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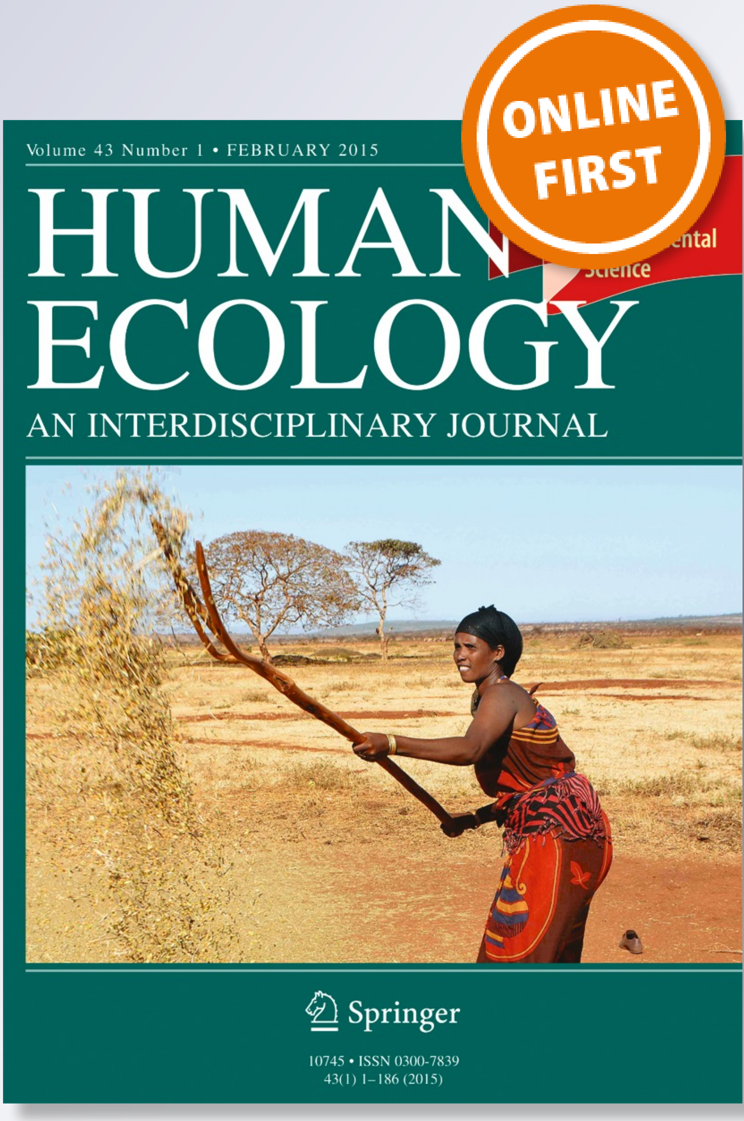

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Barbara L. Harper · Deward E. Walker Jr.

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

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

The Concept of Heritage Fish Consumption Rates

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

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

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

B. L. Harper (✉)
School of Biological and Population Health Sciences, Oregon State University, Corvallis, OR 97331, USA
e-mail: bharper@amerion.com

D. E. Walker Jr.
Walker Research Group, Ltd., University of Colorado Boulder, P.O Box 4147, Boulder, CO 80306-4147, USA

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

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

Approaches to Dietary Reconstruction

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

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

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

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

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

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

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

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

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

Heritage Rates in the Columbia Basin

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

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

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

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

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

Per Capita Fish Consumption – Early Estimates Through 1974

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

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

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

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

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

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

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

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

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

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

Per Capita Consumption—Improved Estimates

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

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

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

Conclusion

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

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

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

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

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

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

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