequency (number of fish meals eaten per day, per week, per month or per year over a one-year period) and portion size of each meal. Respondents were

asked to consider seasonal variations in fish consumption: fresh and readily available (in season) and/or frozen and stored (out of season)."

"Both raw and cooked fish were used to build fish models. Raw fish were used for finfish, horse clam, shrimp, squid, and scallops. Cooked fish were used for malina/littleneck clam, butter clam, mussels and cockles."

"Adults who consumed no fish at all were completely excluded from the survey // However, if a respondent did not consume a specific fish group (e.g., anadromous), a consumption rate of zero was assigned for the fish group, and this value of zero was used in the calculation of means, median, etc."

"A pilot survey was conducted prior to implementation of the final survey, and its purpose was to test the design and clarity of the questionnaire."

"A substantial number of adults (age thirty and over) reported changes in their fish consumption patterns over the last twenty year (64% of Tulalip and 70% of Squaxin Island Tribal members//). Among those adults who had changed their consumption habits, a greater number reported eating less fish now than they had in the past (58% Tulalip and 74% Squaxin Island)."

"A comparison of the two methods of assessing fish consumption shows that the median interview-based consumption rate was higher than the self-administered consumption rate."

15. Sechena, R., et al. 1999. Asian and Pacific Islander Seafood Consumption Study (EPA 910/R-99-003)

This study described the seafood consumption rates, species and seafood parts commonly consumed and cooking methods for Asian and Pacific Islander subpopulations in King County, Washington. The majority of respondents participating in the survey (89%) were first generation Asian or Pacific Islanders identified with the assistance of a community based agency known as the Refugee Federation Service Center. The average overall consumption rate for all seafood combined was 1.891 g/kg/day with a median consumption rate of 1.439 g/kg/day. The predominant seafood consumed was shellfish. The API community consumed more shellfish (average consumption rate of 0.867 g/kg/day) than all finfish combined (an average rate of 0.819 g/kg/day). Within the finfish category, pelagic fish were most consumed followed by anadromous fish, freshwater fish and finally bottom fish. Results from this study suggest that first generation respondents consumed more fish than second generation in all categories except pelagic fish. The main source of all forms of fish consumed by API community was purchased from grocery stores, street vendors, or restaurants, ranging from a low of 79% to a high of 97% across types of seafood. Overall, the harvested portion of the fish consumed by the API community was less than a quarter of the total consumption.

"The original sampling strategy specified that the ten API ethnic groups would be represented in the sample proportionate to their composition as reported in the 1990 US Census data for King County. The Community Steering Committee, however, had concerns about this strategy. They felt such an allocation of sample across ethnic groups purely based on the population size would polarize the community because: 1) certain groups appeared to be 'preferred'; and 2) too few individuals would be interviewed from the API groups they felt to be most at risk..."

"The daily consumption amount for each person was then calculated by dividing the annual amount by 365 days. The daily average amount was further adjusted for the body weight of the respondent (based upon self-reported body weight), yielding a common daily consumption rate across all respondents...."

“Questioning about other harvest sites was not pursued because the Community Steering Committee felt that more explicit questioning about harvest sites was culturally intrusive.”

“The lack of a complete sample frame called for a special sampling approach in this study. Particularly, two recruitment methods, ‘roster’ and ‘volunteer’ approach, were employed.”

“In an effort to reduce possible selection bias based upon participants’ knowledge that the study’s focus was seafood consumption, the study was advertised as a Dietary Habits Study for Asian Pacific Islanders. A \$25 check or grocery store gift certificate was offered as an incentive for study participation.”

16. U.S. EPA. 2002. *Estimated Per Capita Fish Consumption in the United States*. EPA-821- C- 02-003. 262 pp.

This study is representative of the general population; non-targeted population w/sensitive groups were also addressed. Native Americans not specifically targeted or addressed in the study. Study considers all types and sources of fish, rather than what is caught and consumed locally. Methods were well-described and documented. Body weight of participants was also considered.

“This report presents per capita estimates of daily average fish consumption. The primary population of interest is the United States population in the 50 states and the District of Columbia. Population subsets are also included: (1) children 14 years of age and younger, (2) women in their childbearing years, and (3) low-income individuals. Quantities of consumed food reported by participants in the combined USDA 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) serve as the basis for the estimates. Estimates are empirical daily averages across two survey days as opposed to usual intake estimates.”

“Empirical daily averages in this report are estimated by two methods: “as prepared” fish and “uncooked” fish. Finfish and Shellfish (grams/person/day and milligrams/kilogram of body weight/day), includes tabulated presentations of daily average per capita consumption by age category for each gender, across gender, across age groups, and across age and gender. Age by gender estimates separately report consumption of freshwater and estuarine, marine, and all fish. In addition, age by gender consumption estimates across the fish habitat types and consumption estimates for individuals 18 years of age and older and for children ages 3 to 17 in fine age categories by fish habitat type are included. Cumulative distributions and histograms of selected subpopulation consumption distributions are also provided.”

“Appendix B, Statistical Methods, provides the statistical formulae for generating point and interval estimates about the mean and upper percentiles of the distribution of two day average per capita fish consumption. This appendix also demonstrates that the variance of the mean, calculated from ultimate-cluster estimates using a synthetic variable, is equivalent to the estimator of the variance of the combined ratio estimator for a stratified, multistage ultimate-cluster sample with replacement.”

“The estimated mean daily average per capita consumption of “as prepared” freshwater and estuarine finfish and shellfish is 4.58 ± 0.42 grams/person/day. When consumption is estimated per kilogram of the consumer’s body weight, the mean daily average of “as prepared” freshwater and estuarine finfish and shellfish consumption is 70.79 ± 6.23 milligrams/kilogram of body weight/day. The estimated mean daily average per capita consumption of “uncooked” freshwater and estuarine finfish and shellfish is 6.30 ± 0.58 grams/person/day. When consumption is estimated per kilogram of the consumer’s body weight, the

mean daily average of “uncooked” freshwater and estuarine finfish and shellfish consumption is 98.38 ± 8.62 milligrams/kilogram of body weight/day.”

Subpopulations:

- Women aged 15 to 44 years, the childbearing years, consume a mean daily average of 5.78 grams of “uncooked” freshwater and estuarine finfish and shellfish. This same group consumed, on average, 8.95 ± 1.12 grams/person/day of “uncooked” marine finfish and shellfish.
- Individuals in the low-income group, consume a mean daily average of 15.47 ± 2.30 grams/person/day of “uncooked” total (freshwater/estuarine and marine) finfish and shellfish. The estimated mean daily average consumption of “uncooked” freshwater and estuarine finfish and shellfish by low-income individuals is 6.05 ± 1.27 grams/person/day.

“The primary advantage of the CSFII surveys is that they were designed and conducted by the USDA to support unbiased estimation of food consumption across the population in the United States and the District of Columbia. One limitation of the CSFII surveys is that individual food consumption data were collected for only two days—a brief period which does not necessarily depict “usual intake.” Usual dietary intake is defined as “the long-run average of daily intakes by an individual.” Upper percentile estimates may differ for short-term and long-term data because short term food consumption data tend to be inherently more variable. It is important to note, however, that variability due to duration of the survey does not result in bias of estimates of overall mean consumption levels. Also, the multistage survey design does not support interval estimates for many of the subpopulations because of sparse representation in the sample. Subpopulations with sparse representation include Native Americans on reservations and certain ethnic groups. While these individuals are participants in the survey, they are not present in sufficient numbers to support fish consumption estimates. The survey does support interval estimates for the U.S. population and some large subpopulations. Sections 4 and 5 present interval estimates about the mean, 90th, 95th, and 99th percentile estimates.”

17. Washington Department of Health (WADOH). 1991. *Lake Whatcom Residential and Angler Fish Consumption Survey*. 36 pp.

Although this study was fairly recent, the data set was very small. The study was targeted specifically to Lake Whatcom anglers and was not in any way representative of a general population. There was very little QA/QC discussed in the report, mostly it was focused on data entry methods. Study was inconclusive, did not include calculations needed to develop a FCR, was not relevant for the purposes of establishing a statewide fish consumption rate, did not evaluate fish tissue toxicity, and body weight of the individual consumer was not considered.

“A survey of Lake Whatcom residents and anglers was conducted between July 21 and July 24, 2000 to gather information on their consumption of Lake Whatcom caught fish, as well as perceptions related to fish advisories. Surveys were conducted through door-to-door interviews, at frequently used boat launch facilities, and at popular shore-fishing locations. Survey efforts focused on the north end of Lake Whatcom, since the majority of residents and potential anglers live and access this section of the lake.” Slightly more women than men were surveyed, most were Caucasian and 71% were older than 46 years of age.

The most commonly caught fish species included: smallmouth bass, yellow perch, kokanee, pumpkinseed, cutthroat trout, brown bullhead and signal crayfish. *“The most commonly consumed Lake Whatcom caught fish species was cutthroat trout (n=14), followed by kokanee (n=10), smallmouth bass (n=9), perch (n=6), and crayfish (n=4).”*

“Survey data were entered into a Microsoft Access® database. A data entry screen, similar in appearance to the actual survey form, was developed to improve data entry efficiency and quality. Survey forms were labeled with a three-digit sequential unique identification number. This number was also assigned to the record in the database, ensuring that surveys would not be entered twice into the database and allowed for Quality Assurance/Quality Control (QA/QC) checking of database entries. Upon completion of initial data entry, all records underwent a QA/QC check through data re-entry and review. Data tabulation and statistical analyses were conducted using STATA® software (College Station, TX).”

“The small number of anglers and the small proportion of the residential population that actually consume any Lake Whatcom caught fish during the four week recall period prior to the survey, limited our ability to fully quantify fish consumption characteristics of the local population, especially women and children.”

“The majority of anglers consume fish from Lake Whatcom at a rate of less than one meal per month and that anglers consume Lake Whatcom caught fish three or fewer months out of the year.”

18. Washington Department of Health (WADOH). 1997. *Consumption Patterns of Anglers Who Frequently Fish Lake Roosevelt*. 21 pp.

Report discusses weaknesses of the survey, and recommends using creel surveys in conjunction with fish consumption surveys in future studies. This study was specific to Lake Roosevelt, was not representative of a general population and did not address the amount of fish consumed per meal. This report is not pertinent for our purposes, too narrow in scope.

“Chemical contaminants are known to be present in Lake Roosevelt, and have been measured in other studies.” This area was subject to historical mining. This fish consumption survey was conducted with the primary objective of obtaining catch and consumption data from individuals who repeatedly fish Lake Roosevelt. Collection of fish consumption data from Lake Roosevelt anglers was conducted by the Spokane Tribe of Indians in concert with on-going creel data collection for the Lake Roosevelt Monitoring Program. The study does not attempt to determine species-specific fish consumption levels in terms of grams of fish per day for the entire population.

“These data were gathered in an effort to determine fish consumption patterns for the population of concern, those who consume the greatest amount of fish, in order to assess the public health impacts associated with ingestion of chemically contaminated fish. Inherently all other populations consuming fish less frequently (or in lesser quantity) will also be protected. Surveyed individuals were primarily older adult Caucasian males that are part of two adult households in which both individuals consume fish. Results indicate that surveyed anglers consume an average of 42 meals per year, with greater than 90% consuming 103.2 meals (2 meals/week) or less per year. These individuals consume fish as fillets, prefer to pan fry fish, and prefer rainbow trout and walleye above kokanee and bass, with no sturgeon, sucker, or whitefish caught and consumed.”

19. Lumni Tribe. 2012. *Lummi Nation Seafood Consumption Study*. 329 pp.

This was a very detailed and well done fish consumption survey, but also very targeted. The survey aims to quantify the high end of the consumption range by focusing on older (45 years +) adult male Lumni Tribal members that are, or likely were, boat owners and thus fishermen by trade. Rather unique in its retrospective look at an ‘environmental baseline’, chosen to be the year 1985 in order to estimate recent historic peak fish consumption rates, and avoid suppression (due to reduced abundance and possibly contamination). Although respondents were asked if their consumption of fish had changed and why between 1985 and 2011/2012, contamination was not one a possible reason. Survey looked at 54 species of fish and shellfish consumed, but the data reveal that the Lumni fish diet is dominated by locally harvested fish and seafood, and that most of the harvest is from marine waters. The report has a thorough description of the statistical approach and good discussion of biases. The survey interviews were conducted from May 2011 through March 2012, but not spread equally across time period. However, individuals interviewed were asked about year round consumption frequency, in 1985. One of the few surveys that used respondents weights to adjust consumption rate to g/kg/day.

“Based on this information, the Technical Advisory Committee concluded that even though the elder population of the tribes may adhere more closely to a traditional seafood-based diet, more seafood is available to the part of the population that owns fishing boats or works on fishing boats, and therefore that this population represents the highest level consumers of the Lummi community.”

“The environmental baseline chosen for the Lummi Seafood Consumption Study is 1985, as this was the peak fish harvest year for the Lummi Nation in recent history and a goal of the Lummi Natural Resources Department is to restore fish habitat so that at least the 1985 harvest levels can be sustained.”

“The assertion of this study is that current seafood consumption is artificially reduced and toxic substance criteria based on current seafood consumption rates would not be protective of Lummi tribal members.”

“The seafood consumption value was first divided by the respondent’s reported weight in 1985, and then by 365 days per year, to arrive at the desired statistic of g/kg/day for each individual that participated in the survey.”

“The respondents reported their body weight for 1985 during the interviews. The reported weight distribution is shown in Table 3.3 and Figure 3.4. The majority of all respondents (36.6 percent) reported weights between 71 and 80 kg (155 and 176 pounds [lb]). The average reported weight of the respondents was 82.6 kg (182 lb).”

“As shown in Table 3.4, 95 percent of the 82 respondents held a fishing license during 1985. Of these respondents 73 percent also held a fishing license during the 2011/2012 season.”

“All respondents were consumers of seafood. Respondents were asked about the origin of the seafood they consumed and any changes in where the seafood they consumed originated between 1985 and present. As shown in Table 3.7 and Figure 3.6, the majority of seafood consumed during 1985 and 2011/2012 was caught by the respondents, their family, or friends in local waters (see Figure 1.2).”

“Of the total respondents, 67 percent ate more seafood in 1985 than in 2011/2012, 23 percent were eating the same amount in 2011/2012 as in 1985, and 10 percent were eating less seafood in 1985 than in 2011/2012. Independent of this decrease or increase in seafood consumption, 84 percent reported that they would like to eat more seafood than they were eating in 2011/2012.”

“The average Lummi seafood consumption rate in 1985, if the outliers are included, was 7.37 g/kg/day or approximately 591 grams per day (g/day) for all seafood consumed; the median seafood consumption rate was 4.41 g/kg/day or approximately 378 g/day.”

“Based on a visual inspection of the histogram of results and discussions with members of the Tribal Advisory Committee about an individual eating 2.33 pounds of seafood (just over 5 salmon fillets per day) every day for a year, values exceeding the 90th percentile value were considered to be outliers.”

“After removal of the nine outliers, the final Lummi fish consumption rates were calculated. As shown in Table 3.15, the average Lummi fish consumption rate is 4.73 g/kg/day or approximately 383 g/day for all seafood consumed. Converted to U.S. customary units, the average fish consumption rate is approximately 0.84 pounds per day (lb/day) or 13.5 ounces per day (oz/day). The median fish consumption rate was calculated to be 3.82 g/kg/day or approximately 314 g/day (0.69 lb/day). The 90th percentile consumption rate was 10.03 g/kg/day or approximately 800 g/day (1.76 lb/day); the 95th percentile consumption rate was 11.28 g/kg/day or approximately 918 g/day (2.02 lb/day).”

“These values confirm the assumption of this study that the members of the Lummi Nation consume considerably more seafood than the average American population. In the judgment of the Tribal Advisory Committee, a fish consumption rate for the Lummi Nation must be no less than the average value resulting from this study in order to be protective of the public health and the Lummi Nation Sche lang en (“Way of Life”).”