IEc

RECREATIONAL CONSUMPTION AND RESOURCE USE SURVEY SAMPLING AND ANALYSIS PLAN FOR THE UPPER COLUMBIA RIVER SITE HUMAN HEALTH RISK ASSESSMENT AND REMEDIAL INVESTIGATION/FEASIBILITY STUDY

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prepared for:

U.S. Department of the Interior

National Park Service

Lake Roosevelt National Recreation Area

Coulee Dam, WA

prepared by:

Chris Leggett, Mark Curry, and Nora Scherer

Industrial Economics, Incorporated

2067 Massachusetts Avenue

Cambridge, MA 02140

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INTRODUCTION

As requested by the U.S. Environmental Protection Agency (EPA), the U.S. Department of the Interior's National Park Service (NPS) is conducting a recreational consumption and resource use survey on the Upper Columbia River (UCR) from the Grand Coulee Dam to the U.S./Canadian border (Appendix A). This survey is being conducted as described in the June 2006 Settlement Agreement for the UCR Remedial Investigation and Feasibility Study (RI/FS) entered into by the U.S. Department of Justice, the U.S. Environmental Protection Agency, Teck Cominco Metals Ltd. (currently known as Teck Metals Ltd.), and Teck Cominco American Incorporated (currently known as Teck American Incorporated). The purpose of this survey is to obtain site-specific data on human uses of the UCR for use in the baseline human health risk assessment being conducted by the EPA. In addition, this survey will provide information to assist in risk communication and risk management. The U.S. Department of the Interior (DOI) will be responsible for implementing the survey in coordination with the EPA, the State of Washington, the Confederated Tribes of the Colville Reservation, the Spokane Tribe of Indians, and Teck.

The study will be conducted through an on-site survey of visitors to the UCR. This on-site survey will consist of three components: a boating component, a camping component, and a day-use beach component. All three components of the survey effort will involve on-site interviews with samples of randomly selected visitors. The interviews will take place over a 12-month period to account for seasonal variation in use and exposure. In addition, we will recruit frequent fish consumers to participate in a three-month panel designed to establish fish consumption rates with minimal recall bias. By combining data from the three components of the survey and the panel, EPA will be able to characterize exposure of the overall population of UCR visitors.

The sampling and analysis plan is organized as follows. We begin by providing a brief description of the overall study design. We then describe the sampling plan, including the selection of survey days, survey locations/shifts, and visitors; vehicle counting procedures; and expected sample sizes. Finally, we describe in detail how the data collected through the survey effort will be used to quantify exposure and how appropriate sampling weights will be calculated.

OVERVIEW OF STUDY

Objective

The purpose of this survey is to establish a site-specific estimate of the degree of recreational use of the UCR. The survey will gather data that will allow for the characterization of the population of recreational visitors to the UCR with respect to activities that may involve health risks due to exposure to UCR-related contaminants. The population of visitors includes both local visitors who reside near the UCR and visitors who have traveled far from their homes.

EPA has specified detailed data quality objectives (DQOs) that describe visitor characteristics required for the human health risk assessment (Appendix B). The survey

will gather data on these characteristics, which will allow EPA to quantify exposures associated with typical recreational activities and fish consumption (Exhibit 1). For each exposure scenario, the survey will provide data that will allow for the development of central tendency exposure (CTE) and reasonable maximum exposure (RME) estimates for the UCR recreational visitor population.

Three exposure scenarios identified in the DQOs will not be addressed by the survey:

- The survey will not seek to collect information on shellfish consumption, as the consumption of shellfish by recreational visitors to the UCR is expected to be rare.
- The survey will not seek to collect information on consumption of game. Although hunters frequently stay overnight at campgrounds within Lake Roosevelt National Recreation Area, they typically hunt either in upland areas away from the lake or, in the case of waterfowl hunting, on upstream sections of UCR tributaries.
- The survey will not seek to collect information on exposures during showering. A review of site amenities has found that there are no enclosed private showering facilities. Although major day-use beaches have cold water foot washes, the water source for these wash areas is not expected to be untreated UCR water. Therefore, exposure during showering is unlikely to be a complete UCR exposure pathway.

EXHIBIT 1: SUMMARY OF DQO DATA REQUIREMENTS ADDRESSED BY SURVEY

DATA REQUIREMENT (FROM TABLE 1 OF DQOS)	SURVEY QUESTION(S) PROVIDING REQUIRED DATA
Respondent age, gender, and zip code	E1, E2, E4
Total number of visits/year and average days/visit at UCR location 'x'	C3, C4, C7, C8, C9, C11, C12
Average number of hours/day spent outdoors at UCR location 'x'	B1, B2, B5, B6 (boating survey); B1, B4, B5 (camping survey); B1 (beach survey)
Average number of days/visit and hours/day spent swimming in UCR at location 'x'	B3, B7 (beach survey); B3, B4, B5, B6 (boating survey); B4, B5 (camping survey)
Average number of days/visit and hours/day spent performing activity 'a' at UCR location 'x'	B4, B5, B8, B9 (beach survey); B3, B4, B5, B6 (boating survey); B4, B5 (camping survey)
Average number of showers/visit and minutes/shower using facilities at UCR location 'x'	Not applicable
Total number of meals/year, average meal size, and typical size range of fish species 's' and tissue type 't' derived from UCR location 'x'	D3, D4, D5, D6, D7, D8, D9, angler diary
Total number of days/visit and average number of liters ingested/day for untreated UCR surface water from location 'x'	B8 (boating survey); B7 (camping survey), B11 (beach survey)

Visitor Contacts

Visitors to the UCR will be contacted at public boat launches, marinas, day-use beaches, and campgrounds. Boaters and day-use beach visitors will be contacted as they depart the UCR after completing trips, while campers will be contacted during the early evening at their campsites. The allocation of the sampling effort across time will approximately reflect the temporal pattern of visitation at the site, with increased effort on weekends and during the peak season. The allocation of effort across access points will approximately reflect the geographic distribution of visitation, with increased sampling rates at more popular sites.

Preliminary estimates based on expected visitation levels, response rates, and survey length indicate that we will obtain approximately 3,500 to 4,000 completed interviews with UCR visitors: approximately 40% of these interviews will be at boat launches and marinas, 30% at campgrounds, and 30% at day-use beaches. With regard to the spatial distribution, we estimate that approximately 45% of the completed interviews will take place in the Lower UCR, approximately 35% in the Middle UCR, and approximately 20% in the Upper UCR.

On-Site Survey

The on-site survey is designed to collect data that will allow us to characterize visitors' potential exposure to contaminated media at the site. The survey will consist of four components: (1) questions about the activities pursued over the past 24 hours (for day trips, the focus is on activities pursued since arriving at the site), (2) questions about trips to the site during the most recent 12-month period, (3) questions about annual fish consumption from the site, and (4) questions related to respondent demographics. Each of these components is described in detail below, and the draft survey instrument is attached in Appendix C.

- **Recreational Activities Pursued Within Last 24 Hours**: Questions about the most recent 24-hour period are designed to provide information about exposure durations for a variety of activities. For each of several activities (e.g., swimming, wading, spending time on the beach), the survey will ask how much time was devoted to that activity over the past 24 hours. Respondents will also be asked about the quantity of UCR water that they intentionally consumed over the past 24 hours (e.g., filling a water bottle with lake water). For reference, the interviewer will show the respondent a water bottle with relevant volumes marked on the outside.
- **Annual Trips**: Questions about annual trips to the site will provide information that will allow for the calculation of exposure frequencies and sampling weights. The survey will request information on trips taken to the UCR over the most recent 12-month period, including specific destinations visited. This information will be provided separately for overnight camping trips, boating day trips, and beach day trips.

- **Annual Fish Consumption**: Given the potential for high exposure rates via fish consumption, every respondent will be asked a set of detailed questions about annual consumption of fish. The fish consumption questions will focus on consumption of UCR fish over the last 12 months, region of the UCR from which fish were obtained (see Appendix D), the size range for fish kept for consumption on the current trip, body parts that are typically consumed, responses to fish consumption advisories, and typical meal size. The interviewer will show the respondent photographs of 6-oz, 8-oz, and 10-oz fish fillets for reference in determining typical meal size (Appendix E).
- **Respondent Demographics**: The survey will gather basic data on demographic characteristics that are expected to be useful as covariates in the risk assessment. These include age, gender, number and age of children, and zip code. There will be no effort to distinguish tribal from non-tribal visitors in the survey. However, respondents will be asked if they are currently participating in the CCT Tribal Use Survey.

Fish Consumption Diary

Anglers who consume fish frequently from the site will likely have difficulty remembering the number of fish meals consumed over the last twelve months (see, e.g., Chase and Godbey 1983, Chase and Harada 1984, Chu et al. 1992, Harris and Bergersen, 1985, Tarrant et al. 1994). In order to improve the accuracy of consumption information obtained from these anglers, we will recruit high-consumption anglers to complete a fish consumption diary. We define high consumption anglers as anglers who report eating more than ten fish meals per year from the UCR.

At the beginning of each month, all high-consumption anglers recruited during the previous month will be sent a packet of materials consisting of (1) an introductory letter, (2) a booklet or "diary" for recording fish meals consumed, (3) a photograph depicting 6-oz, 8-oz, and 10-oz fillets, and (4) drawings of the fish species available in the UCR (Appendix F). The diary will request the following details for all fish meals consumed over a three-month period:

- Date that the meal was consumed
- Fish species consumed
- Origin of the fish
- Fish body parts consumed
- Approximate meal size
- Consumption by a randomly selected child within the household
- Meal size for the child (if applicable)

The anglers will be telephoned every month for three months to obtain information on all meals recorded in the booklet. The monthly telephone calls serve several purposes: they provide a reminder to anglers to fill out their diary, they provide a regular connection to the research team that will encourage participation, and they gather monthly data that can

be used in the event the angler drops out of the study before the three months are over. At the end of the three-month period, the angler will be asked to return the diary in a self-addressed, stamped envelope. We limit the diary period to three months to minimize burden on individual anglers and to avoid the attrition that would likely occur over a longer time period.[1] In order to encourage participation, every angler who completes the diary will be paid $50 at the end of the three-month period.

Survey Pretesting

A field pretest was conducted at the UCR over a four-day period (two weekdays and two weekend days) from Thursday, June 17, 2010 to Sunday, June 20, 2010. The purpose of the pretest was to evaluate the survey instrument and intercept procedures so that potential problems could be identified and addressed prior to implementing the full survey. IEc staff conducted surveys with visitors at boat launches, campgrounds, and day-use beaches (Exhibit 2) using intercept procedures similar to those planned for the full survey. When feasible, post-interview probes were used to evaluate the survey instrument and visual aids.

EXHIBIT 2: PRETEST LOCATIONS

BOAT LAUNCHES	CAMPGROUNDS	DAY-USE BEACHES
Northport[a]	Evans	Evans
China Bend	Kettle Falls	Colville Flats
Kettle Falls	Haag Cove	Bradbury
Hunters	Two Rivers	Fort Spokane[a]
Fort Spokane	Fort Spokane	Spring Canyon[a]
Porcupine Bay	Keller Ferry	
Seven Bays	Spring Canyon	
Lincoln		
Keller Ferry		
Spring Canyon		

Note:
[a] –Interviewing terminated prior to end of shift due to absence of visitors.

Overall, 130 individuals were intercepted during the four-day period, resulting in 106 completed surveys and 24 refusals, for a response rate of approximately 82 percent. Of the completed surveys, 36 were at boat launches, 46 were at campgrounds, and 24 were at day-use beaches. Response rates were relatively high for all three types of sites, with an 87 percent response rate at boat launches, an 80 percent response rate at campgrounds, and a 75 percent response rate at beaches. Significant observations from the pretest regarding the survey instrument and intercept procedures are described in Appendix G.

[1] Tarrant et al. (1994) also used a three-month diary period to obtain data on fishing trips taken by licensed anglers in Illinois.

Overview of Exposure Calculations

Exposure from fish consumption will be calculated by combining reach-specific data on chemical concentrations in fish with information obtained directly from the survey on the frequency, quantity, species, and source of fish that each individual respondent ingested from the UCR during the most recent 12-month period.

Exposure to abiotic media (e.g., surface water, sediment, air) during recreational activities will be calculated by combining location-specific chemical concentrations with two types of information from the survey: (1) information obtained directly from each respondent on the number and location of recreation days at the Site during the most recent 12-month period and (2) averages across respondents for the amount of time spent pursuing various activities on each recreation day. Average exposure times are transferred from other respondents due to concerns about recall bias: to minimize recall bias, the survey focuses on exposure times during the current trip only and does not ask about exposure times during past trips to the Site.[2]

The sampling approach and survey instrument have been carefully designed to maintain consistency between the types of recreation days for which we are calculating average exposure times and the types of recreation days for which we are determining exposure frequencies. Recreation days at the UCR have been classified into four groups:

1. Beach Day Trips: trips to UCR day-use beaches where the visitor *does not* stay overnight at a UCR campground (intercepted at day-use beaches).
2. Boating Day Trips: boating trips to the UCR where the visitor *does not* stay overnight at a UCR campground (intercepted at boat launches and marinas).
3. Camping Days at Drive-In Sites: camping days at UCR drive-in campgrounds (intercepted at drive-in campgrounds).
4. Camping Days at Boat-In Sites: camping days at UCR boat-in locations (intercepted at boat launches and marinas).

Visitors who stay at UCR drive-in campgrounds will not be intercepted at day-use beaches or boat launches, as campers' boating and swimming exposures will be included in exposure times for drive-in camping days. That is, interviews conducted at campgrounds will include questions about all activities within the most recent 24-hour period, and any swimming or boating activities by campers will be included in these responses.

[2] While a diary-type approach could be used to minimize recall bias in reporting recreational activities in addition to fish consumption, preliminary risk estimates (U.S. EPA 2009) indicate that exposure during recreational activities is likely to be a less important risk driver than fish consumption. The baseline HHRA will acknowledge the potential uncertainties associated with the use of 12-month recall estimates for recreational activities.

SAMPLING PLAN

1. OVERVIEW

The target population for this survey is individuals who visit the UCR between the Grand Coulee Dam and the U.S./Canadian border. Visitors will be sampled on site at boat launches, marinas, campgrounds, and day-use beaches. The sampling unit at boat launches and marinas will be boats departing the lake, the sampling unit at campgrounds will be occupied campsites, and the sampling unit at day-use beaches will be departing visitor parties. For convenience, we describe these sampling units as "trips" in the discussion that follows.[3] From a sampling perspective, these trips are clustered by day, access point, and shift.

As visitor characteristics may differ across access points and times of year, our sampling plan is designed to spread sampled trips across all seasons and across all sites, with higher sampling rates used at high-use sites and during high-use time periods. For logistical reasons and because actual use will differ from expected use, the sampling rates will not be exactly proportional to actual use. However, we will be able to characterize *trips* to the lake using weights that reflect actual sampling rates. Characterizing the *visitor* population requires weights that reflect visitor selection probabilities. These weights will be discussed in detail in the analysis plan.

The sampling will be implemented in three stages:

1. Sampling Days: a stratified sample of survey days will be selected, with days stratified by peak season versus off-peak season and weekdays versus weekend days. In addition, the peak season will be stratified by month, and it will have a separate stratum representing high-use holiday weekends.
2. Sampling Sites/Shifts: on each selected survey day, interview sites/shifts will be randomly selected, with sites stratified by lake region (Upper, Middle, and Lower UCR). Sites and shifts with high expected use will be sampled with higher probabilities than sites/shifts with low expected use.
3. Sampling Visiting Parties: at each selected site/shift, a sample of visiting parties will be selected for interviews. Within each selected visiting party, a randomly-selected adult (i.e., at least 18 years old) will be interviewed by survey personnel. At sites with low visitation, all visiting parties will be interviewed.

This multi-stage sampling approach is described as "cluster sampling" in the statistics literature, as visiting parties are clustered into groups by day and site/shift for sampling purposes. The days are referred to as primary sampling units, and the sites/shifts are referred to as secondary sampling units.

[3] In the case of the camping survey, the sampling unit would more accurately be described as a camping "day" rather than a "trip."

2. SAMPLING DAYS

This survey will take place over the course of 12 months, from October 1, 2010 to September 30, 2011. We divide the 12-month period into eleven mutually exclusive and exhaustive strata based on type of day (weekend, weekday, or holiday), month, and season (peak or off-peak season). The peak season is defined as the first day of Memorial Day weekend to the end of September. The off-peak season is defined as the first day of October to the last day prior to Memorial Day weekend. Off-peak season days are classified as either weekend days or weekdays, while peak season days are classified by month and as weekend days, weekdays, or holidays. We use the additional "holiday" category during the peak season to identify days that fall during the three key summer holiday weekends: Memorial Day, July 4th, and Labor Day.[4] Definitions for each of the eleven strata are provided in Exhibit 3.

EXHIBIT 3: SAMPLING STRATA FOR DAYS

STRATUM	SEASON	TYPE OF DAY	MONTH	TOTAL DAYS	REGIONS SAMPLED PER DAY	SAMPLED BOATING DAYS[a]	SAMPLED CAMPING DAYS[b]	SAMPLED BEACH DAYS
T1	Off-peak	Weekend	OCT-MAY	68	1	34	34	0
T2		Weekday	OCT-MAY	171	1	17	17	0
T3	Peak	Weekend	JUN	8	3	4	4	4
T4			JUL	8	3	4	4	4
T5			AUG	8	3	4	4	4
T6			SEP	6	3	3	3	3
T7		Weekday	JUN	23	3	4	4	4
T8			JUL	20	3	4	4	4
T9			AUG	23	3	4	4	4
T10			SEP	21	3	4	4	4
T11		Holiday	n/a	9	3	9	9	9
Total:				**365**		**91**	**1**	**40**

Notes:

[a] – These columns do not represent total interviewer effort within each stratum; they simply depict the number of days during which interviewers will be on site. When calculating total interviewer effort, one must account for the fact that multiple sites are selected for sampling during every selected peak-season day (see overview of sampling effort in Exhibit 11).

[b] – Camping interviews are only conducted in the early evening when campers are expected to be at their campsites.

[4] The following days are considered holidays: May 28, 29, and 30; July 2, 3, and 4; and September 3, 4, and 5.

Peak Season

Within each of the nine peak-season strata, we select a simple random sample of days for boater interviews (Exhibit 4), with holiday and weekend strata sampled at higher rates than weekday strata. Sample sizes for the nine strata are provided in Exhibit 3. The holidays are selected with certainty (i.e., all days are selected). In addition to holidays, four non-holiday weekdays and four non-holiday weekend days are selected each month throughout June, July, and August. Four non-holiday weekdays and three non-holiday weekend days are selected in September.[5]

After removing days selected for boater interviews, we select a simple random sample of days for beach/camping interviews from each stratum.[6] Beach and camping interviews are conducted on identical days in the interest of efficiency: as camping interviews are conducted in the evenings, a single interviewer can cover a camping and a beach shift in the same day. Sample sizes for beach/camping interviews are identical to the sample sizes for the boating interviews (Exhibit 3).

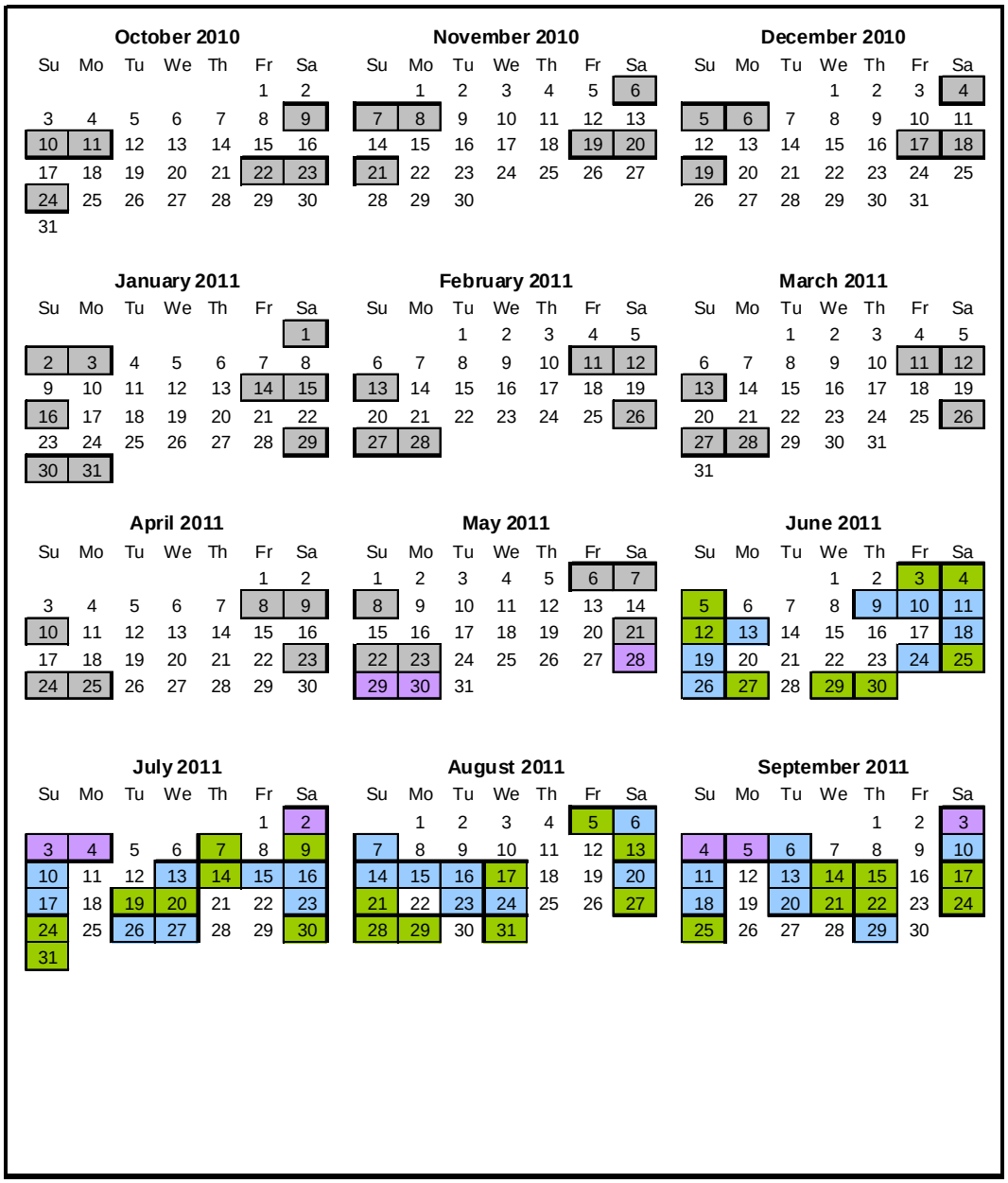
Off-Peak Season

During the off-peak season, camping and boating interviews will be conducted on identical days. Beach interviews will not be conducted at all during the off-peak season, as visitation at day-use beaches is expected to be minimal from October to May.

Within each off-peak season stratum, we use systematic sampling of days to ensure that the sampled days are evenly spread throughout the time period and to simplify the logistics of survey implementation (see Pollock et al. 1994 and Chapter 8 in Cochran 1977). We will conduct off-peak season interviews on every other weekend, on every fourth Monday, and on every fourth Friday.[7] In the interest of efficiency, we will not conduct interviews on Tuesdays, Wednesdays, and Thursdays during the off season and will instead use interviews conducted on Mondays and Fridays to represent off-season weekday visits. The first Monday of off-season interviews will take place immediately *after* the first weekend of off-season interviews, while the first Friday of interviews will take place immediately *prior* to the second weekend of off-season interviews. This will lead to alternating blocks of three interview days every other weekend. The sample sizes for off-peak season strata are depicted in Exhibit 3.

[5] September only has six non-holiday weekend days versus eight in each of the other peak-season months.
[6] The only exception is peak-season holidays, when all three types of interviews will take place.
[7] Although the off-peak season sampling frequency is similar to the peak season sampling frequency, the sampling intensity will be lower during the off-peak season (see discussion below).

EXHIBIT 4: SAMPLED DAYS



Key:

= boating, camping, and beach interviews
= boating and camping interviews
= boating interviews
= camping and beach interviews

3. SAMPLING SITES AND SHIFTS

Overview

On each selected day, one or more interview sites will be randomly selected from a pre-defined set of public access points (Exhibit 5). In addition, each selected site will be randomly assigned either an AM or a PM interview shift. The selection probabilities will be approximately proportional to expected visitation, with the selection probability for every site/shift combination equal to the product of the probability assigned to the site and the probability assigned to the shift.

Sampling Sites

The set of sampled access points comprises all major public access to the UCR between the Grand Coulee Dam and the U.S./Canadian border, with the following exceptions: (1) sites located on UCR tributaries (e.g., Napolean Bridge launch, Sanpoil campground, and Kettle River campground), (2) boat-in campgrounds (e.g., Summer Island, Barnaby Island, Sterling Point, Penix Canyon, and Plum Point), and (3) sites where interviewer access is particularly difficult (e.g., Rogers Bar and Wilmont Creek). The sites will be stratified into three regions hereafter referred to as Upper, Middle, and Lower UCR (Exhibit 5). "Upper UCR" comprises access points between Marcus Flats and the U.S./Canadian border. "Middle UCR" comprises access points between Marcus Flats and the Spokane River confluence. "Lower UCR" comprises access points between the Grand Coulee Dam and the Spokane River confluence. National Park Service car counter data indicate that approximately 48,000 vehicles visit Upper UCR sites managed by the Park Service annually, approximately 134,000 vehicles visit Middle UCR sites, and approximately 245,000 vehicles visit Lower UCR sites (Exhibit 5).

Several access points with very low expected use will not be sampled in the study. The omitted sites include Cloverleaf day-use beach, North Gorge boat launch, Jones Bay boat launch, Marcus Island day-use beach, and Kettle Falls day-use beach (Exhibit 6). At Cloverleaf and Marcus Island, the campground will be sampled but the day-use beach will not. At these sites, we expect that the majority of beach users will be individuals who are camping at the site. Similarly, at North Gorge and Jones Bay, the campground will be sampled but the boat launches will not, as we expect that mainly campers will use these boat launches, given the extremely limited parking for trailers.

For each selected peak-season day, we will randomly select three sites for interviews: one from each of the three regions. For example, boating interviews on June 9 will take place at three different randomly-selected sites: an Upper UCR site, a Middle UCR site, and a Lower UCR site.

EXHIBIT 5: SAMPLED PUBLIC ACCESS POINTS

SITE	AVERAGE ANNUAL VEHICLES, 2004-2008 (THOUSANDS)
Upper UCR	
Black Sands[a]	--
Northport[a]	--
China Bend	13.3
North Gorge	1.6
Snag Cove	4.9
Evans	15.1
Kamloops Island	3.8
Marcus Island	9.7
Total:	48.4
Middle UCR	
Kettle Falls	66.3
Colville Flats	4.6
Haag Cove	2.9
Bradbury Beach	10.6
French Rocks	1.4
Daisy	3.7
Cloverleaf	1.9
Gifford	12.3
Hunters	29.9
Total:	133.6
Lower UCR	
Porcupine Bay[b]	27.7
Fort Spokane (camping/boat launch)	59.5
Fort Spokane (beach)	18.7
Two Rivers[a]	--
Seven Bays	22.0
Hawk Creek	18.5
Lincoln	16.9
Jones Bay	1.7
Hanson Harbor	5.2
Keller Ferry	29.6
Spring Canyon	34.6
Crescent Bay	10.7
Total:	245.1

Notes:

[a] – This site is not located within the Lake Roosevelt National Recreation Area and is therefore not monitored by the NPS Public Use Statistics program.

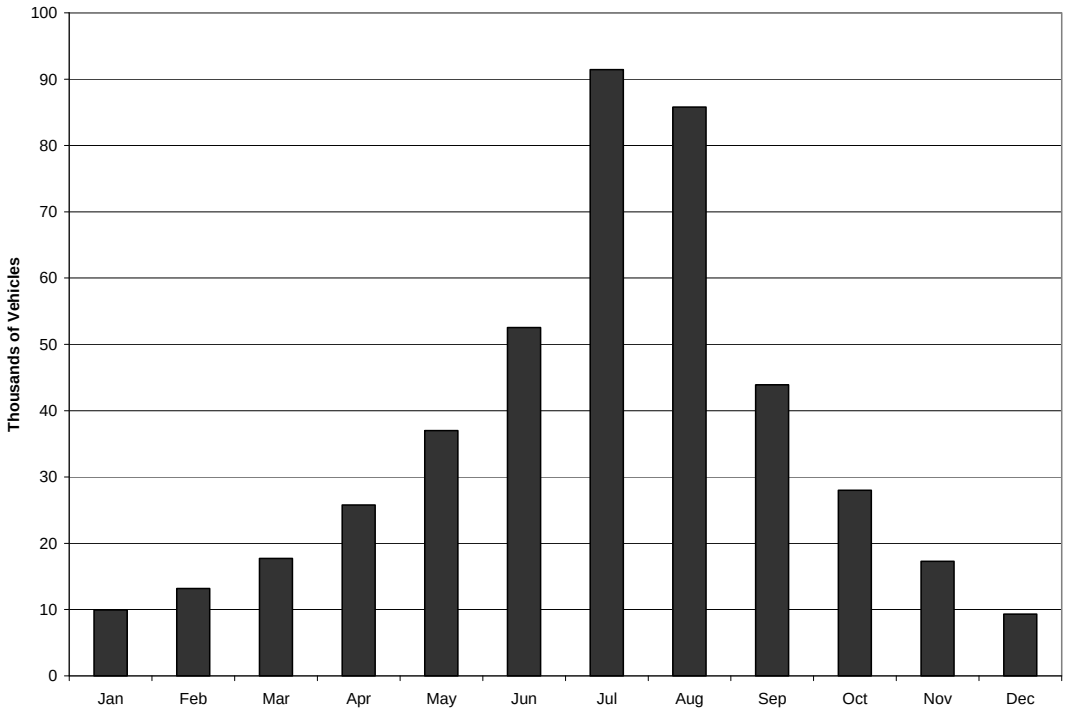
[b] - Only the boat launch will be sampled at Porcupine Bay; the day-use beach and campground will not be sampled.

EXHIBIT 6: SITES NOT SAMPLED

SITE	RATIONALE FOR OMISSION
Cloverleaf Beach	Low expected use by non-campers; campground will be sampled
North Gorge Launch	Low expected use by non-campers; campground will be sampled
Marcus Island Beach	Low expected use by non-campers; campground will be sampled
Jones Bay Launch	Low expected use by non-campers; campground will be sampled
Kettle Falls Beach	Low expected use due to stagnant water; campground and boat launch will be sampled

For each selected off-peak season day, we will randomly select one site for interviews. The decreased sampling intensity during the off season (interviewing at one site per day rather than three) reflects the decrease in expected visitation during that period (Exhibit 7). The interview region will rotate every sampling day, so that interviewing takes place in all three regions during each 3-day block of off-season sampling days. For example, during the first three-day block, a site will be selected from the Upper UCR on Saturday, from the Middle UCR on Sunday, and from the Lower UCR on Monday. The rotation pattern will vary during each 3-day block so that interviews for a given region will take place on all types of days. The specific rotation pattern for interviews in the Upper UCR will be Saturday, Sunday, Monday, Saturday, Sunday, Friday. The rotation pattern for the other two regions will be identical, but with different starting days. The pattern for Middle UCR is Sunday, Friday, Saturday, Sunday, Monday, Saturday, and the pattern for Lower UCR is Monday, Saturday, Sunday, Friday, Saturday, Sunday.

EXHIBIT 7: SEASONAL DISTRIBUTION OF VISITATION (NPS VEHICLE COUNTS)



This sampling approach will result in an equal number of survey days in each of the three regions. As noted above, however, the Lower UCR region has substantially higher visitation than the other two regions combined, and the Middle UCR region has substantially higher visitation than the Upper UCR region. Thus, our sampling approach will oversample visitors in upstream areas of the UCR relative to visitors in downstream areas. This approach is appropriate given the distribution of contaminants in the UCR: it is desirable to have larger sample sizes and therefore more accurate exposure information in areas where contaminant concentrations are highest. However, as we describe later, we will weight responses to adjust for this oversampling in developing summaries intended to reflect the entire UCR visitor population.

Sampling Shifts

Every selected boating or beach site will be randomly assigned either an AM or a PM interview shift. Camping interviews will always be conducted in the early evening from 6:00 PM to 8:00 PM, when campers are expected to be at their campsites. For boater interviews, the AM shift will cover the period from 7:00 a.m. to 1:00 p.m., while the PM shift will cover the period from 1:00 p.m. to 8:00 p.m. These sampling periods will be adjusted as daylight hours change throughout the year to avoid having interviews stationed at sites in the dark (see sunrise/sunset times in Appendix H). As more boaters are expected to leave the site during the afternoon/evening, PM shifts will be selected with probability 0.6, while AM shifts will be selected with probability 0.4. For beach interviews, the AM shift will cover the period from 8:00 a.m. to 1:00 p.m. and be selected with probability 0.25, while the PM shift will cover the period from 1:00 p.m. to 6:00 p.m. and be selected with probability 0.75.

Sampling Probabilities for Boating Sites/Shifts

Surveying will be conducted at 21 boater access sites on the UCR, 5 within the Upper UCR, 6 within Middle UCR, and 10 within Lower UCR (Exhibit 8). Selection probabilities for boating sites within each region are designed to be approximately proportional to expected use. Expected use was estimated by reviewing a variety of data sources, including NPS automated vehicle counts; NPS tent, RV, and trailer counts; campground capacities; and parking lot capacities. Expected use estimates developed from these data sources were then reviewed by NPS personnel familiar with visitor use patterns at the UCR.

EXHIBIT 8: SELECTION PROBABILITIES FOR BOATING SITES/SHIFTS

SITE	ESTIMATED BOATS LAUNCHED ON AVERAGE SUMMER WEEKEND DAY	SITE SELECTION PROBABILITY	SHIFT	SHIFT SELECTION PROBABILITY	SITE/SHIFT SELECTION PROBABILITY	EXPECTED ANNUAL SHIFTS
Upper UCR						
Northport	15	0.20	AM	0.40	0.08	5
			PM	0.60	0.12	7
China Bend	15	0.20	AM	0.40	0.08	5
			PM	0.60	0.12	7
Snag Cove	10	0.13	AM	0.40	0.05	3
			PM	0.60	0.08	5
Evans	20	0.27	AM	0.40	0.11	6
			PM	0.60	0.16	9
Marcus Island	15	0.20	AM	0.40	0.08	5
			PM	0.60	0.12	7
Total:	**75**	**1.00**			**1.00**	**57**
Middle UCR						
Kettle Falls	85	0.39	AM	0.40	0.15	9
			PM	0.60	0.23	13
Bradbury Beach	20	0.09	AM	0.40	0.04	2
			PM	0.60	0.05	3
French Rocks	5	0.02	AM	0.40	0.01	1
			PM	0.60	0.01	1
Daisy	15	0.07	AM	0.40	0.03	2
			PM	0.60	0.04	2
Gifford	20	0.09	AM	0.40	0.04	2
			PM	0.60	0.05	3
Hunters	75	0.34	AM	0.40	0.14	8
			PM	0.60	0.20	12
Total:	**220**	**1.00**			**1.00**	**57**
Lower UCR						
Porcupine Bay[a]	95	0.17	AM	0.40	0.07	4
			PM	0.60	0.10	6
Fort Spokane	125	0.22	AM	0.40	0.09	5
			PM	0.60	0.13	8
Two Rivers	45	0.08	AM	0.40	0.03	2
			PM	0.60	0.05	3
Seven Bays	45	0.08	AM	0.40	0.03	2
			PM	0.60	0.05	3
Hawk Creek	10	0.02	AM	0.40	0.01	0
			PM	0.60	0.01	1

SITE	ESTIMATED BOATS LAUNCHED ON AVERAGE SUMMER WEEKEND DAY	SITE SELECTION PROBABILITY	SHIFT	SHIFT SELECTION PROBABILITY	SITE/SHIFT SELECTION PROBABILITY	EXPECTED ANNUAL SHIFTS
Lincoln	50	0.09	AM	0.40	0.04	2
			PM	0.60	0.05	3
Hanson Harbor	15	0.03	AM	0.40	0.01	1
			PM	0.60	0.02	1
Keller Ferry	90	0.16	AM	0.40	0.06	4
			PM	0.60	0.10	5
Spring Canyon	55	0.10	AM	0.40	0.04	2
			PM	0.60	0.06	3
Crescent Bay	35	0.06	AM	0.40	0.02	1
			PM	0.60	0.04	2
Total:	**565**	**1.00**			**1.00**	**57**

Note:
[a] – Although Porcupine Bay does not lie within the boundaries of the UCR, boaters may travel to the UCR after launching from Porcupine Bay.

The site selection probabilities for the boating survey are presented in Exhibit 8. The expected number of survey days at each boating site can be determined by multiplying the selection probabilities by 57, which is the total number of boater survey days allocated to each region (40 peak-season days plus 17 off-peak season days). The resulting expected values range from a low of 1 expected shift at Hawk Creek (total AM and PM shifts) to a high of 22 expected shifts at Kettle Falls, with an overall average across all sites of 8 shifts per site (Exhibit 8). It is important to note that these figures reflect the number of *expected* shifts at each site based on selection probabilities; the number of *actual* shifts at each site may be higher or lower, depending on the outcome of the random selection process.

Due to lake level fluctuations, snow conditions, or other factors, it is possible that one or more of the sites selected for interviews on a boater sampling shift will be closed or inaccessible. As a result, a list of alternate sampling locations will be developed (in advance) for each sampling shift. The selection probabilities for this list will be as specified in Exhibit 8. When a selected site is closed on a given sampling day, the survey team will conduct interviews at the first site on the list of randomly selected alternative sampling locations for that region and day. If that site is also closed, then the survey team will continue down the list of alternative sampling locations until an open site is identified. The list of closed/inaccessible sites will be documented throughout the course of the study.[8]

[8] These site closures will increase the selection probabilities for the sites that remain open, and the adjusted probabilities will be used in the analysis. For each site, the new probability of selection

Sampling Probabilities for Camping Sites

Surveying will be conducted at 18 camping sites on the UCR, 5 within the Upper UCR, 6 within Middle UCR, and 7 within Lower UCR (Exhibit 9). Boat-in camping sites will not be surveyed as part of the camping survey, as visitors using these sites will be contacted as part of the boater survey. As with the boater survey, selection probabilities are designed to be approximately proportional to expected use.

EXHIBIT 9: SELECTION PROBABILITIES FOR CAMPING SITES

	ESTIMATED OCCUPIED CAMPSITES ON AVERAGE SUMMER WEEKEND DAY	SELECTION PROBABILITY	EXPECTED ANNUAL SHIFTS
Upper UCR			
North Gorge	5	0.05	3
Snag Cove	10	0.11	6
Evans	45	0.47	27
Kamloops Island	10	0.11	6
Marcus Island	25	0.26	15
Total:	**95**	**1.00**	**57**
Middle UCR			
Kettle Falls	65	0.54	31
Haag Cove	10	0.08	5
Cloverleaf	5	0.04	2
Gifford	25	0.21	12
Hunters	15	0.13	7
Total:	**120**	**1.00**	**57**
Lower UCR			
Fort Spokane	65	0.24	14
Two Rivers	65	0.24	14
Seven Bays	40	0.15	8
Hawk Creek	15	0.06	3
Jones Bay	10	0.04	2
Keller Ferry	25	0.09	5
Spring Canyon	50	0.19	11
Total:	**270**	**1.00**	**57**

The site selection probabilities for the camping survey are presented in Exhibit 9. The expected number of survey shifts at each camping site can be determined by multiplying the selection probabilities by 57, which is the total number of camping survey shifts allocated to each region (40 peak-season shifts plus 17 off-season shifts). The resulting

is equal to the original probability of selection divided by the sum of the original probabilities for the set of sites that were not closed.

expected values range from a low of 2 expected shifts for Cloverleaf and Jones Bay to a high of 30 expected shifts at Kettle Falls, with an overall average across all sites of 10 shifts per site.

Sampling Probabilities for Beach Sites/Shifts

Surveying will be conducted at eight day-use beaches on the UCR, two within the Upper UCR, three within Middle UCR, and three within Lower UCR (Exhibit 10). Boat-in swimming beaches will not be surveyed as part of the beach survey, as visitors using these sites will be contacted as part of the boater survey.

The selection probabilities for day-use beaches will be approximately proportional to expected use, and they will be related to the selection probabilities of nearby camping sites. Given the length of the beach and camping survey periods (five hours for beaches and two hours for camping), we plan to have a single interviewer cover both types of shifts on each sampled day. In order to limit driving time between the selected day-use beach and the selected camping site on any given day, we associate each day-use beach with one or more nearby camping sites. Whenever a camping site is selected for surveying, the associated day-use beach will also be surveyed. In some locations, sampling day-use beaches only when nearby camping sites are selected would result in sampling probabilities quite dissimilar from expected use. As a result, some beach sites are necessarily associated with camping sites that are not close by (although they are always within the same region of the UCR). When this occurs during a PM beach shift, the interviewer will not be able to begin the camping shift exactly at 6:00 p.m. In these cases, the camping shift will begin as soon as the interviewer arrives at the campground (shortly after 6:00 p.m.), and it will last for two hours.

The site selection probabilities for the day-use beach survey are presented in Exhibit 10. The expected number of survey shifts at each site can be determined by multiplying the selection probabilities by 40, which is the total number of day-use beach survey shifts allocated to each region. The resulting expected values range from a low of 5 expected shifts for Keller Ferry to a high of 28 expected shifts at Evans, with an overall average across all sites of 15 shifts per site.

EXHIBIT 10: SELECTION PROBABILITIES FOR DAY-USE BEACHES

SITE	ESTIMATED PARTIES ON AVERAGE SUMMER WEEKEND DAY	ASSOCIATED CAMPING SITES[a]	SITE SELECTION PROBABILITY	SHIFT	SHIFT SELECTION PROB.	SITE/SHIFT SELECTION PROB.	EXPECTED ANNUAL SHIFTS
Upper UCR							
Black Sands	10	NG, MI	0.31	AM	0.25	0.08	3
				PM	0.75	0.23	9
Evans	25	SC, E, KI	0.69	AM	0.25	0.17	7
				PM	0.75	0.52	21
Total:	**35**		**1.00**			**1.00**	**40**
Middle UCR							
Colville Flats	30	KF (0.5)[b]	0.27	AM	0.25	0.07	3
				PM	0.75	0.20	8
Bradbury	40	C, HC, KF (0.5) [b]	0.39	AM	0.25	0.10	4
				PM	0.75	0.29	12
Hunters	30	H, G	0.34	AM	0.25	0.09	3
				PM	0.75	0.26	10
Total:	**100**		**1.00**			**1.00**	**40**
Lower UCR							
Fort Spokane	65	FS	0.24	AM	0.25	0.06	2
				PM	0.75	0.18	7
Keller Ferry	20	KFY, JB	0.13	AM	0.25	0.03	1
				PM	0.75	0.10	4
Spring Canyon	110	SpC, HWK, SB, TR	0.63	AM	0.25	0.16	6
				PM	0.75	0.47	19
Total:	**195**		**1.00**				**40**

Notes:

[a] – NG = North Gorge, MI = Marcus Island, SC = Snag Cove, E = Evans, KI = Kamloops Island, KF = Kettle Falls, C = Cloverleaf, HC = Haag Cove, H = Hunters, G = Gifford, PB = Porcupine Bay, TR = Two Rivers, HWC = Hawk Creek, SB = Seven Bays, FS = Fort Spokane, KFY = Keller Ferry, JB = Jones Bay, SpC = Spring Canyon.

[b] –Each day that Kettle Falls is selected for camping interviews, this day-use beach will be selected for interviews with probability 0.50.

Summary

Exhibit 11 provides a summary of the allocation of sampling effort across the three regions for each of the three activities. There will be a total of 462 interview shifts during the 12-month survey period. Approximately 37% of these shifts will be allocated to boating, 37% to camping, and 26% to beach use. As camping shifts are covered together with beach shifts during the peak season and together with boating shifts during the off-peak season, these 462 interview shifts will require 291 person-days interviewing. This estimate of person-days assumes that only one interviewer is stationed at each interview location, and it does not include supervisor effort.

EXHIBIT 11: OVERVIEW OF SAMPLING EFFORT

	PEAK INTERVIEW SHIFTS	OFF-PEAK INTERVIEW SHIFTS	TOTAL INTERVIEW SHIFTS
Boating			
Upper UCR	40	17	57
Middle UCR	40	17	57
Lower UCR	40	17	57
Total:	120	51	171
Camping			
Upper UCR	40	17	57
Middle UCR	40	17	57
Lower UCR	40	17	57
Total:	120	51	171
Beach			
Upper UCR	40	0	40
Middle UCR	40	0	40
Lower UCR	40	0	40
Total:	120	0	120
Overall Total:	**360**	**102**	**462**

4. SAMPLING VISITING PARTIES

The interviewers at each selected site will follow strict procedures with regard to sampling visiting parties and selecting a single adult within each party for the interview. These procedures will help to avoid selection bias, or a tendency to over-sample individuals who are convenient to interview, not busy with other activities, or who appear friendly. We describe recommended sampling procedures for each activity below. These sampling procedures may be revised to address logistical issues that arise during the first few weeks of the survey effort.

On rare occasions, it is possible that interviewers will contact individuals who have previously completed the survey. When this occurs, the individual will be asked to provide information about his or her current trip only.

Boating Visitors

For the boating survey, interviewers will contact all visiting parties as they depart the launch site.[9] They will approach an adult within the party and ask to interview the adult who had the most recent birthday (i.e., a randomly selected adult). If the targeted adult refuses to complete the survey but an alternative adult within the party would like to complete the survey, then the party will be recorded as a completed interview, but the use of a substitute adult will be noted in the dataset. At heavily used sites, there will be occasions where the interviewer cannot contact every boating party. If a boat arrives while an interview is being conducted, then the boat will be recorded as "missed," and the interviewer will contact the next available boating party after the interview has been completed. At the conclusion of the shift, the interviewer will have separate counts of the number of parties that were interviewed, the number of parties that refused to be interviewed, and the number of parties that were missed. These counts should sum to the total number of boats departing the launch site during the shift.

Visitors will not be interviewed at boat launches if they are also camping at UCR drive-in campgrounds during their current trip. Visitors who camp at these campgrounds and who bring their boat with them on their trip will be characterized through interviews at campgrounds. Thus, interviews at boat launches will focus only on boating day trips and on boat-in camping trips. Activities pursued during these two types of UCR trips will be captured *only* through interviews at boat launches.

Four of the boating sites (Kettle Falls, Seven Bays, Two Rivers, and Keller Ferry) have houseboat rentals and/or private slips in addition to a launch ramp. Two interviewers will be stationed at each of these sites. One interviewer will focus only on the launch ramp, while the other interviewer will focus only on parties completing trips on houseboats or from private slips.

At non-marina launches, the boating interview shift will be terminated after three hours if there are no boat trailers in the launch parking lot.

Camping Visitors

With the camping survey, interviewers will begin by driving through the camping area and marking each occupied campsite on a map of the campground. (Occupied campsites are defined as individual campsites that have a tent, camper/RV, or personal equipment.) They will then use the map to count the number of occupied campsites (N). If the number of occupied campsites is less than the number of parties that can likely be approached during a single shift (n), then all camping parties will be approached by the interviewers.

[9] The interviewer location will vary by site and will depend on the physical layout of each launch area. Interviewers will typically be stationed either at the side of the paved approach to the launch or in a nearby truck/trailer parking space.

If the number of occupied campsites is greater than the number of parties that can likely be approached during a single shift, then the interviewer will systematically select camping parties. The systematic selection of camping parties will begin with the calculation of a sampling interval (k), which equals the number of occupied campsites divided by the number of parties that can likely be approached during the shift, rounded to the nearest integer ($k = N/n$). The interviewer will then proceed through the campground following the pre-established route indicated by the NPS campsite numbering system, approaching every k_{th} occupied campsite for an interview.[10] The starting point will be randomly selected. If the interviewer completes a circuit of all campsites before the end of the shift, he or she will begin a new circuit after incrementing the starting point by one.

For each camping site selected, the interviewer will approach an adult within the campsite and ask to interview the adult who had the most recent birthday (i.e., a randomly selected adult). If the targeted adult refuses to complete the survey but an alternative adult within the party would like to complete the survey, then the party will be recorded as a completed interview, but the use of a substitute adult will be noted in the dataset. At the conclusion of the shift, the interviewer will have separate counts of the number of interviews completed, the number of refusals, and the number of parties that were not approached. These counts should sum to the total number of occupied campsites counted at the beginning of the shift.

Beach Visitors

For the day-use beach survey, interviewers will contact all visiting parties after they depart the beach and head towards the parking lot.[11] They will approach an adult within the party and ask to interview the adult who had the most recent birthday (i.e., a randomly selected adult). If the targeted adult refuses to complete the survey but an alternative adult within the party would like to complete the survey, then the party will be recorded as a completed interview, but the use of a substitute adult will be noted in the dataset. At busy sites, there will be occasions where the interviewer cannot contact every party leaving the beach. If a party departs while an interview is being conducted, then the party will be recorded as "missed," and the interviewer will contact the next available party after the interview has been completed. At the conclusion of the shift, the interviewer will have separate counts of the number of interviews completed, the number of refusals, and the number of missed parties. These counts should sum to the total number of parties departing the beach during the shift.

Visitors will not be interviewed at day-use beaches if they are also camping at a UCR drive-in campground during their current trip. Visitors who camp at UCR drive-in

[10] Visitors arriving after the initial count of occupied campsites will not be interviewed.

[11] Although it is possible to survey visitors while they are on the beach, this may complicate the effort in a number of ways, including: 1) identifying distinct groups of visiting parties when parties don't remain together on the beach, 2) selecting an appropriate random sample when individuals are frequently moving in and out of the water, moving laterally along the beach, and arriving/departing, 3) describing the respondent's activities for an incomplete beach day, and 4) estimating the total number of visitors during the shift.

campgrounds and visit day-use beaches during their camping trip will be characterized through interviews at campgrounds. Thus, interviews at day-use beaches will focus only on day trips to the beach.

Bradbury Beach and Spring Canyon Beach each have multiple parking lots, which will make it difficult to determine the total number of parties completing trips to the site. However, at Bradbury Beach, an interviewer stationed in the main parking lot will be able to count vehicles exiting the secondary parking lot, as these vehicles must pass by the main parking lot en route to the exit. At Spring Canyon, additional interviewers will be required, as there are several parking lots, and it would be difficult for a single interviewer to see all of the departures.

The beach interview shift will be terminated after two hours if there is no one on the beach. In addition, the beach interview shift will be cancelled at the discretion of the supervisor if it is raining.

5. VEHICLE COUNT DATA

The sampling plan is designed to obtain a sample of trips that is well distributed across seasons, days, and times of day. However, in order to ensure that our estimates accurately reflect the temporal distribution of trips, we will use data from automated vehicle counters in the development of sampling weights. Magnetic field vehicle counters will be installed at three different sites: Evans, Hunters, and Fort Spokane (Exhibit 12). At each of the three sites, we will deploy three different vehicle counters (total of nine counters across all sites): one each at the boat launch entrance, the campground entrance, and the day-use beach entrance (Appendix I). The counters will provide time-stamped data on all vehicle entrances, which will be downloaded monthly. The counters at Evans will be used to represent Upper UCR visitation patterns, the counters at Hunters will be used to represent Middle UCR visitation patterns, and the counters at Fort Spokane will be used to represent Lower UCR visitation patterns. These three sites were selected because each site offers all three activities (boating, camping, and day-use beaches), the site entrance layouts offer the opportunity to obtain separate vehicle counts for each activity, and use levels are high enough to provide low-variance estimates of relative use levels.

EXHIBIT 12: LOCATIONS FOR SUPPLEMENTAL VEHICLE COUNTERS

AREA	SELECTED SITE	COUNTER LOCATIONS
Upper UCR	Evans	Boat Launch Campground Day-Use Beach
Middle UCR	Hunters	Boat Launch Campground Day-Use Beach
Lower UCR	Fort Spokane	Boat Launch Campground Day-Use Beach

6. EXPECTED NUMBER OF COMPLETED INTERVIEWS

This section provides estimates of the number of completed interviews that will be generated by the sampling plan described above. The expected number of completed interviews can be estimated using information on the number of interviewer shifts planned for each activity, the spatial and temporal allocation of these shifts, and assumed visitation levels at each site. It is important to keep in mind that although estimating completed interviews is important for planning purposes, the estimates are based on limited information and therefore have a large amount of uncertainty. IEc will provide an interim briefing after the first full month of surveying to determine whether adjustments to sampling rates are required to achieve adequate sample sizes.

The number of completed interviews is estimated in four steps:

1. Daily Visitation by Site: For each site, we estimate the number of sampling units (i.e., completed boating trips, occupied campsites, and completed day-use beach trips) that are likely to be at the site on a typical day. Initial estimates were developed through a review of NPS car counter data, campground capacities, and parking lot capacities. These initial estimates were revised after being reviewed by NPS personnel familiar with the site. Separate estimates are developed by month and by type of day (i.e., weekday versus weekend/holiday).
2. Daily Interviews by Site: For each site, we estimate the number of interviews that would potentially be completed if that site were randomly selected for the boating, camping, or beach survey. These estimates are obtained by multiplying the number of sampling units calculated in Step 1 by (1) the percentage of each day covered by an interview shift and (2) the expected survey response rate (70%). The estimates are truncated from above if they exceed the upper limit to the number of interviews that can be completed during a shift. This upper limit is calculated as the length of the shift divided by the expected average length of an interview (15 minutes).
3. Interviews by Shift: For each shift, we calculate the expected number of interviews anticipated. This estimate is simply a weighted average of the number of daily interviews calculated in Step 2, where the weights are equal to the site selection probabilities. Separate estimates are developed by month and by type of day.
4. Completed Interviews: We estimate the total number of interviews by multiplying the expected number of interviews per shift calculated in Step 3 by the total number of expected shifts. Separate estimates are developed by month and by type of day.

We estimate that a total of approximately 3,905 interviews will be completed during the 12-month study period: 1,622 interviews with boaters, 1,126 interviews with campers, and 1,157 interviews with day-use beach visitors (Exhibit 13). Approximately 12% of the interviews will occur during the spring, 65% during the summer, 20% during the fall, and 3% during the winter. Approximately 768 of the interviews will be completed at Upper UCR sites, approximately 1,437 at Middle UCR sites, and approximately 1,700 at Lower UCR sites (Exhibit 14).

EXHIBIT 13: NUMBER OF EXPECTED INTERVIEWS BY SEASON AND ACTIVITY

	SPRING (MAR-MAY)	SUMMER (JUN-AUG)	FALL (SEP-NOV)	WINTER (DEC-FEB)	TOTAL
Boaters	208	1,039	326	50	1,622
Campers	185	602	260	78	1,126
Beach Users	65	904	188	0	1,157
Total:	**458**	**2,545**	**774**	**128**	**3,905**

EXHIBIT 14: NUMBER OF EXPECTED INTERVIEWS BY REGION AND ACTIVITY

	LOWER UCR	MIDDLE UCR	UPPER UCR	TOTAL
Boaters	697	721	204	1,622
Campers	414	381	331	1,126
Beach Users	589	335	233	1,157
Total:	**1,700**	**1,437**	**768**	**3,905**

It is important to note that the anticipated number of completed interviews reflects a sampling plan designed to obtain a representative sample of visitors. That is, the interviews will be well distributed across the site and throughout the year. Clearly, this type of approach differs from a sampling approach designed to maximize the number of interviews with boaters, campers, and beach users. That type of sampling design would likely involve stationing interviewers only at high-use sites on weekends during the peak season. While such an approach would undoubtedly lead to a large number of interviews, it would not provide a representative view of visitor behavior.

Under certain assumptions, these sample sizes can be used to calculate expected margins of error for the exposure estimates desired. Unfortunately, such calculations require an estimate of the population variance for each parameter, which is typically unavailable prior to a site-specific study. A notable exception for the UCR involves annual fish consumption, which was assessed through a survey of frequent anglers conducted by Patrick and Marten (1997). Patrick and Marten estimated mean consumption of 42 meals per year, with a sample standard deviation of 48 meals per year.[12,13]

[12] Although mean fish consumption is reported in Patrick and Marten (2007) as "42 (+/- 48) meals per year," a review of the distribution of fish consumption reported in Table 2 of the report indicates that the 48 refers to the sample standard deviation rather than the margin of error of the estimated mean.

[13] For comparison, a survey of tribal fish consumers in the Columbia River Basin downstream of the Grand Coulee Dam (CRITFC 1994) estimated mean fish consumption of 96 meals per year with a standard deviation of 123 meals per year (see Table 8 of CRITFC; standard deviation estimated as 0.11 meals per week x 52 weeks x $\sqrt{464}$).

With a study designed to select a simple random sample of fish consumers from the UCR, the expected margin of error (i.e., confidence interval half-width) for the estimate of mean consumption can be calculated using the Patrick and Marten (1997) results and the anticipated sample size. With a 95% confidence level, the expected margin of error for the mean would equal:

$$m.e. = 1.96\frac{s}{\sqrt{n}}, \quad (1)$$

where s is the sample standard deviation from the Patrick and Marten study and n is the anticipated sample size for the current study.[14]

The sample design for the current study is considerably more complicated than that of a simple random sample. In addition, it is difficult to estimate the number of UCR fish consumers that will be interviewed. Nonetheless, we use Equation 1 to calculate the margin of error for mean fish consumption under the assumption of a simple random sample and assuming that 25% of the respondents consume fish from the UCR. Specific acceptable limits for margin of error would depend on numerous other parameters in the human health risk assessment as well as decision thresholds.

Under the assumption that 25% of the respondents consume UCR fish, we would have sample sizes of 192 for the Upper UCR, 359 for the Middle UCR, and 425 for the Lower UCR, providing margins of error for mean fish consumption of ± 6.7 meals, ± 4.9 meals, and ± 4.5 meals, for the Upper, Middle, and Lower UCR, respectively (95 percent confidence level; Exhibit 15). Exhibit 16 shows how the margin of error varies with sample size for 90%, 95%, and 99% confidence levels. While the true margin of error will differ due to the clustering and stratification inherent in our sampling plan, the overall impact of these departures from simple random sampling (i.e., the design effect) is difficult to determine *ex ante*.[15]

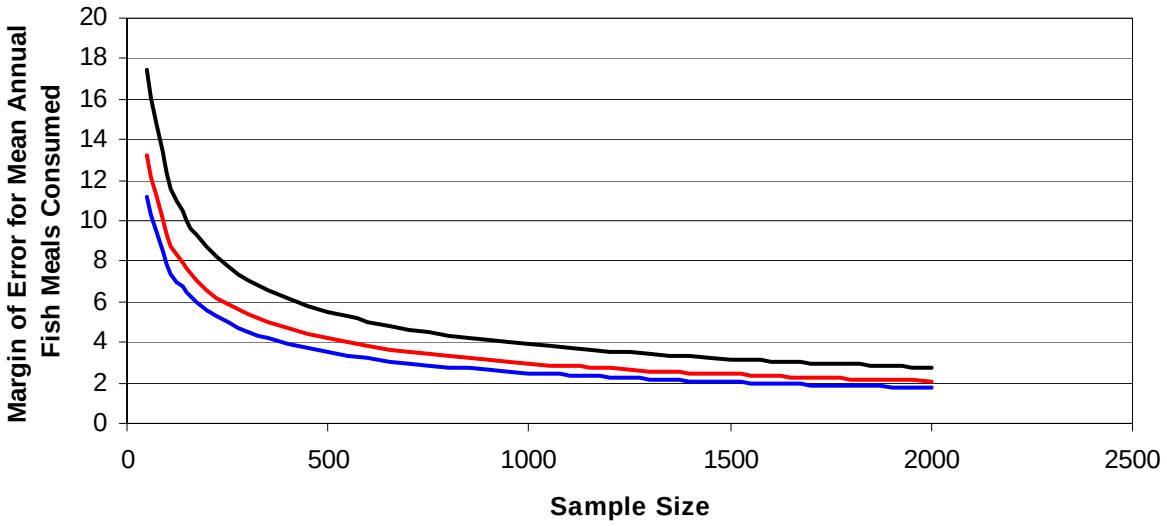
EXHIBIT 15: ANTICIPATED MARGIN OF ERROR FOR MEAN FISH CONSUMPTION

REGION	ANTICIPATED SAMPLE SIZE (FISH CONSUMERS)	MARGIN OF ERROR FOR MEAN ANNUAL FISH CONSUMPTION	RELATIVE ERROR
Upper UCR	192	± 6.7 meals/year	± 16%
Middle UCR	359	± 4.9 meals/year	± 12%
Lower UCR	425	± 4.5 meals/year	± 11%
Total:	976	± 3.0 meals/year	± 7.1%

[14] We do not evaluate the margin of error associated with the 95th percentile, as the data required for this calculation were not available from the Patrick and Marten (1997) report. We would expect greater uncertainty in estimating the 95th percentile than in estimating the mean.

[15] For comparison, Patrick and Marten (1997) obtained 448 completed surveys with Lake Roosevelt anglers and CRITFC (1994) obtained 513 completed surveys with tribal fish consumers in the Columbia River basin.

EXHIBIT 16: IMPACT OF SAMPLE SIZE ON MARGIN OF ERROR FOR 90% (BLUE), 95% (RED), AND 99% (BLACK) CONFIDENCE LEVELS



ANALYSIS PLAN

1. INTRODUCTION

The analysis plan describes the data reduction and analysis steps that are planned in order to utilize results from the visitor survey to support the HHRA. The plan focuses primarily on proposed methodologies for calculating chemical intake rates and sampling weights. For details on additional components of risk calculations, we refer the reader to the HHRA Work Plan (U.S. EPA 2009). The methodologies described in this plan may be revised and improved as data are gathered and experience is gained throughout the course of the survey.

The organization of the analysis plan is as follows. We begin by describing the planned approach to quantifying exposure from fish consumption, including separate methodologies for infrequent and frequent fish consumers. We then describe the planned approach to quantifying exposure to abiotic media during recreational activities. We conclude with a discussion of the calculations required to develop appropriate sampling weights for analyzing the survey data.

2. QUANTIFICATION OF EXPOSURE FROM FISH CONSUMPTION

Each individual's exposure from fish consumption will be calculated by combining location-specific data on chemical concentrations in fish with information from the

survey on the frequency, quantity, species, and source of fish ingested from the UCR. The average daily intake (dose) will be estimated as:

$$D_{isx} = C_{sx} * \left(IR_{isx} / BW \right) * \left(ED / AT \right) \quad (2)$$

where:

D_{isx} = Average daily intake of chemical ingested by individual *i* through consumption of species *s* obtained from UCR location *x* (ug/kg-d)
C_{sx} = Tissue concentration of chemical in species *s* from location *x* (ug/g)
IR_{isx} = Annual average daily ingestion rate by individual *i* of species *s* from location *x* (g/day)[16]
BW = Body weight (kg)
ED = Exposure duration (years)
AT = Averaging time (years)

The total daily dose for individual *i* can be calculated by summing across species and locations.

In the above equation, location-specific information on chemical concentrations for each fish species (C_{sx}) will be calculated by reach, based on site sampling data. To the extent possible, these calculations will be based on concentrations in fish that are similar in size to the fish typically caught by survey respondents.[17] Values for *BW*, *ED* and *AT* will be based on standard EPA default recommendations.

Annual average daily ingestion rates will be calculated for each respondent using one of two methods: (1) for infrequent fish consumers (< 10 meals per year from the UCR), fish ingestion rates will be calculated directly from the on-site interviews using 12-month recall estimates. For frequent fish consumers (≥ 10 meals per year from the UCR), fish ingestion rates will be calculated using data obtained from a three-month consumption diary. These two methods are described in detail below.

Infrequent Fish Consumers

The survey provides data for each respondent on the number of fish meals consumed from the UCR during the most recent 12-month period, by species, and the location(s) where each species is obtained. In addition, respondents will provide information on the typical meal size for fish meals consumed from the UCR. These two sources of information will be combined to estimate annual average daily ingestion:

$$IR_{isx} = MF_{isx} * MS_i / 365 \quad (3)$$

where:

[16] Information on location (i.e., the origin of fish consumed by UCR visitors) will be by reach.
[17] The survey includes a question designed to obtain the size range of the fish kept during the current UCR trip, by species.

IR_{isx} = Annual average daily ingestion by individual *i* of species *s* from location *x* (g/day)

MF_{isx} = Number of meals consumed by individual *i* of species *s* from location *x* during the most recent 12-month period (meals/year)[18]

MS_i = Average meal size for fish meals consumed by individual *i* from UCR (g/meal)

Frequent Fish Consumers

For respondents who eat ten or more fish meals (of any species) annually from the UCR, recall difficulties may lead to inaccurate estimates of fish consumption over the most recent 12-month period. As a result, these individuals will be asked to complete a three-month fish consumption diary, and annual average daily fish consumption will be calculated using data from this diary. The diary will provide information on the size and species of every fish meal consumed from the UCR over a three-month period.

The annual average daily fish ingestion rate (g/day) can be estimated from the diary data for each month as:

(4) $$IR_{isxm} = \left(\frac{1}{365}\sum_{k=1}^{N_{isxm}} MS_{isxmk}\right) * \left(\frac{1}{p_{sxm}}\right)$$

where:

IR_{isxm} = Estimated annual average daily ingestion by individual *i* of species *s* from location *x* based on data collected during diary month *m* (g/day)

N_{isxm} = Total number of meals eaten by individual *i* of species *s* from location *x* during month *m* (meals)

MS_{isxmk} = Size of *k*th meal eaten by individual *i* of species *s* from location *x* during month *m* (grams)

p_{sxm} = Proportion of annual UCR fish consumed by the diary population of species *s* from location *x* during month *m* (unitless)

The proportion of annual UCR fish consumption during the diary month can be estimated based on the temporal distribution of fish consumption for all diary participants. That is, p_{sxm} can be estimated as the proportion of fish consumption reported by all diary participants (*L*) for species *s* from location *x* that occurred during month m:

(5) $$p_{sxm} = \frac{\sum_{i=1}^{L}\sum_{k=1}^{N_{isxm}} MS_{isxmk}}{\sum_{m=1}^{12}\sum_{i=1}^{L}\sum_{k=1}^{N_{isxm}} MS_{isxmk}}$$

[18] When multiple locations are selected for a given species, the total meals for that species will be allocated equally across the locations.

A separate estimate of annual fish consumption can be developed for every month that the participant provides a completed diary (see Appendix J). The final estimate of annual average daily fish ingestion can be calculated by averaging the three separate monthly estimates.

As high-consumption anglers will complete both the initial on-site survey and the three-month diary, a comparison of the 12-month recall estimate from the on-site survey to the diary-based estimate may provide information on the potential uncertainty and bias associated with 12-month recall estimates.

Characterizing the Distribution of Risks

The CTE estimate for daily intake will be calculated as a weighted average across the subset of n respondents who consume fish from the UCR. Letting D_i represent average daily intake for respondent i, the CTE estimate is calculated as:

$$CTE = \frac{\sum_{i=1}^{n} v_i D_i}{\sum_{i=1}^{n} v_i}, \quad (6)$$

where v_i is the sampling weight for visitor i (see section below on sampling weights for visitors).

RME estimates for daily intake will be determined by estimating the empirical cumulative distribution function (c.d.f.) for daily intake, focusing on respondents who consume fish from the UCR:

$$\hat{F}(x) = \frac{\sum_{i=1}^{n} v_i u_i(x)}{\sum_{i=1}^{n} v_i} \quad (7)$$

where $u_i(x) = 1$ if $D_i \le x$

0 if $D_i > x$.

The RME value can then be determined by evaluating the inverse of the estimated c.d.f. at 0.95.[19]

In addition to the subset of respondents who consume fish from the UCR, CTE and RME estimates may be calculated for a variety of other fish consumption populations of interest in the risk assessment. For example, CTE and RME estimates may be calculated for the subset of visitors who consume a particular species of fish from the UCR.

3. QUANTIFICATION OF EXPOSURE FROM RECREATIONAL ACTIVITIES

Overview

Each individual's exposure to abiotic media (i.e., surface water, sediment, and air) during recreational activities (i.e., swimming, wading, spending time on the beach, and spending time indoors while camping) will be calculated by combining location-specific chemical concentrations with two types of information from the survey: (1) individual-specific data on the number of recreation days at the Site and (2) group averages for the amount of time spent pursuing various recreational activities on each recreation day (see Appendix K). Group averages are used to characterize exposure times due to concerns about recall bias: to minimize recall issues, the survey focuses on exposure times during the current trip only and does not ask each respondent about exposure times during past trips to the Site.

Individual-specific data on recreation days at the Site during the most recent 12-month period will be classified by type, timing, and location.

- Type: Four categories will be used to classify the type of recreation day: camping days at drive-in campsites, camping days at boat-in campsites, boating days, and beach days.
- Timing: The timing of recreation days will be classified by season (Spring, Summer, Fall, and Winter).
- Location: The location of recreation days will be classified by access point (e.g., Bradbury Beach or Evans Campground).

Group average exposure times will be calculated by type of day (drive-in camping, boat-in camping, boating, or beach day), timing (Spring, Summer, Fall, or Winter), and contact location (Upper, Middle, and Lower UCR). As described in the section on sampling weights for visitor days, these averages will be weighted by the inverse of the selection probabilities.

[19] This is similar to selecting the 95th percentile from a transformed dataset where each daily intake observation, D_i, is replicated v_i times in the dataset.

Calculating Individual Doses

The individual-specific data on recreation days will be combined with group average exposure times to estimate daily chemical intake (dose) for each survey respondent as follows:

$$(8) \qquad D_{iabtx} = C_x * \left(IR_a / BW \right) * \left(EF_{ibtx} / 365 \right) * ET_{abtx} * \left(ED / AT \right)$$

where:

D_{iabtx} = Intake of chemical by respondent *i* associated with activity *a* during recreation days of type *b* in time period *t* at location *x* (mg/kg-day)
C_x = Concentration of chemical in media at location *x* (mg/L)[20]
IR_a = Intake rate of media while pursuing activity *a* (L/hr)
BW = Body weight (kg)
EF_{ibtx} = Number of recreation days for respondent *i* of type *b* in time period *t* at location *x* (days/year)
ET_{abtx} = Average time spent pursuing activity *a* during recreation days of type *b* in time period *t* at location *x* (hrs/day)
ED = Exposure duration (years)
AT = Averaging time (years)

The total dose for individual *i* can be calculated by summing across locations, time periods, types of recreation days, and activities.

In the above equation, information on chemical concentration (e.g., concentration in surface water) will be based on site sampling data or will be estimated by modeling. For boating day trips, the chemical concentration data will be associated with locations visited by boaters after they have launched. These locations will be determined by asking respondents to list the location(s) visited from each launch site during past trips. For beach day trips and camping trips, the chemical concentration data will be associated with the beach and campsite locations identified by the respondent.

Information on intake rates (e.g., water ingestion while swimming) will be based on default parameters from the literature or professional judgment.

As noted above, the survey will not seek to obtain individual-specific estimates of long-term average exposure time or exposure frequency values for specific recreational activities (e.g., number of days per year and hours per day that the respondent goes swimming), as it would likely be difficult for respondents to recall this information accurately. Instead, visitors will be asked about their recreational activities within the past 24 hours. These data will be used to derive population-based probabilities for each activity, and the probabilities will be used to estimate long-term average activity-specific exposure time and exposure frequency values for each survey respondent. The methods for estimating exposure time and exposure frequency from the data collected in the survey are discussed in detail in Appendix K.

[20] For illustration purposes, all units assume that the abiotic medium is lake water.

Characterizing the Distribution of Risks

As with fish consumption, the CTE estimate of exposure from recreational activities is calculated as a weighted average across respondents:

$$CTE = \frac{\sum_{i=1}^{n} v_i D_i}{\sum_{i=1}^{n} v_i}, \quad (9)$$

where v_i is the sampling weight for visitor *i* (see section below on sampling weights for visitors) and D_i is the dose for individual *i*.

The RME estimate of exposure will be determined by estimating the empirical c.d.f. as:

$$\hat{F}(x) = \frac{\sum_{i=1}^{n} v_i u_i(x)}{\sum_{i=1}^{n} v_i} \quad (10)$$

where $u_i(x)$ is defined above. The RME value can then be determined by evaluating the inverse of the estimated c.d.f. at 0.95.

4. CALCULATING SAMPLING WEIGHTS

When estimating population parameters from sample data, weights must be applied when unequal probabilities are used in sampling. That is, elements of the sample with higher selection probabilities must be assigned lower weights than elements with lower selection probabilities when calculating means or other population parameters. The differential weights compensate for the unequal selection probabilities, resulting in unbiased parameter estimates.

Unequal sampling probabilities are incorporated in the sampling approach for the current study in three general ways:

- Stratified Sampling of Survey Days: The survey days are stratified by peak/off-peak, month, and weekend/weekday. As total visitation within each stratum is unknown, the sampling rates will not necessarily be proportional to visitation.
- Unequal Probabilities of Selection for Access Points and shifts: On each sampling day, a subset of access points and shifts is selected for surveying using selection probabilities that differ across sites/shifts.
- On-Site Sampling of Visitors: As visitors are selected on site, individuals who visit the site more frequently will have a higher probability of selection.

Two different types of sampling weights are required in the analysis: (1) weights for characterizing visitor days and (2) weights for characterizing visitors. We describe each of these weights in detail below.

Sampling Weights for Visitor Days

As described above, the quantification of exposure from recreational activities requires the calculation of average exposure times for visitor days. These averages will be calculated by activity (e.g., swimming), type of recreation day (i.e., camping, boating, beach), time period (Spring, Summer, Fall, Winter), and location (Upper, Middle, or Lower UCR). An example is the average time spent swimming by visitors contacted during the summer at Upper UCR day-use beaches.

Visitor days are not selected with equal probabilities, and they must therefore be weighted before calculating average exposure times. The sampling weight associated with a visitor day is equal to the inverse of that day's probability of selection. Letting p_i represent the probability of selecting visitor day i, the sampling weight is calculated as (Lohr 1999, pg. 103):

$$w_i = \frac{1}{p_i}. \tag{11}$$

Letting S represent a particular set of visitor days, the weighted average exposure time for S would be calculated as:

$$ET = \frac{\sum_{i \in S} w_i ET_i}{\sum_{i \in S} w_i} \tag{12}$$

Note that if the selection probabilities are equal, the sampling weights are identical and this expression simplifies to a standard, unweighted average.

In our application, the sampling weight is given by:

$$w_{hxit} = \left(p_{t|h} * p_{x|t} * p_{i|t,x}\right)^{-1} \tag{13}$$

where:

w_{hxit} = Sampling weight for visitor day i observed at location/shift x during day t within temporal stratum h.

$p_{t|h}$ = Probability of selecting day t, conditional on sampling within temporal stratum h (i.e., fraction of days selected for sampling within stratum h).

$p_{x|t}$ = Probability of selecting location/shift x, conditional on sampling during day t (i.e., site/shift selection probability from the sampling plan).

$p_{i|t,x}$ = Probability of selecting visitor i, conditional on sampling during day t at location/shift x (i.e., fraction of adults interviewed during day t at location/shift x).

The sum of the sampling weights within each temporal stratum provides an estimate of the number of adult visitors within the stratum. However, due to sampling error, these sampling weights may not accurately reflect the temporal distribution of visitor days across strata. For example, if it happens to rain on three out of four weekend days

selected for day-use beach sampling in August, August weekend visits to day-use beaches will be under-represented in the dataset. As a result, data from the supplemental vehicle counters, which provide daily vehicle counts throughout the entire year, are used to adjust these sampling weights, as follows:

(14) $$\widetilde{w}_{hxit} = w_{hxit} * \left(\frac{\alpha_h}{\beta_h} \right)$$

where:

$\widetilde{w}_{hxit}$ = Adjusted sampling weight for visitor day *i* observed at location/shift *x* during day *t* within temporal stratum *h*.

w_{hxit} = Sampling weight for visitor day *i* observed at location/shift *x* during day *t* within temporal stratum *h*.

α_h = Proportion of visitor days in stratum *h* as measured by supplemental car counter.

β_h = Proportion of visitor days in stratum *h* as measured by sampling weights (sum of sampling weights in *h* divided by sum of sampling weights in all temporal strata)

The proportion of recreation days in each temporal stratum will be estimated using data from the supplemental vehicle counters deployed at Evans (Upper UCR), Hunters (Middle UCR), and Fort Spokane (Lower UCR). At each site, three counters will maintain separate counts of vehicles entering the camping area, the boat launch area, and the day-use swimming area. These counters will provide time-stamped data on vehicle entrances, thus allowing us to estimate the relative visitation rates during each temporal stratum, by region and type of visitor day.

Sampling Weights for Visitors

With on-site sampling, visitors do not have identical probabilities of being selected into the sample, so survey responses will need to be weighted when attempting to characterize the visitor population (i.e., through the calculation of CTE and RME exposure estimates). Each sampled visitor must be assigned a weight equal to the inverse of his/her probability of selection (U.S. EPA 1997; Price, Su, and Gray 1994; Ray et al. 2007; Thomson 1991). With a simple random sample, these probabilities are all equal, so the weights are identical and drop out in estimating population parameters. With on-site sampling, the probability of selection will differ for each visitor, depending on the type, timing, location, and number of trips that the visitor takes to the UCR.

Consider a simple example involving day trips to a hypothetical beach. Suppose 500 of the visitors are "Type A" visitors and visit three times a year, while 500 of the visitors are "Type B" visitors and visit only once a year. Clearly, when averaging across the entire population of 1,000 visitors, the average annual trips to the beach is two visits per year. However, as Type A visitors contribute three times as many trips as Type B visitors, Type A visitors would be three times as likely to be selected in a typical on-site sample. That is, in a typical on-site sample of 100 visitors, approximately 75 would be Type A visitors and approximately 25 would be Type B visitors. The average annual trips

calculated from this sample would be 2.5 trips per year: 2.5 = (75 * 3 + 25 * 1)/(75 + 25). Thus, in the absence of weighting, the sample average provides an estimate of the population mean that is biased toward avid visitors.

However, if each respondent in this example is weighted by the inverse of his or her probability of selection, an unbiased estimate of average annual trips can be obtained. Let p represent the probability of selection for a Type B visitor, so that the sampling weight for Type B visitors is $1/p$. The probability of selection for a Type A visitor (who takes three times as many trips) would then be $3p$, with a sampling weight equal to $1/(3p)$. For the typical sample of 100 visitors described above, the weighted average annual trips would be equal to 2.0 trips per year: $2.0 = (1/(3p) * 75 * 3 + (1/p) * 25 * 1)/(1/(3p) * 75 + (1/p)*25)$.

In the current application, the calculation of sampling weights will be considerably more complex, requiring data on: (1) the type, timing, and location of all UCR trips taken during the survey period by visitor *i*, (2) the probability that visitor *i* would be interviewed on each recreation day if that particular day and location/shift were randomly selected for the survey, (3) the number of days selected for surveying within each temporal stratum, and (4) the site/shift selection probabilities. While the latter two inputs can be obtained directly from the sampling plan, the first two inputs must be approximated.

The type, timing, and location of all UCR trips taken during the survey period will be approximated using responses to questions about UCR trips over the past 12 months. The survey will provide information about the number of trips by type, season, and location. However, due to expected recall difficulties the survey will not ask respondents to allocate trips in a given season among weekdays/weekends/holidays or among AM/PM shifts. Instead, trips will be randomly assigned to a type of day (weekdays/weekends/ holidays) and shift (AM/PM) using information from the supplemental vehicle counters on the temporal pattern of visitation.

The probability that the visitor would be interviewed on a given recreation day if the day/location/shift were randomly selected for interviews is equal to the sampling rate for that particular day/location/shift. As not all days/locations/shifts will be sampled, this sampling rate will be approximated for each location and temporal stratum as follows:

(15) $$SR_{xh} = \frac{I_{xh} + R_{xh}}{V_{xh}}$$

where:

SR_{xh} = Sampling rate for location x and temporal stratum h
I_{xh} = Number of completed interviews for location x and stratum h
R_{xh} = Number of refusals by individuals who have already completed the survey for location x and stratum h
V_{xh} = Total number of visitors observed at location x and stratum h

Refusals by individuals who have already completed the survey are included in the numerator of the sampling rate expression because sampling rates are calculated to

approximate the probability that an individual would be interviewed if contacted at this location for the first time. Because they have already completed the survey, these refusals represent individuals who would likely complete the survey if they were being contacted for the first time.

Given these four data sources (UCR visits by visitor *i*, sampling rates, number of days sampled, and site/shift selection probabilities), one can calculate the probability that visitor *i* will be selected for the survey within temporal stratum *h* and region *r* during a visit of type *a*. Assume, for example, that a single day is selected for surveying visits of type *a* within stratum *h* and region *r*. Using $d_1, d_2, ..., d_N$ to denote the *N* days in temporal stratum *h* and assuming that individual *i* visited sites *j* and *k* on two days in temporal stratum *h* (denoted d_j and d_k) within region *r*, the selection probability for individual *i* would be as follows[21]:

$$
\begin{aligned}
p_{arhi} = 1 - \{ & P(not\ d_j\ or\ d_k) + P(d_j)xP(not\ site\ j \mid d_j) + P(d_k)xP(not\ site\ k \mid d_k) \\
& + P(d_j)xP(site\ j \mid d_j)xP(not\ selected \mid site\ j) \\
& + P(d_k)xP(site\ k \mid d_k)xP(not\ selected \mid site\ k)\}
\end{aligned} \tag{16}
$$

where:

$P(not\ d_j\ or\ d_k)$ = Probability that neither of the two days is selected for surveying.

$P(d_j)xP(not\ site\ j \mid d_j)$ = Probability that day *j* is selected for surveying *and* site *j* is not selected for surveying.

$P(d_k)xP(not\ site\ k \mid d_k)$ = Probability that day *k* is selected for surveying *and* site *k* is not selected for surveying.

$P(d_j)xP(site\ j \mid d_j)xP(not\ selected \mid site\ j)$ = Probability that day *j* is selected for surveying *and* site *j* is selected for surveying on day *j and* individual *i* is not interviewed.

$P(d_k)xP(site\ k \mid d_k)xP(not\ selected \mid site\ k)$ = Probability that day *k* is selected for surveying *and* site *k* is selected for surveying on day *k and* individual *i* is not interviewed.

This expression incorporates three different ways that the person may not be sampled: (1) sampling did not occur on either of the days he visited the site, (2) sampling occurred on one of these days, but his site was not selected for sampling on either day, and (3) sampling occurred on one of the days and his site was selected for sampling, but he was not selected for an interview.

The overall probability that visitor *i* will be selected for the survey is then given by:

[21] For simplicity, this example abstracts from the random selection of a survey shift on each sampling day. Shifts can easily be incorporated if the term "site" is interpreted as a site/shift combination within the context of a spatio-temporal sampling frame.

(17) $$p_i = 1 - \prod_{a=1}^{3} \prod_{r=1}^{3} \prod_{h=1}^{H} (1 - p_{arhi})$$

where:

p_i = Probability that visitor *i* will be selected for the survey.
p_{arhi} = Probability that visitor *i* will be selected for the survey during temporal stratum *h* within region *r* during a visit of type *a*.

Given p_i , the sampling weight for visitor *i* is calculated as:

(18) $$v_i = \frac{1}{p_i}.$$

Simplified Sampling Weights for Visitors

The calculations required for *visitor* sampling weights are considerably more complex than the calculations required for *visitor day* sampling weights. This is a result of the fact that an on-site intercept survey directly samples *visitor days* rather than *visitors*. In addition, without detailed data on the locations and dates of all trips taken by each respondent during the 12-month sampling period, the calculations will necessarily rely on a series of simplifying assumptions regarding the distribution of each respondent's trips across the temporal strata.

In the past, some researchers have addressed this issue by simplifying the visitor weight calculations by, for example, ignoring the location and timing of the trips and simply weighting by the inverse of the total number of trips to the site (Thomson 1991; Price, Su, and Gray 1994). While this approach does not rely on true selection probabilities, it may provide reasonable weights for the purposes of the HHRA.

5. SUMMARY STATISTICS

Summary statistics will be developed periodically during survey implementation and at the conclusion of the data collection period. These statistics will provide an opportunity to evaluate data collection methods and to identify unanticipated complications. The summary statistics may include (but may not be limited to) the following:

- Number of completed interviews by type of visit (boating, camping, beach use), season, region (Upper, Middle, Lower), access point (i.e., Porcupine Bay), type of day (weekend, holiday, weekday), and time of day (AM or PM).
- Number of high-consumption anglers recruited for fish consumption diary.
- Frequency distributions for gender, age, zip code, number of annual UCR boating trips, number of annual UCR camping days, number of annual trips to UCR day-use beaches, and consumption of UCR fish.

- For each type of recreation day (boating, camping, beach), percent of respondents participating in each recreational activity, average exposure times for activity participants, percent of respondents drinking water from UCR, and average quantity of water consumed for water consumers.
- For fish consumers, average annual fish consumption by species, distribution of meal sizes.
- For anglers, distribution of advisory awareness, source of advisory information, and responses to advisories.
- For diary participants, average consumption by species and distribution of meal sizes.

REFERENCES

Chase, D.R., and G. Godbey. (1983). The accuracy of self-reported participation rates: a research note. *Leisure Studies* 2:231-235.

Chase, D.R., and M. Harada. (1984). Response error in self-reported recreation participation. *Journal of Leisure Research* 16:322-329.

Chu A., Eisenhower D., Hay M., Morganstein D., Neter J., and Waksberg J. (1992). Measuring the recall error in self-reported fishing and hunting activities. *Journal of Official Statistics* 8(1):19-39.

Columbia River Inter-Tribal Fish Commission (CRITFC). (1994) A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin. CRITFC Technical Report No. 94-3. Portland, OR.

Cochran, W.G. (1977) Sampling Techniques (3rd Edition). John Wiley & Sons. New York.

Harris, C.C. and E.P. Bergersen. (1985). Survey on demand for sport fisheries: problems and potentialities for its use in fishery management planning. *North American Journal of Fisheries Management* 5:400-410.

Lohr, S.L. (1999). Sampling: Design and Analysis. Duxbury Press. Pacific Grove, CA.

Patrick, G. and C. Marten. (1997). Consumption Patterns of Anglers who Frequently Fish Lake Roosevelt. Washington Department of Health, Office of Environmental Health Assessment Services. September.

Pollock, K.H., C.M. Jones, and T.L. Brown. (1994). Angler Survey Methods and their Applications in Fisheries Management. American Fisheries Society Special Publication 25. Bethesda, MD.

Price P.S., Su, S.H., and M.N. Gray. (1994). The effect of sampling bias on estimates of angler consumption rates in creel surveys. *Journal of Exposure Analysis and Environmental Epidemiology* 4:355-371.

Ray R., Craven V., Kinnell J., Bingham M., Freeman M., and Finley B. (2007). A statistical method for analyzing data collected by a creel/angler survey (Part 2). *Journal of Toxicology and Environmental Health, Part A* 70:496-511.

Tarrant, M.A., Manfredo, M.J., Bayley, P.B., and R. Hess. (1993). Effects of Recall Bias and Nonresponse Bias on Self-Report Estimates of Angling Participation. *North American Journal of Fisheries Management* 13: 217-222.

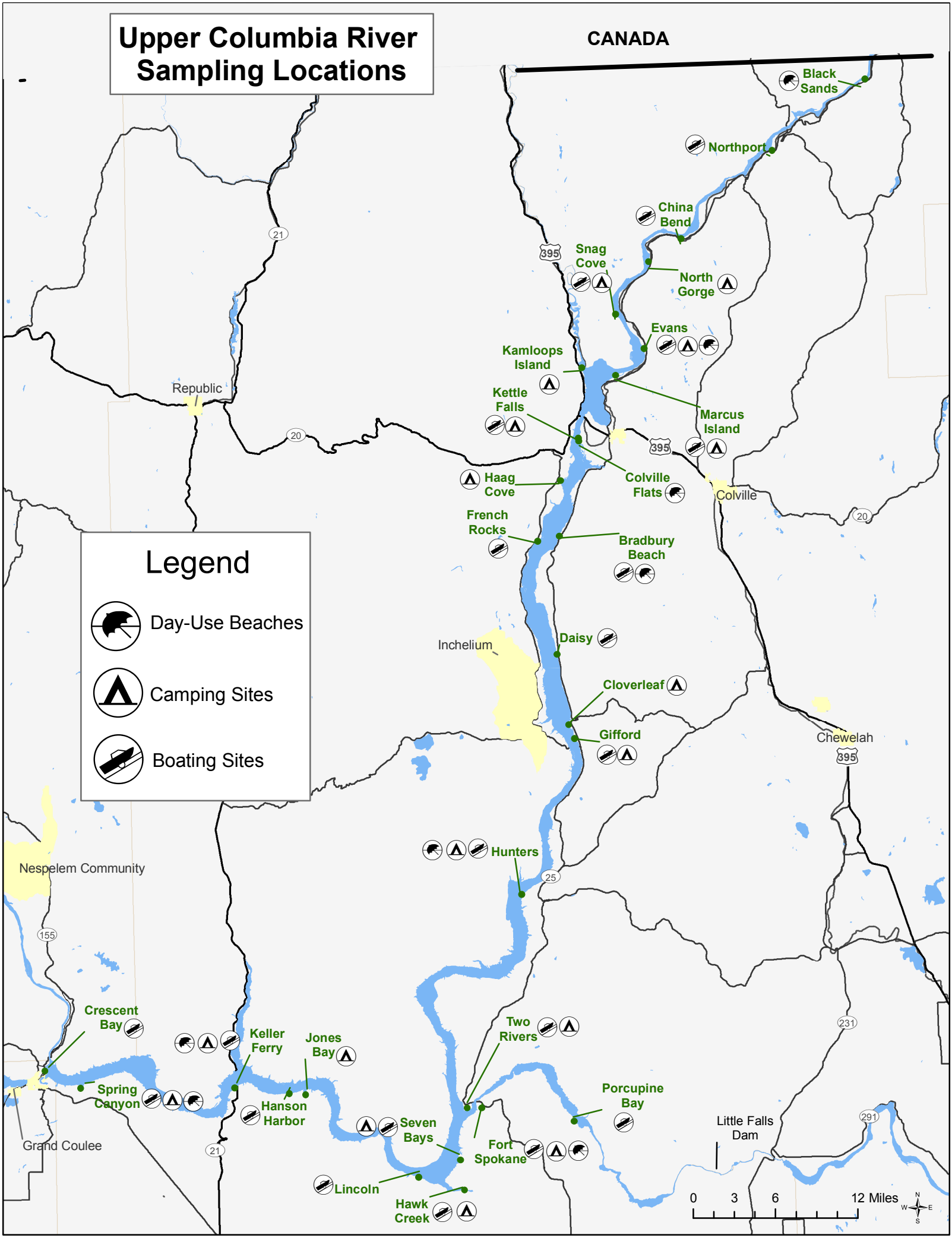
Thomson, C.J. (1991). Effects of the Avidity Bias on Survey Estimates of Fishing Effort and Economic Value. *American Fisheries Society Symposium* 12: 356-366.

U.S. EPA. (1997). Exposure Factors Handbook. Volume II - Food Ingestion Factors. Office of Research and Development. National Center for Environmental Assessment. U.S. Environmental Protection Agency. Washington DC: Document No. EPA/600/P-95/002Fb. August.

U.S. EPA. (2009). Human Health Risk Assessment Workplan for the Upper Columbia River Site Remedial Investigation and Feasibility Study. Prepared for U.S. Environmental Protection Agency, Region 10 by SRC, Inc. Final – March 2009.

APPENDIX A:

MAP OF UPPER COLUMBIA RIVER AND SAMPLING LOCATIONS


Upper Columbia River Sampling Locations
CANADA
Black Sands
Northport
China Bend
Snag Cove
North Gorge
Evans
Kamloops Island
Kettle Falls
Marcus Island
Colville Flats
Haag Cove
Colville
French Rocks
Bradbury Beach
Daisy
Inchelium
Cloverleaf
Gifford
Chewelah
Hunters
Nespelem Community
Crescent Bay
Keller Ferry
Jones Bay
Spring Canyon
Hanson Harbor
Seven Bays
Two Rivers
Porcupine Bay
Fort Spokane
Lincoln
Hawk Creek
Grand Coulee
Little Falls Dam
Republic
Legend
Day-Use Beaches
Camping Sites
Boating Sites
0 3 6 12 Miles
N
W
E
S

APPENDIX B:

DATA QUALITY OBJECTIVES

SRC, Inc.
999 18th Street, Suite 1975
Denver, CO 80202
(303) 292-4760 phone
(303) 292-4755 fax

MEMORANDUM

To: Monica Tonel, Marc Stifelman (EPA, Region 10)
From: Lynn Woodbury, Bill Brattin (SRC)
Task: FD052.CF999.842
Date: June 16, 2009
Re: Data Quality Objectives for the UCR Recreational Use Survey - Revised

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As discussed in the *Human Health Risk Assessment (HHRA) Workplan for the Upper Columbia River (UCR) Site* (EPA 2009), the baseline HHRA will evaluate several ingestion, inhalation, and dermal contact exposure scenarios for several types of recreational, occupational, and subsistence populations that utilize the UCR Site. However, the currently available exposure information is primarily based on default exposure parameters and professional judgment, which may not be sufficient to fully characterize the site-specific exposures that are occurring at the Site. The purpose of this memorandum is to summarize the Data Quality Objectives (DQOs) for the planned *UCR Recreational Use Survey* in support of the baseline HHRA at the UCR Site. This memorandum incorporates comments from EPA as discussed on the June 16, 2009 teleconference.

DATA QUALITY OBJECTIVES

DQOs define the type, quality, quantity, purpose, and intended uses of data to be collected (EPA 2006). In brief, the DQO process utilizes a seven-step procedure, as follows:

1. State the problem
2. Identify the goal of the study
3. Identify information inputs
4. Define the boundaries of the study
5. Develop the analytic approach
6. Specify performance or acceptance criteria
7. Develop the detailed plan for obtaining data

Following these seven steps helps ensure that the sampling plan is carefully thought out and that the data collected will provide sufficient information to support the key decisions which must be made.

Step 1 – State the Problem

Site Overview

The UCR Site is located in the north central portion of the State of Washington and includes approximately 150 river miles of the Columbia River, extending from the United States-Canada border to the Grand Coulee Dam. A remedial investigation and feasibility study (RI/FS) is currently underway to investigate the nature and extent of contamination that has resulted from historical and continuing

discharges of toxic substances into the Columbia River, including, but not limited to, releases from smelting processes and facility operations by Teck Cominco Metals Limited (TCM) at the Trail facility located in Trail, British Columbia.

Human Populations of Potential Concern

A large portion of the UCR Site is within the Lake Roosevelt National Recreation Area (LRNRA), which is managed by the National Park Service (NPS). The LRNRA attracts more than 1.3 million visitors per year (NPS 2006). Developed areas overseen by the NPS include 22 boat launches, 27 campgrounds, and three concessionaire-operated marinas (Seven Bays, Keller Ferry, and Kettle Falls Marinas). Designated recreational uses of the LRNRA include boating, fishing, hiking, swimming, wading, camping, canoeing, and hunting. The remainder of the Lake Roosevelt shoreline managed by the NPS is undeveloped. The NPS allows camping on any undeveloped shoreline.

Portions of Lake Roosevelt that are not included in the LRNRA are managed by the Confederated Tribes of the Colville Reservation (CCT) and the Spokane Tribe of Indians (STI). The Colville and Spokane Indian reservations also provide opportunities for recreational visitors to fish and camp at the UCR (NPS 2006). The Two Rivers Marina is owned and operated by the STI.

Recreational users at the UCR Site may include occasional visitors, local residents, and tribal members. The recreational visitors of primary interest for the purposes of the baseline HHRA are those individuals that frequently use the UCR Site for recreational activities.

Exposure Pathways of Potential Concern

Humans may be exposed to contaminants in environmental media by several pathways, including ingestion, inhalation, and dermal contact exposure scenarios. Figure 1 summarizes the exposure scenarios that are planned for evaluation in the baseline HHRA. As shown, the following exposure pathways are of primary interest for the purposes of evaluating risks to recreational visitors:

- Incidental ingestion of and dermal contact with beach sediment/soil and surface water during recreational activities
- Inhalation of outdoor air near beaches
- Ingestion of fish, shellfish, wild game, and waterfowl derived from the UCR Site
- Ingestion of drinking water derived from untreated groundwater or UCR surface water
- Dermal contact with and inhalation of volatiles from untreated groundwater during showering at UCR facilities

As appropriate, these exposure scenarios may be refined in the baseline HHRA based on information provided by the survey.

Problem Statement

Human exposure data are considered to be adequate if they are based on reliable site-specific information that is representative of the exposure scenario being addressed, and if the uncertainty around the estimates is not large enough to prevent reliable risk management decision-making. Currently, site-specific exposure information is either limited or unavailable for recreational visitor exposure scenarios. Because

preliminary risk estimates presented in the UCR HHRA Workplan (EPA 2009) suggest that risks may approach or exceed a level of potential concern for one or more exposure scenarios, site-specific exposure parameter data are needed to allow for reliable risk management decision-making.

Step 2 – Identify the Goal of the Study

The goal of the study is to obtain site-specific exposure parameter data for recreational visitors that will allow the reliable characterization of risks at the UCR Site. These findings will be used by risk managers to help determine whether or not EPA must take action at one or more locations to ensure that risks at the UCR Site do not exceed an acceptable level.

Step 3 – Identify Information Inputs

Detailed information on the equations and input parameters for calculating ingestion, dermal contact, and inhalation exposures are provided in the UCR HHRA Workplan (EPA 2009). In brief, the information needed to support reliable calculations of human exposure to potentially contaminated environmental media includes data on contact rates, frequencies, and durations for each exposure scenario of potential concern.

It is not possible, or necessary, to obtain site-specific data for every input parameter (e.g., obtaining site-specific data on incidental ingestion rates for surface water or dermal adherence of sediment is not likely to be feasible). Therefore, the survey will focus on the collection of the exposure parameters that are likely to be most important for the purposes of reducing uncertainties in the baseline HHRA. Table 1 lists the specific data items that would be desirable to support reliable site-specific human health risk calculations for the UCR Site.

These data items are expected to vary between different individuals, so data are needed from many individuals in order to fully characterize the distribution of values for each exposure parameter. In addition, because values may depend on age and gender, this information is also needed for each individual. Finally, because the concentration of contaminants in environmental media may differ depending on location at the UCR Site, data are also needed on where the exposure occurs or where the media was obtained.

For exposures to dietary food items, considerable detail is needed on the species and tissue types of food that are ingested. This is because concentration values may differ between species and tissue types. Table 2 provides an example of the detailed types of information needed to evaluate dietary exposures at the UCR Site.

Step 4 – Define the Boundaries of the Study

<u>Spatial Bounds</u>

As noted above, the UCR Site includes approximately 150 river miles of the Columbia River and Lake Roosevelt, extending from the United States-Canada border to the Grand Coulee Dam. For the purposes of evaluating potential human health risks to recreational visitors, the survey should focus on those areas within the UCR Site where recreational activities occur, including campgrounds, marinas, and beaches

both within the LRNRA and along undeveloped shorelines outside of the LRNRA that may be used by recreational visitors.

Temporal Bounds

According to NPS (2009), recreational use of the LRNRA occurs year-round, but peak visitation months are in the summer from June to September (see Figure 2). Because it is likely that exposures will be highest during the summer months, the survey timing should focus on this time period. However, to ensure that other activities that may preferentially take place outside of peak visitation months (e.g., hunting) are also included in the survey, additional sampling should also be performed during non-peak visitation months (i.e., October to May).

Target Populations

Because recreational visitors of all ages and genders may be exposed to contamination at the UCR Site via a variety of exposure scenarios, the survey goal should be to collect data which represent the entire recreational population of interest (i.e., no age or gender restrictions are necessary).

Step 5 – Develop the Analytic Approach

For every exposure pathway, it is expected that there will be differences between different individuals in the level of exposure due to differences in intake rates, body weights, exposure frequencies, and exposure durations. Thus, there is normally a wide range of average daily intakes between different members of an exposed population. When evaluating risks, attention is focused on intakes that are "average" or are otherwise near the central portion of the range (e.g., the mean or median), and on intakes that are near the upper end of the range (e.g., the 95th percentile). These two exposure estimates are referred to as Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME), respectively. Both CTE and RME receptors will be evaluated in the baseline HHRA.

There are two approaches for calculating CTE and RME estimates of daily intake from information derived from the survey:

> Approach #1: For each exposure parameter variable used to calculate daily intake (e.g., intake rate, exposure frequency, exposure duration), estimate an "average" (e.g., mean or median) and an "upper-bound" value (e.g., 95^{th} percentile) from the distribution of survey responses. Then, calculate the CTE and RME daily intake from the selected exposure parameter variables. When calculating the CTE daily intake, all the exposure parameter variables for a specific exposure pathway would be based "average" values. When calculating the RME daily intake, the exposure parameter variables would be selected such that the combination of the input variables results in a "reasonable" maximum estimate of the daily intake (EPA 1989). In other words, some inputs are set equal to "average" values (e.g., body weight) and some inputs are set equal to "upper-bound" values (e.g., ingestion rates, exposure frequency, and exposure duration), such that the resulting combination yields a daily intake estimate that is RME (EPA 1989).
>
> Approach #2: For each exposure pathway, compute the daily intake for each individual based on the exposure parameters for that individual, and then derive the CTE and RME estimates of daily

intake from the resulting distribution of daily intake values. The CTE daily intake will be based on the central portion of the distribution (e.g., mean or median) and the RME daily intake will be based on the upper end of the distribution (e.g., 95th percentile).

Because some of the exposure parameter variables that are utilized in the calculation of daily intake may be correlated, the preferred approach for estimating daily intake in the baseline HHRA will be Approach #2. This approach requires that each individual survey response reports data for all of the exposure parameter variables necessary to calculate the daily intake for the specified exposure pathway (i.e., if the respondent only provides information on intake rate and not exposure frequency, the daily intake cannot be directly calculated). If implementation of this approach becomes problematic due to a high number of non-responses or incomplete surveys, the baseline HHRA will use Approach #1 to estimate daily intake.

Step 6 – Specify Performance Metrics and Acceptable Levels of Uncertainty

The purpose of a survey is to collect information for a sample from a population in order to draw inferences about the population as a whole. Sampling error measures the extent to which the values estimated for the sample differ from the values that would have been obtained if the entire population were surveyed. Sampling error is influenced by the inherent variability of the population, the sample collection design, and the number of samples collected. In general, increasing the number of samples collected (i.e., the number of survey respondents) will tend to decrease the level of uncertainty in the exposure parameter estimates. This concept is illustrated below.

In this example, the distribution of individual responses is assumed to be distributed as shown in Figure 3. The true mean daily intake for the population is 0.33 and the true 95th percentile is 0.66. If the survey sample size is 25, estimates of the sample mean tend to be fairly variable, ranging from 0.22 to 0.47 (coefficient of variation [CV] = 0.11). Estimates of the sample 95th percentile are also variable, ranging from 0.38 to 0.88. As shown in Figure 4, as the survey sample size increases, the distribution of sample means (Panel A) and 95th percentile values (Panel B) gets narrower and the accuracy of the estimates increases.

EPA, in consultation with NPS, has determined that the recreational use survey will focus on collecting data during peak visitation months (i.e., June to September) in order to maximize the number of survey respondents. Data collection will also be performed at a decreased level of effort during non-peak visitation months (i.e., October to May) to ensure that other activities that may preferentially take place outside of peak visitation months (e.g., hunting) are also included in the survey.

Step 7 – Develop the Detailed Plan for Obtaining Data

It is anticipated that detailed information on the sampling plan for obtaining the recreational exposure data which addresses the DQOs specified in Steps 1-6 above will be provided in the *UCR Recreational Use Survey Workplan* prepared by EPA and NPS.

References

EPA (U.S. Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund (RAGS). Volume I. Human Health Evaluation Manual (Part A). U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. EPA/540/1-89/002. December 1989. http://www.epa.gov/oswer/riskassessment/ragsa/index.htm.

EPA. 2005. Midnite Mine Human Health Risk Assessment Report. U.S. Environmental Protection Agency, Region 10, Seattle, WA. September 2005.

EPA. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process – EPA QA/G4. Office of Environmental Information, U.S. Environmental Protection Agency. EPA/240/B-06/001. February 2006. http://www.epa.gov/quality/qs-docs/g4-final.pdf

EPA. 2009. Human Health Risk Assessment Workplan for the Upper Columbia River Site Remedial Investigation and Feasibility Study. Prepared for U.S. Environmental Protection Agency, Region 10 by Syracuse Research Corporation. Final – March 2009.

Harper BL, Flett B, Harris S, Abeyta C, Kirschner F. 2002. The Spokane Tribes' Multipathway Subsistence Exposure Scenario and Screening Level RME. *Risk Analysis* 22(3):513-526.

NPS (National Park Service). 2006. Lake Roosevelt National Recreation Area. www.nps.gov/laro.

NPS. 2009. NPS Public Use Statistics Office. http://www.nature.nps.gov/stats/

STI (Spokane Tribe of Indians). 2008. http://www.spokanetribe.com.

Figure 1
Human Health Exposure Pathways and Populations

Exposure Media	Exposure Route	Exposed Populations: Recreational - Child & Adult (a)	Occupational - Adult (b) (4)	Subsistence - Child & Adult (c)	Resident - Child & Adult (d)
Primary Media:					
Sediment (13)	Ingestion	✓	✓	✓	
	Dermal (2)	✓	✓	✓	
Surface Water	Ingestion (18)	✓	✓	✓	? (19)
	Dermal (2)	✓	✓	✓	
Outdoor Air (directly impacted by emissions)	Inhalation	✓	✓	✓	✓
Secondary Media:					
Outdoor Air (impacted by windblown sediment/soil)	Inhalation (1)	✓	✓	✓	✓
Upland Soil	Ingestion	✓	✓	✓	✓
	Dermal (2)	✓	✓	✓	✓
Indoor Dust	Ingestion	✓ (3,7)			✓
Sweat Lodge Air	Inhalation (5)			✓	
Groundwater	Ingestion	?	?	?	?
	Dermal (2)	? (3,16)			? (16)
Terrestrial/ Aquatic Plants	Ingestion			✓ (11)	
	Dermal (2)			✓ (9)	
Birds/Mammals (12)	Ingestion	✓		✓	
	Dermal (2)			✓ (10)	
Amphibians/Reptiles	Ingestion			? (17)	
	Dermal (2)			? (10,17)	
Fish/Shellfish	Ingestion	✓		✓	
	Dermal (2)			✓ (10)	
Tertiary Media:					
Indoor Air	Inhalation	✓ (3,15)			✓? (20)
Smoke-filled Air	Inhalation (8)			✓	
Shower Air	Inhalation (6)	? (3)			?
Crops (14)	Ingestion			✓	
	Dermal (2)			✓ (9)	

LEGEND:

	Exposure pathway is not complete for this population or potential exposures are negligible
?	Exposure pathway is potentially complete for this population
✓	Exposure pathway is complete for this population

exposures of interest for the recreational use survey

Figure 1
Human Health Exposure Pathways and Populations

Receptor Population Descriptions:

(a) Recreational activities include fishing, hunting, swimming, camping, etc.
Three recreational visitor exposure scenarios will be evaluated --
Short-term: Individuals (both local and non-local) that visit the river as part of occasional recreational activities
Seasonal: Individuals that reside seasonally within the site boundary and frequently engage in recreational activitie
Year-round: Individuals that reside locally and may engage in year-round recreational activities

(b) Individuals that work along the river banks (e.g., park employees, construction workers, ferry boat workers, etc.).
Two worker exposure scenarios will be evaluated --
Contact Intensive: Workers that engage in activities with a high opportunity for contact with sediments
Non-contact Intensive: Workers that engage in activities that do not usually have extensive contact with sediments

(c) Individuals that reside outside of the site boundary and fish/hunt/gather plants along the river.
Two subsistence exposure scenarios will be evaluated --
Modern: Intake and use rates represent modern subsistence scenarios
Traditional: Intake and use rates represent traditional subsistence scenarios

(d) Individuals that reside outside of the site boundary, but residence proximity to the river may result in site-related exposures (e.g., windborne impacts to indoor air, or sediment track-in into indoor dust, etc.)

Notes:

(1) includes both chronic exposure to long-term average concentrations and short-term exposures during windstorm events
(2) dermal exposures will be evaluated for COIs with dermal absorption coefficients
(3) evaluated for short-term and seasonal visitors staying within the site boundary during recreational activities
(4) it is expected that exposure is likely to be lower for indoor workers than for outdoor workers, therefore occupational exposures are assumed occur entirely outdoors
(5) exposure to aerosols and water vapor
(6) inhalation exposures during showering, will be evaluated for semi-volatile and volatile COIs only
(7) dust ingestion is included in the total ingestion rates for soil/sediment
(8) inhalation of smoke/ash particulates from burning plant materials
(9) dermal exposures from plants used medicinally and/or ceremonially and contact during basket weaving activities
(10) dermal exposures from animal tissues used medicinally and/or ceremonially and contact during preservation activities
(11) includes ingestion of gathered plants as food and incidental ingestion of plants during basket weaving activities
(12) wild game, waterfowl, and livestock that have been watered with UCR water and/or fed irrigated plants
(13) includes solid materials from beaches, wetlands, and riparian areas (i.e., within the current high water mark) that become exposed at some time during the year (e.g., during reservoir draw-down or low-flow conditions)
(14) crops that have been irrigated with UCR water
(15) indoor exposures (inside RVs, campers, tents) evaluated for short-term and seasonal visitors only; year-round visitors are assumed to reside off-site (evaluated under the residential scenario)
(16) during showering
(17) a determination of exposures to amphibians/reptiles will be based on site-specific survey results
(18) includes incidental ingestion exposures for on-site receptors (e.g., during swimming, wading, fishing, etc.) and ingestion of untreated surface water as drinking water
(19) assumes that untreated surface water is used as the source for residential drinking water
(20) inhalation of chemicals in indoor air derived from outdoor air and indoor dust is a complete exposure pathway; inhalation of chemicals in indoor air derived from groundwater (e.g., SVOCs released from residential water use) is a potentially complete pathway

FIGURE 2
SEASONAL DISTRIBUTION OF VISITS TO LAKE ROOSEVELT NATIONAL RECREATION AREA, 2000-2008

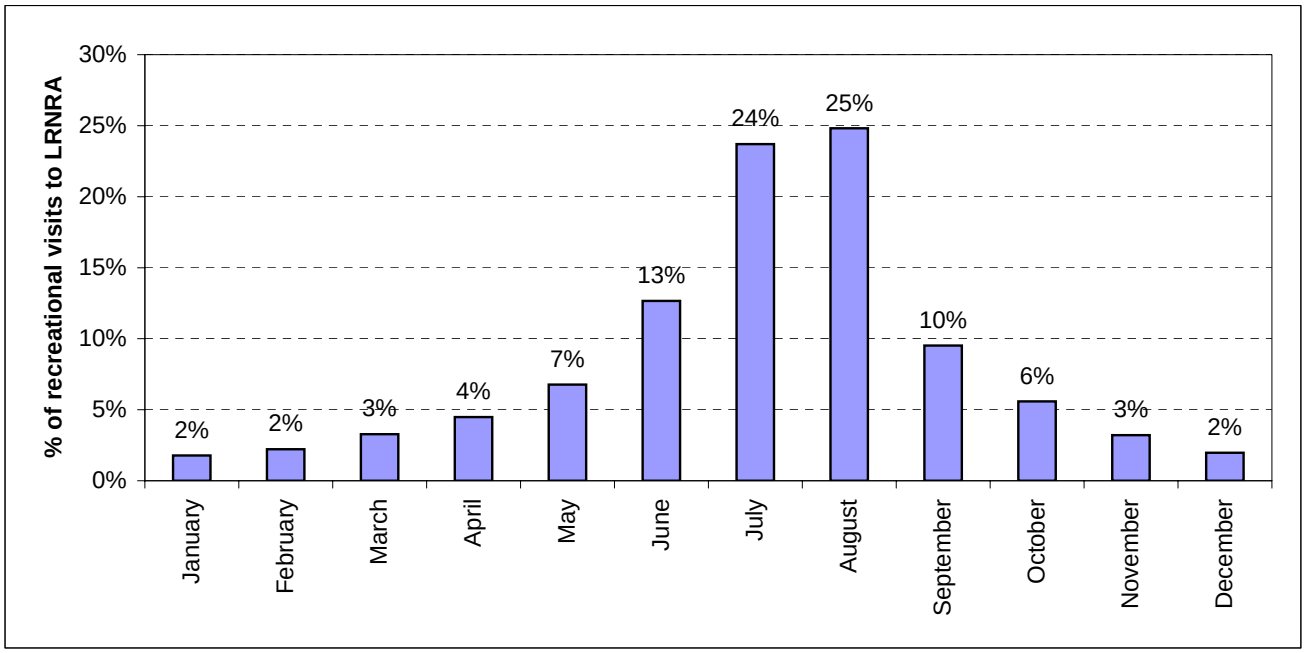


Fig 2_NPS LRNRA Rec Use 2000-2008.xls

Figure 3
Example of Population Distribution of Daily Intakes

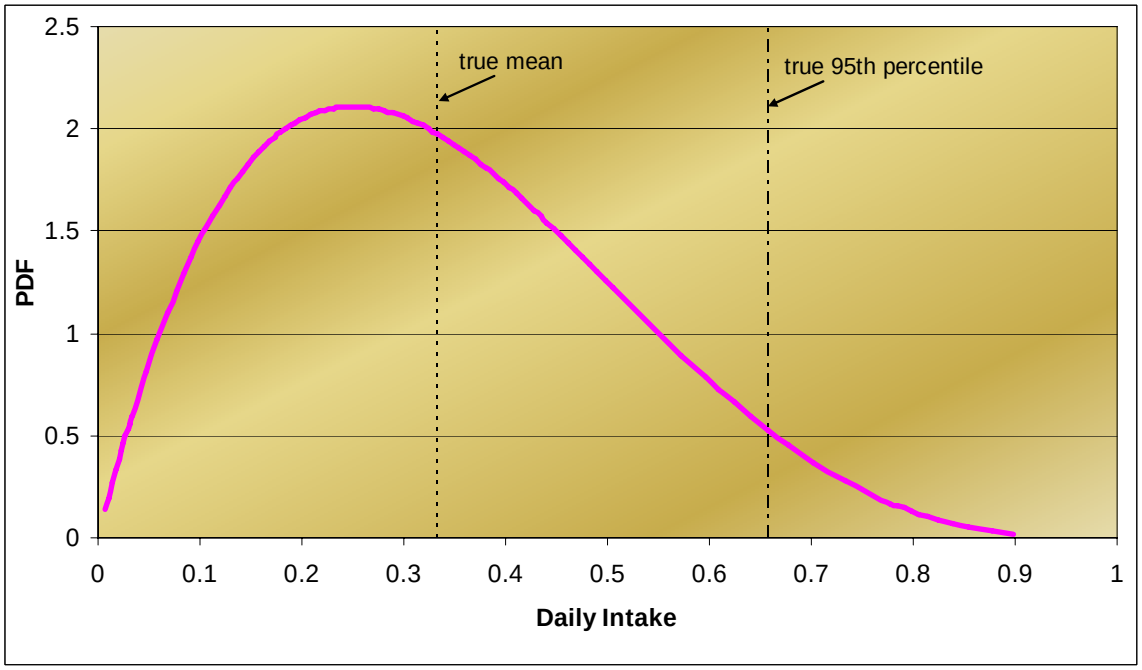
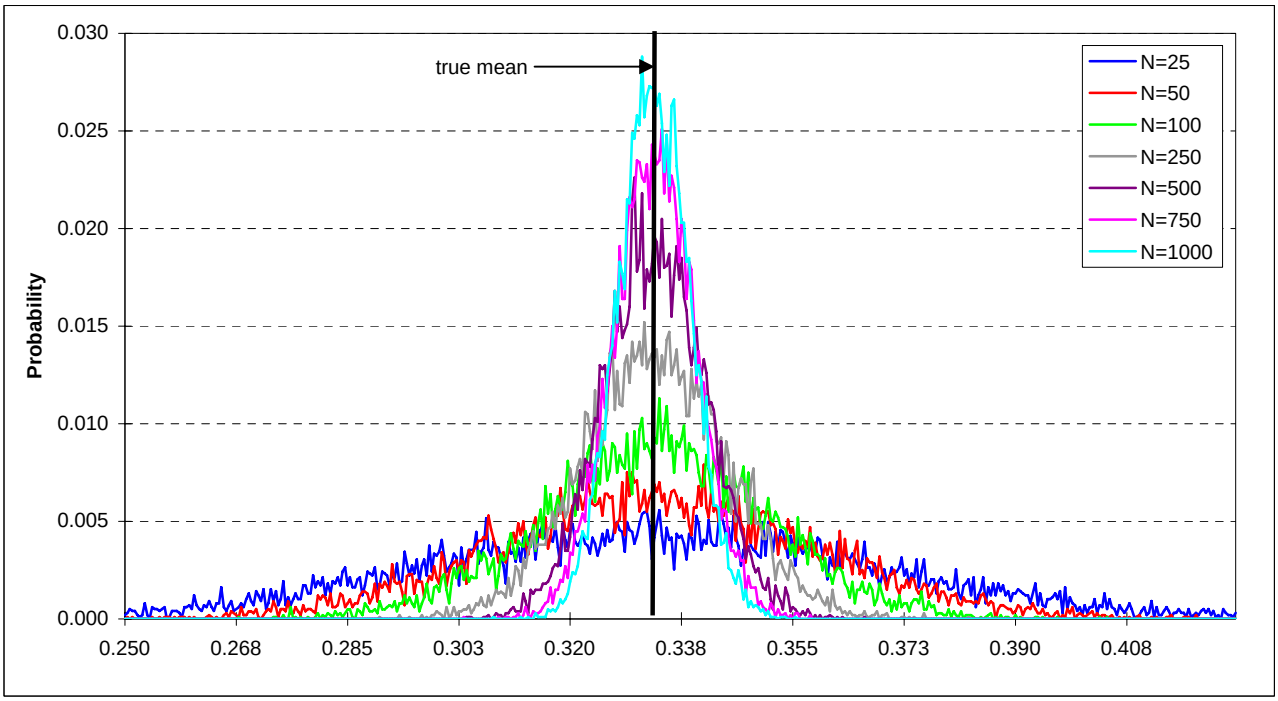
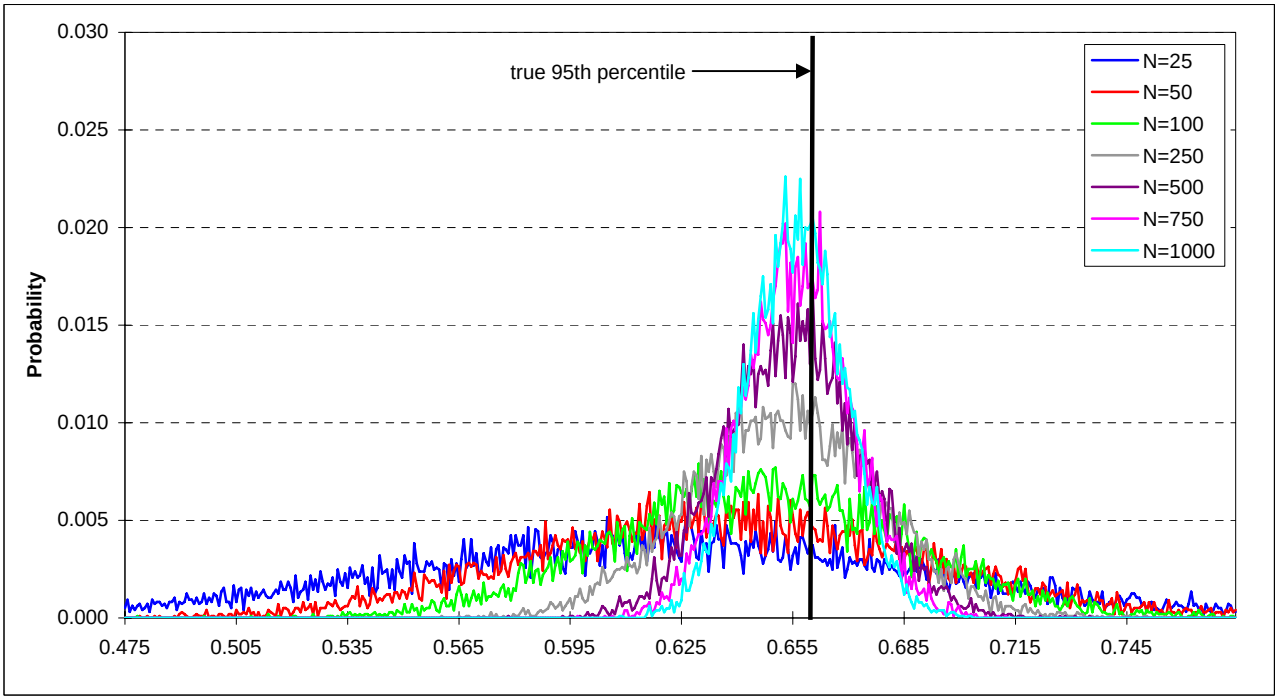


Figure 4
Example of Variability in Dietary Intakes as a Function of Survey Size

Panel A: Mean (CTE)



Panel B: 95th Percentile (RME)



Based on a simulation of 10,000 iterations.

Fig 4_Sample Size Sim.xls

TABLE 1
EXPOSURE PARAMETER DATA NEEDS

Survey Respondent Information

- Age
- Gender
- Zip Code of Primary Residence

General Exposure Frequency Information

- Total number of visits/year at UCR location 'x'
- Average number of days/visit at UCR location 'x'

Outdoor Exposure Scenario-Specific Information

Inhalation of Outdoor Air

- Average number of hours/day spent outdoors at UCR location 'x'

Incidental Ingestion and Dermal Contact with UCR Surface Water During Swimming

- Average number of days/visit spent swimming in UCR at location 'x'
- Average number of hours/day spent swimming in UCR at location 'x'

Exposures to UCR Site Media During Other Recreational Activities
(e.g., hunting, fishing, camping, wading, hiking)

- Average number of days/visit spent performing activity 'a' at UCR location 'x'
- Average number of hours/day spent performing activity 'a' at UCR location 'x'

Indoor Exposure Scenario-Specific Information

Dermal Contact with Water During Showering at UCR Facilities

- Average number of showers/visit spent showering using facilities at UCR location 'x'
- Average number of minutes/day spent showering using facilities at UCR location 'x'

Dietary Exposure Specific Information

Ingestion of Fish/Shellfish/Game that is Harvested from the UCR Site

- Total number of meals/year of species 's' and tissue type 't'
- Average meal size (reported as mass) of species 's' and tissue type 't'
- For fish, typical size range of species 's' kept for consumption
- Fraction of species 's' and tissue type 't' derived from UCR location 'x'

Ingestion of Untreated Surface Water

- Total number of days/visit that untreated UCR surface water ingested
- Average number of liters/day of untreated UCR surface water ingested from location 'x'
- Fraction of untreated UCR surface water ingested from location 'x'

Table 2

Example of Data Needed for Each Survey Respondent to Evaluate Dietary Intake of Species that are Harvested from the UCR Site

Species	% from Source				Tissue Type	Number of meals in the past year	Average amount ingested per meal (oz)
	UCR			Non-UCR			
	Upper	Middle	Lower				
Mallard			50%	50%	Muscle	25	6
					Liver	5	2
Rainbow Trout (8-10 inches)		25%	5%	70%	Fillet	50	10
Razor Clams		5%		95%	Muscle	20	10
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...

Upper: U.S.-Canada border to Marcus Flats
Middle: Marcus Flats to confluence with Spokane River
Lower: Spokane River to Grand Coulee Dam

APPENDIX C:

DRAFT SURVEY INSTRUMENT

UPPER COLUMBIA RIVER VISITOR SURVEY -- BEACH

Interviewer _____ Time _____ am / pm

Location _____ Month_____/Day____/2010

Hi, I'm conducting a survey for the National Park Service about how people use Lake Roosevelt and the Upper Columbia River. I'm hoping to speak with the person in your group who had the most recent birthday.

Interviewer check one:

☐ Survey completed by adult with most recent birthday

☐ Survey completed by another adult

After targeted individual has been identified: Would you be willing to answer a few questions about your visits to this area?

PART A: PRELIMINARY QUESTIONS

Before I start, let me show you exactly what area the survey will focus on. It's the area outlined in red on this map, which includes the Columbia River from the Grand Coulee Dam to the Canadian border and part of the Spokane River. Most of Lake Roosevelt is also included in this area. During the survey, I'll refer to this entire area as the "Upper Columbia River." *Point out respondent's current location on the map.*

A1. Have you taken this survey before?

☐ Yes → Great, then I'll only ask you a few quick questions about your current trip.

☐ No

A2. Are you camping at a drive-in campground on the Upper Columbia River tonight?

☐ Yes → Ok. Thank you very much for your time. This version of our survey focuses on visitors who are *not* camping at drive-in sites on the Upper Columbia River. →*Terminate survey*

☐ No

A3. Did you camp at a drive-in campground on the Upper Columbia River last night?

☐ Yes → Ok. Thank you very much for your time. This version of our survey only focuses on visitors who are *not* camping at drive-in sites on the Upper Columbia River. →*Terminate survey*

☐ No

A4. How many people in your group today are…

_____ adults 18 or older?

_____ children 7 to 17 years old?

_____ children under 7?

If no children, skip to B1

A5. A few of my questions will be about the child in your group who had the most recent birthday. Could you tell me that child's first name?

_____ child's first name

A6. How old is *[child]*?

_____ years old

A7. And is *[child]* a boy or a girl?

☐ Boy

☐ Girl

PART B: CURRENT TRIP

B1. When did you arrive at the beach today?

_____ am / pm

B2. Since you arrived, have you <u>personally</u> spent any time in the water?

☐ Yes

☐ No → *Skip to B5*

B3. About how much of your time in the water was spent swimming or wading in water over waist deep?

_____ hours _____ minutes

B4. About how much of your time in the water was spent wading in water shallower than waist deep?

_____ hours _____ minutes

B5. Since you arrived, have you <u>personally</u> spent any time on the sand?

☐ Yes → About how much time? _____ hours _____ minutes

☐ No

If no children in group, skip to B10

B6. Since you arrived, has *[child]* spent any time in the water?

☐ Yes

☐ No → *Skip to B9*

B7. About how much of *[child]'s* time in the water was spent swimming or wading in water over waist deep?

_____ hours _____ minutes

B8. About how much of *[child]'s* time in the water was spent wading in water shallower than waist deep?

_____ hours _____ minutes

B9. Since you arrived, has *[child]* spent any time on the sand?

☐ Yes → About how much time? _____ hours _____ minutes

☐ No

B10. Did you drink any water from the Upper Columbia River since you arrived? I'm asking only about water that you drank on purpose from the Upper Columbia River. I'm not asking about water that you may have swallowed accidentally, and I'm also not asking about water that you drank from a faucet or water fountain.

☐ Yes

☐ No → *If respondent has completed survey before, skip to E1; otherwise skip to C1*

B11. Approximately how many ounces of water would you say that you drank from the Upper Columbia River since you arrived? *[Read response options.]* How about *[child]*? *[Show respondent water bottle with each amount marked on the outside]*

Respondent:	Child:
☐ Less than 8 ounces	☐ Less than 8 ounces
☐ Approximately 8 ounces	☐ Approximately 8 ounces
☐ Approximately 12 ounces	☐ Approximately 12 ounces
☐ Approximately 16 ounces	☐ Approximately 16 ounces
☐ Approximately 20 ounces	☐ Approximately 20 ounces
☐ More than 20 ounces	☐ More than 20 ounces

If respondent has completed survey before, skip to E1

PART C: PAST TRIPS

Now I'd like to ask you a few questions about other trips that you may have taken to the Upper Columbia River since September of last year.

C1. Have you gone on any overnight camping trips to the Upper Columbia River since September of last year? By "overnight camping trips" I mean trips where you stayed overnight in a tent, RV, camper, or boat.

☐ Yes

☐ No → *Skip to C5*

C2. Did you take any of these trips…	C3. Where did you camp? *(list all locations mentioned; list area of lake if location unknown)*	C4. How many nights did you stay at *[location]*?
Last Fall (Sep/Oct/Nov)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Winter (Dec/Jan/Feb)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Spring (Mar/Apr/May)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Summer (Jun/Jul/Aug)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
So far this Fall (Sep/Oct/Nov)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No	3.	_____ nights

C5. Have you gone on any boating day trips to the Upper Columbia River since September of last year? By "boating day trips" I mean boating or boat fishing trips where you <u>didn't</u> stay overnight at the Upper Columbia River.

□ Yes

□ No → *Skip to C10*

C6. Did you take any of these trips…	C7. Where did you launch your boat last *[season]*? *(list all locations mentioned; if location unknown, list area of lake)*	C8. How many times did you launch from *[location]* last *[season]*?	C9. What areas of the lake did you visit when you launched from *[location]* last *[season]* ? (circle all that apply)
Last Fall (Sep/Oct/Nov)?	1.	_____ times	1 2 3 4 5 6 7 8
□ Yes	2.	_____ times	1 2 3 4 5 6 7 8
□ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Winter (Dec/Jan/Feb)?	1.	_____ times	1 2 3 4 5 6 7 8
□ Yes	2.	_____ times	1 2 3 4 5 6 7 8
□ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Spring (Mar/Apr/May)?	1.	_____ times	1 2 3 4 5 6 7 8
□ Yes	2.	_____ times	1 2 3 4 5 6 7 8
□ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Summer (Jun/Jul/Aug)?	1.	_____ times	1 2 3 4 5 6 7 8
□ Yes	2.	_____ times	1 2 3 4 5 6 7 8
□ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
So far this Fall (Sep/Oct/Nov)?	1.	_____ times	1 2 3 4 5 6 7 8
□ Yes	2.	_____ times	1 2 3 4 5 6 7 8
□ No	3.	_____ times	1 2 3 4 5 6 7 8

C10. How about beach <u>day</u> trips? By "beach day trips" I mean beach trips where you <u>didn't</u> stay overnight at the Upper Columbia River. Did you go on any beach day trips to the Upper Columbia River last summer, between June and September?

□ Yes

□ No → *Skip to D1*

C11. Which beaches did you visit on these day trips? *(refer to map; list all locations mentioned; use supplemental sheet if necessary)*	C12. How many day trips did you take to *[beach]* ?
1.	_____ trips
2.	_____ trips
3.	_____ trips
4.	_____ trips

PART D: FISH CONSUMPTION

D1. Do you fish in the Upper Columbia River?

☐ Yes → D2. Do you eat fish from the Upper Columbia River?
☐ Yes
☐ No → *Skip to D10*

☐ No → D2. Do you eat fish from the Upper Columbia River?
☐ Yes
☐ No → *Skip to E1*

The next few questions will be about the fish that you've eaten from the Upper Columbia River over the past 12 months, and about any fish you kept on this trip. I will not be asking to see any of the fish that you kept.

D3. Over the past 12 months, have you eaten any *[species]* from the Upper Columbia River?	D4. About how many meals of *[species]* have you eaten over the past 12 months?	D5. Could you tell me where the *[species]* was caught? *(show map; circle all that apply)*	D6. What parts of the *[species]* do you typically eat? (*check all that apply*)	D7. Did you keep any *[species]* today?	D8. How long were the biggest and smallest *[species]* that you kept today?
Kokanee (Silvers) ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Rainbow Trout ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Walleye ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Bass ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Other fish _____ ☐ Yes ☐ No → *Skip to D9*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → D9	____ inches (biggest) ____ inches (smallest)

D9. Please look at this photo, which shows three different fish fillet serving sizes. How much fillet do you typically eat when you eat a fish fillet meal from the Upper Columbia River? Do you eat an amount... *[read response options]*

- ☐ Less than Photo A
- ☐ Similar to Photo A
- ☐ Similar to Photo B
- ☐ Similar to Photo C
- ☐ More than Photo C

D10. Do you typically share fish from the Upper Columbia River with any children?

☐ Yes → a. Children under the age of 7? ☐ Yes ☐ No

b. Children ages 7 to 17? ☐ Yes ☐ No

☐ No

D11. Are you aware of any fish consumption advisories that have been issued for the Upper Columbia River?

☐ Yes

☐ No → *Offer advisory brochure to respondent; Skip to Section E*

D12. How did you first hear about these advisories? (*check all that apply*)

- ☐ Posted signs
- ☐ Fishing regulations
- ☐ Friend or family
- ☐ Website
- ☐ Newspaper
- ☐ Other _____

D13. Do you find the advisories helpful in making decisions about eating fish from the Upper Columbia River?

☐ Yes

☐ No → Why not? _____

_____

D14. Do you generally follow the advisory recommendations?

☐ Yes

☐ No

D15. In response to the advisories, have you changed…

a. … how often you fish in the Upper Columbia River?

☐ Yes → Do you fish in the Upper Columbia River more or less often? ☐ More ☐ Less

☐ No

b. ….how often you eat fish from the Upper Columbia River?

☐ Yes → Do you eat Upper Columbia River fish more or less often? ☐ More ☐ Less

☐ No

c. ….how you clean the fish that you catch from the Upper Columbia River?

☐ Yes

☐ No

d. …the species that you target when fishing the Upper Columbia River?

☐ Yes

☐ No

e. …how often you share fish from the Upper Columbia River with your family?

☐ Yes → Do you share Upper Columbia River fish with your family more or less often? ☐ More ☐ Less

☐ No

Offer advisory brochure to respondent; proceed to Section E.

PART E: DEMOGRAPHIC CHARACTERISTICS

Now I just have a few final questions…

E1. What year were you born?

_____ year of birth

E2. What is the zip code of your primary residence?

_____ zip code or postal code (write country if respondent not from the United States or Canada)

E3. Are you currently participating in something called the "CCT tribal use survey"?

☐ Yes

☐ No/Don't know

E4. *Interviewer: record gender of respondent*

☐ Male

☐ Female

E5. *Interviewer: has respondent completed survey before?*

☐ Yes → That's the end of the survey. Thank you very much for helping out!

☐ No

E6. *Interviewer: did respondent consume at least 10 fish meals (total across all species) from the Upper Columbia River over the last 12 months (question D4)?*

☐ Yes

☐ No → That's the end of the survey. Thank you very much for helping out!

E7. The National Park Service is conducting a study that focuses on people who eat fish from the Upper Columbia River. They are mailing booklets to every participant for recording fish consumption information over a three-month period. Every participant will receive a $50 check at the end of the study. Would you be interested in helping us out by participating in this study?

☐ Yes

☐ No → That's the end of the survey. Thank you very much for helping out!

If respondent declines but offers his or her companion, say "I'm sorry, but you were randomly selected to participate, and I can't make this offer to anyone else in your group."

E8. That's great. Could I please have your name, address, phone number, and email so that we can contact you?

Name _____

Address _____

_____

Telephone _____

Email _____

That's the end of the survey. Thank you very much for helping out!

END OF SURVEY

UPPER COLUMBIA RIVER VISITOR SURVEY -- BOATING

Interviewer _____ Time _____ am / pm

Location _____ Month_____/Day____/2010

Hi, I'm conducting a survey for the National Park Service about how people use Lake Roosevelt and the Upper Columbia River. I'm hoping to speak with the person in your group who had the most recent birthday.

Interviewer check one:

☐ Survey completed by adult with most recent birthday

☐ Survey completed by another adult

After targeted individual has been identified: Would you be willing to answer a few questions about your visits to this area?

PART A: PRELIMINARY QUESTIONS

Before I start, let me show you exactly what area the survey will focus on. It's the area outlined in red on this map, which includes the Columbia River from the Grand Coulee Dam to the Canadian border and part of the Spokane River. Most of Lake Roosevelt is also included in this area. During the survey, I'll refer to this entire area as the "Upper Columbia River." *Point out respondent's current location on the map.*

A1. Have you taken this survey before?

☐ Yes → Great, then I'll only ask you a few quick questions about your current trip.

☐ No

A2. Are you camping at a drive-in campground on the Upper Columbia River tonight?

☐ Yes → Ok. Thank you very much for your time. This version of our survey only focuses on visitors who are *not* staying at drive-in campgrounds on the Upper Columbia River. →*Terminate survey*

☐ No

A3. Did you camp at the Upper Columbia River last night?

☐ Yes

☐ No → *Skip to A5*

A4. Where did you camp?

_____ Camping site (list area of lake if location unknown or if respondent slept in boat)

Interviewer: Is the camping site a drive-in campground?

☐ Yes → Ok. Thank you very much for your time. This version of our survey only focuses on visitors who are *not* staying at drive-in campgrounds on the Upper Columbia River.

☐ No

A5. How many people on your boat today were…

_____ adults 18 or older?

_____ children 7 to 17 years old?

_____ children under 7?

If no children, skip to B1

A6. A few of my questions will be about the child on your boat who had the most recent birthday. Could you tell me that child's first name?

_____ child's first name

A7. How old is *[child]*?

_____ years old

A8. And is *[child]* a boy or a girl?

□ Boy

□ Girl

PART B: CURRENT TRIP

B1. When did you launch your boat for this trip?

Month_____/Day____/2010

_____ am / pm

B2. What areas of the Upper Columbia River did you visit since you launched? *(Show map, circle all areas visited)*

1 2 3 4 5 6 7 8 Don't know

If trip 24 hours or longer, skip to B5

B3. Since you launched your boat, have you <u>personally</u> spent any time...

a. Waterskiing, tubing, or doing similar activities?	□ Yes □ No	→ About how much time?	_____ hours _____ minutes
b. Wading in water shallower than waist deep?	□ Yes □ No	→ About how much time?	_____ hours _____ minutes
c. Swimming or wading in water over waist deep?	□ Yes □ No	→ About how much time?	_____ hours _____ minutes
d. Hanging out on the beach or sand along the shore?	□ Yes □ No	→ About how much time?	_____ hours _____ minutes

If no children in group, skip to B7

B4. Since you launched your boat, has *[child]* spent any time...

a. Waterskiing, tubing, or doing similar activities?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
b. Wading in water shallower than waist deep?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
c. Swimming or wading in water over waist deep?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
d. Hanging out on the beach or sand along the shore?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes

Skip to B7

B5. Over the past 24 hours, have you <u>personally</u> spent any time...

a. Waterskiing, tubing, or doing similar activities?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
b. Wading in water shallower than waist deep?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
c. Swimming or wading in water over waist deep?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
d. Hanging out on the beach or sand along the shore?	☐ Yes ☐ No	→ About how much time? (Please do <u>not</u> include any time spent inside a tent)	_____ hours _____ minutes
e. Sleeping or relaxing inside a tent?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes

If no children in group, skip to B7

B6. Over the past 24 hours, has *[child]* spent any time...

a. Waterskiing, tubing, or doing similar activities?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
b. Wading in water shallower than waist deep?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
c. Swimming or wading in water over waist deep?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes
d. Hanging out on the beach or sand along the shore?	☐ Yes ☐ No	→ About how much time? (Please do <u>not</u> include any time spent inside a tent)	_____ hours _____ minutes
e. Sleeping or relaxing inside a tent?	☐ Yes ☐ No	→ About how much time?	_____ hours _____ minutes

B7. Did you drink any water from the Upper Columbia River since you launched your boat? I'm asking only about water that you drank on purpose from the Upper Columbia River. I'm not asking about water that you may have swallowed accidentally, and I'm also not asking about water that you drank from a faucet or water fountain.

☐ Yes

☐ No → *If respondent has completed survey before, skip to E1; otherwise skip to C1*

B8. *[Interviewer: was trip longer than 24 hours?]*

☐ Yes → Approximately how many ounces of water would you say that you drank from the Upper Columbia River in the last 24 hours? *[Read response options.]* How about *[child]* ?

☐ No → Approximately how many ounces of water would you say that you drank from the Upper Columbia River since you launched your boat? *[Read response options.]* How about *[child]* ?

[Show respondent water bottle with each amount marked on the outside]

Respondent:

☐ Less than 8 ounces
☐ Approximately 8 ounces
☐ Approximately 12 ounces
☐ Approximately 16 ounces
☐ Approximately 20 ounces
☐ More than 20 ounces

Child:

☐ Less than 8 ounces
☐ Approximately 8 ounces
☐ Approximately 12 ounces
☐ Approximately 16 ounces
☐ Approximately 20 ounces
☐ More than 20 ounces

If respondent has completed survey before, skip to E1

PART C: PAST TRIPS

Now I'd like to ask you a few questions about other trips that you may have taken to the Upper Columbia River since September of last year.

C1. Have you gone on any overnight camping trips to the Upper Columbia River since September of last year? By "overnight camping trips" I mean trips where you stayed overnight in a tent, RV, camper, or boat.

☐ Yes
☐ No → *Skip to C5*

C2. Did you take any of these trips…	C3. Where did you camp? *(list all locations mentioned; list area of lake if location unknown)*	C4. How many nights did you stay at *[location]*?
Last Fall (Sep/Oct/Nov)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Winter (Dec/Jan/Feb)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Spring (Mar/Apr/May)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Summer (Jun/Jul/Aug)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
So far this Fall (Sep/Oct/Nov)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No	3.	_____ nights

C5. Have you gone on any boating day trips to the Upper Columbia River since September of last year? By "boating day trips" I mean boating or boat fishing trips where you <u>didn't</u> stay overnight at the Upper Columbia River.

☐ Yes

☐ No → *Skip to C10*

C6. Did you take any of these trips…	C7. Where did you launch your boat last *[season]*? *(list all locations mentioned; if location unknown, list area of lake)*	C8. How many times did you launch from *[location]* last *[season]*?	C9. What areas of the lake did you visit when you launched from *[location]* last *[season]*? (circle all that apply)
Last Fall (Sep/Oct/Nov)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Winter (Dec/Jan/Feb)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Spring (Mar/Apr/May)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Summer (Jun/Jul/Aug)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
So far this Fall (Sep/Oct/Nov)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No	3.	_____ times	1 2 3 4 5 6 7 8

C10. How about beach <u>day</u> trips? By "beach day trips" I mean beach trips where you <u>didn't</u> stay overnight at the Upper Columbia River. Did you go on any beach day trips to the Upper Columbia River last summer, between June and September?

☐ Yes

☐ No → *Skip to D1*

C11. Which beaches did you visit on these day trips? *(refer to map; list all locations mentioned; use supplemental sheet if necessary)*	C12. How many day trips did you take to *[beach]* ?
1.	_____ trips
2.	_____ trips
3.	_____ trips
4.	_____ trips

PART D: FISH CONSUMPTION

D1. Do you fish in the Upper Columbia River?

☐ Yes → D2. Do you eat fish from the Upper Columbia River?
☐ Yes
☐ No → *Skip to D10*

☐ No → D2. Do you eat fish from the Upper Columbia River?
☐ Yes
☐ No → *Skip to E1*

The next few questions will be about the fish that you've eaten from the Upper Columbia River over the past 12 months, and about any fish you kept on this trip. I will not be asking to see any of the fish that you kept.

D3. Over the past 12 months, have you eaten any *[species]* from the Upper Columbia River?	D4. About how many meals of *[species]* have you eaten over the past 12 months?	D5. Could you tell me where the *[species]* was caught? *(show map; circle all that apply)*	D6. What parts of the *[species]* do you typically eat? (*check all that apply*)	D7. Did you keep any *[species]* today?	D8. How long were the biggest and smallest *[species]* that you kept today?
Kokanee (Silvers) ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Rainbow Trout ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Walleye ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Bass ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Other fish _____ ☐ Yes ☐ No → *Skip to D9*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → D9	____ inches (biggest) ____ inches (smallest)

D9. Please look at this photo, which shows three different fish fillet serving sizes. How much fillet do you typically eat when you eat a fish fillet meal from the Upper Columbia River? Do you eat an amount... *[read response options]*

- ☐ Less than Photo A
- ☐ Similar to Photo A
- ☐ Similar to Photo B
- ☐ Similar to Photo C
- ☐ More than Photo C

D10. Do you typically share fish from the Upper Columbia River with any children?

☐ Yes → a. Children under the age of 7? ☐ Yes ☐ No

b. Children ages 7 to 17? ☐ Yes ☐ No

☐ No

D11. Are you aware of any fish consumption advisories that have been issued for the Upper Columbia River?

- ☐ Yes
- ☐ No → *Offer advisory brochure to respondent; Skip to Section E*

D12. How did you first hear about these advisories? (*check all that apply*)

- ☐ Posted signs
- ☐ Fishing regulations
- ☐ Friend or family
- ☐ Website
- ☐ Newspaper
- ☐ Other _____

D13. Do you find the advisories helpful in making decisions about eating fish from the Upper Columbia River?

- ☐ Yes
- ☐ No → Why not? _____

_____

D14. Do you generally follow the advisory recommendations?

- ☐ Yes
- ☐ No

D15. In response to the advisories, have you changed…

a. … how often you fish in the Upper Columbia River?

☐ Yes → Do you fish in the Upper Columbia River more or less often? ☐ More ☐ Less

☐ No

b. ….how often you eat fish from the Upper Columbia River?

☐ Yes → Do you eat Upper Columbia River fish more or less often? ☐ More ☐ Less

☐ No

c. ….how you clean the fish that you catch from the Upper Columbia River?

☐ Yes

☐ No

d. …the species that you target when fishing the Upper Columbia River?

☐ Yes

☐ No

e. …how often you share fish from the Upper Columbia River with your family?

☐ Yes → Do you share Upper Columbia River fish with your family more or less often? ☐ More ☐ Less

☐ No

Offer advisory brochure to respondent; proceed to Section E.

PART E: DEMOGRAPHIC CHARACTERISTICS

Now I just have a few final questions…

E1. What year were you born?

_____ year of birth

E2. What is the zip code of your primary residence?

_____ zip code or postal code (write country if respondent not from the United States or Canada)

E3. Are you currently participating in something called the "CCT tribal use survey"?

☐ Yes

☐ No/Don't know

E4. *Interviewer: record gender of respondent*

☐ Male

☐ Female

E5. *Interviewer: record type of boating trip*

☐ Boat launch

☐ Rented boat slip (marinas only)

☐ Rented houseboat (marinas only)

E6. *Interviewer: has respondent completed survey before?*

☐ Yes → That's the end of the survey. Thank you very much for helping out!

☐ No

E7. *Interviewer: did respondent consume at least 10 fish meals (total across all species) from the Upper Columbia River over the last 12 months (question D4)?*

☐ Yes

☐ No → That's the end of the survey. Thank you very much for helping out!

E8. The National Park Service is conducting a study that focuses on people who eat fish from the Upper Columbia River. They are mailing booklets to every participant for recording fish consumption information over a three-month period. Every participant will receive a $50 check at the end of the study. Would you be interested in helping us out by participating in this study?

☐ Yes

☐ No → That's the end of the survey. Thank you very much for helping out!

If respondent declines but offers his or her companion, say "I'm sorry, but you were randomly selected to participate, and I can't make this offer to anyone else in your group."

E9. That's great. Could I please have your name, address, phone number, and email so that we can contact you?

Name _____

Address _____

_____

Telephone _____

Email _____

That's the end of the survey. Thank you very much for helping out!

END OF SURVEY

UPPER COLUMBIA RIVER VISITOR SURVEY -- CAMPING

Interviewer _____ Time _____ am / pm

Location _____ Month_____/Day____/2010

Hi, I'm conducting a survey for the National Park Service about how people use Lake Roosevelt and the Upper Columbia River. I'm hoping to speak with the person in your group who had the most recent birthday.

Interviewer check one:

☐ Survey completed by adult with most recent birthday

☐ Survey completed by another adult

After targeted individual has been identified: Would you be willing to answer a few questions about your visits to this area?

PART A: PRELIMINARY QUESTIONS

Before I start, let me show you exactly what area the survey will focus on. It's the area outlined in red on this map, which includes the Columbia River from the Grand Coulee Dam to the Canadian border and part of the Spokane River. Most of Lake Roosevelt is also included in this area. During the survey, I'll refer to this entire area as the "Upper Columbia River." *Point out respondent's current location on the map.*

A1. Have you taken this survey before?

☐ Yes → Great, then I'll only ask you a few quick questions about your current trip.

☐ No

A2. How many people staying at your campsite tonight are…

_____ adults 18 or older?

_____ children 7 to 17 years old?

_____ children under 7?

If no children, skip to B1

A3. A few of my questions will be about the child at your campsite who had the most recent birthday. Could you tell me that child's first name?

_____ child's first name

A4. How old is *[child]*?

_____ years old

A5. And is *[child]* a boy or a girl?

☐ Boy

☐ Girl

PART B: CURRENT TRIP

B1. When did you arrive at the Upper Columbia River for this camping trip?

Month_____/Day____/2010 At about what time? _____ am / pm

B2. When do you plan to leave?

Month_____/Day____/2010 Do you know about what time? _____ am / pm

□ Don't know/not sure

B3. Did you bring a boat with you?

□ Yes

□ No

B4. Since you arrived, have you <u>personally</u> spent any time...

a. Waterskiing, tubing, or doing similar activities?	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes
b. Wading in water shallower ▫han waist deep?	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes
c. Swimming or wading in water over waist deep?	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes
d. Hanging out on the beach or sand along the shore?	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes
e. Inside a tent, camper, or RV	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes

If no children in group, skip to B6

B5. Since you arrived, has *[child]* spent any time...

a. Waterskiing, tubing, or doing similar activities?	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes
b. Wading in water shallower than waist deep?	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes
c. Swimming or wading in water over waist deep?	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes
d. Hanging out on the beach or sand along the shore?	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes
e. Inside a tent, camper, or RV	□ Yes □ No	→ About how much time over the past 24 hours?	_____ hours _____ minutes

B6. Did you drink any water from the Upper Columbia River since you arrived? I'm asking only about water that you drank on purpose from the Upper Columbia River. I'm not asking about water that you may have swallowed accidentally, and I'm also not asking about water that you drank from a faucet or water fountain.

□ Yes

□ No → *If respondent has completed survey before, skip to E1; otherwise skip to C1*

B7. Approximately how many ounces of water would you say that you drank from the Upper Columbia River in the last 24 hours? *[Read response options.]* How about *[child]* ? *[Show respondent water bottle with each amount marked on the outside]*

Respondent:

- ☐ Less than 8 ounces
- ☐ Approximately 8 ounces
- ☐ Approximately 12 ounces
- ☐ Approximately 16 ounces
- ☐ Approximately 20 ounces
- ☐ More than 20 ounces

Child:

- ☐ Less than 8 ounces
- ☐ Approximately 8 ounces
- ☐ Approximately 12 ounces
- ☐ Approximately 16 ounces
- ☐ Approximately 20 ounces
- ☐ More than 20 ounces

If respondent has completed survey before, skip to E1

PART C: PAST TRIPS

Now I'd like to ask you a few questions about other trips that you may have taken to the Upper Columbia River since September of last year.

C1. Have you gone on any other overnight camping trips to the Upper Columbia River since September of last year? By "overnight camping trips" I mean trips where you stayed overnight in a tent, RV, camper, or boat.

- ☐ Yes
- ☐ No → *Skip to C5*

C2. Did you take any of these trips…	C3. Where did you camp? *(list all locations mentioned; list area of lake if location unknown)*	C4. How many nights did you stay at *[location]* ?
Last Fall (Sep/Oct/Nov)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Winter (Dec/Jan/Feb)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Spring (Mar/Apr/May)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
Last Summer (Jun/Jul/Aug)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No → *Skip to next season*	3.	_____ nights
So far this Fall (Sep/Oct/Nov)?	1.	_____ nights
☐ Yes	2.	_____ nights
☐ No	3.	_____ nights

C5. Have you gone on any boating day trips to the Upper Columbia River since September of last year? By "boating day trips" I mean boating or boat fishing trips where you <u>didn't</u> stay overnight at the Upper Columbia River.

☐ Yes

☐ No → *Skip to C10*

C6. Did you take any of these trips…	C7. Where did you launch your boat last *[season]*? *(list all locations mentioned; if location unknown, list area of lake)*	C8. How many times did you launch from *[location]* last *[season]*?	C9. What areas of the lake did you visit when you launched from *[location]* last *[season]* ? (circle all that apply)
Last Fall (Sep/Oct/Nov)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Winter (Dec/Jan/Feb)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Spring (Mar/Apr/May)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
Last Summer (Jun/Jul/Aug)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No → *Skip to next season*	3.	_____ times	1 2 3 4 5 6 7 8
So far this Fall (Sep/Oct/Nov)?	1.	_____ times	1 2 3 4 5 6 7 8
☐ Yes	2.	_____ times	1 2 3 4 5 6 7 8
☐ No	3.	_____ times	1 2 3 4 5 6 7 8

C10. How about beach <u>day</u> trips? By "beach day trips" I mean beach trips where you <u>didn't</u> stay overnight at the Upper Columbia River. Did you go on any beach day trips to the Upper Columbia River last summer, between June and September?

☐ Yes

☐ No → *Skip to D1*

C11. Which beaches did you visit on these day trips? *(refer to map; list all locations mentioned; use supplemental sheet if necessary)*	C12. How many day trips did you take to *[beach]* ?
1.	_____ trips
2.	_____ trips
3.	_____ trips
4.	_____ trips

PART D: FISH CONSUMPTION

D1. Do you fish in the Upper Columbia River?

☐ Yes → D2. Do you eat fish from the Upper Columbia River?
☐ Yes
☐ No → *Skip to D10*

☐ No → D2. Do you eat fish from the Upper Columbia River?
☐ Yes
☐ No → *Skip to E1*

The next few questions will be about the fish that you've eaten from the Upper Columbia River over the past 12 months, and about any fish you kept on this trip. I will not be asking to see any of the fish that you kept.

D3. Over the past 12 months, have you eaten any *[species]* from the Upper Columbia River?	D4. About how many meals of *[species]* have you eaten over the past 12 months?	D5. Could you tell me where the *[species]* was caught? *(show map; circle all that apply)*	D6. What parts of the *[species]* do you typically eat? (*check all that apply*)	D7. Did you keep any *[species]* today?	D8. How long were the biggest and smallest *[species]* that you kept today?
Kokanee (Silvers) ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Rainbow Trout ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Walleye ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Bass ☐ Yes ☐ No → *Skip to next species*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → *next species*	____ inches (biggest) ____ inches (smallest)
Other fish _____ ☐ Yes ☐ No → *Skip to D9*	_____ meals *If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…	1 2 3 4 5 6 7 8 Don't know _____	☐ Fillet ☐ Skin ☐ Eggs ☐ Head ☐ Guts	☐ Yes ☐ No → D9	____ inches (biggest) ____ inches (smallest)

D9. Please look at this photo, which shows three different fish fillet serving sizes. How much fillet do you typically eat when you eat a fish fillet meal from the Upper Columbia River? Do you eat an amount... *[read response options]*

- ☐ Less than Photo A
- ☐ Similar to Photo A
- ☐ Similar to Photo B
- ☐ Similar to Photo C
- ☐ More than Photo C

D10. Do you typically share fish from the Upper Columbia River with any children?

- ☐ Yes → a. Children under the age of 7? ☐ Yes ☐ No
  b. Children ages 7 to 17? ☐ Yes ☐ No
- ☐ No

D11. Are you aware of any fish consumption advisories that have been issued for the Upper Columbia River?

- ☐ Yes
- ☐ No → *Offer advisory brochure to respondent; Skip to Section E*

D12. How did you first hear about these advisories? (*check all that apply*)

- ☐ Posted signs
- ☐ Fishing regulations
- ☐ Friend or family
- ☐ Website
- ☐ Newspaper
- ☐ Other _____

D13. Do you find the advisories helpful in making decisions about eating fish from the Upper Columbia River?

- ☐ Yes
- ☐ No → Why not? _____

_____

D14. Do you generally follow the advisory recommendations?

- ☐ Yes
- ☐ No

D15. In response to the advisories, have you changed…

a. … how often you fish in the Upper Columbia River?

☐ Yes → Do you fish in the Upper Columbia River more or less often? ☐ More ☐ Less

☐ No

b. ….how often you eat fish from the Upper Columbia River?

☐ Yes → Do you eat Upper Columbia River fish more or less often? ☐ More ☐ Less

☐ No

c. ….how you clean the fish that you catch from the Upper Columbia River?

☐ Yes

☐ No

d. …the species that you target when fishing the Upper Columbia River?

☐ Yes

☐ No

e. …how often you share fish from the Upper Columbia River with your family?

☐ Yes → Do you share Upper Columbia River fish with your family more or less often? ☐ More ☐ Less

☐ No

Offer advisory brochure to respondent; proceed to Section E.

PART E: DEMOGRAPHIC CHARACTERISTICS

Now I just have a few final questions…

E1. What year were you born?

_____ year of birth

E2. What is the zip code of your primary residence?

_____ zip code or postal code (write country if respondent not from the United States or Canada)

E3. Are you currently participating in something called the "CCT tribal use survey"?

☐ Yes

☐ No/Don't know

E4. *Interviewer: record gender of respondent*

☐ Male

☐ Female

E5. *Interviewer: has respondent completed survey before?*

☐ Yes → That's the end of the survey. Thank you very much for helping out!

☐ No

E6. *Interviewer: did respondent consume at least 10 fish meals (total across all species) from the Upper Columbia River over the last 12 months (question D4)?*

☐ Yes

☐ No → That's the end of the survey. Thank you very much for helping out!

E7. The National Park Service is conducting a study that focuses on people who eat fish from the Upper Columbia River. They are mailing booklets to every participant for recording fish consumption information over a three-month period. Every participant will receive a $50 check at the end of the study. Would you be interested in helping us out by participating in this study?

☐ Yes

☐ No → That's the end of the survey. Thank you very much for helping out!

If respondent declines but offers his or her companion, say "I'm sorry, but you were randomly selected to participate, and I can't make this offer to anyone else in your group."

E8. That's great. Could I please have your name, address, phone number, and email so that we can contact you?

Name _____

Address _____

_____

Telephone _____

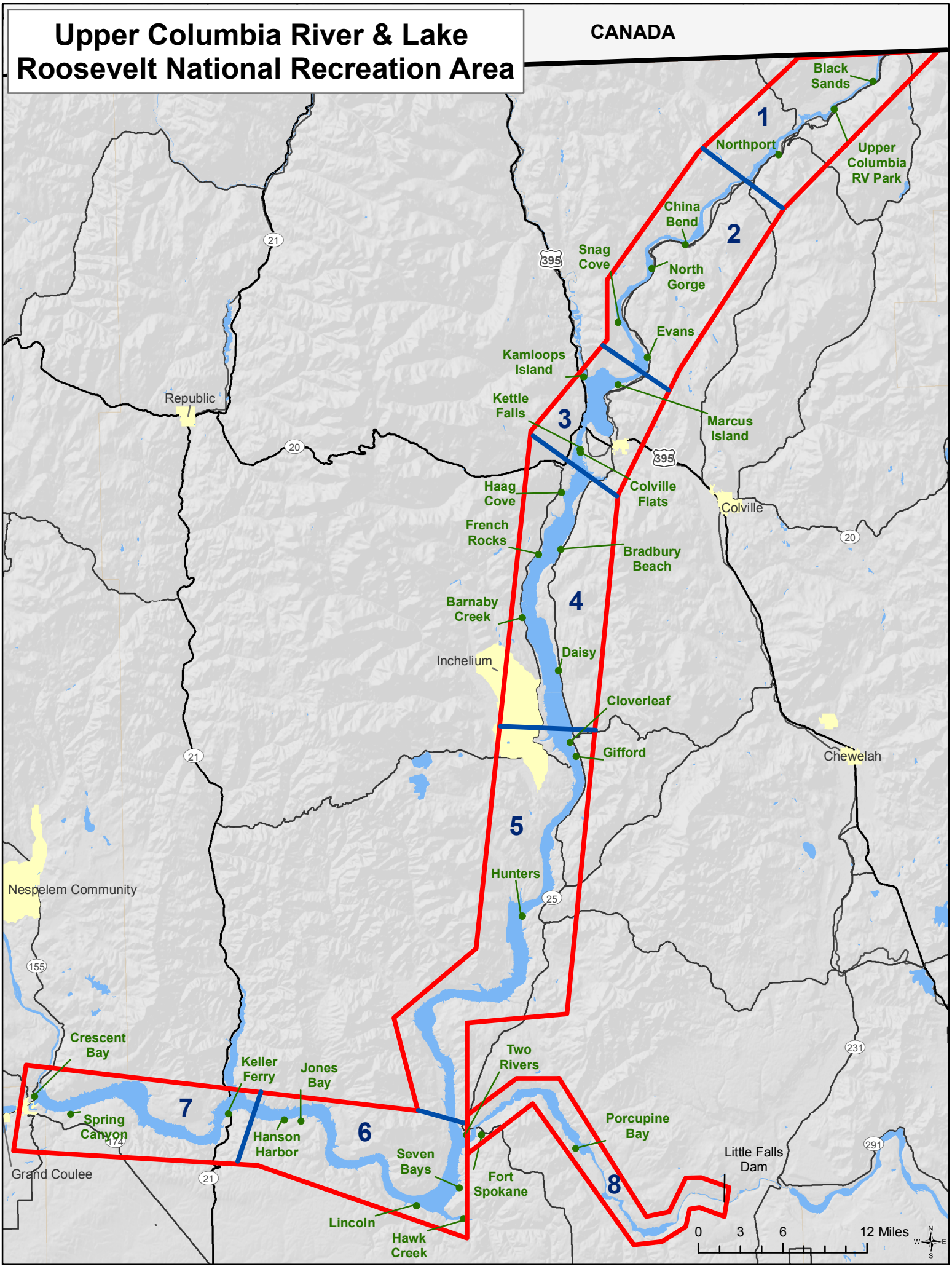
Email _____

That's the end of the survey. Thank you very much for helping out!

END OF SURVEY

APPENDIX D:

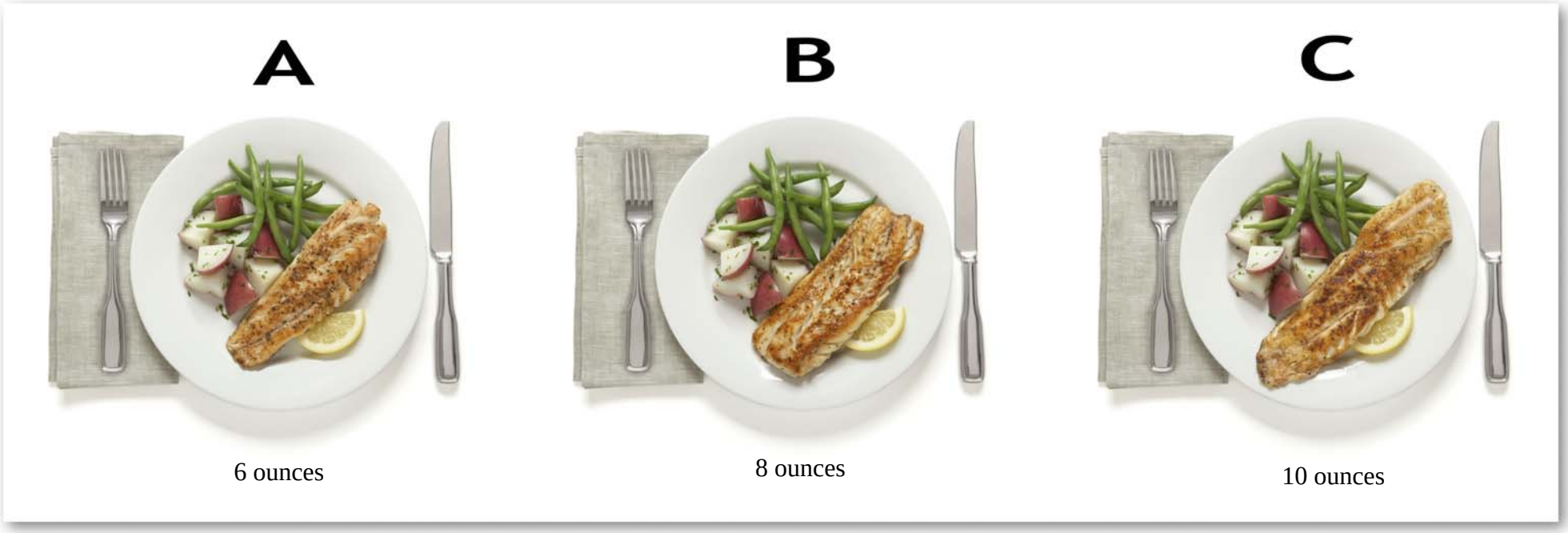
MAP DEPICTING UPPER COLUMBIA RIVER REGION FOR SURVEY RESPONDENTS


Upper Columbia River & Lake Roosevelt National Recreation Area
CANADA
Black Sands
Northport
Upper Columbia RV Park
China Bend
Snag Cove
North Gorge
Evans
Kamloops Island
Kettle Falls
Marcus Island
Colville Flats
Haag Cove
French Rocks
Bradbury Beach
Barnaby Creek
Daisy
Cloverleaf
Gifford
Hunters
Two Rivers
Porcupine Bay
Fort Spokane
Seven Bays
Hawk Creek
Lincoln
Hanson Harbor
Keller Ferry
Jones Bay
Crescent Bay
Spring Canyon
1
2
3
4
5
6
7
8
Republic
Colville
Inchelium
Chewelah
Nespelem Community
Grand Coulee
Little Falls Dam
395
21
20
25
155
174
231
291
0 3 6 12 Miles

APPENDIX E:

PHOTOGRAPHS OF 6-OZ, 8-OZ, AND 10-OZ FISH FILLETS (PRE-COOKED WEIGHTS)

Fish Fillet Size Comparison



APPENDIX F:

ANGLER CONSUMPTION DIARY

November 1, 2010

Dear Angler,

On a recent trip to the Upper Columbia River, you participated in a visitor survey for the National Park Service. At the end of that survey, you agreed to participate in a follow-up study that focuses on people who eat fish from the Upper Columbia River. The purpose of this follow-up study is to collect information on fish consumption so that the U.S. Environmental Protection Agency can evaluate potential health risks from contamination in the Upper Columbia River.

Thank you for participating! Each month for the next three months, we will send you a diary to record every fish meal that you eat. Your first diary is enclosed along with instructions for filling it out. At the end of each month, we will call you for your entries. After you have completed diaries for all three months, we will send you a self-addressed, stamped envelope so that you can send us your completed diaries. We will also send a check for $50 to show our appreciation for your time helping with this study.

All of the information that we collect from you is confidential. Your name, address, and phone number will not be shared with anyone, and are being used only to communicate with you during this three-month process.

If you lose any of the materials from this packet, please let us know immediately so that we can send you replacements. If you have any questions about your participation in this study, or about how to fill out your diary, please let me know. You can reach me at:

(617) 354-0074	or	nscherer@indecon.com

Thank you very much for your time. We look forward to speaking with you soon.

Sincerely,

Nora Scherer

This is your

FISHING DIARY

for the month of:

NOVEMBER 2010

Please ***start*** using this diary on: November 1, 2010
Please ***stop*** using this diary on: November 30, 2010

THANKS AGAIN FOR PARTICIPATING!

Your responses are very important to us.

Every time you eat a fish meal (regardless of the source), please record that meal in the tables in the following pages of this booklet. You will find instructions for filling out these tables and an example on the next page.

Here are some details to keep in mind:

- **We chose you!** Please complete the diary yourself. Do not let other members of your family fill out the diary for you.

- **Each meal counts!** Your responses are very important to us. Please fill out this diary even if you don't eat fish very often.

At the beginning of each month, we will call you to ask you about the meals you recorded for the previous month. At the end of three months, we will send you a self-addressed stamped envelope to return all your diaries, and your **$50**.

Please don't hesitate to call or email me if you have any questions about how to fill out this diary, or if you need any replacement materials.

Happy fishing and we'll talk to you soon!

If you have any questions about this diary, please call or email
Nora Scherer at:
(617) 354-0074
nscherer@indecon.com

INSTRUCTIONS

Please fill out one table in this booklet after **every meal** of fish that you eat **this month**.

Date:
At the top of the table, write the date that you ate any fish meal. If you had more than one meal per day, please fill out another table for that meal.

Species:
We'd like to know which fish you eat. Circle all the types of fish that you ate during that meal. We've included a set of pictures that show some of the most common fish in the area, which you may use to help identify the fish you eat. If you eat a fish that is not listed, please write it in the "Other" line.

Source:
We'd like to know where you catch your fish. For fish that you caught in the lake/river, we've included a map that divides the lake/river into 8 sections. Please use the map and identify all of the areas of the lake where the fish were caught: 1 through 8. Circle "don't know" if you're not sure.

Date: November 2, 2010

Species (circle all that apply)	**Source** (circle all that apply)		
Kokanee (Silvers)	**Upper Columbia River**	**Local Area**	**Other**
Rainbow Trout	1	Sanpoil River	Store
Walleye	2	Columbia River below Coulee Dam	Restaurant
Bass	3		
Other_____	4	Other local fishing site:	Non-local fishing site
_____	5	_____(please specify)	
_____	6		
_____	7		
	8		

Parts Consumed (circle all that apply)

Fillet Skin Eggs Head Guts

Meal Size (circle one)

Less than A Similar to A Similar to B Similar to C More than C

Did the child with the birthday closest to January 1 also eat fish during this meal?

YES

NO

N/A

If YES, what was the child's meal size?

Less than A

Similar to A

Similar to B

Similar to C

More than C

Parts Consumed:
We'd like to know which parts of the fish you eat. Circle ALL of the parts of the fish that you ate during the meal.

Meal Size:
We'd like to know how much fish you ate during the meal. Your packet includes a picture of three plates of cooked fish labeled "A", "B", and "C". Look at the picture and estimate the amount of fish you ate.

Child's Meal:
If you have children in your household, pick the child whose birthday is closest to January 1. When you eat fish, we want to know whether this child also ate fish during this meal. If they did, circle YES and record the amount of fish they ate using the meal size picture. If the child did not eat fish, circle NO. If there are no children in your household, circle N/A.

NOVEMBER 2010

YOUR NAME: _____

In addition to recording your fish meals, we also ask whether any children in your family eat fish. If you have children in your household, please select the child whose birthday is closest to January 1 and record their initials and age below. Every time you eat fish, we ask you if your child also ate this fish as part of this meal. If you have more than one child, always record the information for the child whose birthday is closest to January 1.

AGE OF CHILD: _____

INITIALS OF CHILD: _____

Date:

Species (circle all that apply)	**Source** (circle all that apply)		
	Upper Columbia River	**Local Area**	**Other**
Kokanee (Silvers)	1	Sanpoil River	Store
Rainbow Trout	2	Columbia River below Coulee Dam	Restaurant
Walleye	3		Non-local fishing site
Bass	4	Other local fishing site:	
Other_____	5	_____	
_____	6	(please specify)	
_____	7		
_____	8		

Parts Consumed (circle all that apply)

Fillet Skin Eggs Head Guts

Meal Size (circle one)

Less than A Similar to A Similar to B Similar to C More than C

Did the child with the birthday closest to January 1 also eat fish during this meal?

YES

NO

N/A

➡

If YES, what was the child's meal size?

Less than A

Similar to A

Similar to B

Similar to C

More than C

Date:

Species (circle all that apply)	**Source** (circle all that apply)		
	Upper Columbia River	**Local Area**	**Other**
Kokanee (Silvers)	1	Sanpoil River	Store
Rainbow Trout	2	Columbia River below Coulee Dam	Restaurant
Walleye	3		Non-local fishing site
Bass	4	Other local fishing site:	
Other_____	5	_____	
_____	6	(please specify)	
_____	7		
_____	8		

Parts Consumed (circle all that apply)

Fillet Skin Eggs Head Guts

Meal Size (circle one)

Less than A Similar to A Similar to B Similar to C More than C

Did the child with the birthday closest to January 1 also eat fish during this meal?

YES

NO

N/A

If YES, what was the child's meal size?

Less than A

Similar to A

Similar to B

Similar to C

More than C

Date:

Species (circle all that apply)	**Source** (circle all that apply)		
	Upper Columbia River	**Local Area**	**Other**
Kokanee (Silvers)	1	Sanpoil River	Store
Rainbow Trout	2	Columbia River below Coulee Dam	Restaurant
Walleye	3		Non-local fishing site
Bass	4	Other local fishing site:	
Other_____	5	_____	
_____	6	(please specify)	
_____	7		
_____	8		

Parts Consumed (circle all that apply)

Fillet Skin Eggs Head Guts

Meal Size (circle one)

Less than A Similar to A Similar to B Similar to C More than C

Did the child with the birthday closest to January 1 also eat fish during this meal?

YES

NO

N/A

If YES, what was the child's meal size?

Less than A

Similar to A

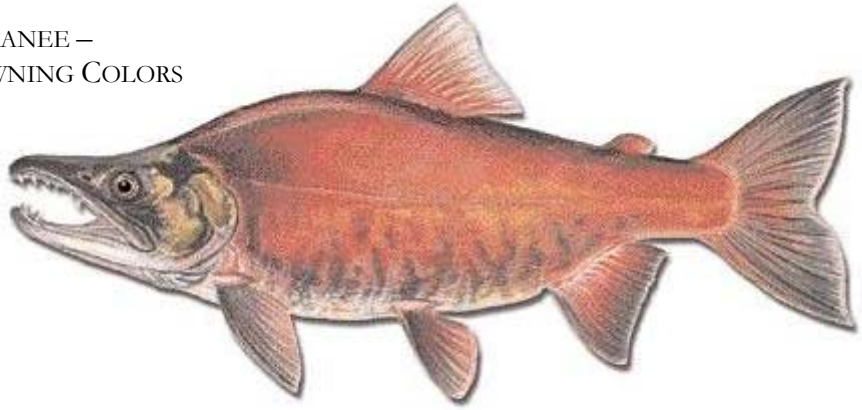
Similar to B

Similar to C

More than C

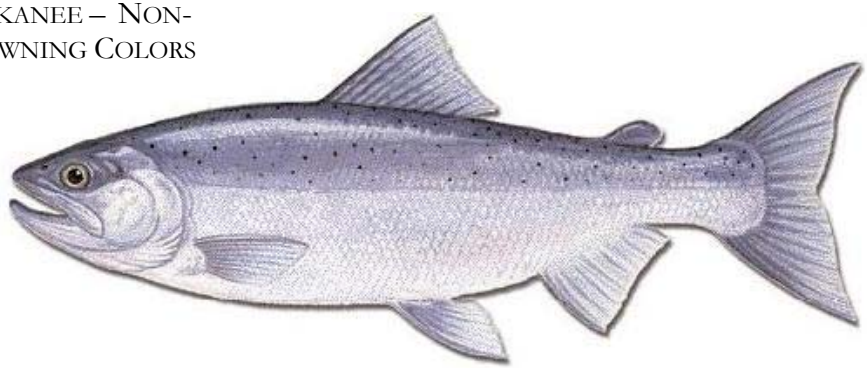
Upper Columbia River Fish Species

Kokanee – Spawning Colors

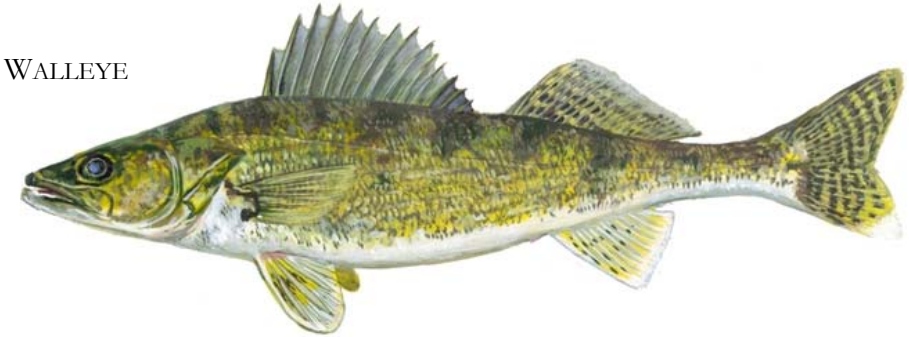


Rainbow Trout

Kokanee – Non-Spawning Colors



Walleye



Bass

December 1, 2010

Dear Angler,

One month down, and two to go!

For the last month, you have been filling out your angler diary, and we will be calling you this week to ask you for those records. In this packet, you will find your diary for the month of December. Please start using this diary on December 1st and stop using it on December 31st.

If you have any questions about filling out your diary, or need any replacement materials, please send me an email or give me a call at:

(617) 354-0074	or	nscherer@indecon.com

Again, thank you so much for participating!

Sincerely,

Nora Scherer
(617) 354-0074
nscherer@indecon.com

January 1, 2011

Dear Angler,

You're almost there!

For the last two months, you have been filling out your angler diary, and we really appreciate you sticking with it. We will be calling you again sometime this week to ask you for your records for the month of December. In this packet, you will find your diary for the month of January. Please start using this diary on January 1st and stop using it on January 31st.

At the end of this month, we will be sending you a self-addressed stamped envelope for you to return all three diaries to us. We will also be sending you a check for $50!

If you have any questions about filling out your diary, or need any replacement materials, please send me an email or give me a call at:

(617) 354-0074	or	nscherer@indecon.com

Again, thank you so much for participating!

Sincerely,

Nora Scherer
(617) 354-0074
nscherer@indecon.com

February 1, 2011

Dear Angler,

You made it! The three months are over! We want to thank you so much for participating in our survey. Your responses will be very helpful for us. Please find enclosed a check for $50 as a token of our appreciation for your participation in this survey effort.

Please also find a self-addressed stamped envelope for you to return your diaries to us. Please put all three diaries that you have been filling out for the last three months in the envelope, drop it in the mail, and you're done!

We would also like to remind you that all of the information that we have collected from you over the last three months both over the phone and in the diaries that you are sending back today will be kept completely confidential. Your name, address, and phone number will not be shared with anyone.

Again, thank you so much for participating!

Sincerely,

Nora Scherer
(617) 354-0074
nscherer@indecon.com

APPENDIX G:

SUMMARY OF PRETEST OBSERVATIONS

IEc

MEMORANDUM | 13 August 2010

TO Dan Audet
DOI Project Manager, Upper Columbia River

FROM Chris Leggett, Nora Scherer, and Mark Curry
Industrial Economics, Incorporated

SUBJECT Observations from Pretest of Survey Instrument and Intercept Methods: Lake Roosevelt Recreational Consumption and Resource Use Survey

INTRODUCTION

Industrial Economics, Inc. (IEc) has developed a draft sampling and analysis plan (SAP) for a recreational consumption and resource use survey on the Upper Columbia River (UCR) from the Grand Coulee Dam to the U.S./Canadian border.[1] The purpose of the survey is to obtain site-specific data on human uses of the UCR for use in the baseline human health risk assessment being conducted by the EPA. A pretest of the survey was conducted at the UCR over a four-day period (two weekdays and two weekend days) from Thursday, June 17, 2010 to Sunday, June 20, 2010. The purpose of the pretest was to evaluate the survey instrument and intercept procedures so that potential problems could be identified and addressed prior to implementing the full survey. IEc staff conducted surveys with visitors at boat launches, campgrounds, and day-use beaches (Exhibit 1) using intercept procedures similar to those planned for the full survey. When feasible, post-interview probes were used to evaluate the survey instrument and visual aids.

PRETEST OBSERVATIONS

Overall, 130 individuals were intercepted during the four-day period, resulting in 106 completed surveys and 24 refusals, for a response rate of approximately 82 percent. Of the completed surveys, 36 were at boat launches, 46 were at campgrounds, and 24 were at day-use beaches. Response rates were relatively high for all three types of sites, with an 87 percent response rate at boat launches, an 80 percent response rate at campgrounds, and a 75 percent response rate at beaches.

The following survey-related issues were identified during the pretest:

- When respondents refused to complete the survey, the additional clarification regarding the purpose of the survey did not persuade them to change their minds. With non-respondents, it was often clear that they were in a hurry, and reading the clarification text seemed irrelevant/rude. This text has been removed from the survey.

[1] "Recreational Consumption and Resource Use Survey Sampling and Analysis Plan for the Upper Columbia River Site Human Health Risk Assessment and Remedial Investigation/Feasibility Study." DRAFT prepared March 19, 2010 by Industrial Economics, Inc.

EXHIBIT 1: PRETEST LOCATIONS

BOAT LAUNCHES	CAMPGROUNDS	DAY-USE BEACHES
Northport[a]	Evans	Evans
China Bend	Kettle Falls	Colville Flats
Kettle Falls	Haag Cove	Bradbury
Hunters	Two Rivers	Fort Spokane[a]
Fort Spokane	Fort Spokane	Spring Canyon[a]
Porcupine Bay	Keller Ferry	
Seven Bays	Spring Canyon	
Lincoln		
Keller Ferry		
Spring Canyon		

Note:

[a] –Interviewing terminated prior to end of shift due to absence of visitors.

- At day-use beaches, respondents generally reported the entire trip time, including time swimming and wading, when asked about the amount of time spent "on the beach." As a result, the question was revised to inquire about time "on the sand." In addition, it seemed natural for respondents to classify their time at the beach as either "in the water" or "out of the water." Thus, the revised survey first asks whether or not the respondent spent any time in the water. Respondents who respond affirmatively are then asked to estimate the amount of time spent swimming or wading.
- Many respondents seemed to have difficulty estimating the amount of time that they spent inside a tent, camper, or RV over the past 24 hours. This seemed be the result of the need to sum numerous time periods of varying lengths, including time sleeping, napping, cooking, playing games, or pursuing other indoor activities. The pretest team was not able to identify any suitable alternatives to this question wording.
- When asked to recall trips to the UCR over the past 12 months, respondents had difficulty remembering the exact dates of trips taken approximately one year earlier. They would often remember the season or month of the trip, but not the exact day, making it difficult to determine whether or not the trip fell within the 12-month window. This issue was particularly difficult for respondents who took an annual trip to the UCR at about the same time every year. To address this issue, the survey was revised to remove the 12-month window for past trips. Instead, respondents are asked to provide information about past trips by season (i.e., trips taken last summer, fall, winter, and spring).
- Interviewers found the wording of the questions that define boating and swimming day trips to be slightly awkward. In addition, they were concerned that some anglers may not be including boat fishing trips when reporting about boating day trips. As a result, these questions were revised to more clearly define

a “day trip,” and specific language on boat fishing was added to the boating day trip question.

- Some respondents misinterpreted the question about drinking UCR water as including water consumed from campground faucets. The question was therefore revised to specifically state that the interview is “not asking about water that you drank from a faucet or water fountain.”
- Only 2 out of 106 respondents reported that they drank any water at all from the UCR during their trip. Given the extremely low incidence of this activity, we recommend not having interviewers carry an entire set of water bottles as visual aids. Instead, the interviewers will carry a single water bottle with the relevant volumes marked on the side of the bottle.
- Interviewers noted that the introduction to the fish consumption questions, which noted that responses would not be used “for enforcement,” was awkward and did not seem to serve the intended purpose of making the respondent feel at ease reporting the size of any fish kept during the current trip. As a result, the introduction was revised to simply state that the interviewer would not be asking to look at any of the respondent’s fish.
- When high-consumption anglers were asked about the number of UCR fish meals consumed over the past 12 months, some required prompting that indicated that an approximate number of meals would be acceptable. As a result, language was added to the survey to standardize this prompting (“*If unsure:* Would you say it was less than 10, 10 to 20, 20 to 30…”).
- Respondents were not able to accurately describe the number of fish meals consumed from each area of the lake over the past 12 months. When asked to allocate 12-month consumption across multiple regions, respondents would often say they didn’t know or simply say that they caught the same amount in each of the regions mentioned. As a result, the question was revised to simply ask the respondent to list the region(s) where the fish were caught.
- There was concern that asking for the length of the most recently kept fish would lead to a biased estimate of the length of a typical kept fish, as anglers may either (1) be inclined to report the largest fish that they kept regardless of the question wording or (2) keep fish in a livewell until they reach their limit, then only keep larger fish caught towards the end of the trip (i.e., replacing the smaller fish in the livewell with larger fish). To address this issue, the survey has been revised to simply ask for the range of sizes kept on the current trip (i.e., largest and smallest).
- Two of the questions related to fish consumption advisories seemed repetitive to the interviewers and respondents: one asking if the advisories are “clear and understandable” and the other asking if the advisories are “helpful in making decisions” about consumption. As a result, the question about whether or not the advisories were “clear and understandable” was dropped from the survey.

- Although anglers were asked to review the angler diary after completing the survey, very few looked carefully through the instructions and questions in the diary. As a result, we intend to recruit several local NPS anglers to pretest the diary during the month of August.

The following issues related to intercept procedures were identified during the pretest:

- It was somewhat awkward to ask to speak with the adult who celebrated the most recent birthday after an intercepted individual had *already* agreed to take the survey. As a result, the introductory text was revised to quickly state that the interviewer is "hoping to speak to the person in your group who had the most recent birthday."
- When the targeted adult refused to complete the survey, the survey protocol called for the interviewer to ask to speak with the adult with the next most recent birthday. However, the dynamics of the interview process generally did not allow for this type of procedure. Instead, when a refusal occurred, either (1) it was clear that the entire party was refusing or (2) the party nominated a single representative to take the survey. Thus, the protocols have been revised so that after refusals interviewers will no longer ask for the adult who had the next most recent birthday. Instead, a checkbox has been added to the survey to indicate whether or not the interview was conducted with the targeted adult.
- At some campgrounds, NPS designates one or two sites as "group" campsites, where multiple parties can rent a single, large site. At these sites, it was often difficult to identify the person with the most recent birthday due to the number of adults at the site. In addition, these large groups would sometimes insist that a frequent UCR visitor answer the survey questions. If it is not possible to interview the adult with the most recent birthday, the interviewer will complete the interview and mark the box indicating that the interview was not conducted with the targeted adult.
- The length of the interviews generally ranged from approximately five to fifteen minutes and generally seemed acceptable to respondents. Interviews with day-use beach visitors were typically shorter than camping/boating interviews, as many day-use beach visitors did not consume UCR fish.
- More visitors were observed departing the site during afternoon/evening shifts than during morning shifts. This was particularly true at day-use beaches. This temporal pattern of visitation was confirmed through discussions with NPS personnel. As a result, the sampling plan has been revised so that PM interview shifts are selected with higher probability than AM interview shifts.
- In general, visitors asked very few questions about the purpose of the survey, so that the list of frequently asked questions was sufficient. This list will be updated as needed throughout the course of the main survey.

APPENDIX H:

SUNRISE AND SUNSET TIMES FOR COLVILLE, WA

COLVILLE, WASHINGTON
Location: W117 54, N48 32

Rise and Set for the Sun for 2010

Pacific Standard Time

Astronomical Applications Dept.
U. S. Naval Observatory
Washington, DC 20392-5420

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
Day	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
01	0744	1607	0721	1650	0633	1736	0529	1822	0432	1906	0354	1945	0354	1957	0426	1929	0509	1833	0551	1730	0638	1632	0723	1559
02	0744	1608	0719	1652	0631	1737	0527	1824	0430	1908	0353	1946	0354	1957	0427	1927	0510	1831	0553	1728	0640	1630	0724	1558
03	0744	1609	0718	1654	0629	1739	0525	1825	0429	1909	0353	1947	0355	1956	0429	1926	0512	1829	0554	1726	0641	1629	0725	1558
04	0743	1610	0716	1655	0627	1740	0523	1827	0427	1911	0352	1948	0356	1956	0430	1924	0513	1827	0555	1724	0643	1627	0726	1557
05	0743	1611	0715	1657	0625	1742	0521	1828	0425	1912	0352	1949	0357	1956	0431	1923	0515	1825	0557	1722	0644	1626	0727	1557
06	0743	1612	0713	1659	0623	1743	0519	1830	0424	1913	0351	1950	0357	1955	0433	1921	0516	1823	0558	1720	0646	1624	0729	1557
07	0743	1614	0712	1700	0621	1745	0517	1831	0422	1915	0351	1951	0358	1955	0434	1920	0517	1821	0600	1718	0647	1623	0730	1557
08	0742	1615	0710	1702	0619	1746	0515	1833	0421	1916	0350	1951	0359	1954	0436	1918	0519	1819	0601	1716	0649	1621	0731	1556
09	0742	1616	0709	1703	0617	1748	0513	1834	0419	1918	0350	1952	0400	1953	0437	1916	0520	1817	0603	1714	0651	1620	0732	1556
10	0741	1617	0707	1705	0615	1750	0511	1836	0418	1919	0350	1953	0401	1953	0438	1915	0522	1815	0604	1712	0652	1618	0733	1556
11	0741	1619	0706	1707	0613	1751	0509	1837	0416	1920	0350	1953	0402	1952	0440	1913	0523	1812	0606	1710	0654	1617	0734	1556
12	0740	1620	0704	1708	0611	1753	0507	1839	0415	1922	0349	1954	0403	1951	0441	1911	0524	1810	0607	1708	0655	1616	0735	1556
13	0740	1621	0702	1710	0609	1754	0505	1840	0414	1923	0349	1954	0404	1951	0442	1909	0526	1808	0609	1706	0657	1615	0735	1556
14	0739	1623	0701	1712	0607	1756	0503	1842	0412	1924	0349	1955	0405	1950	0444	1908	0527	1806	0610	1704	0658	1613	0736	1556
15	0738	1624	0659	1713	0605	1757	0501	1843	0411	1926	0349	1955	0406	1949	0445	1906	0529	1804	0612	1702	0700	1612	0737	1557
16	0738	1626	0657	1715	0603	1759	0459	1844	0410	1927	0349	1956	0407	1948	0447	1904	0530	1802	0613	1700	0701	1611	0738	1557
17	0737	1627	0655	1716	0601	1800	0457	1846	0408	1928	0349	1956	0408	1947	0448	1902	0531	1800	0615	1658	0703	1610	0739	1557
18	0736	1629	0654	1718	0558	1802	0455	1847	0407	1930	0349	1957	0409	1946	0449	1900	0533	1758	0616	1656	0704	1609	0739	1557
19	0735	1630	0652	1720	0556	1803	0453	1849	0406	1931	0349	1957	0410	1945	0451	1859	0534	1756	0618	1655	0706	1608	0740	1558
20	0734	1631	0650	1721	0554	1805	0452	1850	0405	1932	0349	1957	0411	1944	0452	1857	0536	1754	0619	1653	0707	1607	0740	1558
21	0733	1633	0648	1723	0552	1806	0450	1852	0404	1933	0350	1957	0412	1943	0454	1855	0537	1751	0621	1651	0709	1606	0741	1559
22	0732	1635	0646	1725	0550	1808	0448	1853	0403	1935	0350	1958	0414	1942	0455	1853	0538	1749	0622	1649	0710	1605	0742	1559
23	0731	1636	0644	1726	0548	1809	0446	1855	0402	1936	0350	1958	0415	1941	0456	1851	0540	1747	0624	1647	0712	1604	0742	1600
24	0730	1638	0643	1728	0546	1811	0444	1856	0401	1937	0350	1958	0416	1940	0458	1849	0541	1745	0625	1645	0713	1603	0742	1600
25	0729	1639	0641	1729	0544	1812	0442	1858	0400	1938	0351	1958	0417	1938	0459	1847	0543	1743	0627	1644	0715	1602	0743	1601
26	0728	1641	0639	1731	0542	1813	0441	1859	0359	1939	0351	1958	0418	1937	0501	1845	0544	1741	0629	1642	0716	1602	0743	1602
27	0727	1642	0637	1732	0540	1815	0439	1901	0358	1940	0352	1958	0420	1936	0502	1843	0545	1739	0630	1640	0717	1601	0743	1602
28	0726	1644	0635	1734	0538	1816	0437	1902	0357	1941	0352	1958	0421	1934	0503	1841	0547	1737	0632	1638	0719	1600	0743	1603
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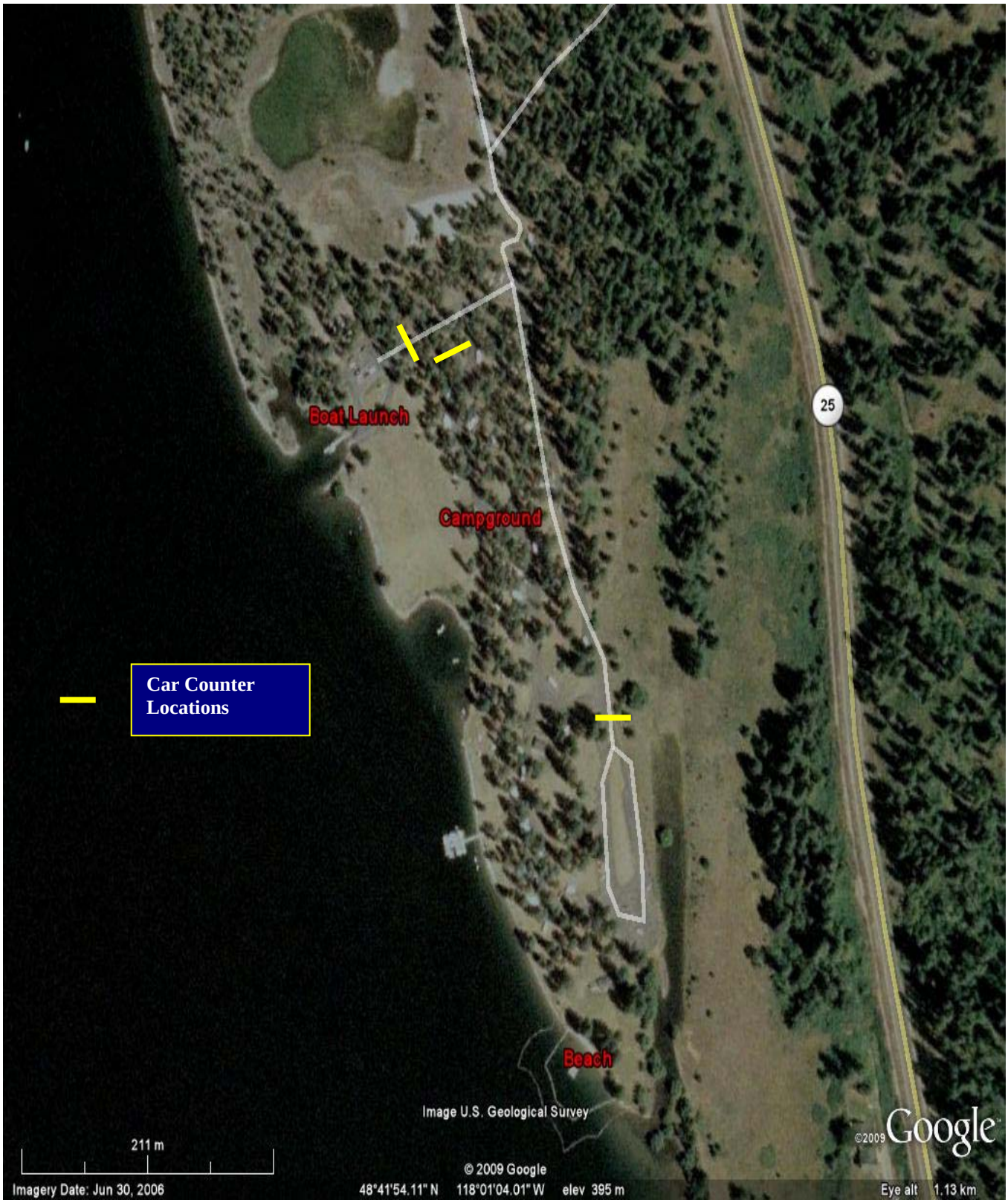
30	0723	1647			0534	1819	0434	1905	0355	1944	0353	1957	0424	1932	0506	1837	0550	1732	0635	1635	0721	1559	0744	1605
31	0722	1649			0531	1821			0355	1945			0425	1930	0508	1835			0636	1633			0744	1606

Add one hour for daylight time, if and when in use.

APPENDIX I:

LOCATIONS FOR SUPPLEMENTAL VEHICLE COUNTERS

Evans


Boat Launch
Campground
25
Car Counter Locations
Beach
Image U.S. Geological Survey
211 m
©2009 Google
© 2009 Google
Imagery Date: Jun 30, 2006
48°41'54.11" N 118°01'04.01" W elev 395 m
Eye alt 1.13 km

Hunters


Car Counter Locations
Boat Launch
Campground
Beach
Hunters Campground Rd
Image U.S. Geological Survey
© 2009 Europa Technologies
©2009 Google
248 m
Imagery Date: Jun 30, 2006
48°07'31.05" N 118°13'39.91" W elev 410 m
Eye alt 1.30 km

Fort Spokane

APPENDIX J:

HIGH CONSUMPTION ANGLER DIARY SIMULATIONS

SRC, Inc.
999 18th Street, Suite 1975
Denver, CO 80202
(303) 292-4760 phone
(303) 292-4755 fax

MEMORANDUM

To: Monica Tonel, Marc Stifelman, Helen Bottcher (EPA, Region 10)
From: Lynn Woodbury, Bill Brattin (SRC)
Task: FD052.CF999.842
Date: January 25, 2010
Re: Recreational Use Survey – High Consumption Angler Diary Simulations

INTRODUCTION

Because of expected limitations in the accuracy of annual fish consumption recalls, the draft Recreational Use Survey Sampling and Analysis Plan (SAP) calls for the completion of a 3-month diary (with the 3 months recorded being sequential) by high consumption anglers (i.e., individuals consuming more than 10 fish meals per year) to supplement the annual recall data. The SAP proposes the following data reduction strategy for obtaining annual fish consumption estimates for these high consumption anglers:

> *For these respondents, we will calculate consumption rates using information from the three-month fish consumption diary. The average monthly consumption rate calculated from the diary will be multiplied by the number of months that the respondent indicates he or she typically eats fish from the UCR to estimate species-specific annual consumption rates. For high-consumption anglers who decline to participate in the consumption diary, annual fish consumption can be estimated by multiplying the one-month recall estimate by the number of months that the respondent indicates he or she typically eats fish from the UCR.*

This proposed data reduction strategy does not account for potential seasonal variability, so annual fish consumption estimates for these high consumption anglers could be biased (with the direction and magnitude of the potential bias depending upon the 3-month period recorded). To address this concern, SRC has proposed changing the format of the diary from a 3-month sequential diary to four non-sequential 1-month diaries spread across the year to capture seasonal patterns (this type of diary will be referred to as a "4-month non-sequential diary"). Because this change would effectively extend the study duration from 15 months to 24 months, which could impact both the project cost and schedule, before making a decision on the diary format, EPA requested an evaluation to determine if it were possible to develop a modified data analysis approach which could utilize a 3-month sequential diary to obtain reliable estimates of annual fish consumption.

DATA ANALYSIS STRATEGIES EVALUATED

As requested by EPA, SRC has generated several synthetic datasets using Monte Carlo simulation to test alternative data analysis strategies for the high consumption angler diaries. As part of these simulations, 4 different data analysis strategies for estimating annual fish consumption from the diary were evaluated:

1. Simple estimate based on the 3-month sequential diary
2. Seasonally adjusted estimate based on the 3-month sequential diary
3. Simple estimate based on the 4-month non-sequential diary
4. Seasonally adjusted estimate based on the 4-month non-sequential diary

Approach #1 is similar to the proposed estimation approach described in the draft SAP. In this approach, the annual fish consumption is calculated by multiplying the average monthly consumption from the 3-month diary by 4 (to scale the estimate to be representative of 12 months).

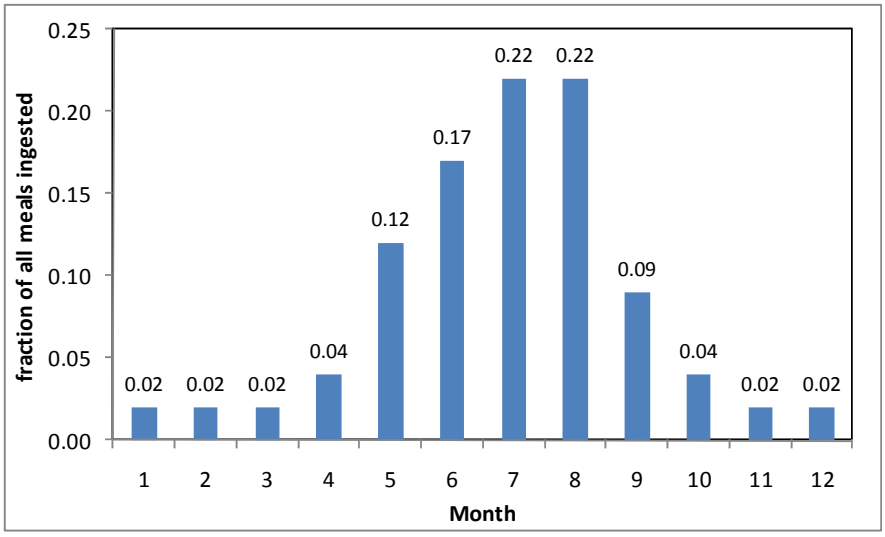
In Approach #3, the annual fish consumption is calculated by multiplying the average monthly consumption across the 4-month non-sequential diaries by a factor of 3.

In Approaches #2 and #4, the annual fish consumption is calculated using a weighting factor to adjust for seasonal variability. In this approach, reported monthly fish consumption information from the diaries across all individuals is used to develop an estimate of the population distribution of monthly consumption. This is illustrated below:

Example of Diary Output (3-month sequential diary)

Angler	Reported Monthly Fish Consumption							
	Jan	Feb	Mar	Apr	May	Jun	Jul	…
1	1	2	2					
2			3	2	6			
3					4	5	5	
4	0	1	0					
…								
Total	40	40	80	240	340	440	440	∑=2,000

Estimated Monthly Distribution of Fish Consumption for the Population



Using this population distribution, and assuming the seasonal variability of each person is similar to the population average, it is then possible to estimate the annual fish consumption from the data for one or more months as follows:

$$IR_{annual} = IR_x / Fract_x$$

where:

IR_{annual} Annual fish consumption estimate
IR_x Reported fish consumption in month 'x'
$Fract_x$ Fraction of annual fish consumption that occurs in month 'x' (as predicted from the population distribution of monthly consumption)

The final annual final consumption is calculated as the mean across each of the annual fish consumption estimates from each month. An example of the seasonal weighting calculation approach is illustrated below for each type of diary instrument:

Example of Seasonal Weighting Calculation

Diary Month	Reported Monthly Fish Consumption	Fraction of Annual Consumption†	Estimated Annual Fish Consumption	
Example based on 3-month sequential diary				
March	7	0.02	350	Mean = 336
April	15	0.04	375	
May	34	0.12	283	
Example based on 4-month non-sequential diary				
February	0	0.02	0	Mean = 252
May	34	0.12	283	
August	50	0.22	227	
November	10	0.02	500	

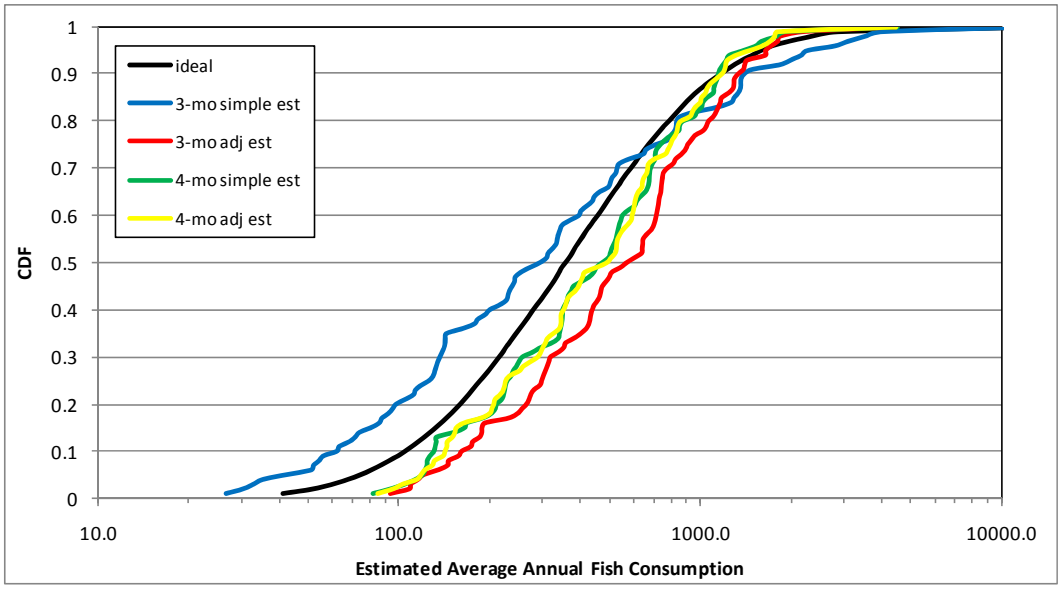
† From the estimated population distribution of monthly consumption

As illustrated, this approach may be utilized regardless of the type of diary instrument (i.e., can be used for both the 3-month sequential diary and the 4-month non-sequential diary). However, it is based on an underlying assumption that the monthly distribution of fish consumption for an individual is similar to the monthly distribution of fish consumption of the population.

SIMULATION RESULTS

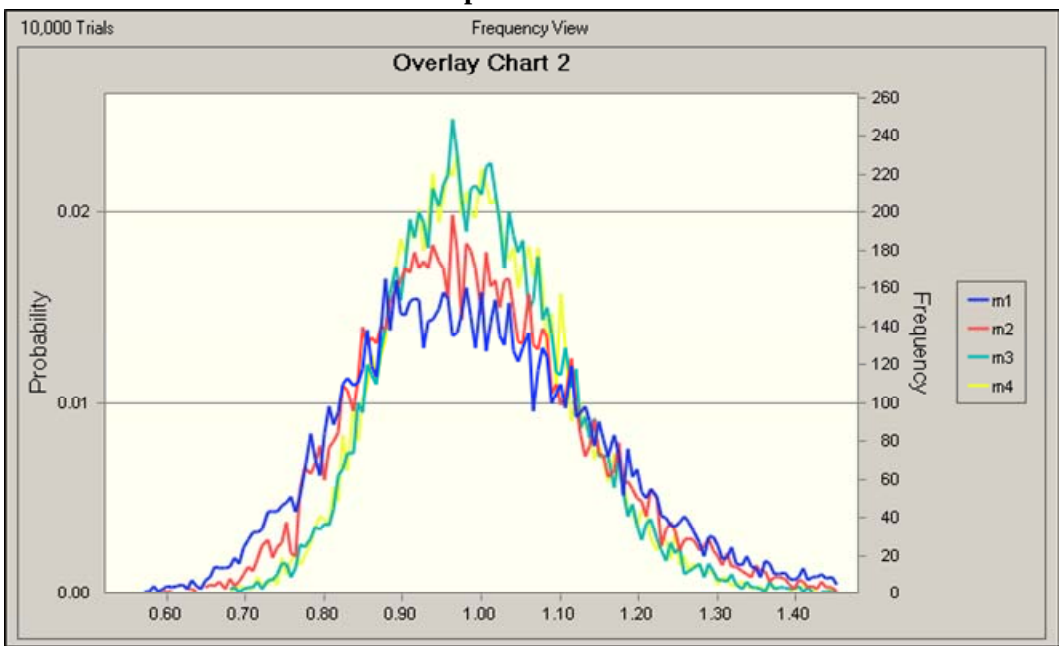
SRC utilized Monte Carlo simulation techniques to evaluate the effectiveness of each data analysis approach. In these simulations, the true meal frequency was distributed as LN(10,10), the true meal size was distributed as N(50,10), and meal frequency was positively correlated with meal size (rho = 0.8). It was assumed that the number of anglers that provided completed diaries was 100. The following figure illustrates the cumulative distribution for each approach compared to truth (shown as the "ideal" black line in the graph) based on a simulation of 10,000 iterations.

Simulation Results: CDF of Estimated Average Annual Fish Consumption

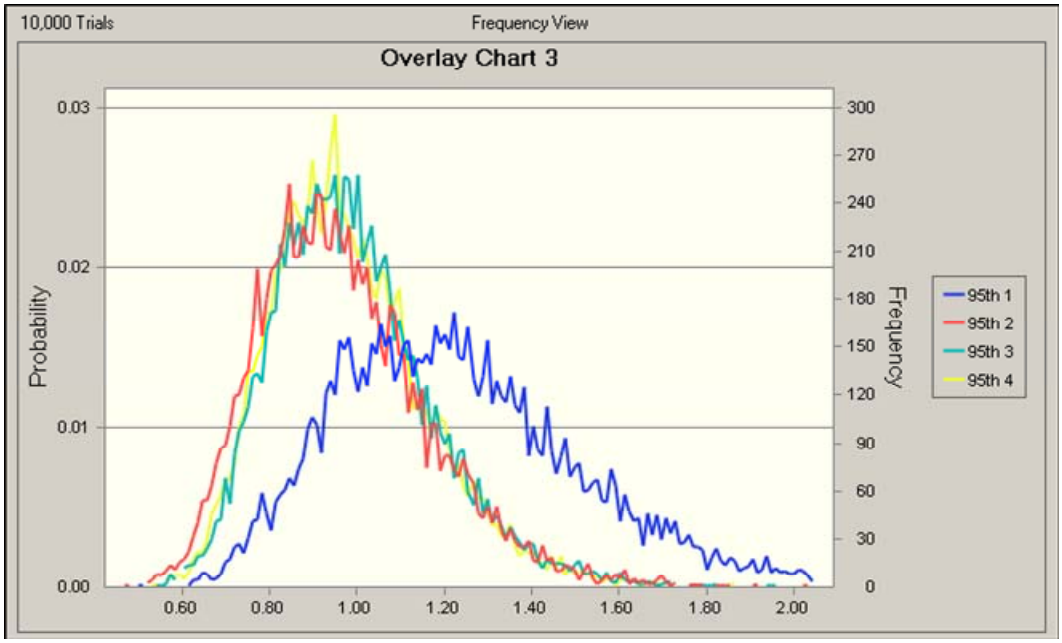


The following two figures compare the estimated mean and 95th percentile fish consumption across all individuals to truth for each approach. These statistics were selected because they will be utilized to evaluate CTE and RME exposure conditions in the human health risk assessment.

Simulation Results: Comparison of Estimated Mean to Truth



Simulation Results: Comparison of Estimated 95th Percentile to Truth

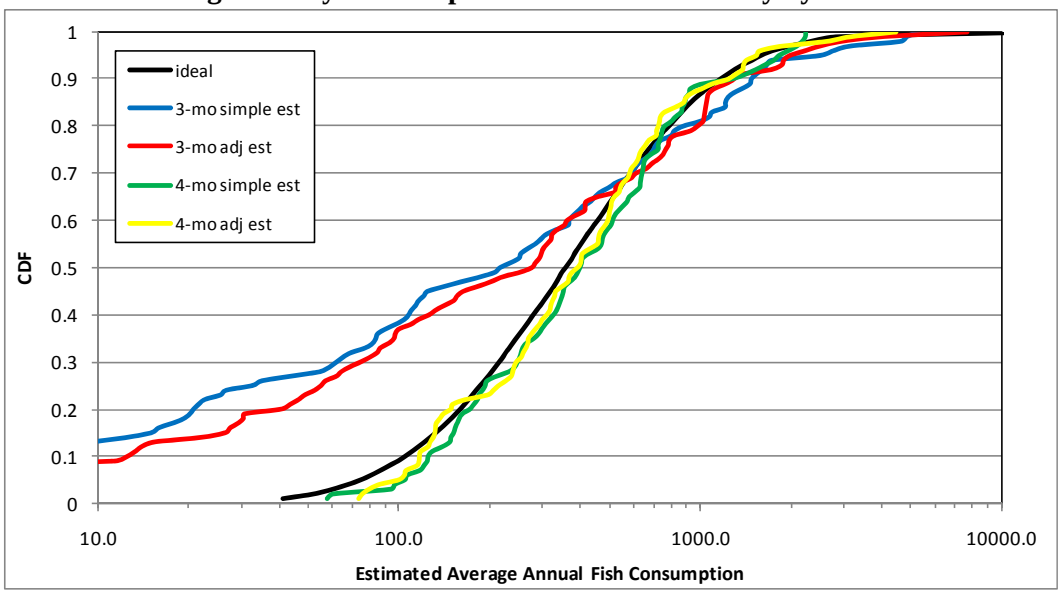


The results of these simulations show that the simple estimate of annual fish consumption based on a 3-month sequential diary (Approach #1) yielded results that tended to be poorer than the other approaches, especially for the 95th percentile. The seasonally adjusted estimate of annual fish consumption based on a 3-month sequential diary (Approach #2) provides a fairly accurate estimate of the true annual fish consumption. In addition, this approach yields results similar to what would be obtained via a 4-month non-sequential diary (Approaches #3 and #4).

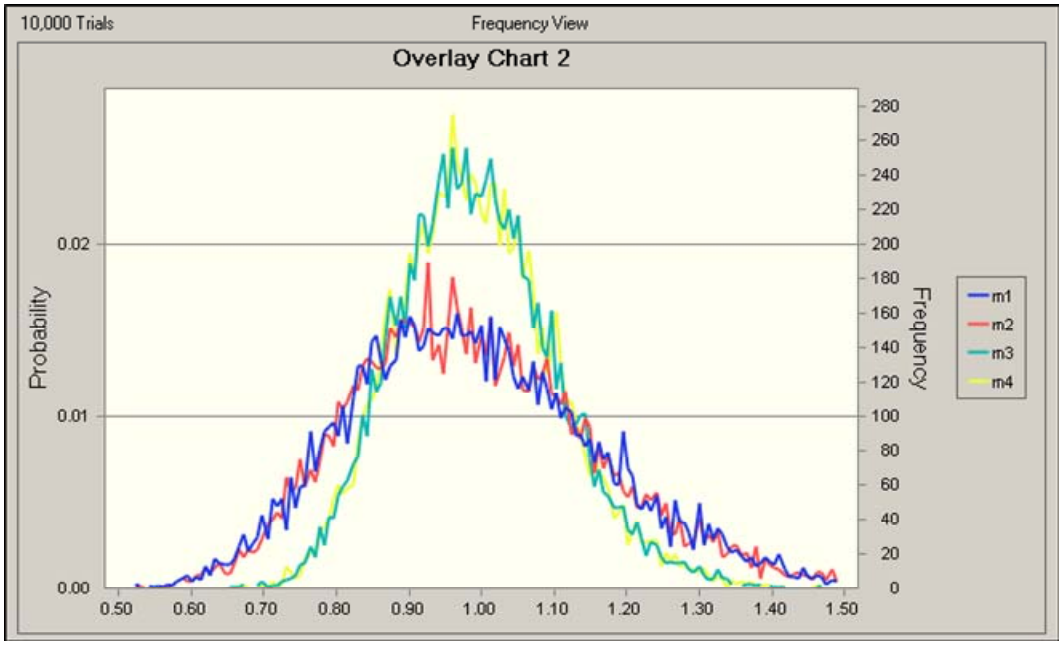
Note that it may be possible to reduce uncertainties in the annual fish consumption estimates if the NCI macros were used to analyze the diary results (i.e., instead of 1 daily AMPM recall for each season, the diaries provide 30 daily AMPM recalls for each month reported). SRC has not evaluated the feasibility of using the NCI macros for the purposes of recreational use survey data reduction at this time. It is important to note, however, that it is expected that the NCI macros could only be utilized if the underlying data are seasonally representative (i.e., data must be derived from a 4-month non-sequential diary format).

As noted above, the seasonal weight approach is based on an underlying assumption that the monthly distribution of fish consumption for an individual is similar to the monthly distribution of fish consumption of the population. In order to determine how sensitive the seasonal weighting approach was to the accuracy of this assumption, a second set of simulations were performed. In these simulations, the true average monthly consumption pattern for each individual was allowed to differ from person to person. The following figure illustrates the cumulative distribution for each approach compared to truth under these test conditions.

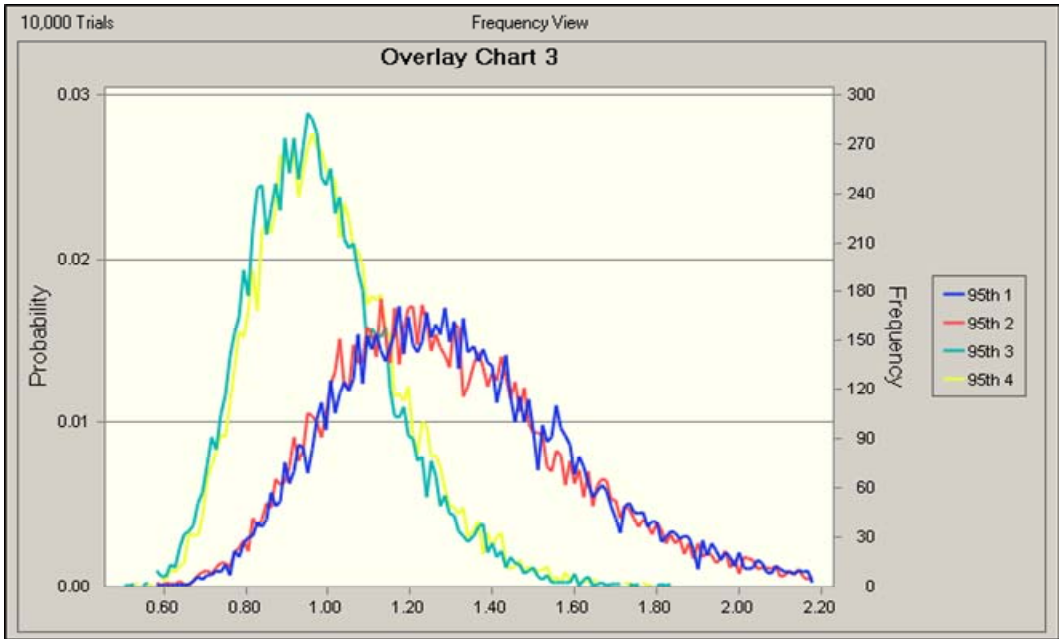
Simulation Results: CDF of Estimated Average Annual Fish Consumption
Allowing Monthly Consumption Distribution to Vary by Individual



Simulation Results: Comparison of Estimated Mean to Truth
Allowing Monthly Consumption Distribution to Vary by Individual



Simulation Results: Comparison of Estimated 95th Percentile to Truth Allowing Monthly Consumption Distribution to Vary by Individual



The results of these simulations show that estimates of annual fish consumption based on a 3-month sequential diary (Approaches #1 and #2) yielded results that were consistently poorer than estimates of based on a 4-month non-sequential diary (Approaches #3 and #4), especially for the 95th percentile. The simple estimate of annual fish consumption based on a 4-month non-sequential diary (Approach #3) provided the best estimate of annual consumption.

In interpreting these results, it is important to remember that the simulation outcome is conditional upon the values specified as "truth" (i.e., results may differ under different simulation conditions).

CONCLUSIONS

Based on the simulation evaluations of each data analysis approach, it is concluded that a 3-month sequential diary can be used to obtain a fairly reliable estimate of annual fish consumption provided that monthly consumption pattern for most individuals is generally similar to the monthly consumption pattern for the population.

If it is possible that monthly consumption patterns may differ from individual to individual, a 4-month non-sequential diary will provide the best estimate of annual fish consumption with limited bias. In addition, if this diary format were utilized, it may be possible to use the NCI macros to further refine and improve estimates of annual fish consumption for the high consumption anglers.

APPENDIX K:

RECREATIONAL ACTIVITY SIMULATIONS

SRC, Inc.
999 18th Street, Suite 1975
Denver, CO 80202
(303) 292-4760 phone
(303) 292-4755 fax

MEMORANDUM

To: Monica Tonel, Marc Stifelman, Helen Bottcher (EPA, Region 10)
From: Lynn Woodbury (SRC)
Task: FD052.CF999.842
Date: August 4, 2010
Re: Recreational Use Survey – Recreational Activity Simulations

---

Introduction

The National Park Service (NPS) will be conducting a survey beginning in the Fall 2010 on recreational use of the Upper Columbia River (UCR) Site. The purpose of this survey is to provide site-specific information on human exposures from fish consumption and recreational activities such as swimming, boating, beach use, etc for use in the UCR baseline human health risk assessment (HHRA). In support of this study, Industrial Economics, Inc. prepared a draft sampling and analysis plan (SAP) (IEc 2010). Since the draft SAP was released, alternative data reduction approaches have been discussed for quantifying recreational visitor exposures from abiotic environmental media and fish ingestion.

The purpose of this memorandum is to summarize and evaluate the effectiveness of the proposed data reduction approach for quantifying exposures to abiotic environmental media (e.g., surface water, sediment, air) during recreational activities (i.e., determine if the data reduction strategy will derive reliable estimates of long-term average exposure rates). An evaluation of the data reduction approaches for quantifying recreational visitor exposures from fish ingestion was presented in SRC (2010). The effectiveness of the data reduction approach will be evaluated using Monte Carlo simulation. These simulations can be used to gain an understanding of the potential uncertainties and biases associated with the analysis approach. It is anticipated that these uncertainties and biases would be acknowledged in the baseline HHRA.

Quantification of Exposure to Abiotic Environmental Media During Recreational Activities

Survey respondents will be stratified into three recreational use categories – boater, camper, beach user – depending upon the intercept location (i.e., docks/marinas, campgrounds, beaches, respectively). Survey respondents will be asked to provide information on the types of recreational activities that were performed in the past 24 hours. These recreational activities may include swimming/waterskiing/tubing, wading, playing on the beach, spending time inside a tent/camper/recreational vehicle. In addition, respondents will be asked to estimate the number of days in the last 12 months spent boating, camping, using beaches at the UCR Site, and the locations of these activities.

Estimates of chemical intake (dose), expressed in units of mg/kg-day, for a specific recreational activity (e.g., swimming) can be calculated for each individual survey respondent as follows:

$$\text{Dose(swimming total)} = \text{Dose(swimming during boating)} + \text{Dose(swimming during camping)} + \text{Dose(swimming during beach use)}$$

The dose from an activity (e.g., swimming) for an individual in a recreational use category (e.g., boating) may be calculated as follows:

$$\text{Dose(swimming during boating)}_{i,s,b} = C_s * (IR_s/BW) * (EF_{i,b}/365) * ET_{s,b} * (ED/AT)$$

where:

$\text{Dose}_{i,s,b}$ = Intake of chemical (mg/kg-day) by individual "i" from swimming while boating
C_s = Concentration of chemical in water (mg/L) at the location where swimming occurs
IR_s = Intake rate of water (L/hr) from swimming
BW = Body weight (kg)
$EF_{i,b}$ = Exposure frequency (days/yr) of boating by individual "i"
$ET_{s,b}$ = Average time (hrs/day) spent swimming while boating
ED = Exposure duration (years)
AT = Averaging time (years)

In the above equation, information on chemical concentration (e.g., concentration in surface water) will be based on site sampling data or will be estimated by modeling. Information on intake rates (e.g., water ingestion while swimming) will be based on default parameters from the literature or professional judgment.

As described above, the recreational use survey will obtain estimates of annual EF for each respondent, stratified by recreational use category (boating, camping, beach use). However, the survey will not seek to obtain person-specific estimates of long-term average ET or EF values for specific recreational activities (e.g., "How many days per year and hours per day do you go swimming?"). This is because it is believed that most people will not be able to provide reliable answers to questions about long-term activity-specific average frequencies and times. Rather, survey respondents will be asked about their recreational activities in the past 24 hours (which can be recalled with accuracy). These data are then used to estimate the long-term average activity-specific ET and EF values needed to estimate human exposure. The methods for estimating these ET and EF terms from the data collected in the survey are discussed below.

Estimating Recreational Activity-Specific Exposure Time (ET)

The recreational activity-specific exposure time (ET) utilized in the individual dose calculations will be estimated as the average exposure time reported by survey respondents who engaged in the activity.

For example, if 142 boaters indicate that they engaged in swimming in the past 24 hours, and they each provide an estimate of the time spent swimming in the past 24 hours, then the $ET_{s,b}$ term in the above equation is the simple average of the time values reported by these 142 people.

Estimating Recreational Activity-Specific Exposure Frequency (EF)

Long-term average exposure frequency (EF) associated with a recreational activity (e.g., swimming) for an individual in a recreational use category (e.g., boaters) may be estimated as follows:

$$EF_{i,s,b} = EF_{i,b} * P_{s,b}$$

where:

$EF_{i,s,b}$ = Estimated exposure frequency (day/yr) of swimming while boating by individual "i"
$EF_{i,b}$ = Exposure frequency (day/yr) of boating reported by individual "i"
$P_{s,b}$ = Estimated probability of swimming while boating

For example, suppose that an individual reports that they boated at the UCR Site 50 days in the past 12 months. If there is a 0.5 probability that swimming occurs on any given boating day, the estimated number of swimming days while boating for that individual is 25 days/year.

An estimate of P for each recreational activity (e.g., swimming) for each recreational use category (e.g., boating) can be calculated based on the survey responses from the 24-hour recall for the population as follows:

$$P_{s,b} = \frac{\text{total number of boaters that reported engaging in swimming in the past 24 hours}}{\text{total number of boaters surveyed}}$$

In some cases, it may be appropriate to evaluate exposure stratified not only by recreational use category (e.g., boaters) and recreational activity (e.g., swimming), but also by location (e.g., Reach A). In this event, the EF term for the recreational activity (e.g., swimming while boating in Reach A) is estimated as follows:

$$EF_{i,s,b,x} = EF_{i,s,b} * Fract_{i,b,x}$$

where:

$EF_{i,s,b}$ = Estimated exposure frequency (day/yr) of swimming while boating by individual "i"
$Fract_{i,b,x}$= Fraction of time spent boating in location 'x' by individual "i"

Calculating the Distribution of Individual Doses

For any given population of interest, the calculated individual doses will be weighted as appropriate and results will be used to generate an empiric cumulative density function (cdf). **Attachment A** provides a hypothetical example of how the empiric dose cdf would be generated from the survey responses. For the purposes of illustration, this example focuses on exposures to surface water during swimming. The approach for other recreational exposures (e.g., exposures to sediment during beach use) would be calculated in a similar manner.

When evaluating risks, attention is focused on doses that are "typical" (mean) and on doses at the upper-end (95^{th} percentile) of the cdf. These two exposure estimates are referred to as Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME), respectively. Both CTE and RME will be evaluated in the baseline

HHRA. These doses will be combined with appropriate chemical-specific toxicity factors to estimate CTE and RME risk values for cancer and non-cancer effects.

Simulation Testing of the Data Reduction Approach

It is recognized that the data reduction approach described above has several limitations. First, reported estimates of long-term average exposure frequency of boating, camping, and beach use have the potential to be biased due to recall errors. Second, because activity-specific estimates of exposure frequency are based on average probabilities derived for the population, the data reduction approach is equivalent to assuming that all individuals participate in all recreational activities (i.e., there are no "non-participants"). This is because, unless every individual reports that they do not engage in the recreational activity (which is unlikely), the population-based probability for a specific recreational activity will always be greater than zero. Thus, the estimated activity-specific exposure frequency for an individual will also be greater than zero. Finally, because information on exposure time is not available for all individuals, the data reduction approach assumes that all individuals within a recreational category (e.g., boaters) have the same activity-specific exposure time (i.e., the mean ET). To the extent that different individuals have exposure times that are shorter or longer than the population average, this will tend to diminish the between-person variability, which could tend to underestimate the RME exposure.

In order to determine if the data reduction strategy will derive reliable estimates of long-term average exposure rates, a series of Monte Carlo simulations were performed to evaluate effectiveness of the approach. When performing simulation testing, there are three basic components of each simulation test. First, the simulation establishes the "true" condition. Second, the simulation generates an "observed" dataset that mimics what will be available from the survey. This "observed" data set is based on the specified "truth", but reflects the variability, uncertainty, and data gaps that will be encountered in the study. Third, the simulation applies the data reduction strategy to the "observed" data set and compares the observed results to truth. The simulation is performed many times (e.g., 10,000 trials per test) to gain a comprehensive understanding of the potential uncertainties and biases associated with the analysis approach. Simulations can also provide information on the sensitivity of an analysis approach to key survey variables, such as sample size.

In interpreting simulation results, it is important to remember that the simulation outcome is conditional upon the values specified as "truth" (i.e., results may differ under different simulation conditions).

Specifying the "True" Condition

In the recreational activity simulations, "true" condition was established as follows:

- Three different recreational activities were evaluated – swimming in deep undisturbed water, wading in shallow disturbed water, and engaging in various activities on the beach. The total individual dose was the sum across these three recreational activities.

- The true annual exposure frequency (EF) was assumed to be distributed as LN(m,s) and was allowed to differ based on the recreational category (i.e., boating, camping, beach use). For example, the true annual exposure frequency was assumed to be distributed as LN(10,10) for boating, LN(5,5) for camping, and LN(12,12) for beach use.

- The true probability of engaging in a specific recreational activity (P) was modeled using the logit function:

  $$P = 1/[1+\exp(-z)]$$

  where z is assumed to be distributed as $N(\mu,\sigma)$. The parameters μ and σ were assumed to be different for each recreational activity based on the recreational category (i.e., boaters had a different probability of swimming than campers):

Recreational Category	Swimming			Wading			Beach Activities		
	μ	σ	Mean P	μ	σ	Mean P	μ	σ	Mean P
Boating	-1.5	0.8	0.18	-3.0	0.8	0.05	-3.0	0.8	0.05
Camping	-3.0	0.8	0.05	-1.5	0.8	0.18	-1.5	0.8	0.18
Beach Use	-0.8	0.8	0.31	-0.8	0.8	0.31	-0.8	0.8	0.31

- The true daily exposure time (ET) for each recreational activity (e.g., swimming) was assumed to be distributed as LN(m,s) and did not depend upon the recreational category (i.e., amount of time per day spent swimming by boaters was assumed to be similar to campers). For example, the true average exposure time was assumed to be distributed as LN(2,2) for swimming, LN(1,1) for wading, and LN(4,4) for beach activities.

In generating the "observed" dataset the following assumptions were applied:

- The *recall bias* associated with the estimate of the boating, camping, and beach use annual exposure frequency was characterized by N(m, 0.3*m), where "m" is the true multi-year average exposure frequency by that individual. In addition, the *variability* in the annual exposure frequency estimate for an individual for any given year was characterized by N(m, 0.3*m), where "m" is the true multi-year average exposure frequency by that individual.

- It was assumed that some proportion of the population surveyed were "non-participants" for specific recreational activities (i.e., some individuals never engaged in the recreational activity) as follows:

Recreational Category	% Non-Participants		
	Swimming	Wading	Beach Activities
Boating	30%	50%	50%
Camping	50%	30%	30%
Beach Use	10%	10%	10%

- It was assumed that the *variability* in the activity-specific daily exposure time estimate for an individual for any given day was characterized by N(m, 0.3*m), where "m" is the true multi-year average exposure time by that individual.

- It was assumed that 200 individuals participated in the survey (N=200).

Simulation Results

The data analysis approach was evaluated with regard to ability to estimate the mean and 95th percentile of the dose from all recreational activities. These statistics were selected because they will be utilized to evaluate CTE and RME exposure conditions in the baseline HHRA.

Figure 1 compares the cdf of mean and 95th percentile of estimated individual doses compared to the "true" cdf. As shown, ratio distribution for the mean tends to be centered on 1.00, indicating that the method will tend to yield CTE estimates that are unbiased. The ratio distribution for the 95th percentile tends to be left-shifted from 1.00, indicating that the method will tend to yield RME estimates that are biased somewhat low (i.e., underestimating the total exposure dose by about 20%). This bias is a consequence of utilizing the population-based mean probability (P) to estimate an activity-specific EF for each individual. Use of the mean probability reduces the underlying variability in the estimated EF distribution, which will impact the 95th percentile more than the mean (which is why the mean tends to be unbiased).

A series of other simulations were also performed to evaluate the sensitivity of the data reduction strategy to the degree of recall bias in the annual estimates of exposure frequency, the percentage of non-participants, and the sample size. Results of these simulations are summarized in the table below.

Simulation Condition	Mean Ratio	95th Percentile Ratio
Annual EF Recall Bias Evaluation		
N(m, m*0.001) , N=200	1.01	0.85
N(m, m*0.3) , N=200	1.00	0.83
N(m, m*0.6) , N=200	1.00	0.87
N(m, m*1.0) , N=200	1.00	0.89
N(m, m*1.5), N=200	1.00	0.92
N(m, m*1.5), **N=500**	1.00	0.93
Non-Participant Evaluation		
non-part. = 0.001%, N= 200	1.01	0.91
non-part. = 5%, N= 200	0.99	0.86
non-part. = 10%, N= 200	0.99	0.85
non-part. = 50%, N= 200	0.97	0.63
non-part. = 50%, **N= 500**	0.97	0.63
non-part. = 80%, N= 200	1.01	0.48

As seen, these simulations showed that results do not appear to be highly sensitive to the degree of recall bias in the annual estimates of exposure frequency. These simulations also showed that the degree of bias in the RME estimate appears to be primarily related to the percentage of non-participants (as the percentage of non-participants increased, the bias increased). Increasing the number of survey participants (N=500) did not affect this bias.

In interpreting these results, it is important to remember that the simulation outcome is conditional upon the values specified as "truth" (i.e., results may differ under different simulation conditions).

The baseline HHRA will acknowledge the potential uncertainties and biases associated with the proposed data reduction strategy.

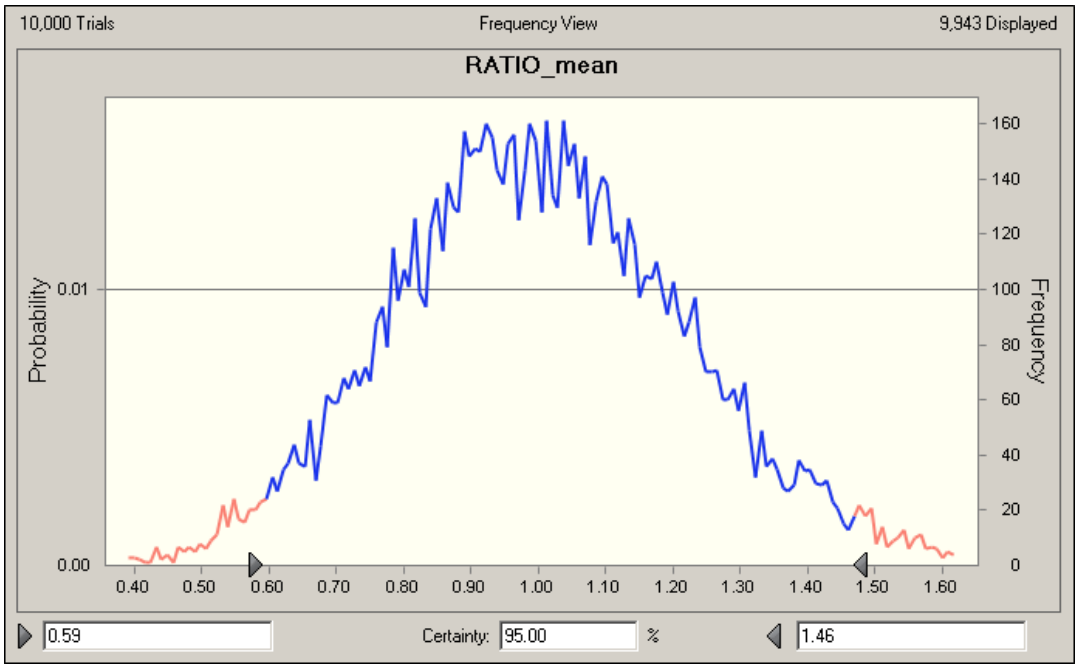
References

IEc. 2010. Recreational Consumption and Resource Use Survey, Sampling and Analysis Plan for the Upper Columbia River Site Human Health Risk Assessment and Remedial Investigation/Feasibility Study. Prepared for U.S. Department of the Interior, National Park Service by Industrial Economics, Inc. Draft – March 19, 2010.

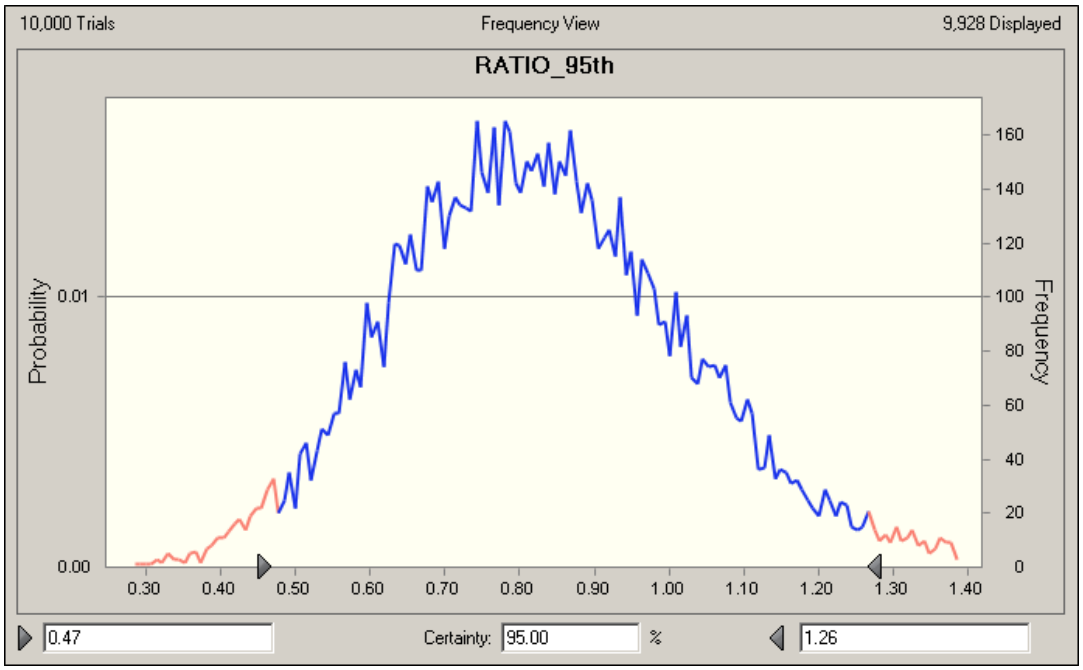
SRC. 2010. Memorandum: Recreational Use Survey – High Consumption Angler Diary Simulations. Memo from Lynn Woodbury and Bill Brattin (SRC, Inc.) to Monica Tonel, Marc Stifelman, Helen Bottcher (U.S. Environmental Protection Agency, Region 10). January 25, 2010.

FIGURE 1
SIMULATION RESULTS FOR ESTIMATING DOSES
FROM RECREATIONAL EXPOSURES

Distribution of Ratios Based on the Mean



Distribution of Ratios Based on the 95th Percentile



ATTACHMENT A

HYPOTHETICAL EXAMPLE OF DATA REDUCTION APPROACH FOR RECREATIONAL ACTIVITY EXPOSURES TO ABIOTIC MEDIA

ATTACHMENT A

HYPOTHETICAL EXAMPLE OF RECREATIONAL ACTIVITY SURVEY OUTPUT

Person #	Rec. Use Category [(a)]	Current Trip (24 hr recall)		Past Trips (12 month recall)								
				Boating			Camping			Beach Use		
		Activity = Swimming		EFboat (d/yr)	Locations visited during boating		EFcamp (d/yr)	EFcamp spent in location 'x'…		EFbeach (d/yr)	EFbeach spent in location 'x'…	
		Engaged in activity?	ETswim (hrs)		Reach A	Reach B		Reach A	Reach B		Reach A	Reach B
1	beach user	no		2	x		1	0	1	4	3	1
2	camper	yes	2.0	6	x		10	9	1	17	15	2
3	camper	no		3	x	x	5	3	3	7	7	0
4	beach user	no		9		x	1	1	1	27	24	3
5	camper	no		5		x	4	4	0	2	0	2
6	beach user	yes	2.6	1	x		2	1	1	8	6	2
7	boater	no		28			2	1	1	8	7	1
8	camper	yes	3.6	2	x	x	22	4	18	16	14	2
9	camper	no		6		x	6	4	2	5	3	3
10	beach user	yes	0.6	3	x		2	0	2	12	10	2
11	boater	no		11	x		2	2	0	3	1	2
12	boater	no		4	x	x	1	1	0	6	4	2
13	beach user	no		5			10	4	6	39	35	4
14	boater	no		13	x		1	0	1	3	2	2
15	beach user	yes	0.3	16		x	10	8	2	96	77	19
16	camper	no		12	x		7	2	5	2	2	0
17	beach user	yes	2.1	13	x		5	4	1	5	3	3
18	beach user	yes	0.1	8		x	26	3	23	78	0	78
19	beach user	no		6			8	6	2	30	24	6
20	beach user	yes	3.3	36			35	7	28	16	0	16
…	…	…	…	…	…	…	…	…	…	…	…	…

[(a)] Based on intercept location -- dock/marina = boater, campground = camper, beach = beach user

ET = exposure time (hours/day)
EF = exposure frequency (days/year)

ATTACHMENT A

TABLE A-1. ESTIMATION OF EXPOSURE TIME (ET) AND ACTIVITY PROBABILITY (P) BY RECREATIONAL USE CATEGORY

Person #	Rec. Use Category	Current Trip (24 hr recall)		Past Trips (12 month recall)								
				Boating			Camping			Beach Use		
		Activity = Swimming		EFboat (d/yr)	Locations visited during boating		EFcamp (d/yr)	EFcamp spent in location 'x'...		EFbeach (d/yr)	EFbeach spent in location 'x'...	
		Engaged in activity?	ETswim (hrs)		Reach A	Reach B		Reach A	Reach B		Reach A	Reach B
1	beach user	no		2	x		1	0	1	4	3	1
2	camper	yes	2.0	6	x		10	9	1	17	15	2
3	camper	no		3	x	x	5	3	3	7	7	0
4	beach user	no		9		x	1	1	1	27	24	3
5	camper	no		5		x	4	4	0	2	0	2
6	beach user	yes	2.6	1	x		2	1	1	8	6	2
7	boater	no		28			2	1	1	8	7	1
8	camper	yes	3.6	2	x	x	22	4	18	16	14	2
9	camper	no		6		x	6	4	2	5	3	3
10	beach user	yes	0.6	3	x		2	0	2	12	10	2
11	boater	no		11	x		2	2	0	3	1	2
12	boater	no		4	x	x	1	1	0	6	4	2
13	beach user	no		5			10	4	6	39	35	4
14	boater	no		13	x		1	0	1	3	2	2
15	beach user	yes	0.3	16		x	10	8	2	96	77	19
16	camper	no		12	x		7	2	5	2	2	0
17	beach user	yes	2.1	13	x		5	4	1	5	3	3
18	beach user	yes	0.1	8		x	26	3	23	78	0	78
19	beach user	no		6			8	6	2	30	24	6
20	beach user	yes	3.3	36			35	7	28	16	0	16
...	...	...	...	...	...	...	...	...	...	...	...	...

$\sum$#boaters = 174
$\sum$#campers = 147
$\sum$#beach users = 179

$\sum$#boaters that swam = 19
$\sum$#campers that swam = 13
$\sum$#beach users that swam = 58

Estimate exposure time (ET) for each recreational use category:

Average ETswim for boaters: 2.8
Average ETswim for campers: 0.15
Average ETswim for beach users: 1.6

Estimate activity-specific probability (P) for each recreational use category:

Swimming while boating (Pswim,boat) = $\sum$#boaters that swam / $\sum$#boaters = 19 / 174 = 0.109
Swimming while camping (Pswim,camp) = $\sum$#campers that swam / $\sum$#campers = 13 / 147 = 0.088
Swimming while using beach (Pswim,beach) = $\sum$#beach users that swam / $\sum$#beach users = 58 / 179 = 0.324

ATTACHMENT A

TABLE A-2 ESTIMATION OF EXPOSURE FREQUENCY OF SWIMMING BY REC. USE CATEGORY

Person #	DERIVED DIRECTLY FROM SURVEY (12 month recall)			Est. Exposure Frequency (d/yr) of swimming [(b)]			
	Boating	Camping	Beach Use	Boating	Camping	Beach Use	EFswim, total
	EFboat (d/yr)	EFcamp (d/yr)	EFbeach (d/yr)	EFswim, boat	EFswim, camp	EFswim, beach	
1	2	1	4	0.22	0.09	1.30	1.60
2	6	10	17	0.66	0.88	5.51	7.05
3	3	5	7	0.33	0.44	2.27	3.04
4	9	1	27	0.98	0.09	8.75	9.82
5	5	4	2	0.55	0.35	0.65	1.55
6	1	2	8	0.11	0.18	2.59	2.88
7	28	2	8	3.06	0.18	2.59	5.83
8	2	22	16	0.22	1.95	5.18	7.35
9	6	6	5	0.66	0.53	1.62	2.81
10	3	2	12	0.33	0.18	3.89	4.39
11	11	2	3	1.20	0.18	0.97	2.35
12	4	1	6	0.44	0.09	1.94	2.47
13	5	10	39	0.55	0.88	12.64	14.07
14	13	1	3	1.42	0.09	0.97	2.48
15	16	10	96	1.75	0.88	31.11	33.74
16	12	7	2	1.31	0.62	0.65	2.58
17	13	5	5	1.42	0.44	1.62	3.48
18	8	26	78	0.87	2.30	25.27	28.45
19	6	8	30	0.66	0.71	9.72	11.08
20	36	35	16	3.93	3.10	5.18	12.21
…	…	…	…	…	…	…	…

[(b)] Calculated as EF * P (e.g., EFboat * Pswim,boat)
where:

Swimming while boating (Pswim,boat) = 0.109
Swimming while camping (Pswim,camp) = 0.088
Swimming while using beach (Pswim,beach) = 0.324

[from Table A-1]

ATTACHMENT A

TABLE A-3a. ESTIMATION OF EXPOSURE FREQUENCY OF SWIMMING DURING BOATING BY LOCATION

Person #	DERIVED DIRECTLY FROM SURVEY (12 month recall)			Est. Fraction of time spent boating in location 'x' ($Fract_{boat,x}$) [(c)]		Est. Exposure Frequency (d/yr) of swimming while boating (EFswim,boat)		
	Boating					total *[from Table A-2]*	location-specific [(d)]	
	EFboat (d/yr)	Locations visited during boating						
		Reach A	Reach B	Reach A	Reach B		Reach A	Reach B
1	2	x		100%	0%	0.22	0.22	0.00
2	6	x		100%	0%	0.66	0.66	0.00
3	3	x	x	50%	50%	0.33	0.16	0.16
4	9		x	0%	100%	0.98	0.00	0.98
5	5		x	0%	100%	0.55	0.00	0.55
6	1	x		100%	0%	0.11	0.11	0.00
7	28			0%	0%	3.06	0.00	0.00
8	2	x	x	50%	50%	0.22	0.11	0.11
9	6		x	0%	100%	0.66	0.00	0.66
10	3	x		100%	0%	0.33	0.33	0.00
…	…	…	…	…	…	…	…	…

[(c)] Assumes equal allocation across all locations identified.

[(d)] Calculated as EF * Fract (e.g., EFswim,boat * $Fract_{boat,x}$)

TABLE A-3b. ESTIMATION OF EXPOSURE FREQUENCY OF SWIMMING DURING CAMPING BY LOCATION

Person #	DERIVED DIRECTLY FROM SURVEY (12 month recall)			Est. Fraction of time spent camping in location 'x' ($Fract_{camp,x}$)		Est. Exposure Frequency (d/yr) of swimming while camping (EFswim,camp)		
	Camping					total *[from Table A-2]*	location-specific [(d)]	
	Efcamp (d/yr)	EFcamp spent in location…						
		Reach A	Reach B	Reach A	Reach B		Reach A	Reach B
1	1	0	1	0%	100%	0.09	0.00	0.09
2	10	9	1	90%	10%	0.88	0.80	0.09
3	5	3	3	60%	60%	0.44	0.27	0.27
4	1	1	1	100%	100%	0.09	0.09	0.09
5	4	4	0	100%	0%	0.35	0.35	0.00
6	2	1	1	50%	50%	0.18	0.09	0.09
7	2	1	1	50%	50%	0.18	0.09	0.09
8	22	4	18	18%	82%	1.95	0.35	1.59
9	6	4	2	67%	33%	0.53	0.35	0.18
10	2	0	2	0%	100%	0.18	0.00	0.18
…	…	…	…	…	…	…	…	…

[(d)] Calculated as EF * Fract (e.g., EFswim,camp * $Fract_{camp,x}$)

TABLE A-3c. ESTIMATION OF EXPOSURE FREQUENCY OF SWIMMING DURING BEACH USE BY LOCATION

Person #	DERIVED DIRECTLY FROM SURVEY (12 month recall)			Est. Fraction of time spent at beaches in location 'x' ($Fract_{beach,x}$)		Est. Exposure Frequency (d/yr) of swimming while at beaches (EFswim,beach)		
	Beach Use					total *[from Table A-2]*	location-specific [(d)]	
	EFbeach (d/yr)	EFbeach spent in location…						
		Reach A	Reach B	Reach A	Reach B		Reach A	Reach B
1	4	3	1	75%	25%	1.30	0.97	0.32
2	17	15	2	88%	12%	5.51	4.86	0.65
3	7	7	0	100%	0%	2.27	2.27	0.00
4	27	24	3	89%	11%	8.75	7.78	0.97
5	2	0	2	0%	100%	0.65	0.00	0.65
6	8	6	2	75%	25%	2.59	1.94	0.65
7	8	7	1	88%	13%	2.59	2.27	0.32
8	16	14	2	88%	13%	5.18	4.54	0.65
9	5	3	3	60%	60%	1.62	0.97	0.97
10	12	10	2	83%	17%	3.89	3.24	0.65
…	…	…	…	…	…	…	…	…

[(d)] Calculated as EF * Fract (e.g., EFswim,beach * $Fract_{beach,x}$)

ATTACHMENT A

TABLE A-4. ESTIMATION OF EXPOSURE DOSE FROM SWIMMING

Person #	Site-specific Cwater (mg/L)		Default IRswim (L/hr)	Est. ETswim (hr/d) *[from Table A-1]*			Est. EFswim (d/yr) *[from Table A-3]*						$Dose_{swim}$ (mg/kg/d)						total
							Reach A			Reach B			Reach A			Reach B			
	Reach A	Reach B		boat	camp	beach	boat	camp	beach	boat	camp	beach	boat	camp	beach	boat	camp	beach	
1	100	10	0.05	2.8	0.15	1.6	0.22	0.00	0.97	0.00	0.09	0.32	8.4E-03	0.0E+00	2.1E-02	0.0E+00	1.8E-05	7.1E-04	3.0E-02
2	100	10	0.05	2.8	0.15	1.6	0.66	0.80	4.86	0.00	0.09	0.65	2.5E-02	1.6E-03	1.1E-01	0.0E+00	1.8E-05	1.4E-03	1.3E-01
3	100	10	0.05	2.8	0.15	1.6	0.16	0.27	2.27	0.16	0.27	0.00	6.3E-03	5.5E-04	5.0E-02	6.3E-04	5.5E-05	0.0E+00	5.7E-02
4	100	10	0.05	2.8	0.15	1.6	0.00	0.09	7.78	0.98	0.09	0.97	0.0E+00	1.8E-04	1.7E-01	3.8E-03	1.8E-05	2.1E-03	1.8E-01
5	100	10	0.05	2.8	0.15	1.6	0.00	0.35	0.00	0.55	0.00	0.65	0.0E+00	7.3E-04	0.0E+00	2.1E-03	0.0E+00	1.4E-03	4.2E-03
6	100	10	0.05	2.8	0.15	1.6	0.11	0.09	1.94	0.00	0.09	0.65	4.2E-03	1.8E-04	4.3E-02	0.0E+00	1.8E-05	1.4E-03	4.8E-02
7	100	10	0.05	2.8	0.15	1.6	0.00	0.09	2.27	0.00	0.09	0.32	0.0E+00	1.8E-04	5.0E-02	0.0E+00	1.8E-05	7.1E-04	5.1E-02
8	100	10	0.05	2.8	0.15	1.6	0.11	0.35	4.54	0.11	1.59	0.65	4.2E-03	7.3E-04	9.9E-02	4.2E-04	3.3E-04	1.4E-03	1.1E-01
9	100	10	0.05	2.8	0.15	1.6	0.00	0.35	0.97	0.66	0.18	0.97	0.0E+00	7.3E-04	2.1E-02	2.5E-03	3.6E-05	2.1E-03	2.7E-02
10	100	10	0.05	2.8	0.15	1.6	0.33	0.00	3.24	0.00	0.18	0.65	1.3E-02	0.0E+00	7.1E-02	0.0E+00	3.6E-05	1.4E-03	8.5E-02
11	100	10	0.05	2.8	0.15	1.6	1.20	0.18	0.32	0.00	0.00	0.65	4.6E-02	3.6E-04	7.1E-03	0.0E+00	0.0E+00	1.4E-03	5.5E-02
12	100	10	0.05	2.8	0.15	1.6	0.22	0.09	1.30	0.22	0.00	0.65	8.4E-03	1.8E-04	2.8E-02	8.4E-04	0.0E+00	1.4E-03	3.9E-02
13	100	10	0.05	2.8	0.15	1.6	0.00	0.35	11.34	0.00	0.53	1.30	0.0E+00	7.3E-04	2.5E-01	0.0E+00	1.1E-04	2.8E-03	2.5E-01
14	100	10	0.05	2.8	0.15	1.6	1.42	0.00	0.65	0.00	0.09	0.65	5.4E-02	0.0E+00	1.4E-02	0.0E+00	1.8E-05	1.4E-03	7.0E-02
15	100	10	0.05	2.8	0.15	1.6	0.00	0.71	24.95	1.75	0.18	6.16	0.0E+00	1.5E-03	5.5E-01	6.7E-03	3.6E-05	1.3E-02	5.7E-01
16	100	10	0.05	2.8	0.15	1.6	1.31	0.18	0.65	0.00	0.44	0.00	5.0E-02	3.6E-04	1.4E-02	0.0E+00	9.1E-05	0.0E+00	6.5E-02
17	100	10	0.05	2.8	0.15	1.6	1.42	0.35	0.97	0.00	0.09	0.97	5.4E-02	7.3E-04	2.1E-02	0.0E+00	1.8E-05	2.1E-03	7.9E-02
18	100	10	0.05	2.8	0.15	1.6	0.00	0.27	0.00	0.87	2.03	25.27	0.0E+00	5.5E-04	0.0E+00	3.4E-03	4.2E-04	5.5E-02	6.0E-02
19	100	10	0.05	2.8	0.15	1.6	0.00	0.53	7.78	0.00	0.18	1.94	0.0E+00	1.1E-03	1.7E-01	0.0E+00	3.6E-05	4.3E-03	1.8E-01
20	100	10	0.05	2.8	0.15	1.6	0.00	0.62	0.00	0.00	2.48	5.18	0.0E+00	1.3E-03	0.0E+00	0.0E+00	5.1E-04	1.1E-02	1.3E-02
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

Doseswim = Cwater * (IRswim / BW) * ET * EF/365 * (ED / AT)

where: BW = 70 kg

ED = 30 yrs

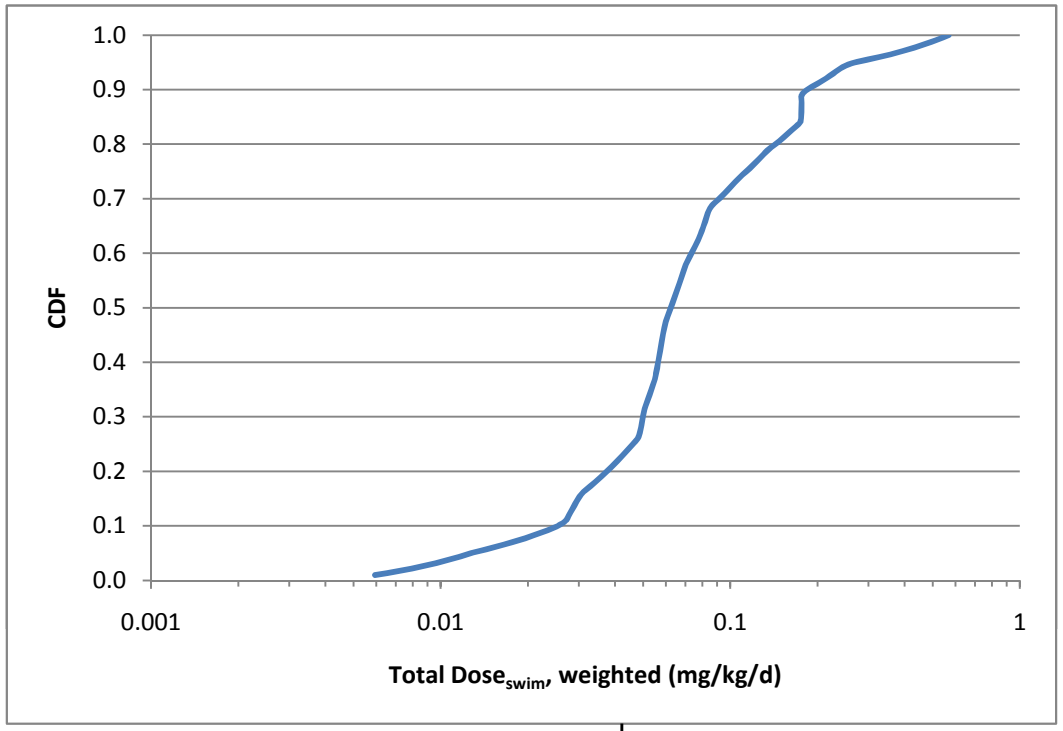
AT = 30 yrs *[example calculation provided is for non-cancer exposures]*

ATTACHMENT A

TABLE A-5. GENERATING EMPIRIC CDF AND ESTIMATION OF CTE AND RME

Person #	Total $Dose_{swim}$ (mg/kg/d) *[from Table A-4]*
1	3.0E-02
2	1.3E-01
3	5.7E-02
4	1.8E-01
5	4.2E-03
6	4.8E-02
7	5.1E-02
8	1.1E-01
9	2.7E-02
10	8.5E-02
11	5.5E-02
12	3.9E-02
13	2.5E-01
14	7.0E-02
15	5.7E-01
16	6.5E-02
17	7.9E-02
18	6.0E-02
19	1.8E-01
20	1.3E-02
…	…

weighting applied →



CTE: Mean = 1.0E-01 mg/kg/d

RME: 95th %tile = 2.7E-01 mg/kg/d