HERITAGE FISH CONSUMPTION RATES OF THE KOOTENAI TRIBE OF IDAHO

December 16, 2016

Prepared for the
Kootenai Tribe of Idaho

Prepared by
RIDOLFI Inc.

Prepared for the U.S. Environmental Protection Agency
through SRA International, Inc. Contract EP- W-14-020

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FCR	fish consumption rate
KTOI	Kootenai Tribe of Idaho
UCUT	Upper Columbia United Tribes

LIST OF UNITS

%	percent
cal/d	calories per day
g/d	grams per day
kCal	kilocalories
km	kilometers
lb/d	pounds per day
lb/yr	pounds per year

1.0 INTRODUCTION

A study of heritage fish consumption rates was conducted for the Kootenai Tribe of Idaho (KTOI or Kootenai Tribe). The study was done as part of a larger fish consumption survey of federally recognized Tribes in Idaho, which was initiated by the U.S. Environmental Protection Agency in 2013. This report presents the results of the KTOI heritage rate research, which was based upon an evaluation of available ethnographic literature on aboriginal fish consumption by Columbia Basin Tribes and other influential studies that have supported previous estimates of heritage rates. Certain key geographic features referred to in the following discussion are mapped in Figure 1.

1.1 Purpose and Objectives

Tribal Governments in the State of Idaho are working closely with the U.S. Environmental Protection Agency (EPA) Region 10, the State of Idaho, and other stakeholders to gather data on fish consumption rates (FCRs). The overarching goal of this process is to obtain information on fish consumption to enable Tribal governments to set water quality standards for tribal waters, and to allow Tribes to meaningfully participate as informed partners in a facilitated process to resolve an environmental problem that impacts tribal interests. A Tribal heritage rate study was conducted as part of this effort.

Recognizing that current Tribal fish consumption is suppressed due to impacted fish populations and other factors, this study compiled and evaluated available data to determine heritage fish consumption rates for the Kootenai Tribe. Knowledge of past rates may help determine how current fish consumption rates might increase in the future if current fisheries resources are improved and fish consumption is restored to past, higher levels. Information about fish consumption rates may be used to support development of water quality standards that protect human health.

Water quality is of great importance to the Kootenai Tribe, since a substantial portion of their diet is derived from aquatic sources, and water and aquatic resources are of great cultural and spiritual significance. As part of the survey effort, discussions with the Tribe highlighted the issue of suppression of current fish consumption due to resource contamination, reduced fish availability, and reduced access to fishing. Therefore, the survey team agreed to review and evaluate heritage rates available in the literature, which may be more relevant than current suppressed rates to the long-term restoration goals of the Tribe.

The Kootenai Tribe's primary objective for the fish consumption survey is based on a holistic approach to protecting Tribal members and the ecosystem. The KTOI has been an active steward of the land, and they are dedicated to restoration efforts that will preserve natural resources as well as their culture, with the goal of passing these resources on to future generations. The KTOI envisions a healthy ecosystem with clean, connected terrestrial and aquatic habitats, which fully support traditional Tribal uses and other important societal uses. To restore and enhance natural resources and to protect and sustain Tribal health, culture, and economy, the KTOI is actively engaging in restoration projects. Increased fisheries resources will support higher fish consumption.

1.2 Study Approach

The approach for estimating heritage rates was based on a comprehensive review and evaluation of literature that is relevant to heritage rates, including historical accounts and modern studies of heritage consumption. For Tribes that harvest fish from the Columbia Basin, there is a significant volume of literature to form the basis for a range of quantitative estimates of fish consumption. Information includes ethnographic studies, personal interviews, historical harvest records, archaeological and ecological information, and nutritional and dietary information. The quantitative assessment includes compilation and analysis of historic and heritage information across the region of the Columbia Basin.

The survey team compiled and evaluated available information regarding heritage consumption rates relevant to the Kootenai Tribe. The development of estimates of heritage rates presented here includes a discussion of the available information, including methodologies used to develop the fish consumption estimates and factors affecting the uncertainty associated with the estimates. Based on available information, a quantitative range of heritage fish consumption rates is presented for the Tribe.

2.0 BACKGROUND

The Kootenai Tribe of Idaho has relied extensively on fish resources and fishing activities throughout time. A summary of the fish harvest and extensive use and consumption of fish historically, as well as the causes of decline in fish availability over time, is provided for context.

2.1 Summary of Historical Fish Harvest and Consumption

The Kootenai Tribe has historically occupied a large tract of the Upper Columbia Basin in northern Idaho, the northwestern corner of Montana, and the southeast corner of British Columbia. The aboriginal territory of the Kootenai was rich in fish and game (Scholz, et al., 1985).

The Kootenai are commonly split into two groups by ethnographers—the Upper Kootenai and the Lower Kootenai--based principally upon their subsistence economy (Schaeffer, 1935 and 1970's; Smith, 1984; Teit, 1930; and Walker, 1977, as cited in Scholz, et al., 1985). At present, the Upper Kootenai are located in the vicinity of Elmo and Jennings, Montana and the Lower Kootenai at Bonners Ferry, Idaho and Creston, British Columbia. The bands from these diverse areas are, as in the past, still bonded together through their common cultural heritage and kin relationships.

Fish, both anadromous and resident, were the staple diet of the Lower Kootenai living downstream of the big bend on the Kootenai River (about at Libby), at Bonners Ferry (formerly Paddlers Lake), around Kootenay Lake and its outlet, and on the Columbia River from the Arrow Lakes to Kettle Falls (Chamberlain, 1905; Northcote, 1972 and 1973; Smith, 1984; Turney-High, 1941; and Walker, 1977, 1982, and 1985, as cited in Scholz, et al., 1985). At least 10 different species of fish were used for food by the Kootenai, although salmon, trout, whitefish, suckers, burbot, and sturgeon were probably the most important.

Lt. John Mullan, who mapped and explored the Upper Columbia Basin in 1854 for Governor Steven's North Pacific Railroad Survey noted of the Lower Kootenai that,"[t]heir chief articles of food are roots and fish. The waters of the Kootenai River afford them at all seasons an abundant supply of salmon-trout." (Scholz, et al., 1985). In 1905, Chamberlain noted that “[f]ishing is still the chief occupation of the Lower Kootenai”, and Schaeffer (1940) indicated that, “from an economic standpoint fishing for both anadromous and resident fish was of basic importance to the Lower Kootenai, since it formed their chief staple” and that "the Kootenai dried immense quantities of fish which was their principal source of sustenance during the winter” (as cited in Scholz, et al., 1985).

The Bonners Ferry Kootenai historically relied heavily on resident fish such as sturgeon, kokanee (landlocked sockeye), kamloops trout, whitefish and suckers. However, they would make regular visits below Bennington falls during the salmon spawning season. The Kootenai also traveled to Kettle Falls during the fishing season (Scholz, et al., 1985). Several species of fish were taken in the resident fishery, with kokanee, trout, char, whitefish, sturgeon, burbot, suckers and squawfish being the most important (Smith 1984 and Walker 1985, as cited in Scholz, et al., 1985). Sturgeon were highly prized for their oil content.

2.2 Summary of Causes of Decline in Fish Populations

Fish and wildlife resources in the Kootenai drainage were historically abundant and were utilized by the Tribe for cultural and subsistence purposes. Over the past decades, native fish and wildlife stocks have declined significantly in the drainage due to changes to the natural ecosystem (KTOI, 1990 and 2009).

During the last century, the Kootenai subbasin was modified by agriculture, logging, mining, flood control and impoundments in the forms of Libby Dam (Koocanusa Reservoir) upstream and Corra Linn Dam (Kootenay Lake) downstream. Conversion of more than 50,000 acres of floodplain to agricultural fields has resulted in loss of riparian and wetland plant and animal species, and related functions that normally support a healthy ecosystem. Constructed levees were built on top of natural sand levees for flood control, limiting the hydrologic connection between the Kootenai River and its floodplain (KTOI, 2009).

Libby Dam became operational in 1972, effectively reducing annual peak flows by half and disrupting the natural hydrograph, which had a single spring freshet that provided energy to drive ecosystem processes. These modifications resulted in unnatural flow fluctuations in the Kootenai River and its floodplain, which no longer provide suitable habitat to support the complete life cycles of some aquatic species, and the ecosystem can no longer support many aspects of the traditional life styles it sustained historically (KTOI, 2009).

Although major habitat alterations such as levee construction and the regulation of the natural flood regime by Libby Dam benefited agriculture, they also reduced the Kootenai Tribe’s access to traditional resources previously relied upon for long-term subsistence and cultural uses. Following levee construction and flood regulation by Libby Dam, native fish stocks such as Kootenai River white sturgeon, burbot, kokanee, redband trout, westslope cutthroat trout, and bull trout, as well as local wildlife populations began to decline (KTOI, 2009).

In 1994, the Kootenai sturgeon was listed as endangered under the Endangered Species Act (ESA). The population has been in decline for at least 50 years and is estimated to consist of between 500 and 1,000 wild adults. There has been no significant recruitment of young sturgeon observed since the early 1970s and consistent annual recruitment has not been seen since the 1950s (KTOI, 2009).

In 2013, the group American Rivers (2013) named the Kootenai River among "America's Most Endangered Rivers" due to the threat that five open-pit coal mines along one of its major tributaries pose to water quality, native fish and wildlife, and world-class recreation. Within the Kootenai River subbasin, the specific anthropogenic activities that have had the most direct effects on aquatic habitat include:

- River diking, flood control and channelization
- Dam construction and operation
- Land clearing, side channel and wetland filling for agriculture
- Suburban and urban development
- Road and railroad construction
- Trapping and killing of beaver
- Introduction of non-native fish and plant species

The following estimates of current abundance of various species as a percent of their historical population level, is presented in the Kootenai Subbasin Plan (MFWP and KTOI, 2004, as cited in KTOI, 2009):

- Bull trout: 60 percent of historical levels
- Westslope cutthroat trout: 20 percent of historical levels
- Redband (subspecies of rainbow) trout: 10 percent of historical levels
- Kokanee: 40 to 50 percent of historical levels
- White sturgeon and burbot: 0 to 10 percent of historical levels

2.3 Hopes for the Future

The Kootenai Tribe believes that restoration efforts are critical and that Tribal members are stewards of the land (KTOI, 2013). The Tribe wants to preserve natural resources as well as their culture, and pass them on to future generations.

Tribal members have shifted to mainstream diets over the last generation or so because less fish were available, and when available, were potentially contaminated. Now, however, they are beginning to shift back to traditional foods, supported by education, training, language restoration/retention, cultural heritage, and recognizing health consequences. As fish return, the Tribe is expected to eat more in the future, similar to past traditional rates.

The Kootenai Tribe of Idaho, working with other state and federal agencies as well as the Bonneville Power Administration, has been at the center of the efforts to recover white sturgeon. This program includes conservation aquaculture, as well as restoration of the Kootenai River ecosystem. The Kootenai Tribe envisions a healthy ecosystem with clean, connected terrestrial and aquatic habits, which fully support traditional Tribal uses and other important societal uses.

In support of restoration efforts, the Tribe has developed a Master Plan for the Kootenai River Habitat Restoration Project (KTOI, 2009). The Master Plan presents a conceptual feasibility analysis and design framework for the Kootenai River Habitat Restoration Project.

The purpose of the Kootenai River Habitat Restoration Project is to:

- Restore and enhance Kootenai River habitat by addressing ecological limiting factors and constraints related to river morphology, riparian vegetation, aquatic habitat and river stewardship. The desired result is a more resilient ecosystem, capable of sustaining diverse native plant and animal populations, and tolerant of natural disturbances.
- Restore and maintain Kootenai River habitat conditions that support all life stages (i.e., migration, occupancy, spawning, incubation, recruitment and early rearing) of endangered Kootenai River white sturgeon and other aquatic focal species.
- Restore the Kootenai River landscape in a way that sustains Tribal and local culture and economy and contributes to the health of the Kootenai subbasin as both an ecological and socio-economic region.

3.0 HERITAGE FISH CONSUMPTION RATES

A summary of the primary source literature reviewed for this heritage rate study is provided here, including a definition of “fish consumption,” as used differently by various authors, and certain factors and other assumptions that have been used to adjust and/or calculate consumption rates. Also presented below are the average aboriginal per capita fish consumption rates estimated for the Columbia Basin Tribes (summarized in Table 1) and rates for the Kootenai Tribe specifically (summarized in Table 2).

3.1 Defining Fish Consumption

The focus of this effort is to compile, summarize, and evaluate estimates of Tribal fish consumption during the period when tribes had full access to their traditional fisheries, which we refer to here as “heritage rates.” Since this effort is intended to provide Tribes with information that may be useful in establishing water quality criteria for the protection of human health, the fish consumption rate is considered here to be the average amount of fish and shellfish ingested each day by an individual.

As evident in review of the documentary record, the definition of fish consumption as fish ingestion is not necessarily shared by the various researchers who have attempted to estimate aboriginal fish consumption rates for various Tribal groups. Several researchers include all uses of fish in what they describe as a “total consumption rate.” For example, one researcher (Schalk, 1986), suggested that a previously calculated consumption estimate was too low because it “only considers human dietary demands.” Another (Griswold, 1954) stated that “[t]he tribes here required salmon for fuel as well as for food. Consequently, it may be inferred that their per capita consumption was considerably greater than that of the tribes [downstream] below.” Still another, (Walker, 1967) discussed “exceptional areas of unusually high consumption, up to 1000 lbs. per capita, per year” which are “caused not only by the high calorie demands typical of colder climates, but also by the use of fish for dog food or for fuel.”

Estimates by various researchers, therefore, may include as part of a total fish consumption rate that portion of the overall fish harvest that was used for trade, for fuel, for animal feed, or may include the inedible portion of fish not actually ingested. To the extent that it is discussed in the literature, this report attempts to describe the assumptions involved in estimating a consumption rate, and, where possible and appropriate, identify that portion that was actually ingested.

3.2 Defining Factors Influencing Consumption Rates

Many sources of information providing estimates of heritage fish consumption rates for Tribal groups in the Columbia Basin tend to refer to or build upon previous work, in some cases revising or adjusting rates from previous reports based on new knowledge, new data, or new approaches for interpreting consumption information. Some authors have attempted to revise earlier estimates of fish consumption, particularly those estimates based on caloric intake, to account for the caloric losses that occur as a result of salmon spawning migration ("migration calorie loss factor") and to account for the fact that not all of an individual fish is consumed ("waste loss factor"). Each of these factors and their effect on consumption estimates, as well as other variables that influence the calculation of consumption rates, are discussed below.

3.2.1 Migration Calorie Loss Factor

Eugene Hunn (1981) appears to be the first author to suggest modifying the calorie-based fish consumption estimates originally developed by Gordon Hewes (1947, 1973). While Hunn considered Hewes' estimates of salmon consumption to be "the most comprehensive attempted to date for the region" he contends that "his interpretation of the nutritional factors is misleading." Specifically, Hewes's caloric calculations did not account for the calories that salmon lose during spawning migration (since migrating salmon no longer feed once they re-enter freshwater).

Citing a study by Idler and Clemens (1959), who determined that sockeye salmon lose 75 percent of their caloric potential during spawning migration in the Fraser River watershed, Hunn proposed the following approach, as transferred to the Columbia River watershed: the "migration calorie loss factor" is computed as a ratio of (a) the distance in river-kilometers (km) from the mouth of the Columbia River to the approximate middle of each group's territory, to (b) the entire length of the Columbia River (1,936 km). This ratio was then multiplied by the average value for calorie loss during salmon migration, 75 percent (0.75), and the product was subtracted from one. For example, a salmon harvested halfway to the headwaters of the Columbia River is assumed to have lost half of 75 percent, or 37.5 percent (0.375) of its beginning caloric potential, and, therefore, would retain 62.5 percent of its beginning caloric potential (1 – 0.375 = 0.625), which is considered the migration calorie loss factor. Based in part on this adjustment, Hunn suggested that Hewes likely overestimated the calories provided by salmon, and therefore salmon's contribution to the overall diet, and that "vegetable resources" likely played a larger dietary role than assumed by other authors. In fact, he concluded that the food collecting societies of the southern half of the Columbia-Fraser Plateau "obtained in the neighborhood of 70% of their food energy needs from plant foods harvested by women."

Other authors (e.g., Scholz et al., 1985; Schalk, 1986) have taken a different approach and assumed that Hewes was correct about the proportion of the diet supplied by salmon (on average 50 percent, or about 1,000 calories), but by not accounting for migration calorie loss, Hewes likely underestimated salmon consumption rates, particularly for upriver Tribes (as Schalk, 1986, stated, “some adjustment should have been made for distance traveled upstream”). To account for this, Schalk divided the consumption estimates developed by Hewes by a specific migration calorie loss factor determined for each Tribal group, following the approach described above.

Again using the example of a salmon harvested halfway to the headwaters of the Columbia River, Hewes’s estimate for average per capita consumption for the Columbia Basin tribes of 365 pounds per year would be revised in the following manner: assuming a salmon has lost 37.5 percent of its initial caloric potential during spawning migration, 62.5 percent of its caloric potential would remain (the migration calorie loss factor). Dividing 365 pounds per year by 62.5 percent (0.625) gives a revised estimate of 584 pounds per year – a 60 percent increase. In other words, a person harvesting salmon halfway up the Columbia River would need to consume 584 pounds of salmon to get the same amount of calories as someone consuming 365 pounds of salmon harvested at the mouth of the Columbia. As Schalk (1986) noted, “the total annual per capita estimate for fish consumed rises significantly when a migration calorie loss factor is included.”

3.2.2 Waste Loss Factor

In addition to considering calorie loss from migration, Hunn (1981) also appears to be the first author to suggest modifying the calorie-based fish consumption estimates originally developed by Hewes (1947, 1973) based upon the fact that some portion of a fish is not edible. Hunn (1981) stated that Hewes “does not allow for the fact that the edible fraction of whole salmon is generally considered to be approximately 80% of the total weight.” Since many authors providing estimates of historical Tribal fish consumption did so for the purpose of estimating historical harvest rates, this factor (if accurate) was likely an important consideration. For example, if only 80 percent of each salmon harvested is edible (i.e., 20 percent is “waste”), then a person consuming 100 pounds of salmon per year would need to harvest 125 pounds of salmon to support that consumption rate.

Schalk (1986) incorporated this “waste loss factor” into his estimates of annual salmonid catch in the Columbia Basin by revising Hewes’s consumption estimates for various Tribes and Tribal groups. Schalk stated that “the revised estimate involves dividing the per capita consumption estimate by a waste loss factor of 0.8 to get the gross weight of fish utilized. This figure is also derived from Hunn's (1981) suggestion that 80 percent of the total weight of a salmon is edible.” While it appears that the main objective in using this factor is in estimating total catch (“the gross weight of fish utilized”), the terms “total catch” and “total consumption” are sometimes used interchangeably. Some subsequent authors have incorporated this waste loss factor into their estimates of actual fish *ingestion* when estimating aboriginal fish consumption rates.

3.2.3 Other Assumptions used to Develop Consumption Rates

In addition to the rate adjustment factors discussed above, there are a number of other assumptions that various authors have made to develop consumption rate estimates, including the following (discussed in more detail in section 4.1.3).

- Fish ingestion versus harvest and other uses (i.e., definition of “consumption”)
- Percent of diet (calories) provided by fish (versus other food items)
- Salmon (anadromous) and/or resident fish consumption
- Historical Tribal population estimates
- Number of fishing sites, fishing methods, and fishing efficiency

3.3 Columbia Basin-Wide Heritage Rates

Below is a summary of the primary source information reviewed on aboriginal fish consumption rates of Columbia Basin Tribes. Relevant information is presented from each of the following publications, including fish consumption estimates and associated assumptions (and summarized in Table 1).

- Craig and Hacker, 1940
- Swindell, 1942
- Hewes, 1947
- Griswold, 1954
- Walker, 1967
- Boldt, 1974
- Hunn, 1981

3.3.1 Craig and Hacker, 1940

In 1940, Joseph Craig and Robert Hacker of the U.S. Bureau of Fisheries estimated an aboriginal per capita salmon consumption rate of 1 pound per day (lb/d), which equates to 365 pounds per year (lb/yr) (or 454 grams per day [g/d]1) for Columbia Basin Tribes (Table 1). This estimate is based on historical ethnographic observations of extensive salmon harvest and use. The authors stated that, based on accounts of early explorers:

> *"Without doubt salmon, either fresh or dried, was the chief single factor in the diet of the Indians of the Columbia Basin in their native state."* (p. 140)

Other species were identified as consumed as well, including sturgeon, trout, and other fish; however, salmon was the primary species consumed. While the authors noted that it was "not possible to make an accurate estimate of the amount of salmon used by the Indians," at the time, an approximation could serve "to illustrate the possible magnitude" of fish caught and consumed, with a wide margin of error (p. 141).

The authors stated that since significant quantities of salmon were available in the Columbia River and its tributaries during at least 6 months of the year, the Indians likely harvested and consumed large quantities of fresh salmon during this period and then consumed dried salmon for the remainder of the year. Therefore, "it appears to be well within the realms of probability that these Indians had an average per capita consumption of salmon of 1 pound per day during the entire year" (p. 142).

3.3.2 Swindell, 1942

In 1942, Edward Swindell of the U.S. Department of the Interior's Office of Indian Affairs estimated an aboriginal per capita salmon consumption rate of 322 lb/yr (or 401 g/d) for Columbia Basin Tribes, specifically in the Celilo region prior to the installation of the Dalles Dam and flooding of Celilo Falls (Table 1). This estimate is based on field survey interviews (and published affidavits) with local Indian families.

Swindell agreed that the estimate reported by Craig and Hacker (1940) of per capita salmon consumption of 1 pound per day was "not unreasonable" (p. 13) and that while "the poundage of the fish used for subsistence purposes cannot be definitely ascertained… the importance of this article of food as shown by a survey of 55 representative families is shown…" in his report (p. 147). As part of this study, the author presented and compared results obtained from interviews conducted with the heads of the 55 selected families, which represented a total of 795 Indian families present "under the jurisdiction of the Yakima, Umatilla, and Warm Springs" (p. 13-14). These interviews determined an average consumption rate of 1,611 lb/yr per family. Assuming a family unit was comprised of 5 members, Swindell calculated this to be a per capita rate of 322 lb/yr. This value accounted for both fresh and cured salmon,

[1] Most sources present rates in pounds per day; this report applies a conversion to grams per day (1 pound = 454 grams) for the reader and for applicability to water quality standards

where the dried weights were converted to wet (fresh) weights. The affidavits given by participants of the survey supported Swindell's aboriginal fish consumption estimates.

An affidavit provided by Tommy Thompson (age 79), of the Wyam Tribe of Indians residing at Celilo, Oregon, stated that "each family of Indians, when he was a boy,[2] would dry and put away for their own future use, about 30 sacks of fish…each sack would contain about 10 or 12 fish which weighed almost 100 pounds [total]… each fish after it had been cleaned, the head and tail removed, and then dried, would only weigh between 6 and 8 pounds" (p. 153). Another affidavit provided by Chief William Yallup (age 75), a Klickitat Indian of Rock Creek, stated that "when he was a boy… during the [fish] runs, they would eat fresh fish three times daily and the surplus they caught would be dried for use when no fresh ones were available" and "that in those days each family would dry for its own personal use approximately 30 sacks of fish, each of which contained about six large salmon weighing, after they had been cleaned for drying, about six pounds; that for purposes of trading, each family would put away about 10 sacks of fish" (p. 165). Further, the affidavit noted that fishing rights "have a value to the Indians which cannot be measured in the terms of dollars and cents of the white man; that the subsistence value to the Indians as a whole is enormous…" (p. 167).

3.3.3 Hewes, 1947

In 1947, as part of his dissertation required for a Ph.D. in Anthropology, Gordon Hewes developed an estimate reflective of Craig and Hacker's (1940) per capita salmon consumption estimate of 1 lb/d (365 lb/yr or 454 g/d) for aboriginal Columbia Basin Tribes (Table 1). The justification for this estimate was based on the average human caloric requirements of 2,000 calories per day (cal/d), the assumption that nearly 50% of the Indian diet was salmon, and that the caloric value of salmon was approximately 1,000 calories per pound (p. 213-215)[3].

Hewes presented various consumption rate estimates for Tribal groups in different regions of Alaska and the Pacific Northwest compiled from various sources, stating that "while we have very few quantitative hints for the regions south of Alaska, it is reasonable to suppose that per capita consumption among intensive fishing peoples in parts of the Plateau…reached amounts equivalent to at least the lower estimates…" provided for Alaska and the Pacific Northwest by other authors (p. 223), including the estimate of 365 lb/yr for the Columbia Basin presented by Craig and Hacker (1940). Acknowledging the guesswork involved, the author made every effort to develop reasonable rates, based on available ethnographic data for the various Tribes in the Pacific Northwest and Alaska, weighing salmon consumption by group or area accordingly. Tribe-specific rates are further discussed in Hewes, 1973 (Section 3.4.1).

[2] Based on the year of the publication (1942) and the age of Tommy Thompson at the time of the affidavit (79 years), the period discussed here equates to the mid to late 1800s.

[1] [3] Calculation: 2000 cal/d * 0.5 * 1 lb/1000 cal = 1 lb/d

3.3.4 Griswold, 1954

In 1954, as part of his dissertation required for a Master of Arts, Gillett Griswold cited Swindell's survey of Indian families in the Celilo region of the Columbia Basin, specifically noting the input factors that, when applied together, would result in an aboriginal per capita salmon consumption rate of 800 lb/yr (or 995 g/d). This rate was not presented in his publication *per se* (and, therefore, not listed in Table 1), only the factors used to calculate the rate.

Referring to affidavits presented in Swindell's study, Griswold assumed that each family cured and stored 30 sacks of salmon for their own use and an additional 10 sacks of salmon for trade each year, with each sack weighing 100 pounds. This equates to 4,000 lb/yr per family harvested. Assuming 5 individuals per family (as stated by Swindell), this equates to a per capita rate of 800 lb/yr. It should be noted that this rate considers all salmon that was harvested for both ingestion as well as trade (i.e., not eaten). While this consumption rate was not presented by Griswold in his dissertation, his input factors (4,000 lb/yr per family of 5 individuals) were used in the rate calculation by another author (Walker, 1967, discussed below) to estimate a range of consumption rates.

3.3.5 Walker, 1967

In 1967, Deward Walker conducted research on behalf of the Nez Perce Tribe and estimated an average per capita salmon consumption rate of 583 lb/yr (or 725 g/d) for aboriginal Tribes of the Columbia Plateau in general (Table 1). This estimate was based on the median value of two previously reported estimates: 365 lb/yr (estimated by Craig and Hacker, 1940) and 800 lb/yr (calculated from assumptions in Griswold, 1954).

Walker stated that "in light of the known annual dietary dependence on fish among aboriginal societies of the Plateau, it seems safe to conclude that the range was between 365 and 800 lbs. per capita with the average probably close to the median, i.e., 583 lbs." (p. 19). It should be noted that the higher value of this range was calculated from Griswold, which, as discussed above, includes salmon harvested for ingestion as well as other uses such as trade. Walker noted that a typical use of fish in the Celilo region was for fuel. He also noted that determining a rate for particular groups in the Plateau would "require substantial, additional research" (p. 19).

3.3.6 Boldt, 1974

In the 1974 decision, Senior District Judge George H. Boldt ruled in the case regarding Treaty fishing rights in Washington State. The Judge stated that salmon "both fresh and cured, was a staple in the food supply" of the Columbia River Tribal fishers, and that salmon was consumed annually "in the neighborhood of 500 pounds per capita" (or 622 g/d) (p. 72) (Table 1). This case decision reaffirmed the reserved right of Native Americans in Washington State to harvest fish from their traditional use areas.

3.3.7 Hunn, 1981

In 1981, Eugene Hunn from the University of Washington, Department of Anthropology, re-evaluated the assumptions associated with Hewes' (1947 and 1973) salmon consumption estimates for Columbia Basin Tribes, suggesting that salmon likely did not provide as many calories as originally estimated in the aboriginal diet. Although Hunn did not present fish consumption rates in his publication (and, therefore, no estimate is included in Table 1), he first introduced the concept of migration calorie loss and waste loss factors, as discussed in Section 3.2 above, and as later applied to fish consumption estimates by other authors (e.g., Scholz, et al., 1985, and Schalk, 1986).

While Hunn considered Hewes' estimates to be the most comprehensive to date, Hunn contended that the caloric calculations were based on commercial fish, which are generally the fattest species, and which are typically harvested prior to upstream migration. Hunn cited Idler and Clemens (1959), which concluded that migrating salmon in the Fraser River "lose on average 75% of their caloric potential during this migration" (p. 127). It may be assumed that fewer calories per pound of salmon upstream results in people consuming more salmon to meet their daily caloric requirements. However, Hunn stated that other foods, such as roots and bulbs, likely provided a large caloric percentage of traditional diets. In addition to migration loss, Hunn determined that only about 80% of the total weight of salmon was edible, therefore introducing the concept of the "waste loss" factor, later applied by other authors to adjust consumption rates.

3.4 Kootenai Tribe Heritage Rates

Below is a summary of the primary source information reviewed on heritage fish consumption rates specific to the Kootenai Tribe. Relevant information is presented from each of the following publications (and summarized in Table 2), including fish consumption estimates and associated assumptions.

- Hewes, 1973
- Northcote, 1973
- Scholz, et al., 1985
- Walker, 1985
- Schalk, 1986

3.4.1 Hewes, 1973

In 1973, continuing on his previous dissertation work, Gordon Hewes presented updated aboriginal per capita salmon consumption rates for specific Tribes in Alaska, British Columbia, and the Pacific Northwest, including a rate of 300 lb/yr (or 373 g/d) for the Kootenai Tribe (Table 2). This rate is based on caloric content and daily requirements, population estimates, and ethnographic accounts of the importance of salmon; it is also based on human dietary demands only, not including other non-ingestion uses.

Hewes initially published a general rate for salmon consumption by Columbia Basin Tribes based on assumptions about dietary caloric requirements and the contribution of salmon to aboriginal diets (see discussion of Hewes, 1947, in Section 3.3.3 above). In this report, Hewes again presents an average per capita estimate of 365 lb/yr (or 454 g/d) for the Columbia Basin Tribes as well as rates for individual Tribes. The Tribe- specific rates account for variability in salmon dependence between regions and population groups, and they reflect population numbers available at the time for each Tribe.

3.4.2 Northcote, 1973

In 1973, T. G. Northcote of the Fish and Wildlife Branch of the Department of Recreation and Conservation in British Columbia, published a technical report for the Great Lakes Fishery Commission where he presented assumptions that resulted in an aboriginal per capita fish consumption estimate of 1,323 lb/yr (or 1,646 g/d) for Kootenai Indians living in the vicinity of Kootenay Lake in British Columbia (Table 2). This rate was estimated by calculating amounts required for a 2,500 calorie per day diet, assuming 75% of the total caloric intake came from fish, and an average value of 113.9 calories per 100 grams wet weight of whole raw fish obtained from rainbow trout, salmon, and whitefish.[4] Northcote acknowledged that the assumption that 75% of total caloric requirements came solely from fish "may overestimate exploitation of that food source" by the Kootenai Tribe.

3.4.3 Scholz, et al., 1985

In 1985, on behalf of the Upper Columbia United Tribes (UCUT), Allan Scholz and other authors calculated salmon consumption rates for several Columbia Basin Tribes by assuming that Hewes had underestimated fish consumption and by applying adjustment factors to Hewes (1947, 1973) estimates. Scholz presented an aboriginal fish consumption rate of 962 lb/yr (or 1,196 g/d) for the Kootenai Tribe (Table 2).

Scholz cited a large body of work conducted by Walker (1985) that included reviews of several hundred historical manuscripts, archival research, and ethnographic field work (see discussion of Walker, 1985). While Walker's report remains unavailable, Scholz suggested that Hewes' estimate of salmon consumption by the Kootenai of 300 lb/yr was reasonable considering the extent of the Kootenai fishery (unlike Schalk, 1986, discussed below, who reduced Hewes' rate by half). The author then factored in migration calorie loss and waste loss factors, as introduced by Hunn (1981), of 39% (0.39) and 80% (0.80), respectively, yielding a value of 962 lb/yr (or 1,196 g/d).[5] These values represent salmon consumption; resident fish (such as sturgeon and burbot) were also consumed by the Tribe, citing Walker (1985) and others. However, Scholz did not present an estimate for resident fish consumption and did not factor it into the fish consumption rates presented in his publication.

3.4.4 Walker, 1985

In 1985, Deward Walker conducted ethnographic research that included information about the Kootenai Tribe; however, the report was never published and remains unavailable due to the sensitivity of the information it contained. The data presented here is based upon citations in Scholz, et al. (1985), discussed above, in which the author included estimates and quotes and, therefore, apparently had access to Walker's (1985) report. Walker calculated an average per capita total (anadromous and resident) fish consumption rate of 1,000 lb/yr (or 1,244 g/d) for the Kootenai Tribe (Table 2). Note that this rate intended to include both salmon and resident fish consumption combined in the estimate.

According to Scholz (1985), Hewes "checked Walker's new figures for populations and per capita consumption and agrees with Walker's revisions" (Scholz, 1985, p. 73). Scholz also stated that Walker's (1985) estimates were significantly different from those of Schalk (1986), discussed below, primarily because Walker assumed higher

[4] Calculation: 2500 cal/d * 0.75 * 100 g/113.9 cal = 1,646 g/d

[5] Calculation: 300 lbs ÷ 0.39 ÷ 0.8 = 962 lbs

Tribal population totals (and also includes resident fish with salmon consumption). Without the original document, however, it is unclear if Walker's estimates represent fish ingestion only or include fish used for other purposes, such as trade and fuel.

3.4.5 Schalk, 1986

In 1986, Randall Schalk calculated salmon consumption estimates for specific Tribes based on Hewes' (1947 and 1973) original estimates, including a rate of 481 lb/yr (or 598 g/d) for the Kootenai Tribe (Table 2). This rate includes migration and waste loss factors applied to Hewes' Tribe-specific values, similar to Scholz' (1985) approach.

Schalk contended that many of Hewes' original estimates were biased low because they were based on:

- A caloric content of fish representing salmon as they enter freshwater in prime condition (i.e., having more calories than upstream salmon). Schalk stated that "since salmonids lose an average of 75 percent of their caloric content during migration (Idler and Clemens 1959), some adjustment should have been made for distance traveled upstream" (i.e., applying a migration loss factor).
- The assumption that salmon were eaten in their entirety. Schalk states that assuming the entire fish was consumed was "unrealistic" and cited Hunn (1981) to state that only "about 80 percent of the weight of a salmon is edible" (p.17).

Schalk, therefore, adjusted (increased) Hewes' consumption rates by applying a migration loss factor (variable by Tribe depending on how far upstream they harvested salmon) of 39% (0.39) for the Kootenai Tribe. Schalk also applied a waste loss factor of 80% (0.80), citing Hunn (1981), therefore, including inedible fish parts in the fish consumption estimate.

4.0 RATE EVALUATION AND DISCUSSION

This section further evaluates and discusses the information presented above, including the uncertainty associated with the rate adjustment factors and other assumptions influencing rate calculations.

4.1 Factors Influencing Consumption Rates

The migration calorie loss factor and waste loss factor are considered here, particularly regarding the uncertainty associated with applying these adjustment factors to heritage rates. Other factors that influence the calculation of heritage rates and that may also increase uncertainty of the estimates include population size estimated at the time, number of fishing sites, and reliability of ethnographic data in general.

4.1.1 Migration Calorie Loss Factor

For a number of reasons, the application of the migration calorie loss factor as described above introduces a high degree of uncertainty into the revised estimates of tribal fish consumption. The study that forms the basis of this adjustment (Idler and Clemens, 1959) is based on one year's run of one species of salmon (sockeye) in one watershed (the Fraser River). The conclusions of this study are then broadly applied to all salmon species within a different watershed (the Columbia River), even though it is estimated that sockeye accounted for only 7 percent of the Upper Columbia salmon harvest (Beiningen, 1976 as cited in Scholz, et al., 1986). The degree to which different salmon species lose calories at different rates or in different proportions during spawning migration, and the degree to which the Columbia River and Fraser River watersheds differ (in length, elevation change, etc.) all affect the degree of uncertainty associated with the calculation and application of a migration calorie loss factor.

The migration calorie loss factor is based on a gross percentage of calories lost by a sockeye salmon during spawning migration in the Fraser River (i.e., ending calories compared to beginning calories). However, the factor is applied in revising consumption rates as though it represents the amount of calories lost *per pound consumed*, which is not the same; salmon not only lose calories during migration, they also lose weight. Based on measurements collected by Idler and Clemens (1959), the average overall weight loss during spawning migration was 25 percent, and the loss in caloric density (calories per gram) was therefore about 65 percent, as opposed to 75 percent. Table 3 provides the total calories, total weight (in grams), and caloric density (in calories per gram) of sockeye salmon measured at various stages in the Fraser River (from Idler and Clemens, 1959).

Further, the overall decrease in caloric potential was based on measurements of sockeye salmon that have spawned *and died* in headwater streams. Michael Kew (1986) describes the results of the Idler and Clemens study as follows:

> *"As a general rule, the further from the sea a salmon is, the less fat and protein it carries. The loss is considerable. Total caloric value of a sockeye, measured at the river mouth, will be reduced to nearly one-half when it reaches the Upper Stuart spawning grounds, one thousand kilometers from the sea. After the enriched gonads have been expended in spawning and the fish die on these upper streams, they will have lost over 90 percent of their fat and one-half to two-thirds of their protein (Idler and Clemens, 1959; reviewed in Foerster, 1968: 74-6)."*

As Kew notes, there is a significant difference in caloric potential between the time a salmon reaches its spawning grounds and the time it has spawned and died. Based on measurements collected by Idler and Clemens (1959), the average sockeye loses almost 15 percent of its caloric density (calories per pound) between the time it reaches its spawning grounds and the time it has spawned and died. At the time a sockeye salmon reaches its spawning grounds in the upper Fraser River watershed, it has lost about 50 percent of its caloric density (Table 3).

Still further, the derivation of the migration calorie loss factor relies on the assumption that the salmon harvest location is at "the approximate middle of each group's territory" (Hunn, 1981). To the extent that a majority of salmon harvest occurs either downstream or upstream of this point, the migration calorie loss factor would either overestimate or underestimate, respectively, the effect on the consumption rate.

Mullan, et al. (1992) note that caloric losses in salmon are generally related to mileage of migration, but not directly. "Idler and Clemens (1959) show much higher energy expenditures by sockeye in some river reaches than others, and higher rates for females than males. In other words, caloric content is not linear in relation to distance." Further, Mullan notes that in migration and maturation the fish tend to mobilize fat reserves and resorb organs (e.g., gastro-intestinal tract), and "[t]hus they lose weight, but not necessarily caloric content, between cessation of ocean feeding and nominal freshwater capture."

While the idea of adjusting calorie-based consumption estimates to account for migration calorie loss does not seem unreasonable, based on the uncertainty described above, it most likely tends to overestimate salmon consumption relative to Hewes' original estimates (because it likely overestimates calorie loss per pound). Since sockeye salmon lose approximately 50 percent of their caloric density upon reaching their spawning grounds, a maximum migration calorie loss factor of 50 percent, as opposed to 75 percent, may be more consistent with the supporting research (although the existing research is limited to a single species of salmon).

Hewes's diet and calorie- based consumption estimate for the Columbia Plateau Tribes is identical to that proposed by Craig and Hacker (1940), which is not based on caloric intake but on observation and review of the ethnohistorical literature (although it is "admittedly liable to a wide margin of error").

4.1.2 Waste Loss Factor

Incorporating a waste loss factor to revise Hewes's fish consumption estimates has the effect of increasing the consumption rate (relative to Hewes's estimate) by 25 percent. If the interest is in understanding how much individuals consumed (ingested), as opposed to "used," then the use of a waste loss factor is not appropriate. Essentially, this factor adjusts a consumption rate, increasing it by 25 percent, to account for the portion of fish NOT consumed. Consumption estimates that have been revised to account for a waste loss factor (as in Scholz et al., 1985, and Schalk, 1986) would tend to overestimate consumption (ingestion) by 25 percent, relative to the "unrevised" rates.

Some estimates of consumption by Tribal groups are based on an estimate of total harvest and total population. For example, some authors estimate a total harvest (in pounds) based on the number of fishing sites, number of fishing days, efficiency of fishing techniques, average weight of fish, etc., and simply divide the total estimated harvest by the total estimated tribal population to arrive at an annual per capita consumption rate. However, this type of estimate does not account for the fact that only a portion of each fish may be edible (i.e., 80 percent), and may tend to overestimate the amount that people are actually consuming.

Mullan, et al. (1992) suggested that, because many Tribal groups prepared and consumed most parts of the salmon, including organs, eyes, eggs, etc., the inedible waste was much less than 20 percent, arguing that "waste factor of a salmon amounted to bones only, under 10% of body weight."

4.1.3 Other Assumptions used to Develop Consumption Rates

In addition to the rate adjustment factors discussed above, other assumptions that various authors have made in developing consumption rates introduce varying degrees of uncertainty to the estimates, including those discussed below.

4.1.3.1 Ingestion, Harvest, and Consumption

As discussed in Section 3.1, the effort here is to summarize estimates of fish ingestion which may be relevant to the development of Tribal water quality standards. The degree to which estimates of Tribal fish consumption in the various studies include uses in addition to ingestion may affect their applicability to Tribal regulatory or policy development.

4.1.3.2 Percent of Diet Supplied by Fish

The calorie-based consumption estimates developed by Hewes, which form the basis for a number of subsequent estimates, are based on the assumption that salmon account for about 50 percent of the average Columbia Basin aboriginal diet. Many authors have made similar estimates, while others have assumed either higher or lower dietary estimates. While 50 percent of the diet (i.e., 50 percent of total calories) is among the most common estimates, the degree to which a specific Tribe has a higher or lower percentage of diet supplied by fish can affect the accuracy of the calculated consumption rate. The consumption estimate included in Northcote (1973) is based on an assumption that 75 percent of dietary calories are provided by fish. Northcote notes, however, that the assumption "that 75% of their total caloric demands came solely from fish…may overestimate exploitation of that food source by the Kootenay Indian population."

4.1.3.3 Salmon and Resident Fish Consumption

Because of the importance of salmon to the Columbia Basin Tribes, and because many studies have attempted to evaluate the impact of the hydroelectric system on anadromous fisheries, a majority of the studies evaluated focused exclusively or primarily on the harvest and consumption of salmon. The degree to which individual Tribal groups relied on resident fish, either to supplement or to substitute for salmon consumption, will affect the accuracy of consumption estimates included in these studies relative to total fish consumption.

4.1.3.4 Tribal Population Estimates

Some authors have estimated total fish consumption for various Tribal groups by estimating an overall harvest rate and dividing that rate by the total Tribal population to develop an average per capita estimate. Therefore, the accuracy of population estimates may directly affect the accuracy of consumption estimates developed using this approach.

4.1.3.5 Number of Fishing Sites, Fishing Methods, and Fishing Efficiency

Some authors have developed consumption estimates based on assumptions about the type and effectiveness of Tribal fishing methods and the number of harvest locations utilized by individual Tribes or Tribal groups. The degree to which these assumptions are accurate will directly affect the accuracy of consumption estimates using this approach.

4.2 Heritage Fish Consumption Rates

The heritage rates estimated for the Columbia Basin Tribes and, specifically, the Kootenai Tribe, introduced in Sections 3.3 and 3.4 above, are evaluated in more detail below, including discussion of the assumptions and uncertainty associated with the estimates.

4.2.1 Columbia Basin-Wide Heritage Rates

Craig and Hacker (1940) presented the first estimate of per capita salmon consumption for aboriginal Tribes of the Columbia Basin of 365 lb/yr (or 454 g/d), which was based on historical ethnographic observations, although acknowledged by the authors as likely having a wide margin of error. Hewes (1947) validated this rate with additional assumptions related to average dietary caloric requirements, the contribution of salmon to the aboriginal diet, and a caloric value for salmon. These assumptions (a 2,000 calorie diet, 50 percent of the diet was salmon, and salmon contained 1,000 calories per pound), while generalized, provided additional justification for this rate. Hunn (1981) later re-evaluated Hewes' assumptions by suggesting that migration calorie loss and inedible waste loss factors should be considered. While variability exists in how many calories each salmon contained and how much of each salmon was eaten, the method for developing and applying such "adjustment factors" (discussed in Section 4.1 above), as done to aboriginal rates by other authors (Scholz, et al., 1985, and Schalk, 1986), may have added a level of uncertainty to those estimates.

Shortly after Craig and Hacker (1940) published the first aboriginal salmon consumption estimate, Swindell (1942) published a very similar estimate of per capita salmon consumption of 322 lb/yr (or 401 g/d) for the Tribes of the Celilo Falls region. This value was based on interviews with Indian families, including affidavits of extensive salmon consumption and use, and total harvest (according to sacks of fish and average weights per fish). Griswold (1954) later cited Swindell's work, referring to these affidavits, to calculate a total annual harvest of 4,000 pounds per family. Although Griswold did not calculate a *per capita* consumption rate in his publication, Walker (1967), by assuming 5 individuals per family, calculated a per capita rate of 800 lb/yr (or 995 g/d) for an upper range of fish consumption. Based on per capita fish consumption rates ranging from 365 lb/yr (presented in Craig and Hacker, 1940, and Hewes, 1947) to 800 lb/yr (calculated from Griswold, 1954), Walker (1967) calculated an average (median) per capita salmon consumption rate of 583 lb/yr (or 725 g/d). A few years later, Boldt (1974) stated that Columbia River Tribes consumed (as food supply) a comparable rate of about 500 lb/yr (or 622 g/d) of salmon.

It is important to remember that the rate calculated from Griswold's (1954) information reflects salmon that was harvested for both consumption as well as trade (i.e., salmon not ingested). If all other assumptions hold true, based on Swindell's (1942) information (3,000 lb/yr harvested per family for consumption, 5 individuals per family)[6], a more accurate per capita upper range for fish consumption as defined for this report would be 600 lb/yr (or 746 g/d). If this alternate value is used from Griswold (1954), calculating an average rate similar to Walker's approach would result in an average rate of 483 lb/yr (or 600 g/d) (Table 1).

[6] If the10 sacks of salmon that were harvested for trade are removed from the equation, the 30 sacks of fish consumed at 100 pounds = 3,000 pounds (per family).

4.2.2 Kootenai Tribe Heritage Rates

Hewes (1973) continued his earlier dissertation research from 1947 and published his estimates for various Tribes based upon fish caloric content and daily requirements, population estimates, and ethnographic accounts of the importance of salmon among different Tribes. He estimated an average per capita salmon consumption rate of 300 lb/yr (or 124 g/d) for the Kootenai Tribe.

In the same year, Northcote (1973) estimated a much greater per capita fish consumption rate of 1,323 lb/yr (or 1,646 g/d) for the Kootenai Tribe based on average dietary caloric requirements, the contribution of fish (salmon and resident fish) to the aboriginal diet, and an average caloric value for fish. Northcote acknowledged that the assumption that 75% of caloric intake came from fish may overestimate the fish intake.

Later, citing Hunn (1981), Scholz, et al. (1985) calculated salmon consumption estimates for some of the same Columbia River Tribes, increasing Hewes' original Tribe-specific estimate for the Kootenai Tribe by applying migration and waste loss factors; this yielded a rate of 962 lb/yr (or 1,196 g/d) for the Kootenai Tribe. Such adjustments to previously published rates may have added a level of uncertainty to those estimates, but demonstrate how alternate assumptions may influence rate estimates.

Similar to Scholz, et al. (1985), at about this same time, Schalk (1986) applied migration and waste loss factors. Although based on Hewes' estimates, Schalk assumed the rate presented by Hewes for the Kootenai Tribe was too high according to the ethnographic information; therefore, he lowered Hewe's estimate of 300 lb/yr by half to 150 lb/yr and then applied the adjustment factors. This yielded a rate of 481 lb/yr (or 598 g/d) for the Kootenai Tribe.

In 1985, Walker expanded upon his previous work from 1967 and calculated Tribe-specific per capita total fish consumption rates for individual tribes, including 1,000 lb/yr (or 1,244 g/d) for the Kootenai Tribe. Although this study remains unpublished, the estimates were presented (with supporting information) by Scholz (1985). Walker's estimates appear to reflect use of both anadromous and resident fish; however, since the report is unavailable, it cannot be verified if these estimates account for only fish ingested or include fish used for other purposes (such as trade).

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TABLES

Table 1. Average Heritage Fish Consumption Rates for the Columbia Basin Tribes

Report by Author	Pounds per Year	Grams per Day
Columbia Basin-Wide		
Craig and Hacker, 1940	365	454
Swindell, 1942	322	401
Hewes, 1947	365	454
Griswold, 1954 - *ALTERNATE*	600	746
Walker, 1967	583	725
Walker, 1967 - *ALTERNATE*	483	600
Boldt, 1974	500	622
Range of Rates		
Minimum	322	401
Maximum	600	746

Notes:

ALTERNATE = Rate was not included in the publication, but it was calculated from assumptions included in the publication (accounting for *ingested* fish only).

Table 2. Average Heritage Fish Consumption Rates for the Kootenai Tribe

Report by Author	Pounds per Year	Grams per Day
Kootenai Tribe		
Hewes, 1973	300	373
Northcote, 1973	1,323	1,646
Scholz, et al., 1985	962[b]	1,196[b]
Walker, 1985[a]	1,000	1,244
Schalk, 1986	481[b]	598[b]
Range of Rates		
Minimum	300	373
Maximum	1,323	1,646

Notes:

4.1.1 Report was not published, but data and quotes are cited in Scholz, et al., 1985.

4.1.2 Rate was calculated in the publication using rate adjustment factors.

Table 3. Spawning Migration and Calorie Loss (Fraser River)

Fraser River Location	Total Calories[1] (kCal)	Total Weight[1] (grams)	Caloric Density (calories/ gram)
At River Mouth	5,173	2,585	2.00
At Spawning Grounds	2,248	2,363	0.95
After Spawning and Death	1,334	1,917	0.70
Percent Loss at Spawning Grounds	**57%**	**9%**	**52%**
Percent Loss After Spawning and Death	**74%**	**26%**	**65%**

Notes:
All values are based on Idler and Clemens, 1959.
[1]Based on average of male and female values.

Note: The Kootenai Tribe finalized their heritage report in November of 2014. Following that finalization, further work was done to summarize various aspects of the derivation of heritage rates in table format. These revised tables were incorporated directly into the heritage rate reports for the other Idaho Tribes. Since the Kootenai report had already been finalized, these more detailed tables are presented as an addendum to the

Review of Heritage Fish Consumption Rates from Idaho Tribal Heritage Fish Consumption Rate Reports for Columbia Basin and Kootenai Tribes (Ridolfi

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)
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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Figure 1. Key geographic features referred to in this report.