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

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

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

Introduction

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

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

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

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

The Concept of Heritage Fish Consumption Rates

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

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

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

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

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

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

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

original heritage rate, but does not make any policy recommendations.

Applications of Contemporary and Heritage Fish Consumption Rates

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

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

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

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

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

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

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

Survey Methods and Columbia Basin Data

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

Contemporary Statistical Surveys

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

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

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

Statistical surveys can be difficult to administer and validate in indigenous populations, particularly in cases where the people continue to use large parts of their traditional territory for subsistence (Wolfe and Walker 1987; Berkes 1990; Berkes *et al*. 1995). Native harvest data are normally obtained by recall survey rather than direct observation, raising typical issues of species identification, precision and uniformity of survey parameters and interview terminology, sampling procedures, non-response bias, and response bias. Most estimates of the fish harvest of northern Native Canadians (Berkes 1990), for example, are recent and were carried out in

connection with development proposals, or arose from conflicts between subsistence and commercial use of valuable salmon species (Berkes 1979, 1983; Hopper and Power 1991; Johnson *et al*. 2009). Nobman *et al.* conducted a large dietary survey of Alaska Natives using a food frequency questionnaire validated with 24-h recall interviews, clinical interviews, and food models. Their study documented the amount of different foods eaten differed by age groups within each gender, illustrating a real variability that would have been masked if only the group mean had been determined. Individual tribes also regulate their own harvests and typically work with states to set annual catch limits based on the size of annual runs, although it is problematic to extrapolate this information into fish consumption rates for individuals.

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

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

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

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

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

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

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

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

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

Ethnographic Surveys

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

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

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

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

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

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

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

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

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

Heritage Rates in the Columbia Basin

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

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

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

[2] Confederated Tribes of the Umatilla Indian Reservation.

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

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

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

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

Discussion

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

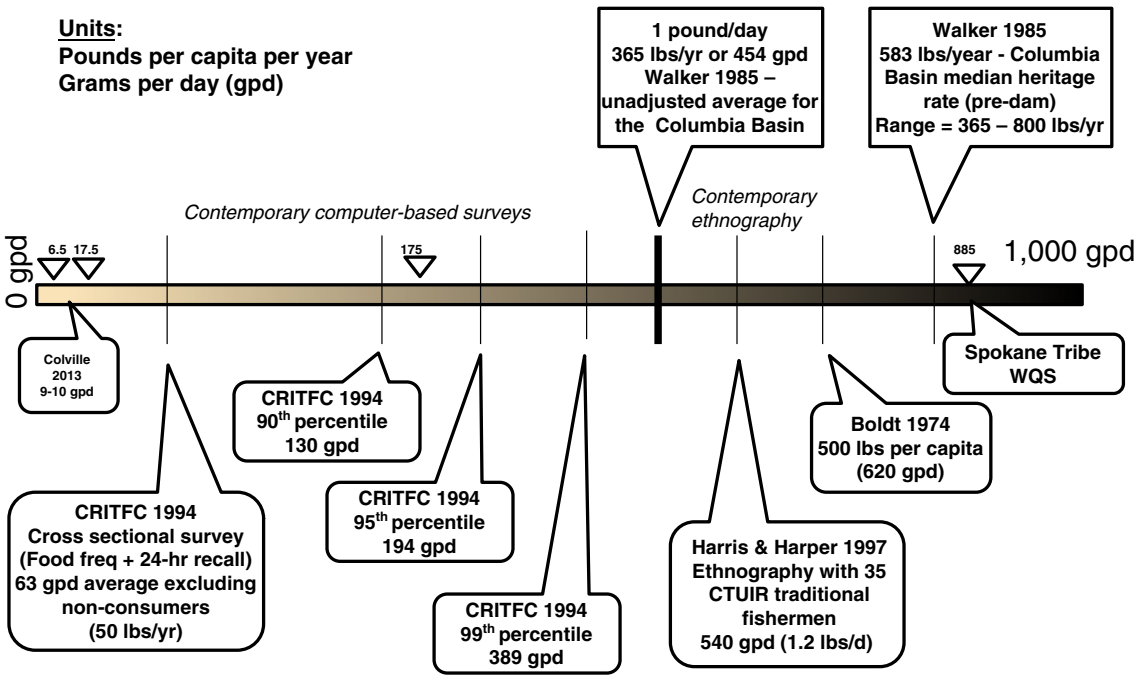

Fig. 1 Columbia Basin fish consumption rates

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

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

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

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

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