APPENDIX A

FIELD SAMPLING PLAN FOR THE 2009 FISH TISSUE STUDY

FIELD SAMPLING PLAN FOR THE 2009 FISH TISSUE STUDY

UPPER COLUMBIA RIVER RI/FS

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ACRONYMS AND ABBREVIATIONS

COC	chain of custody
COIs	chemicals of interest
CRCP	cultural resources coordination plan
DGPS	differential global positioning system
DOT	U.S. Department of Transportation
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FSCA	fish sample collection area
FSP	field sampling plan
GIS	geographic information system
GPS	global positioning system
HNO_3	trace-metal-grade nitric acid
ID	identification
Lake Roosevelt	Franklin D. Roosevelt Lake
MDL	method detection limit
MS/MSD	matrix spike/matrix spike duplicate
NAD83	North American Datum of 1983
PAH	polycyclic aromatic hydrocarbon
Parametrix	Parametrix, Inc.
PBDE	polybrominated diphenylether
PCB	polychlorinated biphenyl
PTFE	polytetrafluoroethylene
QA	quality assurance
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
QC	quality control
RI/FS	remedial investigation and feasibility study
RM	river mile (USGS designations unless otherwise noted)
SHSP	site health and safety plan
Site	Upper Columbia River site
SOP	standard operating procedure

SPC	sample processing coordinator
SVOC	semi-volatile organic compound
TAI	Teck American Incorporated
TAL	Target Analyte List
UCR	Upper Columbia River
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife

UNITS OF MEASURE

°C	Celsius
cm	centimeter(s)
g	gram(s)
m	meter
mm	millimeter(s)

1 INTRODUCTION

This document presents the field sampling plan (FSP) for the 2009 fish tissue study for the Upper Columbia River (UCR) (Site[1]). This study represents one of numerous tasks that will be conducted by Teck American Incorporated (TAI) as part of the remedial investigation and feasibility study (RI/FS) for the Site. The RI/FS Work Plan (TCAI 2007a) was submitted to the U.S. Environmental Protection Agency (EPA) on September 21, 2007, and is currently under review.

The primary objective of the 2009 fish tissue study is to collect information on the chemical concentrations in fish tissues in the UCR. During the study, chemicals of interest (COIs) data will be collected from several fish species and size classes within the six river reaches of the UCR. As discussed in the quality assurance project plan (QAPP), this information will be used to support site characterization and risk assessments (i.e., human health and ecological) that will be conducted as part of the RI/FS.

1.1 OVERVIEW

Fish tissues will be collected within each of the six river reaches in the UCR (Figure A1). These locations match those targeted by EPA in the 2005 fish collection event (USEPA 2007). The fish sample collection areas (FSCAs) are located within each of the following river reaches:

- Reach 1 (U.S.-Canadian Border at River Mile [RM] 745 to RM 730) – riverine
- Reach 2 (RM 730 to RM 712) – transitional (riverine to lacustrine)
- Reach 3 (RM 712 to RM 700) – Marcus Flats (transitional [riverine to lacustrine])
- Reach 4 (RM 700 to RM 640) – lacustrine
- Reach 5 (RM 640 to RM 617) – lacustrine
- Reach 6 (RM 617 to Grand Coulee Dam near RM 596) – lacustrine.

Each FSCA will be sampled to obtain the requisite number of composites during late-summer to fall of 2009. The start date for the 2009 fish tissue sampling event will be determined following EPA approval of this QAPP and FSP. However, for planning purposes, it is anticipated that sampling will occur in September/October of 2009.

[1] The Site is located wholly within Washington State and includes the portion of the UCR extending from the U.S.-Canadian border to Grand Coulee Dam, including Franklin D. Roosevelt Lake (Lake Roosevelt), and the areal extent of related contamination within the United States adjacent to the UCR.

The following groups of analytes will be analyzed in fish tissue samples[2] (see Tables A1 and A2 for complete list of analytes):

- Common (Target Analyte List [TAL]) metals/metalloids[3] will be measured in all tissue samples
- Inorganic arsenic[4]
- Other metals/metalloids
- Organic compounds with a log $K_{ow} \geq 4.0$
- Polychlorinated dibenzo-*p*-dioxins and furans (i.e., 17 dioxin-like congeners)
- Polychlorinated biphenyls (PCBs) (PCB congeners [209 forms])
- Polybrominated diphenylethers (PBDEs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Organochlorine pesticides
- Semi-volatile organic compounds (SVOCs).

This FSP describes the field and laboratory methods that will be used to collect fish tissues for the 2009 study. The background, rationale, data quality objectives (DQOs), and overall study design for this study are described in detail in the QAPP. Sections 2 and 3 of this FSP describes the field procedures that will be followed by the TAI technical team during the field study. Section 4 summarizes the laboratory analyses that are described in greater detail in the QAPP. Section 5 provides information on data management procedures. References cited in this document are listed in Section 6.

The following documents are provided as attachments to this FSP:

- **Site Health and Safety Plan (SHSP) Addendum.** This document describes the specific requirements and procedures that will be implemented to minimize the safety risk to personnel who carry out the field study program (Attachment A1). It is an addendum to the project general SHSP (TCAI 2007b).

[2] Metals/metalloids (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, uranium, vanadium, and zinc), dioxins/furans, and polychlorinated biphenyls (PCBs) will be measured in all samples. The remaining COI groups will be measured in a subset of the tissue samples.
[3] From EPA's Target Analyte List for Superfund. Contract laboratory program: statement of work with inorganic Superfund methods. http://www.epa.gov/fedfac/pdf/ufp_wbk_0305.pdf.
[4] Arsenic speciation will be conducted to evaluate inorganic arsenic (As^{+3} and As^{+5}) and organic arsenic (monomethylarsonate and dimethylarsinate) species.

- **Standard Operating Procedures (SOPs).** The SOPs describe the procedures that will be used to collect fish tissue (Attachment A2).
  - SOP-1 – Positioning at Fish Tissue Sample Collection Areas
  - SOP-2 – Sample Labeling
  - SOP-3 – Fish Collection by Gill Net and Electrofishing
  - SOP-4 – Fish Collection by Backpack Electrofishing
  - SOP-5 – Fish Collection using Burbot Traps
  - SOP-6 – Beach Seines and Shore Traps for Fish Collection
  - SOP-7 – Sample Processing for Target Fish Species
  - SOP-8 – Sample Storage, Packing and Shipping
  - SOP-9 – Field Documentation
  - SOP-10 – Sample Custody.
- **Field Forms.** This attachment contains examples of various forms that will be used during field sampling: fish collection, processing, and external examination forms; a chain-of-custody (COC) form; and sample labeling forms (Attachment A3).
- **Copy of Standard Fish Sampling Guidelines for Washington State Ponds and Lakes (Bonar et al. 2000)**. This document provides recommends sampling techniques for sampling fish in Washington State. This FSP was developed in accordance with these guidelines.

2 SAMPLE COLLECTION AND PROCESSING PROCEDURES

The following sections describe the detailed procedures and methods that will be used during the 2009 fish tissue study, including sampling procedures, record keeping, sample handling, storage, and field quality control procedures. Sample collection and processing will be conducted in accordance with the SOPs provided in Attachment A2. Depending on field conditions, procedures specified in the referenced SOPs may be modified if necessary.

2.1 FIELD SURVEY AND SAMPLING METHODS

To access the sampling areas, at least two sampling vessels and one shore-based team (for sample transport and logistics support) will be used to conduct the fish tissue sampling events. Each vessel will have a deck large enough to accommodate three crew members in addition to the vessel's captain and one EPA oversight individual. The vessel will have enough deck space to accommodate sampling gear (e.g., nets, traps, electroshock equipment), sample coolers, and multiple sampling equipment boxes containing other ancillary equipment. The vessel will include navigational lights, anchors, and basic sonar (e.g., fathometer). At least one of the vessels will contain a live fish well. The vessel operator will be thoroughly familiar with the area of the river that will be navigated and the vessel will have the capability to make headway and maneuver in the potentially turbulent, high-velocity waters of the upper UCR.

All field activities will be conducted in accordance with the SHSP addendum that is provided in Attachment A1.

2.1.1 Task Schedule

The 2009 fish tissue sampling is anticipated to occur during September/October of 2009, subject to EPA approval of this QAPP and FSP. This timeframe is similar to the timing of the sampling event directed by EPA in 2005 (USEPA 2007).

A reconnaissance trip will take place prior to the sampling event with the goals of familiarizing the field crew with the target fishing areas, identifying best collection methods for each area, and determining logistical support and emergency meeting areas.

Prior to fish tissue sampling, it will be necessary to obtain a scientific collection permit from the Washington State Department of Fish and Wildlife (WDFW) (requirements specified in Washington Administrative Code (WAC) 220-20-045, WAC 232-12-276, and RCW 77-32-240). The permit application will be submitted to WDFW during summer of 2009 (pending EPA approval of this QAPP). The requirements for research-related collection as described on the WDFW permit application include the following:

- Submit a study title.
- Submit an introductory section explaining the project objectives and justification for collecting proposed species. This section should describe the management problems to be addressed, explain why resolution is necessary, review related research efforts, discuss how the proposed project will add to the existing body of knowledge, and state the objective(s) for the proposed project, including defining an identifiable end point or conclusion toward which efforts are to be directed.
- Submit a methodology section describing the target species, number to be collected, collection techniques or collection gear, collection locality(s), the approach or plan of action, the organizational framework or logical sequence of events that will lead to the attainment of the study objectives, the disposition of collected specimens, and data collection and analysis techniques. For information in this supplement section that is duplicative of the application, refer to the application section being duplicated. However, all information requested in the application must be listed in the application.
- Submit a justification that identifies the user(s) of the information and indicates how the findings will be used and disseminated.
- Submit the applicant's qualifications for conducting the research, including previous experience working with target species and proposed research techniques, and other relevant information.
- Demonstrate that the applicant can provide adequate facilities and competence to care for live specimens, if applicable.
- Submit identification of supervisory and technical personnel responsible for the study.

2.1.2 Sampling Location Positioning

Latitude and longitude coordinates and water depth (to the nearest 0.5 m) will be obtained at the locations where fish tissue samples are collected (SOP-1). A differential global positioning system (DGPS) will be used to document the sample collection locations. The standard projection method to be used during field activities is Horizontal Datum: North American Datum of 1983 (NAD83), UTM Zone 11. The positioning

objective is to accurately determine and record the positions of all sampling locations. Proposed sampling locations for the 2009 fish tissue study are provided in Figure A1. It is anticipated that fish collection will occur throughout the FSCAs and global positioning system (GPS) coordinates will be recorded at each fish tissue collection location.

The DGPS unit consists of a GPS receiver on the sampling platform and a differential receiver located at a fixed position. The GPS-derived position is compared with the known fix, offsets, or biases calculated, and the correction factors are telemetered to the GPS receiver. Positioning accuracies on the order of ±1 to 3 m can be achieved by avoiding the few minutes per day when the satellites are not providing the same level of signal. The GPS provides the operator with a listing of the time intervals during the day when accuracies are decreased. Avoidance of these time intervals permits the operator to maintain better positioning accuracy.

2.1.2.1 Data Dictionary

A data dictionary and menu-driven data collection system will be developed and programmed into the GPS units to facilitate consistent data collection techniques and to minimize data entry errors. In case the GPS unit fails, handwritten field notebooks will also be used to duplicate data collected using the GPS units and make note of any other field observations. The coordinate data will be downloaded periodically from the GPS units, if necessary, differentially corrected, and projected from geographic coordinates to the state plane coordinate system. The handwritten field notebooks also will be collected from the field crew to accompany the downloaded GPS data. These data will be reviewed immediately after downloads to communicate and correct any data entry errors with the field crew.

2.1.2.2 Positional Data for Moving Targets

The area to be sampled by boat electrofishing, trawling, and beach seining will include the collection of line data consisting of "vertices," or points of inflection, collected every 5 seconds and "nodes" collected at the beginning and end of each sampling run.

2.1.2.3 Positional Data for Stationary Targets

Positional data will be obtained using point coordinates for gill nets, burbot traps and minnow traps.

2.1.3 Field Equipment and Supplies

Field equipment and supplies include sampling equipment, utensils, decontamination supplies, sample containers, coolers, shipping containers, logbooks and forms, personal protection equipment, and personal gear. Protective wear (e.g., gloves) is required to minimize the possibility of cross-contamination between sampling locations.

Sample containers will be clearly labeled at the time of sampling. Labels will include the task name, sample location and number, sampler's initials, analyses to be performed, and sample date and time. Sample labeling procedures are provided in SOP-2 and an example sample label is provided in Attachment A3.

2.1.4 Fish Tissue Sampling

The equipment and procedures that will be used to collect fish tissue samples during the 2009 fish tissue study are discussed in the following sections. The estimated numbers of field samples that will be collected are listed in Table A3.

2.1.5 Target Species and Size Classes

The 2009 fish tissue study targets fish species that are likely to be abundant throughout the UCR, represent varying feeding guilds, and represent likely prey for fish, wildlife, and/or people. Fish will be collected in three target size classes (<15, ≥15 to ≤30, and >30 cm). The two smaller size classes are intended to sample fish species that will provide data for the evaluation of risk to wildlife and fish species, while the largest size class is intended to provide data to support the human health risk assessment and the ecological risk assessment for selected wildlife species.

To meet the DQOs for collecting data to evaluate risks to wildlife and fish, several minimum requirements will be met for each FSCA collection.

Electrofishing techniques will be employed at each FSCA to provide a consistent sampling approach throughout the study. Additional sampling gear types will be used (such as gill nets and burbot traps) if necessary to collect the minimum number of composites.

A minimum of six species-specific composite samples will be collected at each FSCA for each size class (<15 and ≥15 to ≤30 cm). Six species (one composites each) will be identified as the target species for each size class; three additional species will be listed that can be collected if the target species are not available.

The 2009 sampling event will target the following fish size classes, based on total length:

- <15 centimeters (cm)
- ≥15 to ≤30 cm
- >30 cm

These size classes correspond to the sizes of fish that are typically consumed by piscivorous fish and wildlife or human receptors. The fish species targeted within each size class represent varying feeding guilds (e.g., omnivores and piscivores). The target species are:

<15cm size class – A goal of six whole body composites (minimum of five fish per composite) consisting of one species per composite will be targeted. A goal of six species from three feeding guilds will be targeted to achieve representation across guilds:

- Primary species
  - Omnivore – yellow perch
  - Insectivore – rainbow trout
  - Benthivore/detritivore – largescale sucker
- Secondary species
  - Omnivore – bluegill
  - Insectivore – whitefish
  - Benthivore/detritivore – longnose or bridgelip sucker
- Tertiary species (may include)
  - Omnivore – redside shiner, crappie, pumpkinseed, and smallmouth bass
  - Insectivore – pikeminnow
  - Benthivore/detritivore – sculpin

>15 to <30 cm size class – A goal of six whole body composites (minimum of five fish per composite) consisting of one species per composite will be targeted. A goal of six species from three feeding guilds will be targeted to achieve representation across guilds:

- Primary species
  - Benthivore/detritivore – largescale sucker
  - Insectivore – kokanee
  - Piscivore – walleye

- Secondary species
  - Benthivore/detritivore – longnose or bridgelip sucker
  - Insectivore – lake whitefish
  - Piscivore – smallmouth bass
- Tertiary species (may include)
  - Benthivore/detritivore – sculpin
  - Insectivore – mountain whitefish
  - Piscivore – pikeminnow

>30 cm size class — Six single-species composite samples (minimum of five fish) will be collected for each of the following species:

- Walleye – piscivore – fillet and remainder
- Burbot – piscivore - fillet and remainder
- Smallmouth bass – piscivore - fillet and remainder
- Largescale sucker – benthivore/detritivore - fillet and remainder (without gut contents)
- Rainbow trout – omnivore - fillet and remainder
- Kokanee – insectivore - fillet and remainder
- Whitefish – insectivore - fillet and remainder (note that depending on fish distributions and location [e.g. FSCA 1] composites may be formed by either lake or mountain whitefish)

A goal of six composite samples (with a minimum of five individual fish per composite) for the <15 and ≥15 to ≤30 size classes and six composite samples for each species of the >30 cm size class will be collected at each of the six FSCAs, for a total of 576 composite samples (whole body, fillet, and remainder composites). Whole body composite samples will be collected for fish in the two smallest size classes, while fillet (skin on) and remainder samples will be evaluated for the >30 cm composite samples. Fillets from any walleye or smallmouth bass >30 cm length that are caught in addition to those that are needed for the composite samples, will also be collected for total mercury analysis.

The analytical suite of chemicals that will be analyzed in fish tissues will include metals/metalloids (including mercury), inorganic arsenic (arsenic speciation for burbot >30 cm), dioxins/furans, total PCBs, PCB congeners, PBDEs, organochlorine pesticides, polyaromatic hydrocarbons, and some SVOCs.

2.1.5.1 Fish Sampling Methods

As discussed previously, fish tissue will be collected within the six river reaches in the UCR (Figure A1). There are several types of sampling approaches (i.e., sampling gear) that will be used during this project. Each field sampling team will have the necessary knowledge and experience to perform all field activities. This will include experience in the collection of fish, the use of the specified sampling gear, and operation of small boats. All crew will be familiar with the sampling plan and will participate in site and equipment orientation.

Various types of sample gear may be needed to collect the targeted fish. The primary sampling methods will be boat electroshocking, gill netting, and burbot traps for >30 cm fish and electroshocking and beach seines for <30 cm fish. Secondary methods may include backpack electrofishing, gill nets, beach seines, and shore traps. A brief overview of all potential sampling techniques is provided below, and details on equipment and field application of these methods are described in the SOPs provided in Attachment A2.

- **Boat electroshocking** will be the primary sampling gear used in the 2009 fish tissue study. Boat electroshocking will generally be conducted in the evening. Electroshocking will be conducted in littoral habitat, using straight direct current if possible (see SOP-3).
- **Gill netting** will be conducted at night. Gill nets will generally be set in the afternoon or early evening, and pulled out the following morning[5]. The number of gill nets set in a reach during a single day will be determined by the available habitat and feasibility of setting nets in the reach (see SOP-3). Gill netting will generally be used to collect walleye, rainbow trout, kokanee salmon, and smallmouth bass.
- **Backpack electroshocking** will be conducted primarily at night. Backpack electroshocking will be conducted in shallow littoral habitat using straight direct current if possible (see SOP-4). Backpack electroshocking will generally be used to collect small fish in areas where a boat electroshocking unit cannot be used.
- **Burbot traps.** Burbot traps will be set at night. Burbot traps will be set to collect burbot in shallow and deep water (see SOP-5).
- **Beach seines** will be used to target fish in shallow water habitats with low to moderate current. Beach seines will generally be used during the night. Beach

[5] The permit may not allow overnight gill net or set line sets. The nets and set lines may be required to be checked every few hours for the first few days to avoid unnecessary mortality. This may require setting the nets and set lines in the late afternoon and pulling them about 3 hours after dark (checking them every 2 hours or so). Catch rates tend to be greater during the evening crepuscular period than through the night.

seines will generally be used as a supplement to other methods for the collection of sculpin and other species (see SOP-6).

- **Shore traps or minnow traps** will be used as a contingency to other fish collection methods, such as electroshocking (see SOP-6). By design, minnow traps will target small fish. Shore traps could be used day or night depending on the target species.

Following is an overview of the fish collection procedures:

1. Transport sample equipment and samplers by boat to the FSCA
2. Deploy and retrieve sampling gear
3. Transfer fish from sampling gear to appropriate holding containers
4. Separate fish into the three target size classes (<15, ≥15 to ≤30 cm, and >30 cm)
5. Gross-weigh and measure fish on boat
6. Return non-target fish to the water
7. Prepare field sampling records and label each fish
8. Process each fish (i.e., wrap in foil and place in plastic bag on ice)
9. Decontaminate sampling equipment
10. Transfer samples to the onshore fish sample processing station
11. Re-weigh and measure fish
12. Examine fish for external abnormalities and photograph
13. Fillet and remove otoliths for specific fish species
14. Process fillet and remainder samples and store at -20°C
15. Once all target fish are collected, determine fish composite schemes
16. Composite frozen whole body samples; wrap fillets individually.
17. Package and label samples
18. Complete field documentation
19. Ship samples to the offsite processing analytical laboratory.

Detailed descriptions of daily sampling team operations are provided in SOPs 10 through 13 for the fish tissue sampling.

2.1.5.2 Fish Target Sizes

The approximate size ranges for each fish species composite (depending on field conditions) are as follows:

- <15 cm size class—a minimum of six composite samples per sampling area will be collected
- ≥15 to ≤30 cm size class—a minimum of six composite samples per sampling area will be collected
- >30 cm size class—walleye (piscivore), burbot (piscivore), smallmouth bass (piscivore), largescale sucker (omnivore), rainbow trout (omnivore), and kokanee (omnivore) and whitefish (insectivore).

For composite samples (<15 and ≥15 to ≤30 cm size classes), individual fish will be of similar length, within the commensurate length range, and the smallest individual in a composite will be no less than 75 percent of the total length of the largest individual in the same composite. These measurement stipulations are similar to those used by EPA in 2005.

For >30 cm fish, composite samples will be determined based on a random approach (using a random number generator to assign individual fish to composites). No size limitation will be applied; therefore, all collected fish have an equal opportunity to be added to a composite.

2.1.5.3 Sampling Contingencies

For each fish size class, a minimum sampling effort is required after which a contingency rule is invoked if insufficient fish have been captured to complete the required six composites of specified fish species. These contingencies are as follows:

<u><15 cm size class</u>

The initial sampling effort will include the use of beach seines and boat electrofishing. Eight hours or four seine hauls will be conducted along with three hours of active electrofishing (nearshore). If the resulting catch is insufficient to meet the required number of composites/species, then a second sampling effort will be conducted using the same gear and level of effort. Different types of seines may be used in the secondary effort and/or different locations within the same FSCA may be sampled. The gear and sample locations will be decided in consultation with the TAI technical team task manager and field supervisor.

>15 cm to <30 cm size class

The initial sampling effort will include the use of gill nets and boat electrofishing. Two 12-hour gill net sets with four gill nets per set will be conducted along with two 6-hour periods of active electrofishing. If the resulting catch is insufficient to meet the required number of composites/species, then a second sampling effort will be conducted using the same gear, but only with three gill nets per set. Different locations within the same FSCA may be sampled each time. The gear and sample locations will be decided in consultation with the TAI technical team task manager and field supervisor.

>30 cm size class

The initial sampling effort will include the use of gill nets and boat electrofishing (see Bonar et al. 2000; Appendix A), with the same gear and level of effort as for the intermediate size class. Burbot pot traps will be used for targeted collections of these species. Two 12-hour sets with 12 pots per set will be performed for burbot sampling. If the resulting catch is insufficient to meet the required number of species, then a second sampling effort will be conducted using the same gear and level of effort. Different locations within the same FSCA may be sampled each time. The gear and sample locations will be decided in consultation with the TAI technical team task manager and field supervisor.

2.1.5.4 Sample Acceptability and Field Quality Assurance

Fish will be measured on the boat with a measuring board to obtain gross measurements of specimens that will be retained for samples. Fish caught that do not fall within target species or length ranges will be returned to the water.

2.1.5.5 Sample Handling

Specimens meeting sample requirements will be euthanized using a sharp blow to the head with a foil wrapped or decontaminated mallet or club, being careful not to break the skin of the fish. If this is not feasible, fish will be sacrificed via asphyxiation by wrapping in foil and placing in a plastic bag and placed on ice. Each selected fish will be tagged on the boat with a waterproof tag, which will be either placed in the resealable plastic bag with the fish or (if necessary) physically attached to the fish with a cable tie. A sequential numerical coding system will used (see Section 2.1.5.6). The tagged fish will be placed on ice in coolers during transport to the onshore sample processing location.

2.1.5.6 Individual Fish Sample Numbering

Each distinct sampling location (FSCA) will be assigned a unique identifier. Sample identification (ID) will be numbered sequentially beginning with the letters "TAI" (Teck American Incorporated), FSCA location, species abbreviation, size class designation, and tag number (e.g., TC1-WE-S3-001). The codes will include the following information:

FSCA(s):

- FSCA 1 – Reach 1 (RM 745 to RM 730) – Code = 1
- FSCA 2 – Reach 2 (RM 730 to RM 712) – Code = 2
- FSCA 3 – Reach 3 (RM 712 to RM 700) – Code = 3
- FSCA 4 – Reach 4 (RM 700 to RM 640) – Code = 4
- FSCA 5 – Reach 5 (RM 640 to RM 617) – Code = 5
- FSCA 6 – Reach 6 (RM 617 to RM 597) – Code = 6.

Species abbreviation(s) (note, below is a list of abbreviations for abundant species in the UCR; if another species is collected, a new code will be created and applied to the sample labels and noted in the field logs):

- Black crappie – Code = BC
- Bluegill – Code = BG
- Burbot – Code = BU
- Bridgelip sucker – Code = BL
- Kokanee hatchery – Code = KOH
- Kokanee wild – Code = KOW
- Lake whitefish – Code = LW
- Largescale sucker – Code = LS
- Longnose sucker – Code = LN
- Mountain whitefish – Code = MW
- Pikeminnow – Code = PM
- Pumpkinseed – Code = PS
- Sculpin – Code = SN
- Rainbow trout hatchery – Code = RBH
- Rainbow trout wild – Code = RBW

- Redside shiner – Code = RS
- Smallmouth bass – Code = SB
- Walleye – Code = WE
- Yellow perch – Code = YP.

Size class designation(s):

- Size class <15 cm – Code = S1
- Size class ≥15 to ≤30 cm – Code = S2
- Size class >30 cm – Code = S3.

Fish tag numbers will be expressed as four digits starting with 0001 (e.g., 0001 or 0002).

An example of the coding scheme is as follows. The 52nd fish collected during the 2009 event was a wild rainbow trout of 20 cm in length collected at FSCA 3. The resulting sample ID was TC3-RBW-S2-0052.

2.1.5.7 Sample Onshore Processing

Following receipt of the fish from the field collection crew, the onshore sample processing team will weigh, measure, and examine each fish in accordance with SOP-7 provided in Attachment A2. All onshore processing will be performed in a trailer located at a nearby access point; for example, a marina closest to where fishing activities will occur. Fish will be sorted into species-specific composites. Once a composite is completed (i.e., at least five fish grouped), whole body composites will be measured, stored, and processed for shipping and fillet composites will processed according to SOP-7. All fish will have otoliths removed for submission to the WDFW for determining age[6].

Fish length will be measured as total length, defined as the distance from the tip of the tail to the tip of the nose. Fork length will not be measured. For any fish that does not fit on the measuring board, a standard measuring tape will be used. All length measurements will be recorded to the nearest millimeter (mm). Individual fish will be weighed with a digital scale and weight will be recorded to the nearest gram. Observations of condition and an external examination for health and abnormalities will be recorded and photographed (see SOP-7) according to Smith et al. (2002).

[6] As requested by Washington State Department of Fish and Wildlife.

Whole Body Procedures

Whole body fish samples will be grouped for compositing, according to reach, species, and size class (see SOP-7). Fish length and weight will be recorded and otoliths removed and preserved (in alcohol). All individual fish of each composite will be wrapped in aluminum foil and placed in resealable plastic bags with field tags secured on the outside of the bag. The composite samples will then be prepared as described in Section 2.3 for shipment to the offsite processing laboratory or WDFW laboratory for aging.

Filleting Procedures

Fish will be grouped for compositing, according to reach, species, and size class (see SOP-7) before filleting and otolith removal. Fish length and weight will be recorded and otoliths removed and preserved (in alcohol). Filleting will follow general EPA guidelines (USEPA 2000) and those described in SOP-7. Fish will be filleted with the skin on. The following general filleting procedures will be used:

1. Prior to resection, hands will be washed with Ivory soap and rinsed thoroughly in tap water, followed by contaminant-free, deionized water, and a clean pair of cleanroom 100 certified nitrile gloves will be worn.
2. All cutting boards and utensils will be cleaned prior to use by washing with laboratory detergent and deionized water, three times with pesticide-grade methanol followed by three times with 20 percent nitric acid, then three times with deionized water and allowed to air dry before use.
3. Care will be taken to ensure that specimens come into contact only with decontaminated cutting boards and utensils.
4. Individual fish will be placed on decontaminated glass or Teflon® cutting board or on one that has been covered with clean heavy-duty aluminum foil. Otoliths will be removed using a clean, high-quality stainless-steel, ceramic, or titanium utensil. Otoliths will be placed in containers specified by the laboratory (or WDFW) that will prepare and read the otoliths.
5. A clean, high-quality stainless-steel, ceramic, or titanium filleting knife will be used to remove both fillets. The belly flap will be included in each fillet.
6. Bones remaining in the tissue after filleting (e.g., rib bones or fins) will be carefully removed with decontaminated stainless-steel pliers or forceps, or cut out with a knife.

7. Any dark muscle tissue in the vicinity of the lateral line will not be separated from the light muscle tissue that constitutes the rest of the muscle tissue mass. Both fillets from each fish will be removed and combined for the composite sample.
8. Fillets and carcasses will be weighed to the nearest gram and recorded on the fish processing form.
9. For > 30 cm largescale sucker only, the gut must be removed from the carcass and cleaned before placing back with the offal portion of the sample.
    - The gut will be cut from the largescale sucker carcass after filleting by cutting the posterior end of the intestine first and anterior end of the esophagus second.
    - The gut will be removed from the fish body cavity, rinsed with deionized water, gently patted dry with a paper towel.
    - The gut will be cut along its full length and the contents of the stomach extruded into a pre-cleaned glass jar. Sucker gastrointestinal tracts typically do not have distinctive anatomical components (stomach, intestine), are long (approximately 3 m), and narrow.
    - The guts will then be rinsed clean with deionized water.
    - Once rinsed, the gut will be placed back with the offal sample.
    - Entire gut contents from each specimen will be combined for a composite.
10. All cutting boards and utensils will be cleaned between composite samples with detergent and with trace-metal-free and organics-free deionized water, followed by pesticide-grade methanol and 20 percent nitric acid rinses between samples.
11. If an aluminum-foil-covered cutting board is used, the foil will be changed between fish. Care will also be taken to avoid contaminating fillet tissues with material released by the inadvertent puncture of internal organs. If the fillet is inadvertently contaminated, the fillet tissue will be rinsed in contaminant-free, deionized distilled water and blotted dry with Kim Wipes™. In addition, documentation of the contamination will be completed on the fish processing form.
12. Following resection, fillets or carcasses will be individually wrapped in aluminum foil and placed in a resealable plastic bag along with the field sample identifier tag, and stored in a locked freezer.

The identified composite samples will be prepared as described in Section 2.3 for shipment to the offsite processing laboratory.

2.1.5.8 Composite Sample Acceptability and Quality Assurance

Field quality assurance (QA) procedures will be followed to ensure the quality of the data collected. For the two smaller size classes, composite samples will consist of individual fish of similar size, and the smallest individual in a composite will not be less than 75 percent of the total length (size) of the largest individual in the same composite (USEPA 2000). For >30 cm fish, composite samples will be determined based on a random approach (using a random number generator to assign individual fish to composites). No size limitation will be applied; therefore, all collected fish have an equal opportunity to be added to a composite.

2.1.6 Composite Fish Sample Numbering

Composites samples will be formed at the onshore sample processing site. A unique code (i.e., composite sample identification code) will be assigned to each composite sample. The codes will include the following information:

FSCA(s):

- FSCA 1 – Reach 1 (RM 745 to RM 730) – Code = 1
- FSCA 2 – Reach 2 (RM 730 to RM 712) – Code = 2
- FSCA 3 – Reach 3 (RM 712 to RM 700) – Code = 3
- FSCA 4 – Reach 4 (RM 700 to RM 640) – Code = 4
- FSCA 5 – Reach 5 (RM 640 to RM 617) – Code = 5
- FSCA 6 – Reach 6 (RM 617 to RM 597) – Code = 6.

Species Abbreviation(s) (Note: Below is a list of abbreviations for abundant species in the UCR; if another species is collected, a new code will be created and applied to the sample labels and noted in the field logs):

- Black crappie – Code = BC
- Bluegill – Code = BG
- Burbot – Code = BU
- Bridgelip sucker – Code = BL
- Kokanee hatchery – Code = KOH
- Kokanee wild – Code = KOW
- Lake whitefish – Code = LW
- Largescale sucker – Code = LS

- Longnose sucker – Code = LN
- Mountain whitefish – Code = MW
- Pikeminnow – Code = PM
- Pumpkinseed – Code = PS
- Sculpin – Code = SN
- Rainbow trout hatchery – Code = RBH
- Rainbow trout wild – Code = RBW
- Redside shiner – Code = RS
- Smallmouth bass – Code = SB
- Walleye – Code = WE
- Yellow perch – Code = YP.

Size class designation(s):

- Size Class ≤15 cm – Code = S1
- Size Class ≥15 to ≤30 cm – Code = S2
- Size Class >30 cm – Code = S3.

Tissue type:

- Whole body – Code = W
- Fillet – Code = F
- Remainder – Code = R
- Replicate number (e.g., 1 through 6)
- Number of specimens in composite sample (i.e., must be at least five though more may be needed for smaller fish).

An example of the composite coding is as follows. For the third whole body composite formed for sculpin species ranging from 5 to 10 cm in length collected at FSCA 3 and comprising ten individual fish, the resulting composite ID is TAI3-SC-S1-W310.

2.1.6.1 Equipment Decontamination Procedures

The field team will thoroughly rinse all sampling equipment that comes into contact with either fish or bottom sediments between stations and upon completion of the study. This will include equipment such as boat decks, gill nets, dip nets, temporary fish-holding containers, hip waders, and gloves used for electrofishing (i.e., electrician's gloves).

Rinsing will be done using lake water away from the shoreline and any areas where sediment has been disturbed. Field equipment used for measuring and weighing the fish on board and at the onshore processing stations will be washed with soap (i.e., Alconox™) and rinsed with lake water at the boat launches after each use. This will include the digital scale pans, the fish measuring boards, and the holding containers in which the fish were stored and transported. Cleanroom 100 certified nitrile gloves used for handling fish in the field and onshore will be discarded, not decontaminated. Clean gloves will be worn at each sampling location to avoid transfer of potential contaminants among samples.

2.2 SAMPLE HANDLING

This section describes procedures for handling samples prior to shipping to the analytical laboratory (see SOP-7 in Attachment A2). Planning and documentation of all activities are emphasized to ensure that sample identity and integrity are preserved during all stages of the field operation. The following documentation will be provided with the tissue samples:

- A field record form that contains information about each fish and sampling area
- A sample identification label that accompanies and identifies each individual fish
- A COC form that provides continuous tracking information for all samples
- A COC label that seals each shipping container.

The following information will be handwritten on the sample label at the time of collection with an indelible marker:

- Reach
- Composite fish sample number
- Individual fish sample number(s)
- Analysis
- Samplers
- Date
- Time.

If necessary, corrections will be made on the sample labels by drawing a single line through the error and entering the correct information with an indelible marker. All

corrections will be initialed and dated by the person performing the correction. If possible, the individual who made the error will correct it.

The sample labels will be placed inside resealable plastic bags and inserted with each foil-wrapped fish inside a large resealable plastic bag. When the individual fish are wrapped for shipment, this sample label will remain with the specimen. Sample packaging is discussed in the following section.

2.3 SAMPLE PACKAGING AND TRANSPORT

After completing each day of fish tissue sampling, the sampling vessel will return to the boat launch and the field crew will deliver the fish samples, held in coolers with ice, to the onshore sample processing team. The onshore processing team will have at their disposal a secure area for processing and temporary freezer storage where the fish samples will be prepared for shipment to the processing laboratory.

At the onshore sample processing facility, the following procedures will be employed:

1. Leave the original sample label with the fish.
2. Weigh, measure, and examine each fish as described in SOP-7.
3. If required, fillet fish and remove otoliths as described in SOP-7.
4. Wrap individual fish, carcasses, or fillets in heavy-duty aluminum foil, shiny side out.
5. Place each foil-wrapped fish, carcass, or fillet into a section of heavy-duty, food-grade, polyethylene tubing or resealable plastic bags that will be cut to size to fit the specimen, and seal the ends of the tubing with plastic cable ties.
6. Place a secondary field tag in the resealable plastic bag with each specimen to facilitate identification and sample organization at the homogenization/analytical laboratory without unwrapping the fish. The secondary tag will indicate the fish species, FSCA, and the field tag number.
7. Place the wrapped specimen inside a large, clear, resealable plastic bag with the other wrapped specimens for the same composite. Place a new sample label with the composite identification code inside the composite bag and seal. Once the samples are packaged, the onsite sample processing coordinator (SPC) will ship the samples packed on dry ice (in sufficient quantity to keep the samples frozen for up to 48 hours), via priority overnight delivery service or courier service, so

that they arrive at the processing laboratory within 48 hours from the time of sample collection.

Sturdy plastic coolers will be used as shipping containers. Enough fish will be placed in each cooler to occupy 60 to 70 percent of the cooler volume, and the remaining space in the cooler will be filled with dry ice. A completed COC form and copies of the field record forms for the samples will be included in each cooler. Both forms are presented in Attachment A3.

After each cooler is packed with fish samples and dry ice, it will be secured at both ends with nylon strapping tape and the following items will be attached:

- Address label for processing laboratory
- Two custody seals
- Overnight shipping airbill
- Perishable goods label
- Class 9 Dangerous Goods Label (required by U.S. Department of Transportation (DOT) for coolers containing dry ice that will be shipped by air).

2.4 STUDY-DERIVED WASTE

All disposable materials used for sample collection and processing, such as paper towels and gloves, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal at a solid waste landfill.

Measurement, examination, and dissection equipment will be decontaminated every time a composite set for a species and size group is processed. Liquid wastes such as nitric acid and methanol are expected to be generated in the field during fish processing. All solvent wastes will be stored in containers and disposed at an offsite facility. Acid waste will be neutralized and disposed locally.

3 FIELD DOCUMENTATION

The integrity of each sample from the time of collection to the point of data reporting must be maintained. Proper record-keeping and COC procedures will be implemented to allow samples to be traced from collection to final disposition. Representative photographs will be taken of each type of sampling activity performed during the fish tissue study. Site photographs from various angles and views of the sampling locations will also be collected.

3.1 FIELD LOGBOOK

All field activities and observations will be noted in a field logbook. The field logbook will be a bound document containing individual field and sample log forms. Information will include personnel, date, time, station designation, sampler, types of samples collected, and general observations. Any changes that occur during sampling (e.g., personnel, responsibilities, deviations from the FSP) and the reasons for these changes will be documented in the field logbook. The logbook will identify onsite visitors (if any) and the number of photographs taken at each sampling location. The field supervisor is responsible for ensuring that the field logbook and all field data forms are correct. Requirements for logbook entries will include the following:

- Logbooks will be bound, with consecutively numbered pages.
- Removal of any pages, even if illegible, will be prohibited.
- Entries will be made legibly with black (or dark) waterproof ink.
- Unbiased, accurate language will be used.
- Entries will be made while activities are in progress or as soon afterward as possible (the date and time that the notation is made should be noted, as well as the time of the observation itself).
- Each consecutive day's first entry will be made on a new, blank page.
- The date and time, based on a 24-hour clock (e.g., 0900 a.m. for 9 a.m. and 2100 for 9 p.m.), will appear on each page.
- When field activity is complete, the logbook will be entered into the TAI technical team project file.

In addition to the preceding requirements, the person recording the information must initial and date each page of the field logbook. If more than one individual makes entries on the same page, each recorder must initial and date each entry. The bottom of the page must be signed and dated by the individual who makes the last entry. The field supervisor, after reading the day's entries, also must sign and date the last page of each daily entry in the field logbook.

Logbook corrections will be made by drawing a single line through the original entry, allowing the original entry to be read. The corrected entry will be written alongside the original. Corrections will be initialed and dated and may require a footnote for explanation.

The type of information that may be included in the field logbook and/or field data forms includes the following:

- Task name, task location, and task number
- Task start date and end date
- Weather conditions
- Name of person making entries and other field staff
- Onsite visitors, if any
- Sampling vessel, if any
- FSCA name and location
- Date and collection time of each sample
- The sampling location name, date, gear, water depth, and sampling location coordinates derived from GPS
- Specific information on each type of sampling activity
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- Number of photographs taken at each sampling location
- A record of site health and safety meetings, updates, and related monitoring
- Any deviation from the FSP and reasons for deviation.

In addition, a sampling location map will be updated during sampling and will be maintained throughout the sampling event. All logbooks must be completed at the time

any observations are made. Copies of all logbooks and forms will be retained by TAI and its technical team.

3.2 CHAIN-OF-CUSTODY PROCEDURES

Samples are in custody if they are in the custodian's view, stored in a secure place with restricted access, or placed in a container secured with custody seals. A COC record will be signed by each person who has custody of the samples and will accompany the samples at all times. Copies of the COC will be included in laboratory and quality assurance/quality control (QA/QC) reports. Attachment A3 contains an example of the COC form that will be used during the 2009 fish tissue study.

At a minimum, the COC form will include the following information:

- Site name
- Field supervisor's name and team members responsible for collection of the listed samples
- Collection date and time for each sample
- Sample type (i.e., sample for immediate analysis)
- Number of sample containers (i.e., coolers) shipped
- Requested analyses for each sample
- Sample preservation information (if any)
- Name of the carrier relinquishing the samples to the transporter, noting date and time of transfer, and the designated sample custodian at the receiving facility.

The field supervisor, as the designated field sample custodian, will be responsible for all sample tracking and COC procedures for samples in the field. The field sample custodian will be responsible for final sample inventory and will maintain sample custody documentation. The field sample custodian will complete COC forms prior to removing samples from the field. Upon transferring samples to the laboratory sample custodian or shipping courier, the field supervisor will sign, date, and note the time of transfer on the COC form. The original COC form will be transported with the samples to the laboratories. All samples will be shipped to the testing laboratories in either coolers or shipping containers sealed with custody seals.

Each laboratory will designate a sample custodian who will be responsible for receiving samples and documenting their progress through the laboratory analytical process. The

sample custodian for each laboratory will establish the integrity of the custody seals upon sample arrival at the laboratory. The laboratory sample custodian will also ensure that the COC and sample tracking forms are properly completed, signed, dated and initialed upon receipt of the samples.

Upon receipt of the samples by the laboratory, the laboratory sample custodian will inventory the samples by comparing sample labels (numbers and tags) to those on the COC document. If sample temperature falls below acceptable range (i.e., fish samples have thawed), the field supervisor should be alerted immediately. The custodian will enter the sample number into a laboratory tracking system by task code and sample designation. The custodian will assign a unique laboratory sample identifier to each sample number and will be responsible for distributing the samples to the appropriate analyst or for storing samples at the correct temperature in an appropriate secure area.

4 LABORATORY ANALYSES

This section describes the general offsite sample processing and laboratory analyses to be performed by the contract laboratory. The details provided below are subject to change once the final contract laboratory is selected and the QAPP and FSP have been reviewed by EPA and the contract laboratory QA manager.

4.1 OFFSITE SAMPLE PROCESSING

Fish will be shipped from the field to the offsite processing laboratory (which may be the same as the analytical laboratory). The processing laboratory will prepare homogenized tissue samples from whole fish, fillets, or remainder, and, if at a different location than the analytical laboratory, will then ship the samples to analytical laboratories for chemical analysis. This section describes the procedures that will be followed for these activities.

4.1.1 Sample Containers and Preservatives

EPA (USEPA 2000) describes container materials that are suitable for storing homogenized fish tissue samples. Borosilicate glass, quartz, and polytetrafluoroethylene (PTFE, or Teflon) are suitable materials for the suite of target analytes for this study (mercury, other metals, organics, and lipids). Pre-cleaned and certified glass jars with Teflon-lined lids will be used. EPA (USEPA 2000) recommends that homogenized fish tissue samples be stored frozen at –20 degrees Celsius (°C) or lower. This recommendation will be followed for this investigation. The maximum holding time for a sample depends on the target analyte. Holding times will also be a consideration for future analysis of archived sample aliquots.

4.1.2 Sample Processing Procedures

This section describes the procedures and equipment that will be used to create composite fillet samples and composite whole-body samples from whole fish.

4.1.2.1 Operations Schedule and Personnel

The work will be conducted in a timely manner so that subsequent analytical work can be completed within the maximum holding times (e.g., 6 months to 1 year).

4.1.2.2 Processing Equipment

Equipment that will be used to homogenize samples includes pre-cleaned glass or stainless-steel homogenization containers, an automatic grinder (a high speed blender or homogenizer is sufficient), aliquot containers (pre-cleaned glass jar with Teflon-lined lid), a freezer capable of storing all samples at less than –20°C, and dry ice to chill homogenization equipment.

4.1.2.3 Processing Procedures

All homogenization of fish samples will be conducted in the offsite processing laboratory, not in the field. As described in Section 2.3, samples will be shipped from the onshore processing station to the offsite processing laboratory within 48 hours of collection for next-day delivery. Processing procedures in the offsite laboratory will follow the general guidance in USEPA (2000).

4.1.2.4 Initial Procedures for Homogenization

On the day before homogenizing, the frozen fish scheduled to be processed will be moved into a refrigerator (4 ± 2°C) and allowed to partially thaw overnight. Following this procedure, fish will not be allowed to thaw completely, but to the point where it becomes possible to make an incision into the flesh.

Whole fish, most fillets, and remainder samples will be homogenized as composites; fillets from walleye and smallmouth bass will be homoginized individually. Initially, whole fish, fillets and the remainder of the fish will be ground or homogenized using a blender or commercial food grinder. Large fillets and whole fish may be cut into small cubes with high-quality stainless steel or titanium knives to ease homogenization. Because the grinding and homogenization of fish tissue is easier when the tissue is partially frozen, the grinder will be chilled by grinding with a few chips of dry ice before processing each sample.

The fillet or whole fish sample will be ground until it appears to be homogenous on visual inspection, then transferred to a clean (detergent, deionized water, solvent-rinsed, and dried) stainless-steel mixing bowl. The ground sample will then be divided into quarters; opposite quarters will be mixed together using a solvent-rinsed spoon or spatula, and the two halves mixed back together. The grinding, quartering, and hand mixing will be repeated two more times.

4.1.2.5 Compositing Procedures for Homogenized Samples

Composite fish samples will be analyzed for the 2009 fish tissue study. Smaller size classes (≤15 cm and >15 to ≤30 cm) will be analyzed as whole body composites, while the larger size class (>30 cm) will be analyzed as fillet and remainder composites. The composite homogenization procedures are provided below.

Fillet and Remainder Composite Samples. Composite homogenates for the fillet samples will be prepared from individual homogenates. The same type of individual homogenate (i.e., either single fillet or combined fillet) will always be used in a given composite sample. Once individual homogenization is complete for >30 cm fish fillets, all homogenates will be combined prior to analysis such that differences in chemical concentration and fish weight are incorporated into the final concentration. In addition, a 10-gram aliquot of the homogenate from individual smallmouth bass and walleye (>30 cm) will be collected for total mercury analysis prior to compositing. A minimum mass of 325-grams will be needed to conduct all of the analytical assays for each of the chemical groups identified in Tables A-3 and A-4. If individual homogenates are frozen before composite preparation, they will be thawed partially and re-homogenized prior to weighing and compositing. Any associated liquid will be kept as a part of the sample. The weight of each individual homogenate used in the composite homogenate will be recorded, to the nearest gram, on the fish processing form.

The composite sample of the individual homogenates will be combined following the mixing procedure described above (see last paragraph under Procedures, above). At this time, the composite homogenate will be separated into sample aliquots for analyses. The composite homogenate may be frozen and stored at less than –20°C in pre-cleaned glass containers with Teflon-lined lids before preparing aliquots. If the composite homogenates are frozen before aliquot preparation, samples will be re-homogenized before aliquotting for analyses.

The remainder of each homogenate will be archived at less than –20°C with the designation "Archive" and the expiration date recorded on the sample label. The location of the archived samples will be indicated on the appropriate COC form.

Whole-Body Composite Samples. Whole-body composite samples for small fish (<15 cm and ≥15 to ≤30 cm) will be homogenized together. Smaller whole fish (0 to 1,000 grams per individual) will be sorted into the appropriate size class according to the sampling objectives described in Section 2.1.5.2., and groups of fish within a species and size class will be combined, and ground in a commercial meat grinder or blender equipped with stainless-steel blades before homogenizing. Larger fish (>1,000 grams) will be cut into

small pieces with a stainless-steel knife or cleaver and then ground in the blender or grinder. All parts of the grinder or blender that come into contact with the sample will be cleaned prior to use by washing with laboratory detergent and water, three times with de-ionized water, three times with pesticide-grade methanol, and three times with methylene chloride, then allowed to air dry before use.

Because the grinding and homogenization of fish tissue is easier when the tissue is partially frozen, the grinder will be chilled by grinding with a few chips of dry ice prior to fish grinding.

The ground sample will be transferred to a clean (detergent, deionized water, solvent rinsed) mixing bowl and divided into quarters. The opposite quarters will be mixed together by using a solvent-rinsed spoon or spatula, and the two halves mixed back together. Grinding, quartering, and mixing will be repeated two more times. All individual fish homogenates will be mixed and subsampled to form the 325-gram composite sample, or frozen and stored at less than –20°C in pre-cleaned and certified glass containers before creating the 325-gram composite sample. If the composite homogenates are frozen before aliquot preparation, samples will be re-homogenized before aliquotting for analyses. The remainders of each individual homogenate will be archived at less than –20°C with the designation "Archive" and the expiration date (based on holding times in Table A1) recorded on the sample label.

4.2 LABORATORY QUALITY ASSURANCE PROCEDURES

QA procedures will be followed in the fish processing and composite preparation task through recordkeeping and documenting procedures for processing of all individuals and composites. Specific measures will include maintaining laboratory logs and data sheets, using standard data collection forms, and developing routine procedures, as discussed in this document, to assess the accuracy and completeness of records.

4.2.1 Sample Handling and Preservation

The composite tissue samples will be stored according to the methods protocols. COC procedures will be followed when the samples are shipped from the processing laboratory to other laboratories for chemical analysis. Sturdy shipping coolers with dry ice will be used for overnight shipping.

4.2.2 Equipment Decontamination Procedures

The composite tissue samples for this study will be analyzed for both organics and metals, including mercury. Prior to preparing each composite sample, utensils and containers will be cleaned thoroughly with a detergent solution; rinsed with tap water; rinsed with 20 percent trace-metal-grade nitric acid (HNO_3) and with trace-metal-free and organics-free deionized water, and solvent rinsed with methanol and methylene chloride. Stainless-steel parts will be cleaned using this procedure, but without the acid rinse (USEPA 2000).

4.2.3 Containment and Disposal of Investigation-Derived Waste

Waste materials generated during preparation of the fish tissue homogenates will be disposed of according to the SOPs of the offsite processing laboratory.

4.3 ANALYTICAL LABORATORY METHODS

Project analytes, methods, analysis by species, and required quantitation limits are listed in Tables A1 to A4. The analyses for COIs will be performed in accordance with the project QAPP and laboratory SOPs. The analyses will be subject to quality control (QC) requirements specified in Section 4.3.2. For fish analyses, the analytical/laboratory reporting limits are laboratory specific. The laboratories will target the needed levels shown in Table A4 and will report detection levels on a sample/analyte-specific basis. The selected methods will be state of the art and only the methods that are practicable for this study will be used. For reporting limits that are above the levels in Table A2, the project team may use the laboratory-specific method detection limits (MDLs), which are expected to be significantly lower than the reporting levels.

4.3.1 Laboratory Homogenate Replicates

One well-homogenized composite sample for each tissue type from each species will be used to produce triplicate samples for quality assurance of the homogenization (Table A3). If insufficient tissue is available for triplicate samples from some tissue types (e.g., fillets) or species, duplicate samples may be produced from two composites. The replicate samples will be sent (blind) to all laboratories conducting analyses. These replicates primarily provide information about the uniformity of the homogenization procedure, but also provide information about the precision of the analysis.

4.3.2 Analytical Quality Control Samples

The laboratories that analyze the samples will evaluate analytical accuracy by conducting matrix spike/matrix spike duplicate (MS/MSD) analyses on approximately 1 in 20 (or 1 per analytical batch, whichever is more frequent) of the samples and by analyzing certified reference materials. Precision will be evaluated by analyzing spike or laboratory sample duplicates. In addition, the laboratory will analyze reagent blanks to assess the magnitude of any incidental contamination that potentially may bias the results.

5 DATA MANAGEMENT AND REPORTING PROCEDURES

During field, laboratory, and data evaluation operations, effective data management is critical to providing consistent, accurate, and defensible data and data products. Data management and reporting are discussed in the following sections.

5.1 FIELD DATA

Daily field records (a combination of field logbooks, field electronic GPS files, field forms [if any], and COC forms) will make up the main documentation for field activities. Upon completion of sampling, field notes, data sheets (if any), and COC forms will be scanned to create an electronic record for use in creating the field data report. Field data will be manually entered into the project database. One hundred percent of the transferred data will be verified based on hard copy records. Electronic QA checks to identify anomalous values will also be conducted following entry.

5.2 LABORATORY DATA

The contract laboratory will submit data in both electronic and hard-copy format as described in Section A11.2 of the QAPP. The laboratory project managers for the respective testing laboratories will contact each of their respective laboratory QA managers prior to data delivery to discuss specific format requirements. Written documentation will also be used to clarify how field replicate and split samples, and laboratory duplicates and QA/QC samples were recorded in the data tables, and to provide explanations of other issues that may arise. The data management task will include keeping accurate records of field and laboratory QA/QC samples so that TAI technical team personnel who use the data will have appropriate documentation. Data management files will be stored on a secure computer or on a removable hard drive that can be secured.

In addition to placing all data and identifiers in an electronic database, hard copies of all original analytical data or study records will be placed in a filing system. Each analytical data set (or supporting laboratory document) will be given a unique documentation code based on the original source of the data or information, and filed based on that code. A

master list of all filed documents, sorted in order by filing code, will be maintained for easy retrieval from the document library.

5.3 DATA REVIEW AND REPORTING SCHEDULE

Draft data validation reports will be prepared by an independent validator following receipt of the complete laboratory data package for each round of sampling. Validated data will be provided electronically to EPA within 90 days of completion of the data validation. A field sampling report will be prepared by the TAI technical team and submitted to EPA with the data validation reports. The field sampling report will include an overview of the field event, a station location map, sample collection methods used, rationale for any deviations from the FSP and QAPP, and if appropriate, recommendations for changes to the sampling design for upcoming surveys. Sample results will be reported in tabular format in the field sampling report. A final data evaluation report will be prepared by the TAI technical team and submitted to EPA within 150 days following submission of the final set of validated data to EPA.

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FIGURES

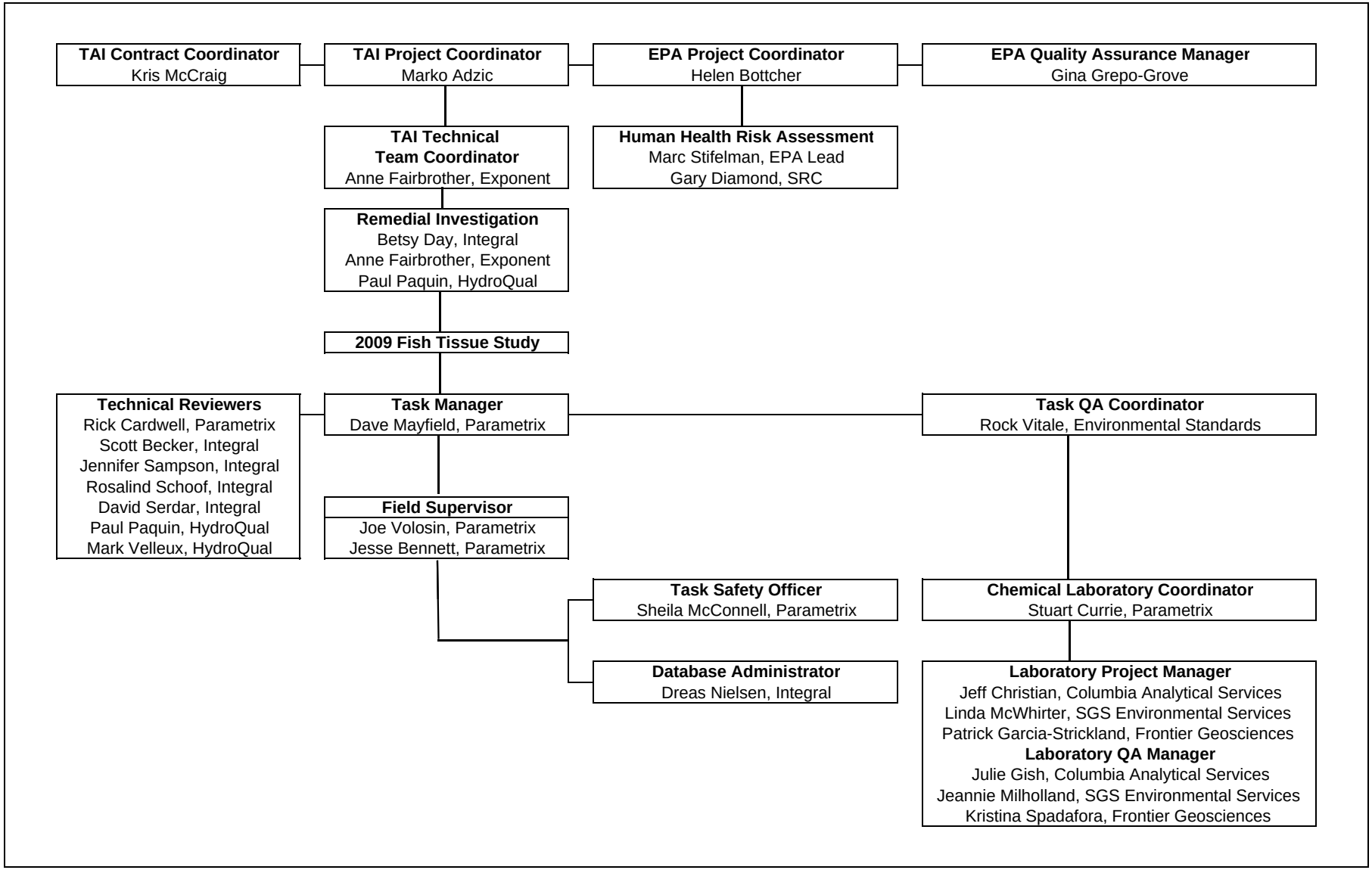

Figure A-1. Organization Chart for the 2009 Fish Tissue Study

Note: SRC = Syracuse Research Corporation

TABLES

Table A1. Recommended Methods for Analysis of COIs in Fish Tissue Samples

Analytes	Analytical method	Description	Container	Holding Time	Preservation
Metals/Metalloids	EPA Method 6010 EPA Method 6020 EPA Method 7471B/EPA Method 1631B or E (Hg) EPA 7000 Series Methods (various metals)	ICP-AES ICP-MS CV-AAS	Aluminum foil, Resealable plastic bag (whole fish)	1 year, except Hg is 6 months	Frozen at -20 °C
Inorganic Arsenic	EPA Method 1632A	HG-QFAAS	Aluminum foil, Resealable plastic bag (whole fish)	2 years	Frozen at -20 °C
PCBs (Congeners)	EPA Method 1668A	HRGC/HRMS	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C
Dioxins/Furans	EPA Method 1613B	HRGC/HRMS	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C
PBDEs	EPA Method 1614	HRGC/HRMS	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C
PAHs	EPA Method 8270 (modified)	GC-MS-SIM	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C
Pentachlorophenol	EPA Method 8151M	GC-ECD	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C
Chlorinated Pesticides	EPA Method 8081B or Method 1856A	GC-ECD	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C
SVOCs	EPA Method 8270D	GC-MS	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C
% Lipids		Freeze-dry/Gravimetric	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C
% Moisture		Freeze-dry/Gravimetric	Aluminum foil, Resealable plastic bag (whole fish)	1 year	Frozen at -20 °C

Notes:

EPA 7000 Series methods may be required for various individual methods

Recommended methods only; final methods will be selected for use based on target detection limits for the specific COIs.

Quantitation limits for the selected analytical methods will be included in the QAPP once a Contract Laboratory has been selected.

CV-AAS	Cold vapour - atomic adsorption spectrometry
GC-ECD	Gas chromatography - electron capture detection
GC-MS	Gas chromatography - mass spectrometry
GC-MS-SIM	Gas chromatography - mass spectrometry (selected ion monitoring)
HG-QFAAS	Hydride generation - quartz furnace atomic adsorption spectrometry
HRGC/HRMS	High resolution gas chromatography - high resolution mass spectrometry
ICP-AES	Inductively-coupled plasma - atomic emission spectrometry
ICP-MS	Inductively-coupled plasma - mass spectrometry

Table A2. Target Analyte List and Analytical Concentration Goals

	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
Conventional Parameters											
Total length	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total mass	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Percent moisture	n/a	n/a	n/a	n/a	n/a	0.1	n/a	0.1	n/a	n/a	n/a
Percent lipids	n/a	n/a	n/a	n/a	n/a	0.1	n/a	0.1	n/a	n/a	n/a
Metals/Metalloids (mg/kg-dry weight)											
Aluminum	3.2	n/a	n/a	11.5	2.3	2	0.4	**0.40**	71	2.40	4.4
Antimony	0.0013	n/a	n/a	n/a	n/a	0.05	0.02	**0.020**	8	0.10	0.03
Arsenic-Total	0.00048	20	4	5.1	1	0.025	0.005	**0.005**	97	0.05	0.0064
Arsenic-Inorganic (As^{+3})	0.00048	n/a	n/a	n/a	n/a	0.025	0.005	**0.005**	37	0.0008	0.00064
Arsenic-Inorganic (As^{+5})	0.00048	n/a	n/a	n/a	n/a	0.025	0.005	**0.005**	37	0.0008	0.00064
Arsenic-Inorganic (MMA)	0.00048	n/a	n/a	n/a	n/a	0.125	n/a	**0.125**	37	0.0008	0.00064
Arsenic-Inorganic (DMA)	0.00048	n/a	n/a	n/a	n/a	0.125	n/a	**0.125**	37	0.0008	0.00064
Barium	0.65	n/a	n/a	308	61.6	0.05	0.01	**0.010**	100	0.28	2.9
Beryllium	0.0065	n/a	n/a	n/a	n/a	0.020	0.004	**0.0040**	13	0.004	0.082
Bismuth	n/a	n/a	n/a	n/a	n/a	0.1	0.003	**0.0030**	n/a	n/a	n/a
Boron	0.65	n/a	n/a	66	13.2	1	0.2	**0.20**	n/a	n/a	n/a
Cadmium	0.0032	55	11	3.4	0.7	0.020	0.005	**0.005**	85	0.01	0.041
Calcium	n/a	n/a	n/a	n/a	n/a	10	TBD[h]	**10**	100	167	n/a
Cerium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Cesium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Chromium	4.9	9.4	1.9	6.1	1.2	0.2	0.07	**0.07**	100	0.24	0.18
Cobalt	0.065	n/a	n/a	17.4	3.5	0.020	0.002	**0.0020**	96	0.004	0.82
Copper	0.13	50	10	9.3	1.9	0.1	0.03	**0.03**	100	0.18	0.3
Dysprosium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Erbium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Europium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Fluoride	0.19	n/a	n/a	n/a	n/a	5	TBD[h]	**5**	n/a	n/a	n/a
Gadolinium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Gallium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Germanium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Gold	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Holmium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Indium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Iron	2.30	n/a	n/a	n/a	n/a	2	0.7	**0.070**	100	2.11	25
Lanthanum	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Lead	n/a	7040	1,408	3.7	0.75	0.020	0.005	**0.005**	89	0.01	0.06
Lithium	0.065	n/a	n/a	n/a	n/a	0.5	0.3	**0.300**	n/a	n/a	n/a
Lutetium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Magnesium	n/a	n/a	n/a	n/a	n/a	5	TBD[h]	**5**	100	129	n/a

Table A2. Target Analyte List and Analytical Concentration Goals

	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
Metals/Metalloids (mg/kg-dry weight) (continued)											
Manganese	0.45	n/a	n/a	306	61	0.05	0.02	**0.02**	100	0.11	5.8
Mercury	0.00024	n/a	n/a	0.01	0.002	0.001	0.0002	**0.00020**	100	0.04	0.004
Molybdenum	0.016	n/a	n/a	1.5	0.3	0.05	0.02	**0.020**	n/a	n/a	n/a
Neodymium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Nickel	0.065	n/a	n/a	10	2.0	0.2	0.025	**0.0**	96	0.03	0.39
Niobium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Potassium	n/a	n/a	n/a	n/a	n/a	100	TBD[h]	**100**	100	1578	n/a
Praseodymium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Rubidium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Samarium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Scandium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Selenium	0.016	n/a	n/a	0.7	0.1	0.1	0.02	**0.0**	100	0.21	0.21
Silver	0.016	3000	600	4.6	0.9	0.02	0.006	**0.01**	5	0.05	0.037
Sodium	n/a	n/a	n/a	n/a	n/a	20	TBD[h]	**20**	100	350	n/a
Strontium	1.90	n/a	n/a	n/a	n/a	0.1	0.02	**0.020**	n/a	n/a	n/a
Tantalum	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Tellurium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Terbium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Thallium	0.00023	n/a	n/a	n/a	n/a	0.02	0.002	**0.00**	4	0.05	0.003
Thorium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Thulium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Tin	n/a	n/a	n/a	n/a	n/a	0.1	0.3	**0.30**	n/a	n/a	n/a
Titanium	n/a	n/a	n/a	n/a	n/a	0.2	0.1	**0.10**	n/a	n/a	n/a
Tungsten	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Uranium	0.0097	n/a	n/a	18	3.7	0.02	0.002	**0.0020**	80	0.0006	0.008
Vanadium	0.0032	2.04	0.4	0.8	0.2	0.2	0.07	**0.070**	36	0.08	0.04
Ytterbium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Yttrium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Zinc	0.97	1900	380	151	30	0.5	0.08	**0.08**	100	5.19	12.4
Zirconium	n/a	n/a	n/a	n/a	n/a	0.05	TBD[h]	**0.05**	n/a	n/a	n/a
Dioxins/Furans (ng/kg-wet weight)[i]											
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	0.00048	n/a	n/a	n/a	n/a	5	0.429	**5.0**	44	0.11	0.67
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	5	0.573	**5.0**	7	0.08	0.67
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	5	0.593	**5.0**	0	0.04	0.67
1,2,3,4,7,8-Hexachlorodibenzodioxin	0.00048	n/a	n/a	n/a	n/a	5	0.407	**5.0**	3	0.20	0.07
1,2,3,4,7,8-Hexachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	5	0.573	**5.0**	4	0.06	0.07
1,2,3,6,7,8-Hexachlorodibenzodioxin	0.00048	n/a	n/a	n/a	n/a	5	0.429	**5.0**	29	0.14	0.07
1,2,3,6,7,8-Hexachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	5	0.138	**5.0**	3	0.06	0.07
1,2,3,7,8,9-Hexachlorodibenzodioxin	0.00048	n/a	n/a	n/a	n/a	5	0.235	**5.0**	7	0.08	0.07

Table A2. Target Analyte List and Analytical Concentration Goals

	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
Dioxins/Furans (ng/kg-wet weight)[i] (continued)											
1,2,3,7,8,9-Hexachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	5	0.265	**5.0**	1	0.10	0.07
1,2,3,7,8-Pentachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	5	0.277	**5.0**	10	0.09	0.13
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.00048	n/a	n/a	n/a	n/a	5	0.319	**5.0**	13	0.13	0.01
2,3,4,6,7,8-Hexachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	5	0.313	**5.0**	2	0.06	0.07
2,3,4,7,8-Pentachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	5	0.261	**5.0**	9	0.13	0.01
2,3,7,8-Tetrachlorodibenzodioxin	0.00048	16.7 [j]	n/a	5.9	1.2	1	0.119	**1**	5	0.18	0.01
2,3,7,8-Tetrachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	1	0.113	**1**	93	0.36	0.01
Octachlorodibenzodioxin	0.00048	n/a	n/a	n/a	n/a	10	0.831	**10**	30	0.51	6
Octachlorodibenzofuran	0.00048	n/a	n/a	n/a	n/a	10	0.738	**10**	5	0.16	6
PCBs Congeners (ng/Kg-wet weight)[i, k]											
2-MoCB	n/a	n/a	n/a	n/a	n/a	80	8	**80**	n/a [n]	n/a [n]	60
3-MoCB	n/a	n/a	n/a	n/a	n/a	4	0.4	**4**	n/a [n]	n/a [n]	60
4-MoCB	n/a	n/a	n/a	n/a	n/a	80	9	**80**	n/a [n]	n/a [n]	60
2,2'-DiCB	n/a	n/a	n/a	n/a	n/a	200	17	**200**	n/a [n]	n/a [n]	60
2,3-DiCB	n/a	n/a	n/a	n/a	n/a	20	1	**20**	n/a [n]	n/a [n]	60
2,3'-DiCB	n/a	n/a	n/a	n/a	n/a	20	1	**20**	n/a [n]	n/a [n]	60
2,4-DiCB	n/a	n/a	n/a	n/a	n/a	20	2	**20**	n/a [n]	n/a [n]	60
2,4'-DiCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,5-DiCB	n/a	n/a	n/a	n/a	n/a	20	2	**20**	n/a [n]	n/a [n]	60
2,6-DiCB	n/a	n/a	n/a	n/a	n/a	20	2	**20**	n/a [n]	n/a [n]	60
3,3'-DiCB	n/a	n/a	n/a	n/a	n/a	400	10	**400**	n/a [n]	n/a [n]	60
3,4-DiCB+3,4'-DiCB	n/a	n/a	n/a	n/a	n/a	40	3	**40**	n/a [n]	n/a [n]	60
3,5-DiCB	n/a	n/a	n/a	n/a	n/a	40	3	**40**	n/a [n]	n/a [n]	60
4,4'-DiCB	n/a	n/a	n/a	n/a	n/a	200	18	**200**	n/a [n]	n/a [n]	60
2,2',3-TrCB	n/a	n/a	n/a	n/a	n/a	40	4	**40**	n/a [n]	n/a [n]	60
2,2',4-TrCB	n/a	n/a	n/a	n/a	n/a	80	9	**80**	n/a [n]	n/a [n]	60
2,2',5-TrCB+2,4,6-TrCB	n/a	n/a	n/a	n/a	n/a	200	20	**200**	n/a [n]	n/a [n]	60
2,2',6-TrCB	n/a	n/a	n/a	n/a	n/a	40	4	**40**	n/a [n]	n/a [n]	60
2,3,3'-TrCB+ 2,4,4'-TrCB	n/a	n/a	n/a	n/a	n/a	200	19	**200**	n/a [n]	n/a [n]	60
2,3,4-TrCB+2',3,4-TrCB	n/a	n/a	n/a	n/a	n/a	80	5	**80**	n/a [n]	n/a [n]	60
2,3,4'-TrCB	n/a	n/a	n/a	n/a	n/a	80	9	**80**	n/a [n]	n/a [n]	60
2,3,5-TrCB	n/a	n/a	n/a	n/a	n/a	80	5	**80**	n/a [n]	n/a [n]	60
2,3,6-TrCB	n/a	n/a	n/a	n/a	n/a	80	5	**80**	n/a [n]	n/a [n]	60
2,3',4-TrCB	n/a	n/a	n/a	n/a	n/a	80	5	**80**	n/a [n]	n/a [n]	60
2,3',5-TrCB+2,4,5-TrCB	n/a	n/a	n/a	n/a	n/a	80	8	**80**	n/a [n]	n/a [n]	60

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	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
PCBs Congeners (ng/Kg-wet weight) [i, k] (continued)											
2,3',6-TrCB	n/a	n/a	n/a	n/a	n/a	80	6	**80**	n/a [n]	n/a [n]	60
2,4',5-TrCB	n/a	n/a	n/a	n/a	n/a	200	15	**200**	n/a [n]	n/a [n]	60
2,4',6-TrCB	n/a	n/a	n/a	n/a	n/a	80	8	**80**	n/a [n]	n/a [n]	60
2',3,5-TrCB	n/a	n/a	n/a	n/a	n/a	80	7	**80**	n/a [n]	n/a [n]	60
3,3',4-TrCB	n/a	n/a	n/a	n/a	n/a	80	8	**80**	n/a [n]	n/a [n]	60
3,3',5-TrCB	n/a	n/a	n/a	n/a	n/a	80	8	**80**	n/a [n]	n/a [n]	60
3,4,4'-TrCB	n/a	n/a	n/a	n/a	n/a	200	13	**200**	n/a [n]	n/a [n]	60
3,4,5-TrCB	n/a	n/a	n/a	n/a	n/a	80	8	**80**	n/a [n]	n/a [n]	60
3,4',5-TrCB	n/a	n/a	n/a	n/a	n/a	80	9	**80**	n/a [n]	n/a [n]	60
2,2',3,4-TeCB+2,3',4',6-TeCB+2,2'.3,3'-TeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,2',3,4'-TeCB	n/a	n/a	n/a	n/a	n/a	80	6	**80**	n/a [n]	n/a [n]	60
2,2',3,5-TeCB+2,3',5',6-TeCB	n/a	n/a	n/a	n/a	n/a	200	9	**200**	n/a [n]	n/a [n]	60
2,2',3,5'-TeCB+2,2'3,4'-TeCB+2356-TeCB	n/a	n/a	n/a	n/a	n/a	200	19	**200**	n/a [n]	n/a [n]	60
2,2',3,6-TeCB+2,2'4,6'-TeCB	n/a	n/a	n/a	n/a	n/a	80	5	**80**	n/a [n]	n/a [n]	60
2,2',3,6'-TeCB	n/a	n/a	n/a	n/a	n/a	80	10	**80**	n/a [n]	n/a [n]	60
2,2',4,5-TeCB	n/a	n/a	n/a	n/a	n/a	80	8	**80**	n/a [n]	n/a [n]	60
2,2',4,5'-TeCB+2,3',4,6-TeCB	n/a	n/a	n/a	n/a	n/a	200	11	**200**	n/a [n]	n/a [n]	60
2,2',4,6-TeCB+2,2',5,6'-TeCB	n/a	n/a	n/a	n/a	n/a	80	6	**80**	n/a [n]	n/a [n]	60
2,2',5,5'-TeCB	n/a	n/a	n/a	n/a	n/a	200	19	**200**	n/a [n]	n/a [n]	60
2,2',6,6'-TeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,3,3',4-TeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,3,3',4'-TeCB	n/a	n/a	n/a	n/a	n/a	80	10	**80**	n/a [n]	n/a [n]	60
2,3,3',5-TeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,3,3',5'-TeCB	n/a	n/a	n/a	n/a	n/a	200	13	**200**	n/a [n]	n/a [n]	60
2,3,3',6-TeCB+2,3,4,6-TeCB+2,4,4',6-TeCB	n/a	n/a	n/a	n/a	n/a	80	6	**80**	n/a [n]	n/a [n]	60
2,3,4,4'-TeCB	n/a	n/a	n/a	n/a	n/a	200	13	**200**	n/a [n]	n/a [n]	60
2,3,4',5-TeCB	n/a	n/a	n/a	n/a	n/a	200	14	**200**	n/a [n]	n/a [n]	60
2,3,4',6-TeCB	n/a	n/a	n/a	n/a	n/a	80	7	**80**	n/a [n]	n/a [n]	60
2,3',4,4'-TeCB	n/a	n/a	n/a	n/a	n/a	200	16	**200**	n/a [n]	n/a [n]	60
2,3',4,5-TeCB	n/a	n/a	n/a	n/a	n/a	200	15	**200**	n/a [n]	n/a [n]	60
2,3',4,5'-TeCB	n/a	n/a	n/a	n/a	n/a	200	15	**200**	n/a [n]	n/a [n]	60
2,3',4',5-TeCB+2,3,4,5-TeCB+2,4,4',5-TeCB +2',3,4',5-TeCB	n/a	n/a	n/a	n/a	n/a	200	17	**200**	n/a [n]	n/a [n]	60
2,3',5,5'-TeCB	n/a	n/a	n/a	n/a	n/a	200	16	**200**	n/a [n]	n/a [n]	60

Table A2. Target Analyte List and Analytical Concentration Goals

	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
PCBs Congeners (ng/Kg-wet weight)[i, k] (continued)											
3,3',4,4'-TeCB	0.00048	n/a	n/a	n/a	n/a	200	17	**200**	n/a [n]	n/a [n]	60
3,3',4,5-TeCB	n/a	n/a	n/a	n/a	n/a	200	17	**200**	n/a [n]	n/a [n]	60
3,3',4,5'-TeCB	n/a	n/a	n/a	n/a	n/a	200	17	**200**	n/a [n]	n/a [n]	60
3,3',5,5'-TeCB	n/a	n/a	n/a	n/a	n/a	200	18	**200**	n/a [n]	n/a [n]	60
3,4,4',5-TeCB	0.00048	n/a	n/a	n/a	n/a	200	18	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4-PeCB	n/a	n/a	n/a	n/a	n/a	200	13	**200**	n/a [n]	n/a [n]	60
2,2',3,3',5-PeCB+2,2',4,4',5-PeCB	n/a	n/a	n/a	n/a	n/a	200	22	**200**	n/a [n]	n/a [n]	60
2,2',3,3',6-PeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,2',3,4,4'-PeCB+2,3,4,5,6-PeCB	n/a	n/a	n/a	n/a	n/a	80	10	**80**	n/a [n]	n/a [n]	60
2,2',3,4,5-PeCB+2,2',3,4,5'-PeCB +2,2',3',4,5-PeCB+2,3,3',4,5'-PeCB +2,3',4,4',6-PeCB+2',3,4,5,6'-PeCB	n/a	n/a	n/a	n/a	n/a	200	15	**200**	n/a [n]	n/a [n]	60
2,2',3,4,6-PeCB+2,2',3,4,6-PeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,2',3,4,6'-PeCB	n/a	n/a	n/a	n/a	n/a	200	19	**200**	n/a [n]	n/a [n]	60
2,2',3,4',5-PeCB+2,2',4,5,5'-PeCB +2,3,3',5',6-PeCB	n/a	n/a	n/a	n/a	n/a	400	24	**400**	n/a [n]	n/a [n]	60
2,2',3,5,5'-PeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,2',3,5,6-PeCB+2,2',4,4',6-PeCB	n/a	n/a	n/a	n/a	n/a	200	22	**200**	n/a [n]	n/a [n]	60
2,2',3,5,6'-PeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,2',3,5',6-PeCB	n/a	n/a	n/a	n/a	n/a	200	22	**200**	n/a [n]	n/a [n]	60
2,2',3,6,6'-PeCB	n/a	n/a	n/a	n/a	n/a	200	21	**200**	n/a [n]	n/a [n]	60
2,2',3',4,6-PeCB+2,2',4,5,6'-PeCB	n/a	n/a	n/a	n/a	n/a	200	22	**200**	n/a [n]	n/a [n]	60
2,2',4,5',6-PeCB	n/a	n/a	n/a	n/a	n/a	200	23	**200**	n/a [n]	n/a [n]	60
2,2',4,6,6'-PeCB	n/a	n/a	n/a	n/a	n/a	200	23	**200**	n/a [n]	n/a [n]	60
2,3,3'4,4'-PeCB	0.00048	n/a	n/a	n/a	n/a	80	11	**80**	n/a [n]	n/a [n]	60
2,3,3',4,5-PeCB	n/a	n/a	n/a	n/a	n/a	200	14	**200**	n/a [n]	n/a [n]	60
2,3,3',4',5-PeCB+2',3,4,5,5'-PeCB	n/a	n/a	n/a	n/a	n/a	400	27	**400**	n/a [n]	n/a [n]	60
2,3,3',4,6-PeCB	n/a	n/a	n/a	n/a	n/a	80	10	**80**	n/a [n]	n/a [n]	60
2,3,3',4',6-PeCB+2,3,4,4',6-PeCB	n/a	n/a	n/a	n/a	n/a	400	24	**400**	n/a [n]	n/a [n]	60
2,3,3',5,5'-PeCB	n/a	n/a	n/a	n/a	n/a	400	24	**400**	n/a [n]	n/a [n]	60
2,3,3',5,6-PeCB	n/a	n/a	n/a	n/a	n/a	400	25	**400**	n/a [n]	n/a [n]	60
2,3,4,4',5-PeCB	0.00048	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	13
2,3,4',5,6-PeCB	n/a	n/a	n/a	n/a	n/a	80	10	**80**	n/a [n]	n/a [n]	60
2,3',4,4',5-PeCB	0.00048	n/a	n/a	n/a	n/a	200	19	**200**	n/a [n]	n/a [n]	60
2,3',4,5,5'-PeCB	n/a	n/a	n/a	n/a	n/a	200	15	**200**	n/a [n]	n/a [n]	60

Table A2. Target Analyte List and Analytical Concentration Goals

	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
PCBs Congeners (ng/Kg-wet weight) [i, k] (continued)											
2,3',4,5,6-PeCB	n/a	n/a	n/a	n/a	n/a	200	21	**200**	n/a [n]	n/a [n]	60
2',3,3',4,5-PeCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2',3,4,4',5-PeCB	0.00048	n/a	n/a	n/a	n/a	200	15	**200**	n/a [n]	n/a [n]	60
3,3',4,4',5-PeCB	0.00048	n/a	n/a	n/a	n/a	200	14	**200**	n/a [n]	n/a [n]	0.067
3,3',4,5,5'-PeCB	n/a	n/a	n/a	n/a	n/a	400	28	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,4'-HxCB+2,3,4,4',5,6-HxCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4,5-HxCB+2,2',3,4,4',5'-HxCB +2.3.3'4',5,6-HxCB	n/a	n/a	n/a	n/a	n/a	200	21	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4,5'-HxCB	n/a	n/a	n/a	n/a	n/a	200	14	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4,6-HxCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4,6'-HxCB	n/a	n/a	n/a	n/a	n/a	200	12	**200**	n/a [n]	n/a [n]	60
2,2',3,3',5,5'-HxCB	n/a	n/a	n/a	n/a	n/a	200	17	**200**	n/a [n]	n/a [n]	60
2,2',3,3',5,6-HxCB	n/a	n/a	n/a	n/a	n/a	200	13	**200**	n/a [n]	n/a [n]	60
2,2',3,3',5,6'-HxCB+2,2',3,5,5',6-HxCB	n/a	n/a	n/a	n/a	n/a	200	11	**200**	n/a [n]	n/a [n]	60
2,2',3,3',6,6'-HxCB	n/a	n/a	n/a	n/a	n/a	80	9	**80**	n/a [n]	n/a [n]	60
2,2',3,4,4',5-HxCB	n/a	n/a	n/a	n/a	n/a	400	30	**400**	n/a [n]	n/a [n]	60
2,2',3,4,4',6-HxCB+2,2',3,4,4',6-HxCB	n/a	n/a	n/a	n/a	n/a	200	20	**200**	n/a [n]	n/a [n]	60
2,2',3,4,5,5'-HxCB	n/a	n/a	n/a	n/a	n/a	80	9	**80**	n/a [n]	n/a [n]	60
2,2',3,4,5,6-HxCB	n/a	n/a	n/a	n/a	n/a	400	31	**400**	n/a [n]	n/a [n]	60
2,2',3,4,5,6'-HxCB	n/a	n/a	n/a	n/a	n/a	200	13	**200**	n/a [n]	n/a [n]	60
2,2',3,4,5',6-HxCB	n/a	n/a	n/a	n/a	n/a	200	17	**200**	n/a [n]	n/a [n]	60
2,2',3,4,6,6'-HxCB	n/a	n/a	n/a	n/a	n/a	400	32	**400**	n/a [n]	n/a [n]	60
2,2',3,4',5,5'-HxCB	n/a	n/a	n/a	n/a	n/a	200	18	**200**	n/a [n]	n/a [n]	60
2,2',3,4',5,6-HxCB+2,2',3,4',5,6-HxCB	n/a	n/a	n/a	n/a	n/a	200	18	**200**	n/a [n]	n/a [n]	60
2,2',3,4',5,6'-HxCB	n/a	n/a	n/a	n/a	n/a	400	32	**400**	n/a [n]	n/a [n]	60
2,2',3,4',6,6'-HxCB	n/a	n/a	n/a	n/a	n/a	400	33	**400**	n/a [n]	n/a [n]	60
2,2',3,5,6,6'-HxCB	n/a	n/a	n/a	n/a	n/a	400	24	**400**	n/a [n]	n/a [n]	60
2,2',4,4',5,5'-HxCB+2,3',4,4',5',6-HxCB	n/a	n/a	n/a	n/a	n/a	200	13	**200**	n/a [n]	n/a [n]	60
2,2',4,4',5',6-HxCB	n/a	n/a	n/a	n/a	n/a	200	11	**200**	n/a [n]	n/a [n]	60
2,2',4,4',6,6'-HxCB	n/a	n/a	n/a	n/a	n/a	400	34	**400**	n/a [n]	n/a [n]	60
2,3,3',4,4',5-HxCB+2,3,3',4,4',5'-HxCB	0.00048	n/a	n/a	n/a	n/a	200	13	**200**	n/a [n]	n/a [n]	13
2,3,3',4,4',6-HxCB	n/a	n/a	n/a	n/a	n/a	80	10	**80**	n/a [n]	n/a [n]	60
2,3,3',4,5,5'-HxCB	n/a	n/a	n/a	n/a	n/a	400	35	**400**	n/a [n]	n/a [n]	60
2,3,3',4,5,6-HxCB	n/a	n/a	n/a	n/a	n/a	200	21	**200**	n/a [n]	n/a [n]	60

Table A2. Target Analyte List and Analytical Concentration Goals

	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
PCBs Congeners (ng/Kg-wet weight)[i, k] (continued)											
2,3,3',4,5',6-HxCB	n/a	n/a	n/a	n/a	n/a	400	35	**400**	n/a [n]	n/a [n]	60
2,3,3',4',5,5'-HxCB	n/a	n/a	n/a	n/a	n/a	400	35	**400**	n/a [n]	n/a [n]	60
2,3,3',4',5',6-HxCB	n/a	n/a	n/a	n/a	n/a	400	14	**400**	n/a [n]	n/a [n]	60
2,3,3',5,5',6-HxCB	n/a	n/a	n/a	n/a	n/a	400	36	**400**	n/a [n]	n/a [n]	60
2,3',4,4',5,5'-HxCB	0.00048	n/a	n/a	n/a	n/a	200	11	**200**	n/a [n]	n/a [n]	60
3,3',4,4',5,5'-HxCB	0.00048	n/a	n/a	n/a	n/a	200	16	**200**	n/a [n]	n/a [n]	0.67
2,2',3,3',4,4',5-HpCB	n/a	n/a	n/a	n/a	n/a	200	16	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4,4',6-HpCB+2,2',3,3',4,4',6-HpCB	n/a	n/a	n/a	n/a	n/a	400	37	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,5,5'-HpCB	n/a	n/a	n/a	n/a	n/a	400	38	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,5,6'-HpCB	n/a	n/a	n/a	n/a	n/a	200	19	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4,5',6-HpCB	n/a	n/a	n/a	n/a	n/a	400	38	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,6,6'-HpCB	n/a	n/a	n/a	n/a	n/a	400	39	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4',5,6-HpCB	n/a	n/a	n/a	n/a	n/a	200	14	**200**	n/a [n]	n/a [n]	60
2,2',3,3',5,5',6-HpCB	n/a	n/a	n/a	n/a	n/a	200	22	**200**	n/a [n]	n/a [n]	60
2,2',3,3',5,6,6'-HpCB	n/a	n/a	n/a	n/a	n/a	200	23	**200**	n/a [n]	n/a [n]	60
2,2',3,4,4',5,5'-HpCB+2,3,3'4',5,5',6-HpCB	n/a	n/a	n/a	n/a	n/a	200	14	**200**	n/a [n]	n/a [n]	60
2,2',3,4,4',5,6-HpCB	n/a	n/a	n/a	n/a	n/a	400	40	**400**	n/a [n]	n/a [n]	60
2,2',3,4,4',5,6'-HpCB	n/a	n/a	n/a	n/a	n/a	400	40	**400**	n/a [n]	n/a [n]	60
2,2',3,4,4',5',6-HpCB	n/a	n/a	n/a	n/a	n/a	400	40	**400**	n/a [n]	n/a [n]	60
2,2',3,4,4',6,6'-HpCB	n/a	n/a	n/a	n/a	n/a	400	40	**400**	n/a [n]	n/a [n]	60
2,2',3,4,5,5',6-HpCB	n/a	n/a	n/a	n/a	n/a	400	40	**400**	n/a [n]	n/a [n]	60
2,2',3,4,5,6,6'-HpCB	n/a	n/a	n/a	n/a	n/a	400	41	**400**	n/a [n]	n/a [n]	60
2,2',3,4,5,5',6-HpCB	n/a	n/a	n/a	n/a	n/a	200	19	**200**	n/a [n]	n/a [n]	60
2,2',3,4',5,6,6'-HpCB	n/a	n/a	n/a	n/a	n/a	200	23	**200**	n/a [n]	n/a [n]	60
2,3,3',4,4',5,5'-HpCB	0.00048	n/a	n/a	n/a	n/a	200	18	**200**	n/a [n]	n/a [n]	60
2,3,3',4,4',5,6-HpCB	n/a	n/a	n/a	n/a	n/a	200	23	**200**	n/a [n]	n/a [n]	60
2,3,3',4,4',5',6-HpCB	n/a	n/a	n/a	n/a	n/a	400	42	**400**	n/a [n]	n/a [n]	60
2,3,3',4,5,5',6-HpCB	n/a	n/a	n/a	n/a	n/a	400	42	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,4',5,5'-OcCB	n/a	n/a	n/a	n/a	n/a	200	17	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4,4',5,6-OcCB	n/a	n/a	n/a	n/a	n/a	400	43	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,4',5,6'-OcCB	n/a	n/a	n/a	n/a	n/a	400	43	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,4',6,6'-OcCB	n/a	n/a	n/a	n/a	n/a	400	25	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,5,5',6-OcCB+2,2',3,3',4,5,5',6'-OcCB	n/a	n/a	n/a	n/a	n/a	200	20	**200**	n/a [n]	n/a [n]	60
2,2',3,3',4,5,6,6'-OcCB	n/a	n/a	n/a	n/a	n/a	400	25	**400**	n/a [n]	n/a [n]	60

Table A2. Target Analyte List and Analytical Concentration Goals

	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
PCBs Congeners (ng/Kg-wet weight) [i, k] (continued)											
2,2',3,3',4,5',6,6'-OcCB	n/a	n/a	n/a	n/a	n/a	400	44	**400**	n/a [n]	n/a [n]	60
2,2',3,3',5,5',6,6'-OcCB	n/a	n/a	n/a	n/a	n/a	400	44	**400**	n/a [n]	n/a [n]	60
2,2',3,4,4',5,5',6-OcCB	n/a	n/a	n/a	n/a	n/a	400	44	**400**	n/a [n]	n/a [n]	60
2,2',3,4,4',5,6,6'-OcCB	n/a	n/a	n/a	n/a	n/a	400	45	**400**	n/a [n]	n/a [n]	60
2,3,3',4,4',5,5',6-OcCB	n/a	n/a	n/a	n/a	n/a	400	45	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,4',5,5',6-NoCB	n/a	n/a	n/a	n/a	n/a	400	45	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,4',5,6,6'-NoCB	n/a	n/a	n/a	n/a	n/a	400	45	**400**	n/a [n]	n/a [n]	60
2,2',3,3',4,5,5',6,6'-NoCB	n/a	n/a	n/a	n/a	n/a	400	46	**400**	n/a [n]	n/a [n]	60
DeCB	n/a	n/a	n/a	n/a	n/a	200	15	**200**	n/a [n]	n/a [n]	60
PAHs (µg/kg-wet weight)											
2-Methylnaphthalene	13	n/a	n/a	17641	3,528	1	0.44	**0.44**	n/a	n/a	n/a
Acenaphthene	190	n/a	n/a	n/a	n/a	0.5	0.11	**0.11**	n/a	n/a	n/a
Acenaphthylene	n/a	n/a	n/a	n/a	n/a	0.5	0.069	**0.069**	n/a	n/a	n/a
Anthracene	970	n/a	n/a	n/a	n/a	0.5	0.065	**0.065**	n/a	n/a	n/a
Benzo(a)anthracene	0.05	n/a	n/a	n/a	n/a	0.5	0.066	**0.066**	n/a	n/a	n/a
Benzo(a)pyrene	0.005	n/a	n/a	321	64	0.5	0.081	**0.081**	n/a	n/a	n/a
Benzo(b)fluoranthene	0.05	n/a	n/a	n/a	n/a	0.5	0.07	**0.07**	n/a	n/a	n/a
Benzo(ghi)perylene	n/a	n/a	n/a	n/a	n/a	0.5	0.073	**0.073**	n/a	n/a	n/a
Benzo(k)fluoranthene	0.5	n/a	n/a	n/a	n/a	0.5	0.056	**0.056**	n/a	n/a	n/a
Chrysene	5	n/a	n/a	n/a	n/a	0.5	0.076	**0.076**	n/a	n/a	n/a
Dibenzo(a,h)anthracene	0.005	n/a	n/a	n/a	n/a	0.5	0.059	**0.059**	n/a	n/a	n/a
Fluoranthene	130	n/a	n/a	n/a	n/a	0.5	0.09	**0.09**	n/a	n/a	n/a
Fluorene	130	n/a	n/a	n/a	n/a	0.5	0.15	**0.15**	n/a	n/a	n/a
Indeno[1,2,3-cd]pyrene	0.05	n/a	n/a	n/a	n/a	0.5	0.064	**0.064**	n/a	n/a	n/a
Naphthalene	65	n/a	n/a	n/a	n/a	1	0.4	**0.4**	n/a	n/a	n/a
Phenanthrene	n/a	n/a	n/a	n/a	n/a	0.5	0.36	**0.36**	n/a	n/a	n/a
Pyrene	97	n/a	n/a	n/a	n/a	0.5	0.098	**0.098**	n/a	n/a	n/a
Polybrominated Diphenylethers (PBDEs) (ng/kg-wet weight) [i, l]											
2,2',4-TriBDE (BDE-17)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a
2,4,4'-TriBDE (BDE-28)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a
2,2',4,4'-TetraBDE (BDE-47)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a
2,2',4,5'-TetraBDE (BDE-49)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a
2,3',4,4'-TetraBDE (BDE-66)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a
2,3',4',6-TetraBDE (BDE-71)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a
2,2',3,4,4'-PentaBDE (BDE-85)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a
2,2',4,4',5-PentaBDE (BDE-99)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a
2,2',4,4',6-PentaBDE (BDE-100)	n/a	n/a	n/a	n/a	n/a	2	TBD [h]	**2**	n/a	n/a	n/a

Table A2. Target Analyte List and Analytical Concentration Goals

	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
Analyte	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
Polybrominated Diphenylethers (PBDEs) (ng/kg-wet weight) [i, l] (continued)											
2,2',3,3',4,4'-HexaBDE (BDE-128)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,2',3,4,4',5'-HexaBDE (BDE-138)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,2',4,4',5,5'-HexaBDE (BDE-153)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,2',4,4',5,6'-HexaBDE (BDE-154)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,2',3,4,4',5',6-HeptaBDE (BDE-183)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,2',3,4,4',6,6'-HeptaBDE (BDE-184)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,3,3',4,4',5,6-HeptaBDE (BDE-190)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,3,3',4,4',5',6-HeptaBDE (BDE-191)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,2',3,4,4',5,5',6-OctaBDE (BDE-203)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
2,2',3,3',4,4',5,5',6-NonaBDE (BDE-206)	n/a	n/a	n/a	n/a	n/a	2	TBD[h]	**2**	n/a	n/a	n/a
Decabromodiphenyl ether (BDE-209)	n/a	n/a	n/a	n/a	n/a	20	TBD[h]	**20**	n/a	n/a	n/a
Pesticides (µg/kg-wet weight)											
2,4'-DDD	0.3	n/a	n/a	n/a	n/a	1	0.38	**0.38**	n/a	n/a	n/a
4,4'-DDD	0.3	n/a	n/a	n/a	n/a	1	0.11	**0.11**	n/a	n/a	n/a
2,4'-DDE	0.21	n/a	n/a	n/a	n/a	1	0.21	**0.21**	n/a	n/a	n/a
4,4'-DDE	0.21	n/a	n/a	n/a	n/a	1	0.16	**0.16**	n/a	n/a	n/a
2,4'-DDT	0.21	n/a	n/a	n/a	n/a	1	0.21	**0.21**	n/a	n/a	n/a
4,4'-DDT	0.21	n/a	n/a	n/a	n/a	1	0.43	**0.43**	n/a	n/a	n/a
Total DDT	n/a	608 [m]	n/a	520	104	1	n/a	**1**	n/a	n/a	n/a
Aldrin	0.0042	n/a	n/a	n/a	n/a	1	0.23	**0.23**	n/a	n/a	n/a
delta-BHC	n/a	n/a	n/a	n/a	n/a	1	0.16	**0.16**	n/a	n/a	n/a
alpha-Chlordane (cis-)	0.21	n/a	n/a	n/a	n/a	1	0.15	**0.15**	n/a	n/a	n/a
gamma-Chlordane (trans-)	0.21	n/a	n/a	n/a	n/a	1	0.26	**0.26**	n/a	n/a	n/a
cis-Nonachlor	n/a	n/a	n/a	n/a	n/a	1	0.19	**0.19**	n/a	n/a	n/a
trans-Nonachlor	n/a	n/a	n/a	n/a	n/a	1	0.14	**0.14**	n/a	n/a	n/a
Oxychlordane	n/a	n/a	n/a	n/a	n/a	1	0.19	**0.19**	n/a	n/a	n/a
Total Chlordane	n/a	n/a	n/a	4903	981	1	n/a	**1**	n/a	n/a	n/a
Dieldrin	0.0045	120	24	n/a	n/a	1	0.25	**0.25**	n/a	n/a	n/a
Endrin	0.97	1.2	0.24	n/a	n/a	1	0.22	**0.22**	n/a	n/a	n/a
Endrin aldehyde	n/a	n/a	n/a	n/a	n/a	1	0.25	**0.25**	n/a	n/a	n/a
Endrin ketone	n/a	n/a	n/a	n/a	n/a	1	0.28	**0.28**	n/a	n/a	n/a
Heptachlor	0.016	n/a	n/a	n/a	n/a	1	0.66	**0.66**	n/a	n/a	n/a
Heptachlor epoxide	0.0079	80	16	n/a	n/a	1	0.38	**0.38**	n/a	n/a	n/a
Hexachlorobenzene	0.045	468,000	93,600	n/a	n/a	1	0.31	**0.31**	n/a	n/a	n/a
Hexachlorobutadiene	0.93	n/a	n/a	n/a	n/a	1	0.13	**0.13**	n/a	n/a	n/a
Methoxychlor	16	n/a	n/a	n/a	n/a	1	1	**1**	n/a	n/a	n/a
Toxaphene	0.066	n/a	n/a	n/a	n/a	50	21	**21**	n/a	n/a	n/a

Table A2. Target Analyte List and Analytical Concentration Goals

Analyte	Risk Based Concentrations (RBCs)					Laboratory			EPA 2005 Tissue Results		
	Human Health [a]	Fish [b]	Fish RBC/5	Piscivorous Wildlife [c]	Wildlife RBC/5	MRL [d]	MDL [d]	**2009 ACGs [e]**	FOD (%) [f]	Minimum Measured Concentration	2005 ACGs [g]
SVOCs (µg/kg-wet weight)											
1,1'-Biphenyl	160	n/a	n/a	n/a	n/a	0.5	0.17	**0.17**	n/a	n/a	n/a
1,2,4-Trichlorobenzene	32	n/a	n/a	n/a	n/a	40	4.2	**4.2**	n/a	n/a	n/a
4-Bromophenyl-phenylether	n/a	n/a	n/a	n/a	n/a	40	4.1	**4.1**	n/a	n/a	n/a
4-Chlorophenyl-phenyl ether	n/a	n/a	n/a	n/a	n/a	40	3.0	**3.0**	n/a	n/a	n/a
bis(2-Ethylhexyl)phthalate	5.2	n/a	n/a	2520	504	200	66	**66**	n/a	n/a	n/a
Butyl benzyl phthalate	650	n/a	n/a	n/a	n/a	40	7.3	**7.3**	n/a	n/a	n/a
Dibenzofuran	3.2	n/a	n/a	n/a	n/a	40	2.6	**2.6**	n/a	n/a	n/a
Di-n-butyl phthalate	320	n/a	n/a	252	50	100	100	**100**	n/a	n/a	n/a
Di-n-octylphthalate	n/a	n/a	n/a	n/a	n/a	40	11	**11**	n/a	n/a	n/a
Hexachlorocyclopentadiene	19	n/a	n/a	n/a	n/a	1000	330	**330**	n/a	n/a	n/a
Hexachloroethane	3.2	n/a	n/a	n/a	n/a	40	12	**12**	n/a	n/a	n/a
Pentachlorophenol	0.6	n/a	n/a	15419	3,084	5	0.4	**0.4**	n/a	n/a	n/a

Notes:

RBC - Risk-based concentration

ACG - Analytical Concentration Goals

n/a - Not available

MRL - Method reporting limit

TBD - To be determined

[a] Lowest Fish RBCs for Human Health provided by EPA, Region 10 (see Appendix E).

[b] Fish RBCs for metals are listed as dry weight no-observed-adverse-effects-concentrations in food of fish. For organics, concentrations are provided as wet weight concentrations in whole fish. Source: Windward (2004), except where noted

[c] Wildlife RBCs derived from the exposure factors and TRVs provided in the draft SLERA (TCAI 2008). Additional TRVs identified from Sample et al. (1996). Wildlife RBCs represent the lowest concentration for piscivorous wildlife (great blue heron, osprey, belted kingfisher, mink, and otter) using the following equation:

Wildlife RBC (mg/kg-ww) = (TRV x BW) / (FIR)

Where: TRV - Toxicity reference value (mg/kg-day)
BW - Body weight (kg)
FIR - Food ingestion rate (kg/d-wet)

[d] MRLs and MDLs obtained from Columbia Analytical Services (CAS). Metals MDLs/MRLs are on a dry weight basis, the rest are wet weight.

[e] ACGs represent the lowest RBC value for human health or 1/5th of the fish or wildlife RBCs. If the RBC is lower than the MRL, than the MRL will be used as the ACG. The lowest RBC or MRL is highlighted.

[f] Frequency of detection (FOD) for all tissue types and species collected in 2005 by EPA.

[g] 2005 ACGs represent the analytical goals of the 2005 EPA Phase 1 fish collection study, shown for informational purposes.

[h] The MDL for these analytes have not been completed at this time. The MRL may be adjusted based on the calculated MDL.

[i] These analytes will be reported to an estimated detection limit (EDL). The EDL is sample and analyte specific and is based on the signal and noise on the instrument.

[j] Concentration is for whole fish, and is considered protective of 95 percent of fish species (Steevens et al 2005). Converted from lipid to wet weight assuming 5 percent lipid.

[k] The values listed in the MDL column for the PCB Congener analytes represent the average of the EDLs for four method blanks and are not MDLs.

[l] Capability to analyze tissues for all of these BDE congeners is uncertain, and will depend on the selected laboratory.

[m] Jarvinen et al. (1977).

[n] See USEPA 2007a

Table A3. Proposed Sample Sizes for the 2009 Fish Tissue Sampling

Species	Number of Composite Samples [a]					
	FSCA 1	FSCA 2	FSCA 3	FSCA 4	FSCA 5	FSCA 6
<15 cm Size Class						
Species-specific composites [b]	6 WB	6 WB	6 WB	6 WB	6 WB	6 WB
≥15-≤30 cm Size Class						
Species-specific composites [c]	6 WB	6 WB	6 WB	6 WB	6 WB	6 WB
>30 cm Size Class						
Walleye	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Smallmouth bass	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Burbot	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Largescale sucker	6F & 6R*	6F & 6R*	6F & 6R*	6F & 6R*	6F & 6R*	6F & 6R*
Lake Whitefish	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Rainbow trout	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Kokanee	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Total=	96	96	96	96	96	96

Notes:

FSCA - Fish Sampling Collection Area

WB – Whole body

F – Fillet

R - Remaining tissue after filleting

* - Largescale suckers will have the gut contents removed prior to analysis of the remainder

[a] One well-homogenized composite sample for each tissue type from each species will be used to produce triplicate samples for quality assurance of the homogenization.

[b] At least one composite will be formed for each of the three general feeding guilds: benthic, invertivorous, and omnivorous fish.

[c] At least one composite will be formed for each of the three general feeding guilds: benthic, omnivorous, and piscivorous fish.

Table A4. Proposed Analyses for the 2009 Fish Tissue Sampling for all FSCAs

	Number of Composite Samples												
Species	TAL Metals/ Metalloids	All Metals/ Metalloids	Total Mercury Analysis on Individual Fillets [a]	Inorganic Arsenic [b]	Dioxins/Furans (17 congeners)	PCBs (209 Congeners), including 12 Dioxin-like congeners	PAHs	Chlorinated Pesticides	PBDEs	SVOCs	Total Length and Weight	% Lipids	% Moisture
<15 cm Size Class													
Whole body composites [c]	36	12	0	0	36	36	12	12	12	12	36	36	36
≥ 15 – ≤ 30 cm Size Class													
Whole body composites [d]	36	12	0	0	36	36	12	12	12	12	36	36	36
>30 cm Size Class													
Walleye													
(Fillet)	36	12	180	12	36	36	12	12	12	12	36	36	36
(Remainder)	36	12	0	0	36	36	12	12	12	12	36	36	36
Smallmouth Bass													
(Fillet)	36	12	180	12	36	36	12	12	12	12	36	36	36
(Remainder)	36	12	0	0	36	36	12	12	12	12	36	36	36
Burbot													
(Fillet)	36	12	0	36	36	36	12	12	12	12	36	36	36
(Remainder)	36	12	0	0	36	36	12	12	12	12	36	36	36
Largescale Sucker													
(Fillet)	36	12	0	12	36	36	12	12	12	12	36	36	36
(Remainder, w/out gut contents)	36	12	0	0	36	36	12	12	12	12	36	36	36
Lake Whitefish													
(Fillet)	36	12	0	12	36	36	12	12	12	12	36	36	36
(Remainder)	36	12	0	0	36	36	12	12	12	12	36	36	36
Rainbow Trout													
(Fillet)	36	12	0	12	36	36	12	12	12	12	36	36	36
(Remainder)	36	12	0	0	36	36	12	12	12	12	36	36	36
Kokanee													
(Fillet)	36	12	0	12	36	36	12	12	12	12	36	36	36
(Remainder)	36	12	0	0	36	36	12	12	12	12	36	36	36
Total =	576	192	360	108	576	576	192	192	192	192	576	576	576

Notes:

See Table A2 for individual analytes included in each analysis.

PAHs - polycyclic aromatic hydrocarbons

PCBs - polychlorinated biphenyls

PBDEs - polybrominated diphenylethers

SVOCs - semivolatile organic compounds

TAL - Target analyte list for metals.

[a] Additional total mercury analyses will be done on individual fillets from any captured walleye or smallmouth bass >30 cm, even after sufficient number are collected for creating required composites

[b] Inorganic arsenic analysis is important for human health assessments, therefore speciation is limited to large-sized fish that are likely to be consumed by people.

[c] At least one composite will be formed for each of the three general feeding guilds: benthic, invertivorous, and omnivorous fish.

[d] At least one composite will be formed for each of the three general feeding guilds: benthic, omnivorous, and piscivorous fish.

ATTACHMENT A1

GENERAL SITE HEALTH AND SAFETY PLAN ADDENDUM

GENERAL SITE HEALTH AND SAFETY PLAN

ADDENDUM 3
2009 FISH TISSUE STUDY

UPPER COLUMBIA RIVER RI/FS

Prepared for

Teck American Incorporated

P.O. Box 3087
Spokane, WA 99220-3087

Prepared by

Parametrix

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Bellevue, WA 98004

integral consulting inc.

7900 SE 28th Street, Suite 410
Mercer Island, WA 98040

September 2009

CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
COI	chemical of interest
CRZ	contamination reduction zone
DGPS	differential global positioning system
FSCAs	fish sample collection areas
HAZWOPER	hazardous waste operations and emergency response
Integral	Integral Consulting Inc.
OSHA	Occupational Safety and Health Administration
PFD	personal flotation device
PPE	personal protective equipment
RI/FS	remedial investigation and feasibility study
RM	river mile
SHSP	site health and safety plan
Site	Upper Columbia River site
TAI	Teck American Incorporated
UCR	Upper Columbia River
WISHA	Washington Industrial Safety and Health Act

SITE HEALTH AND SAFETY PLAN ADDENDUM APPROVAL

Addendum 3 to the general site health and safety plan (SHSP) has been reviewed and approved by Teck American Incorporated's (TAI) technical consultants (Integral Consulting Inc. [Integral]) and Parametrix for the 2009 fish tissue study at the Upper Columbia River (UCR) site (Site) in support of the remedial investigation and feasibility study (RI/FS) for the Site.

Integral Project Manager	Date 9/17/09
Integral Corporate Health and Safety Officer	Date 9/22/09
Parametrix Project Manager	Date 9/16/09
Parametrix Corporate Health and Safety Officer	Date 9/22/09

SITE HEALTH AND SAFETY PLAN ADDENDUM ACKNOWLEDGEMENT

Addendum 3 to the general SHSP (TCAI 2007) is approved by Integral and Parametrix for use at the Site. The general SHSP and Addendum 3 are the minimum health and safety standard for the Site and will be strictly enforced for all personnel conducting fish sampling activities at the Site. Subcontracted personnel may request to adopt Addendum 3 to the general SHSP in lieu of a subcontractor-specific plan, but must obtain prior written approval and provide written concurrence from the subcontractor that the subcontractor will assume direct responsibility and liability for administering the plan for its employees.

I have reviewed Addendum 3, dated August 7, 2009, to the general SHSP for the Site 2009 fish tissue study. I have had an opportunity to ask any questions I may have and have been provided with satisfactory responses. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines.

Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
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1 INTRODUCTION

Addendum 3 to the UCR RI/FS general SHSP provides specific Site information and health and safety provisions to protect workers from potential hazards during fish tissue sampling at locations along the UCR.

Site background information and general health and safety provisions to protect workers from potential hazards during work at the Site are presented in the general SHSP.

Subcontractors that are contracted to perform fieldwork associated with the RI/FS may adopt this SHSP or develop and follow their own SHSPs. However, subcontractor SHSPs must be consistent with the provisions outlined in Addendum 3 and the general SHSP, and any discrepancies will follow the most protective practices.

It is Parametrix's and Integral's policy to provide a safe and healthful work environment. No aspect of the work is more important than protecting the health and safety of all workers.

Parametrix and Integral cannot guarantee the health or safety of any person entering the Site. Because of the potentially hazardous nature of the Site and the activity occurring thereon, it is not possible to regulate personal diligence or to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at the Site. The health and safety guidelines in this plan were prepared specifically for the Site and should not be used on any other site without prior evaluation by trained health and safety personnel.

A copy of Addendum 3 and the general SHSP must be in the custody of the field crew during field activities. All individuals performing field work must read, understand, and comply with this plan before undertaking field activities. Once the information has been read and understood, the individual must sign the Site Health and Safety Acknowledgment Form provided with this addendum to the general plan. Any changes to the plan will be written in the plan and initialed by all potentially affected field personnel. The signed form and any initialed changes will become part of the project file. Copies will also be provided to TAI.

Addendum 3 may be modified at any time based on the judgment of site safety officer in consultation with the corporate health and safety officer and project manager or designee. Any modification will be presented to the onsite team during a safety briefing and will be recorded in the field notebook.

1.1 ORGANIZATION

Task-specific safety procedures associated with fish tissue sampling are presented in this addendum to the general SHSP. In addition, this addendum provides detailed field site and hospital location maps, air monitoring requirements, specific requirements for personal protective equipment (PPE), work zone definitions, and key emergency contact information

The general SHSP provides background site information and general health and safety provisions to protect workers from potential hazards during field activities. The information includes general safety guidelines for physical hazards, a chemical hazard evaluation, health and safety training requirements, general PPE requirements, emergency planning, general decontamination procedures, vehicle and boating safety, spill containment, and shipping instructions.

1.2 SCOPE OF WORK

Fish tissue samples will be collected within the six river reaches of the UCR (Figure 1-1). The fish tissue sampling locations are as follows:

- Reach 1 (U.S.-Canadian Border at river mile [RM] 745 to RM 730)—riverine
- Reach 2 (RM 730 to RM 712)—transitional (riverine to lacustrine)
- Reach 3 (RM 712 to RM 700)—Marcus Flats [transitional (riverine to lacustrine)]
- Reach 4 (RM 700 to RM 640), further subdivided into Reaches 4a and 4b, with the boundary occurring at RM 676—lacustrine
- Reach 5 (RM 640 to RM 617)—lacustrine
- Reach 6 (RM 617 to Grand Coulee Dam near RM 597)—lacustrine.

Access to all of the fish sample collection areas (FSCAs) will require the use of a boat. The coordinates of each fish sample station location will be surveyed using a differential global positioning system (DGPS) unit.

1.3 DEFINITIONS

Contamination reduction zone:	Area between the exclusion and support zones that provides a transition between contaminated and clean zones.
Exclusion zone:	Any area of the Site where hazardous substances are present, or are reasonably suspected to be present, and pose an exposure hazard to personnel.

HAZWOPER:	Hazardous Waste Operations and Emergency Response standard, as described in 29 CFR Part 1910.120.
OSHA:	Occupational Safety and Health Administration.
Support zone:	Any area of the site, so designated, that is outside the exclusion and contamination reduction zones.
WISHA:	Washington Industrial Safety and Health Act, as described in Chapter 49.17 Revised Code of Washington.
WADOSH:	Washington Department of Occupational Safety and Health.

2 SAFETY GUIDELINES FOR PHYSICAL HAZARDS

All work will be done using the buddy system. Depending upon the time of year and the location of work, snakes, cougars (mountain lions), and insects or other animals may be an issue when accessing the sampling vessel and at off-shore sample processing stations during the 2009 sampling event. Drowning and hypothermia are always concerns when working on the water, so it is required that personnel participating in fish tissue sample collection must wear personal flotation devices (PFDs).

Table 2-1 summarizes potential physical hazards posed by proposed site activities.

Table 2-1. Summary of Activities and Potential Hazards

Activity	Potential Hazard
Fish Tissue Sampling	Uneven terrain/tripping, slippery walking surfaces, cold/hypothermia (depending on sampling event), heat stress (depending on sampling event), material handling, adverse weather, work in remote areas, plant and animal hazards, drowning.

Table 2-2 presents possible physical hazards that are expected to be present during fish tissue sampling activities and safety procedures to mitigate the possible hazards.

Table 2-2. Possible Physical Hazards and Proposed Safety Procedures

Possible Hazard	Yes	No	Proposed Safety Procedure
Uneven terrain/tripping, slippery walking surfaces	X		Use caution; wear properly fitting shoes or boots with good gripping capacity and ankle support; keep work area orderly
Cold/hypothermia	X		Keep warm and dry, bring changes of clothes; do not work in extreme conditions without proper equipment and training; follow cold stress information (Attachment A1-1); potential for cold/hypothermia will depend on season
Heat stress	X		Provide at least 1 quart of potable water per person per day, labeled "potable" and if provided in thermos, labeled with the date last cleaned. Drink water frequently in hot weather; take work breaks; follow the heat-related illness policy (Attachment A1-2); potential for heat stress will depend on season
Material handling	X		Use the buddy system to lift coolers and items potentially weighing more than 25 pounds or items that are cumbersome to handle. Lift properly; do not overfill coolers or boxes
Adverse weather	X		Seek shelter during electrical storms; work in adverse weather conditions (rain, high wind, or high river velocities) only with proper training, clothing, and equipment.

Table 2-2. Possible Physical Hazards and Proposed Safety Procedures (continued)

Possible Hazard	Yes	No	Proposed Safety Procedure
Boat electroshocking	X		Wear appropriate electrician gloves (range of possible voltages 100-1,200 voltage for a boat based system; 100-990 voltage for a backpack based system. Gloves should be equivalent to lineman's gloves rated at 5,000 volt minimum); follow safety rules during initial briefing. Personnel will wear rubber gloves of sufficient length to isolate hands from external surfaces. Never touch both electrodes simultaneously while power source is running. Gloves will be visually inspected for punctures before each use and will be replaced if tears or punctures are evident. Net handles will be constructed of a nonconductive material and will be of sufficient length to avoid hand contact with the water. Rubber boots will be worn when on a boat. When electroshocking with the backpack system the people involved must wear non-conductive chest waders (most waders fit this).
Drowning	X		Practice daily the procedures that will be used if a person is overboard. Make certain it is possible to get the person back into the boat safely. Have emergency equipment immediately accessible and understand how to use it. Wear PFD at all times when working over water. Inspect the PFDs prior to use and do not use defective PFDs. Keep sampling equipment on boats organized at all times. Boats are required to be equipped with a throwable life ring, fire extinguisher, and warning horn, and each field member will be briefed on their storage location.
Work in remote areas	X		Use buddy system; carry radio and/or cellular phone; bring sufficient equipment in case of accident or injury (first aid kit, shelter if appropriate)
Work in low light (dawn/dusk, evening)	X		Boats must be equipped with running lights, and flashlights or other hand held lights should be kept for any work or maintenance on board. PFD should be worn at all times. Equipment and engines should be in working order. Weather should be carefully monitored prior to evening work. First aid kits and appropriate communication devices must be on board.
Plant/animal hazards	X		Know local hazards and take appropriate precautions (see Table 2-3).

The boat and equipment will be visually inspected for safety by the supervisor or operator in charge, prior to each use. Significant deficiencies, which could result in employee injury, will be corrected prior to operation or use of the equipment. Any person potentially operating the boat will have successfully completed a USCG, Power Squadron, Washington State Parks and Recreation, or similar course and be licensed in Washington State.

Table 2-3 presents potential wildlife hazards that could be encountered during field activities.

Table 2-3. Potential Wildlife and Plant Hazards

Wildlife/Plant	Location	Potential Hazard	Means of Defense
Black Bear	Selkirk Mountains	Provoke attack	If you come in contact with a black bear, stay calm and avoid eye contact. Try to stay upwind and identify yourself as a human being by standing up, talking, and waving your hands above your head. If you can not safely move away from the bear and the animal does not flee, try to scare it away by clapping your hands or yelling. If the bear attacks, fight back aggressively. As a last resort if the attack continues, protect yourself by curling into a ball or lie on the ground on your stomach playing dead.
Grizzly Bear/ Brown Bear	Selkirk Mountains and border of Canada	Provoke attack	If you are attacked by a grizzly bear, play dead. Lie flat on your stomach or curl up in a ball with your hands behind your head. Remain motionless as long as possible. Do not run.
Cougar	Everywhere	Provoke attack	If you come in contact with a cougar, stop, stand tall, and don't run. Try to appear larger than the cougar. Never take your eyes off the animal or turn your back. If the animal displays aggressive behavior, shout, waive your arms, and throw rocks. If the cougar attacks, fight back aggressively and stay on your feet.
Moose	Everywhere	Between mother/calf	If you come in contact with a moose, step back. Look for the nearest tree, fence, or building or other obstruction to hide behind. It's usually a good idea to run from a moose because it usually won't chase you far. If a moose knocks you down, curl up in a ball, protect your head with your arms and hands, and hold still. Don't move or try to get up until the moose moves a safe distance away.
Bees/Wasps	Everywhere	Allergic reaction	Avoiding wearing bright colors or scents. Use an appropriate insect repellent. Wear long-sleeved shirt, hat, and gloves. Employees must notify supervisor if they have allergies to bee/wasp stings prior to engaging in field activities. Employees with allergies may be required to carry an appropriate antidote kit.
Ticks	Everywhere	Disease transmission	Use an appropriate insect repellant. Wear long sleeved clothing and ankle length boots and try to avoid excessive contact with tall brush or grass. Personnel should change clothes and inspect their skin and scalps for ticks after every day of field work. If individuals discover a tick embedded in their skin, it should be removed as soon as possible. Grasp the tick with a blunt pair of tweezers as close to the skin as possible and remove it using slow even pressure. Do not break off head or release fluids from the tick. Gently scrub the area with soap and water after removal. Note the date of the bite and watch for symptoms such as fever, chills, aches, and rashes for a month after the bite. If these symptoms occur, consult a doctor.

Table 2-3. Potential Wildlife and Plant Hazards (continued)

Wildlife/Plant	Location	Potential Hazard	Means of Defense
Rattlesnakes	Found East of Cascades	Bites	Wear ankle high leather boots, long sleeved shirts, and long pants. Do not reach into burrows or dens, under rocks, or logs. Walk heavily through brush. Back away if a snake is encountered. Take snake bite kit with a complete set of instructions. In case of a snake bite, seek prompt medical assistance. The injured employee should rest while awaiting (or being transported to) medical assistance.
Mosquitoes	Everywhere	West Nile Virus	Use an insect repellent containing DEET. Wear long-sleeved shirts, pants, and hat; spray clothing with insect repellent containing DEET. Avoid handling dead animals. The risk of getting West Nile Virus is very low. Symptoms include fever, headache, neck stiffness, stupor, disorientation, tremors, convulsions, muscle weakness, paralysis, and body aches. If you develop any of these symptoms, contact your health care provider.
Poison Ivy	Primarily along riverbanks	Allergic reaction	Poison ivy generally has three green leaves on each stem. The color and appearance can vary throughout the year. Avoid contact with all parts of the plant. Contact with the oily resins on the plant may cause a skin rash. Poison ivy is also transmitted by burning: The smoke and combustion byproducts can cause a reaction. The rash usually appears after 24 to 48 hours and can last for weeks. If poison ivy is contacted, remove the affected clothing and wash the skin with soap and water to remove the oil resins as soon as possible.

All personnel working in areas potentially inhabited by bears will wear bells or suitable noise making apparatus and carry bear spray. Personnel will communicate with Rangers or Forest Service personnel to obtain information about locations of bears, cougars, etc. This information does not exempt personnel from wearing noise apparatus and carrying bear spray.

Personnel will have at least one means of communication per group that will operate successfully in the locations planned for work.

3 CHEMICAL HAZARD EVALUATION

A chemical hazard evaluation is presented in the general SHSP and incorporated herein by reference.

4 PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

The following sections address PPE and safety equipment required for completing the fish tissue sampling activities. Also recommended are good polarized sunglasses and/or billed caps to protect against glare and to maintain good eyesight.

4.1 PERSONAL PROTECTIVE EQUIPMENT

Based on the chemical and physical hazards associated with the fish tissue sampling activities, Table 4-1 identifies the personal protective equipment required for the sampling.

Table 4-1. Level of Protection Required for Site Activities

Site Activity	Level of Protection	
	Initial	Contingency[a]
Fish tissue sampling	MD	Leave site, reassess situation
Sample handling	D	Leave site, reassess situation

Notes: Level D = Long pants and shirt or work coveralls, safety glasses or goggles (as appropriate), and nitrile, neoprene, or Barrier® 5 layer laminate gloves (as appropriate). Hard hat and hearing protection as needed.
Level MD = Same as Level D with modification (M) of addition of PFD and rain gear, and electrician's gloves for electroshocking.
[a] Based on unexpected change in site conditions.

Table 4-2. Levels of Protection and Personal Protective Equipment

Protection Level	Required	Personal Protection Equipment
Level D	X	Long pants and shirt or work coveralls, safety glasses or goggles (as appropriate), and nitrile, neoprene, or Barrier® 5 layer laminate gloves (as appropriate). Hard hat and hearing protection as needed.
Level MD	X	Same as Level D with modification (M) of addition of PFD, rain gear, and electrician's gloves for electroshocking.

Is there potential for a respirator to be donned during field work? Yes _____ No X

4.2 SAFETY EQUIPMENT

The following safety equipment will be onsite during the proposed field activities.

Air Monitoring (Check the items required for this project.)

☐ PID	☐ Air sampling pumps
☐ LEL/O_2 meter	☐ Miniram
☐ H_2S meter	☐ Radiation meter
☐ Detector pump and tubes	☐ Other: _____

First Aid Kit (mandatory, including adhesive band-aids, gauze, tape, gloves, cardiopulmonary resuscitation shield, triangle bandage)

☒ Emergency blanket	☒ Sunscreen
☒ Insect repellent	☒ Other: Snake bite kit

Other (Check the items required for this project.)

☒ Eyewash	☐ Fit test supplies
☒ Drinking water	☐ Fire extinguisher (drill rigs)
☐ Stopwatch for monitoring heart rate	☐ Windsock
☐ Thermoscan® thermometer (or equivalent) for heat stress monitoring	☒ Cellular phone
	☐ Radio sets
☐ Survival kit	☒ Global positioning system
☒ Personal flotation device	☐ Other: _____
☐ Cool vests	_____

5 EMERGENCY PLANNING

In case of any emergency affecting the site, all affected personnel must immediately evacuate the work area and report to the site safety officer at the following predetermined location.

DESIGNATED ASSEMBLY LOCATION: Field vehicle or boat

In case of injury, field personnel should take precautions to protect the victim from further harm and notify local or facility emergency services. In remote areas, it will be necessary to have first aid-trained personnel on the field team. The victim may require decontamination prior to treatment—requirements will vary based on site conditions.

Emergency medical care will be provided by:

- [X] Local emergency medical provider (i.e., fire department) (see Table 5-1 for contact information)
- [ ] Facility emergency medical provider
- [X] First aid-trained field staff (for remote areas only)

Table 5-1. Emergency Telephone Numbers

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Fire	Varies by location	911	**Yes. Notify the E911 coordinator for Stevens County (Debby McCanna; 509-684-2555) of the schedule and location of work.**
Police	Varies by location	911	**Yes (see above)**
Ambulance	Varies by location	911	**Yes (see above)**
Hospital	Mount Carmel Hospital, Colville, WA	(509) 684-2561	No
Site phone	Field cell phone. Cell phone coverage is spotty in the vicinity of the sampling areas. If cell phone coverage is lost due to a mountain/ hill, drive a little further to get coverage. If cell phone coverage is available, the 911 system will work. A satellite phone may be necessary for areas with limited cell phone coverage. Use of VHF radio will be available on sampling vessels.	TBD Channel TBD	NA
Directions to the hospital (from Highway 395):	Begin traveling SE on Highway 395. Highway 395 becomes Main Street in Colville. Turn LEFT on E. Columbia Ave. Go 0.6 miles. Arrive at 982 E. Columbia Ave. Hospital is on right. (See detailed hospital location maps in Attachment A1-3)		

Table 5-1. Emergency Telephone Numbers (continued)

Corporate Resources	Name	Work/Cell Telephone	Home Telephone
Parametrix Corporate Health and Safety Officer	Sheila McConnell	Work: (425) 452-8655 Cell: (425) 681-7516	----
Medical consultant	Dr. Calvin Jones (HealthForce Partners)	(425) 806-5700	----

In case of serious injuries, death, or other emergency, the Parametrix corporate health and safety officer must be notified immediately. To contact the Parametrix corporate health and safety officer (or delegate), try calling the phone numbers listed above. Table 5-2 provides local hospital contact and location information. See Attachment A1-3 for a detailed hospital location map.

Table 5-2. Hospital Information

Facility Name	Hours of Operation	Phone Number	Address	City	State
Mount Carmel Hospital	24 hour emergency	(509) 684-2561	982 East Columbia Street	Colville	WA

6 WORK ZONES

The following work zones are defined for the fish tissue sampling activities.

Exclusion zone. The aft deck of the sampling vessel will be considered to be the exclusion zone while sample collection and processing (e.g., weighing and measuring) is taking place. Sample collection and processing will occur in this area. Only properly equipped and trained (i.e., wearing modified D protective clothing) personnel will be allowed in this area.

Contamination reduction zone (CRZ). The rest of the deck will be the contamination reduction zone. Sample storage and other support functions will occur in these areas.

Support zone. The cabin or pilot house will be the support zone. Personnel will be required to rinse off rain gear with potable or river water before entering this area.

Controls to be used to prevent entry by unauthorized persons. No unauthorized personnel will be allowed on the sampling vessel.

7 DECONTAMINATION

The field team will decontaminate all onboard sampling equipment that comes into contact with either fish or bottom sediments prior to the commencement of sampling at each location and upon completion of the study. This will include equipment such as gill nets, dip nets, temporary fish-holding containers, and gloves used for electrofishing (i.e., electrician's gloves). The decontamination will consist of thoroughly rinsing all of the equipment with lake water away from the shoreline and any areas where sediment has been disturbed, such as in a location where gill nets and their anchors were removed. Field equipment used for measuring and weighing the fish at the onshore processing stations will be washed with soap (i.e., Alonox™) and rinsed with lake water after each use. This will include the digital scale pans, the fish measuring boards, and the holding containers in which the fish were stored and transported. Nitrile gloves used for handling fish in the field and onshore will be discarded, not decontaminated. Clean gloves will be worn at each sampling location to avoid transfer of potential contaminants among samples. Otherwise decontamination procedures will follow those presented in the general SHSP and are incorporated herein.

8 VEHICLE SAFETY, SPILL CONTAINMENT, AND SHIPPING INSTRUCTIONS

Vehicle safety, spill containment, and shipping instructions are presented in the general SHSP and are incorporated herein.

9 TASK-SPECIFIC SAFETY PROCEDURES

Slips, trips, and falls are anticipated to be the greatest hazards to field personnel during the fish tissue sampling event. When working on the sampling vessel, always be aware of slippery areas or uneven terrain. When accessing the sampling vessel or near-shore sampling stations by foot, always proceed with caution, watching footfalls in slippery areas or uneven terrain and avoid contact with thorny vegetation. Wear properly fitting shoes or boots with non-slip soles and good ankle support.

Access to all of the fish tissue sample collection areas will require the use of a boat. Wear PFD at all times when working over water. Inspect the PFDs prior to use and do not use defective PFDs. Keep sampling equipment on boats organized at all times. Boats are required to be equipped with a throwable life ring, fire extinguisher, first aid kit, eyewash bottle and water (if acids are taken on the boat), drinking water (for long trips), alternate propulsion mechanism (e.g., paddles), rope, and warning horn, and each field member will be briefed on their storage location.

The fish tissue sample collection will require the use of electrofishing, gill netting, or other fishing equipment. General safety issues and safety precautions when using this equipment are as follows:

- Use only boats designed for electrofishing.
- Boat electrofishing involves having high-voltage/low-amperage electricity discharged into the water to stun fish. The discharge is not constant. It is administered in short durations under the direction of the boat operator.
- Use only long-handle fiberglass pole nets to retrieve fish.
- Wear thick rubber-insulated gloves while using the nets.
- Wear rubber-insulated boots while on the boat.
- Boats must be equipped with high rails to prevent workers from falling in while netting fish.
- Boats must be equipped with "dead-man" switches that shut off the power to the electro-fishing equipment in case of an emergency. There are usually about six to nine switches on a boat, depending on their size. They are located all around the boat. All personnel will understand where the dead man switches are and how to use them.
- When deploying and retrieving gill nets, ensure that personnel do not have on loose-fitting clothing, jewelry, or other items that may become entangled in nets. Personnel or boat operators should keep a knife onboard in the event of an emergency involving someone being caught in the netting.

- When initiating electrical shock to the water surrounding the vessel, ensure that no recreational boaters are within 100 ft. If need be, wait until they leave the area or wave them off. If problems still persist, contact the National Park Service for assistance
- Additional preparations should be made for any boat activity during periods of low light (dawn/dusk, evening). Boats must be equipped with running lights, and flashlights or other hand held lights should be kept for any work or maintenance on board. PFDs should be worn at all times. Equipment and engines should be checked and in working order. Weather should be carefully monitored prior to evening work. First aid kits and appropriate communication devices must be on board at all times.

Additional information on boating safety is presented in the general SHSP (Section 9.2).

All of the areas that will be sampled are accessible to the public. Always be aware of your surroundings. Use the buddy system and keep in line-of-sight contact with other sampling personnel at all times. Do not leave samples or sampling equipment unattended. If you feel threatened, or if the situation feels unpredictable, leave the area immediately.

Always wear appropriate chemical-resistant gloves and safety glasses or goggles when handling sampling equipment, samples, or preservative chemicals. Keep a 1-liter eye wash bottle accessible during all field work. Avoid getting preservatives on your skin or clothes. If any preservatives are spilled or splashed on your skin or clothes, immediately rinse the affected area with water and get medical attention, if warranted. If any preservative is splashed in the eye, flush the eye with the eye wash solution and get immediate medical attention.

10 REFERENCE

TCAI. 2007. Upper Columbia River: Draft general health and safety plan for the remedial investigation and feasibility study. Prepared for Teck Cominco American Incorporated. Integral Consulting Inc., Mercer Island, Washington, and Parametrix, Bellevue, Washington.

ATTACHMENT A1-1

COLD-STRESS FACT SHEET

FROSTBITE

What happens to the body:

Freezing in deep layers of skin and tissue; pale, waxy-white skin color; skin becomes hard and numb; usually affects fingers, hands, toes, feet, ears, and nose.

What to do: (land temperatures)

- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet or tight clothing that may cut off blood flow to the affected area.
- **Do not** rub the affected area because rubbing damaged the skin and tissue.
- Gently place the affected area in a warm water bath (105°) and monitor the water temperature to **slowly** warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage. Warming takes 25-40 minutes.
- After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm. **Note:** If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

How to Protect Workers

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Train workers about cold-induced illnesses and injuries.
- Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene.)
- Take frequent short breaks in warm, dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system (work in pairs.)
- Drink warm, sweet beverages (sugar water, sports-type drinks.) **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Eat warm, high-calorie foods like hot pasta dishes.

Workers are at increased risk when…

- They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
- They take certain medications. Check with your doctor, nurse, or pharmacy and ask if medicines you take affect you while working in cold environments.
- They are in poor physical condition, have a poor diet, or are older.

HYPOTHERMIA - (Medical Emergency)

What happens to the body:

Normal body temperature (98.6°F/37°C) drops to or below 95°F/35°C; fatigue or drowsiness; uncontrolled shivering; cool, bluish skin; slurred speech; clumsy movements; irritable, irrational, or confused behavior.

What to do: (land temperatures)

- Call for emergency help (i.e., ambulance or 911).
- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if he is alert. **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Have the person move his arms and legs to create muscle heat. If he is unable to do this, place warm bottles or hot packs in the armpits, groin, neck, and head areas. **Do not** rub the person's body or place him in a warm water bath. This may stop his heart.

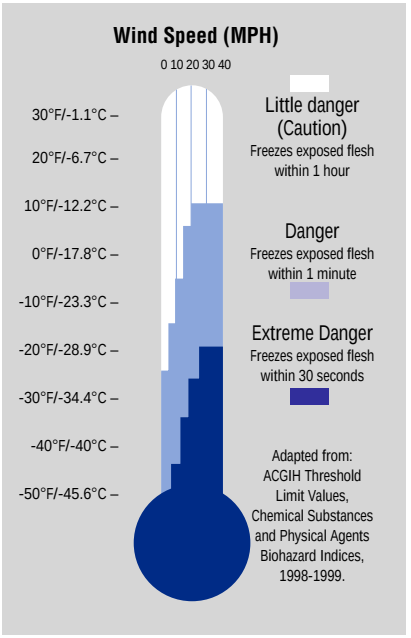
What to do: (water temperatures)

- Call for emergency help (i.e., ambulance or 911). Body heat is lost up to 25 times faster in water.
- **Do not** remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating. **Do not** attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses body heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

THE COLD STRESS EQUATION

LOW TEMPERATURE + WIND SPEED + WETNESS = INJURIES & ILLNESS

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result. **Hypothermia** can occur when *land temperatures* are **above** freezing or *water temperatures* are below 98.6°F/37°C. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.



Oregon Occupational Safety & Health Division
440-3336E-S (9/03)

FROSTBITE

What happens to the body:

Freezing in deep layers of skin and tissue; pale, waxy-white skin color; skin becomes hard and numb; usually affects fingers, hands, toes, feet, ears, and nose.

What to do: (land temperatures)

- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet or tight clothing that may cut off blood flow to the affected area.
- **Do not** rub the affected area because rubbing damaged the skin and tissue.
- Gently place the affected area in a warm water bath (105°) and monitor the water temperature to **slowly** warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage. Warming takes 25-40 minutes.
- After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm. **Note:** If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

How to Protect Workers

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Train workers about cold-induced illnesses and injuries.
- Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene.)
- Take frequent short breaks in warm, dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system (work in pairs.)
- Drink warm, sweet beverages (sugar water, sports-type drinks.) **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Eat warm, high-calorie foods like hot pasta dishes.

Workers are at increased risk when…

- They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
- They take certain medications. Check with your doctor, nurse, or pharmacy and ask if medicines you take affect you while working in cold environments.
- They are in poor physical condition, have a poor diet, or are older.

HYPOTHERMIA - (Medical Emergency)

What happens to the body:

Normal body temperature (98.6°F/37°C) drops to or below 95°F/35°C; fatigue or drowsiness; uncontrolled shivering; cool, bluish skin; slurred speech; clumsy movements; irritable, irrational, or confused behavior.

What to do: (land temperatures)

- Call for emergency help (i.e., ambulance or 911).
- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if he is alert. **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Have the person move his arms and legs to create muscle heat. If he is unable to do this, place warm bottles or hot packs in the armpits, groin, neck, and head areas. **Do not** rub the person's body or place him in a warm water bath. This may stop his heart.

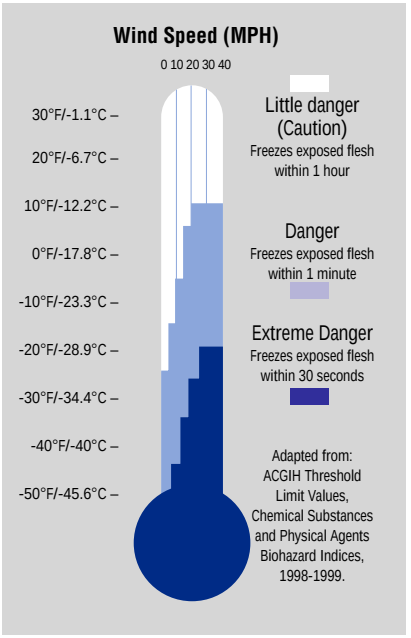
What to do: (water temperatures)

- Call for emergency help (i.e., ambulance or 911). Body heat is lost up to 25 times faster in water.
- **Do not** remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating. **Do not** attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses body heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

THE COLD STRESS EQUATION

LOW TEMPERATURE + WIND SPEED + WETNESS = INJURIES & ILLNESS

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result. **Hypothermia** can occur when *land temperatures* are **above** freezing or *water temperatures* are below 98.6°F/37°C. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.



Oregon Occupational Safety & Health Division
440-3336E-S (9/03)

ATTACHMENT A1-2

HEAT-RELATED ILLNESS PREVENTION POLICY

Instructions:

The following document has been provided to assist your company in developing a written Heat Related Illness (HRI) Prevention Policy for Outdoor Work activities per WAC 296-62-095 through WAC 296-62-09570, Heat Related Illnesses in the Outdoor Environment.

The program outline follows the recommendations found in DOSH Directive (WRD) 18.50, Heat Related Illness in the Outdoor Environment.

You must tailor these procedures to meet your specific work site conditions. Simply printing off the procedures would not comply with the provisions of the HRI Rule.

The underlined areas and tables must be filled in to tailor this program to meet your needs.

To assist you in tailoring these sample procedures to your work site conditions the following documents are available for reference:

Appendix A: Heat and Humidity Chart
Appendix B: Examples of Workload Activities
Appendix C: Sample HRI First Aid and Emergency Response Procedures

"Protecting Employees Working Outdoors from Heat-Related Illnesses"

"Training Guide for Heat-Related Illnesses"

DOSH Directive (WRD) 18.50: Heat Related Illness in the Outdoor Environment (June 5, 2007)

You can find these documents and other helpful tools by visiting the Department of Labor and Industries website at:

http://www.lni.wa.gov/safety/topics/atoz/heatstress/default.asp

Heat-Related Illness (HRI) Prevention
Outdoor Work Policy

⇨ _____is committed to preventing Heat Related Illnesses—HRI that can occur to employees working in the outdoor environment.

⇨ _____recognizes that exposure to extreme temperature, humidity and other environmental factors can lead to serious illnesses including heat fatigue, heat rash, fainting, heat cramps, heat exhaustion, and heat stroke. The following formal policy has been developed to protect employees from the hazards posed by working in the outdoor environment and to comply with the written procedures as required by WAC 296-62-095 through WAC 296-62-09570, Heat Related Illnesses in the Outdoor Environment. Outdoor work includes any employee assigned to work in the outdoor environment on a regular basis.

I. HRI Training Plan

Prior to assignment of any outdoor work activities, employees and supervisors of

⇨ _____ will be trained on our HRI procedures and the elements outlined below.
(See "Training Guide for Heat-Related Illness"-Found on DOSH website)

A. Employee Training

- Recognizing the environmental causes of HRI and personal factors that can increase the risk
- How our company identifies, evaluates, and controls HRI exposure
- Removal of Personal Protective Equipment during all breaks
- Frequently consuming water when HRI hazards are present
- Importance of acclimatization (Getting used to hot weather)
- Different types of HRI and the common signs and symptoms
- Importance of immediately reporting HRI symptoms of themselves or co-workers
- How our company will respond to HRI symptoms and emergencies
- The purpose and requirements of the HRI rules

B. Supervisor Training

- How to implement the provisions of the HRI rule
- What to do when an employee exhibits signs or symptoms of HRI, including emergency response
- How to safely move employees to a place that is easily reached by emergency medical providers
- How to provide clear directions to emergency medical providers so they can find the work site

II. Evaluation of HRI Hazards

⇨ _____ will evaluate HRI hazards based on a combination of factors including temperature, humidity, and other environmental conditions in all workplaces where outdoor work is performed. ⇨ _____ will routinely evaluate potential HRI hazards by checking one or more of the following:

(See Appendix A: Heat Index Chart as an evaluation option)

Air Temperature and Humidity *(list your source of information)*

- o Local weather report predictions from:

  _____

- o On-site temperature and humidity measuring equipment (and location):

  _____

- o Historical area weather data to approximate work site conditions from:

  _____

Other Environmental Factors *(list what may be present and increase HRI risk)*

- o **Radiant Heat** *(Example: Reflection of heat from asphalt, rocks, or composite roofing material; or work in direct sunlight)*

  _____

  _____

- o **Air Movement** *(Example: Wind blowing and temperature above 95 degrees F)*

  _____

  _____

- o **Conductive Heat Sources** *(Example: Operating orchard tractor for mowing)*

  _____

  _____

- o **Workload Activity and Duration** *(Example: Hand sawing wood, carrying masonry blocks, digging with a shovel)*

  _____

  _____

- o **Personal Protective Equipment/Clothing** *(Example: Wearing respirator, chemical resistant suit, and gloves for pesticide application or HAZMAT clean-up; or leathers and gloves for welding)*

  _____

  _____

III. Procedures for Controlling Environmental Factors

⇨ _____ will control HRI environmental factors at the worksite to reduce HRI risks. Depending on the environmental factors present, we will use one or more of the following methods for controlling HRI risks to protect employees:

List your control methods, when they will be used, and what the expected outcome is.

Control Method	When Used	Expected Outcome
Example 1: Use water hose to wet towels or clothing and place on the body; use cooling vest or cooling headbands	*When temperature is going to reach 95 degrees or more; or Heat Index reaches 90*	*Cool the body temperature*
Example 2: Take breaks in shaded area (house, garage, canopy, under trees)	*When working in direct sun light (e.g. roofers, asphalt pavers, berry pickers)*	*Cool the body temperature*
Example 3: Start work shift early (when daylight begins) and end shift early, or do not work during hottest parts of day	*When temperature expected to reach 90 degrees or more*	*Reduce time exposed to heat and keep body temperature cooler*
Example 4:Remove respirator, chemical suit and gloves, or welding leathers during breaks	*When temperature is going reach 80 degrees or more*	*Cool the body temperature and all reduce humidity close to body*

IV. Drinking Water

Sufficient potable drinking water will be provided and made accessible to employees.

⇨ _____ is responsible for ensuring sufficient water is available. At least **one quart of water per employee per hour** will be available when HRI hazards are present. **If you notice water is not present notify your supervisor immediately**. Water can be found in the following locations: *(List your water sources and locations)*

- _____
- _____
- _____

V. Adjusting Rest Breaks for Increased Work Load and Duration

⇨_____ will use an adjusted rest break schedule to minimize employees risk when there is an increased risk of HRI hazards due to work loads. Supervisors will adjust rest breaks as follows:

(See Appendix B: Examples of Work Load Activities)

Work Activity	Adjusted Rested Breaks and When Used
Example: Thinning apples 8-hours, roofing a residential house 6-hours, carrying masonry blocks 4-hours, shoveling hot asphalt for 8-hours	*Example: An additional break before and after lunch when. . .* *-temperature reaches 90 degrees and humidity is 50%* *-performing heavy work in direct sunlight or on hot surfaces*

VI. Procedures for Responding to Heat-Related Illnesses

⇨_____ will respond to HRI in a quick and safe manner. The table below outlines the potential types of heat-related illnesses, signs and symptoms, and specific First Aid and HRI Emergency procedures. The information will be present at all work sites where outdoor work activities are present.

- Emergency medical phone number:_____
- Specific work site address:_____
- Driving directions from a major roadway to the work site:_____

  .

  _____

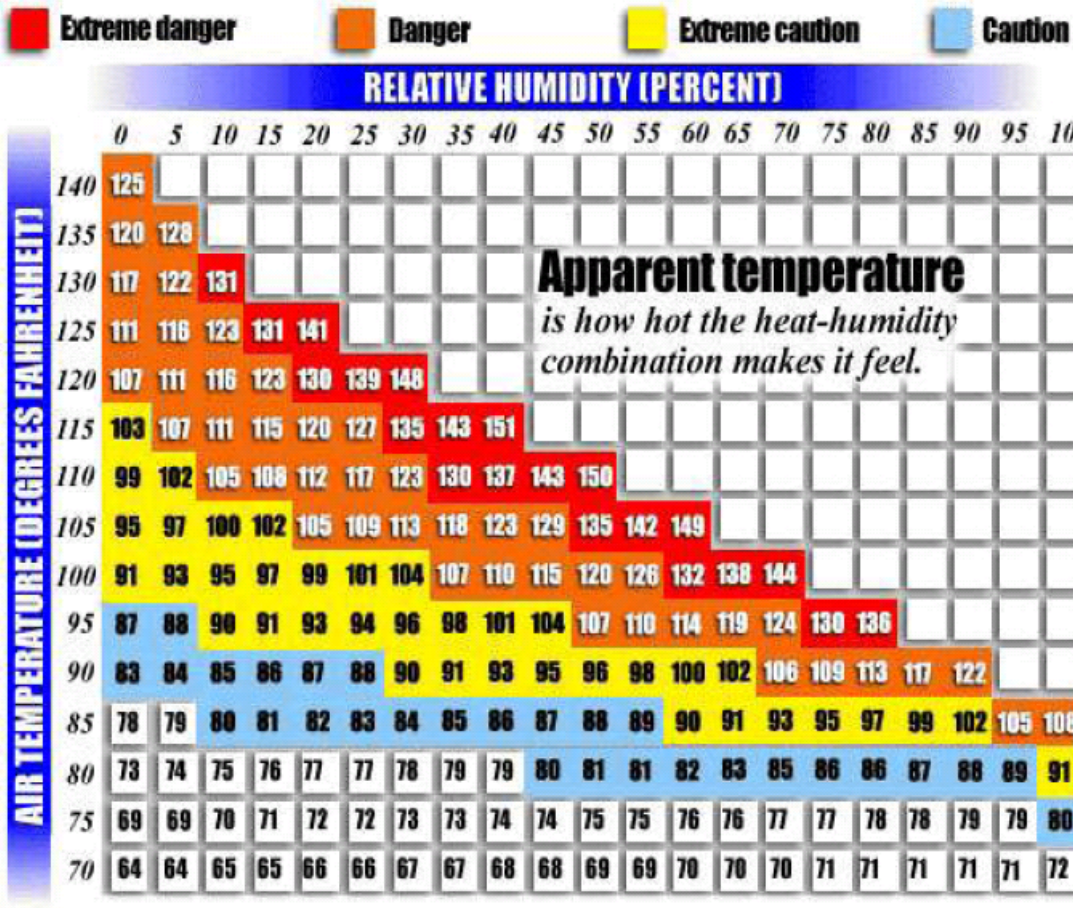
Procedures for Responding to Heat-Related Illnesses

(See Appendix C: Sample First Aid and Emergency Response Procedures)

Heat-Related Illness	Signs and Symptoms	First Aid and Emergency Response Procedures
Sunburn		
Heat Rash		
Heat Cramps		
Heat Exhaustion		
Heat Stroke		

APPENDIX A

Heat and Humidity Chart



http://www.crh.noaa.gov/dvn/tools/heatindex.pdf.

Heat Index	General Effect of Heat Index on People in Higher Risk Groups
80 - 89 *Caution*	Fatigue possible with prolonged exposure and physical activity.
90 - 104 *Extreme Caution*	Sunstroke, heat cramps, and heat exhaustion possible.
105 - 129 *Danger*	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130 or higher *Extreme Danger*	Heat Stroke highly likely with continued exposure.

APPENDIX B

Examples of Workload Activities

Categories	Example Activities
Resting	Sitting quietly
	Sitting with moderate arm movements
Light	Sitting with moderate arm and leg movements
	Standing with light work at machine or bench while using mostly arms
	Using a table saw
	Standing with light or moderate work at machine or bench and some walking about
Moderate	Scrubbing in a standing position
	Walking about with moderate lifting or pushing
	Walking on level at 6 Km/hr while carrying 3 kg weight load
Heavy	Carpenter sawing by hand
	Shoveling dry sand
	Heavy assembly work on a non-continuous basis
	Intermittent heavy lifting with pushing or pulling (e.g. pick-and-shovel work)
Very Heavy	Shoveling wet sand

APPENDIX C:

Sample HRI First Aid and Emergency Response Procedures

Heat-Related Illness	Signs and Symptoms	First Aid and Emergency Response Procedures
Sunburn	• Red, hot skin • May blister	• Move to shade, loosen clothes to reduce temperature • Apply cool compress or water to cool burn • Get medical evaluation if severe
Heat Rash	• Red, itchy skin • Bumpy skin • Skin infection	• Apply cool water or compress to cool rash • Keep affected area dry to minimize infection • Control itching and infection with prescribed medication
Heat Cramps	• Muscle cramps or spasms • Grasping the affected area • Abnormal body posture	• Drink water or sports drinks to re-hydrate body • Rest, cool down in shaded area • Massage affected muscle to release body toxins • Get medical evaluation if cramps persist
Heat Exhaustion	• High pulse rate • Extreme sweating • Pale face • Insecure gait • Headache • Clammy and moist skin • Weakness • Fatigue • Dizziness	• Move to shade and loosen clothing to cool down • Initiate rapid cooling with fan, water mister, or ice packs • Lay flat and elevate feet to reduce heart rate and blood pressure • Monitor recovery (is body cooling?) • Drink small amounts of water to cool body and re-hydrate • Evaluate mental status (ask Who? Where? When? Q's) • **If no improvement call 911**
Heat Stroke	• Any of the above but more severe • Hot, dry skin (25-50% of cases) • Altered mental status with confusion and agitation • Can progress to loss of consciousness and seizures • Can be fatal	• **Call 911** • **Provide EMS with directions to work site** • Immediately remove from work activity to slow/stop body temp rise • Start rapid cooling with fan, water mister, or ice packs • Lay flat and elevate feet to reduce heart rate and blood pressure • If conscious give sips of water to cool body and re-hydrate • Monitor airway and breathing-administer CPR if needed

ATTACHMENT A1-3

MOUNT CARMEL HOSPITAL

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Note:
• background imagery is from 2006, and is for reference purposes only

DRAFT

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BUENA VISTA RD
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2ND AV
1ST AV
ASTOR AV
BIRCH AV
COLUMBIA AV
DOMINION AV
ELEP AV
FOREST AV
GLENN AV
JUNIPER AV
IVY AV
GARDEN HOMES DR
HAWTHORNE AV
395 HWY
20 HWY
OAKSHOT RD
LOUIS PERRAS RD
CEDAR LOOP RD
WITHAM RD
WYNNE ST
MAIN ST
CARTER ST
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JEFFERSON ST
ALDER ST
PINE ST
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RAILROAD ST
LINCOLN ST
ELM ST
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MAPLE ST
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TAMARAC ST
MINER ST

Mount Carmel Hospital
982 East Columbia Street
COLVILLE, WA 99114-3352

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Mount Carmel Hospital, Colville
Upper Columbia River, WA

ATTACHMENT A2

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE SOP-1

POSITIONING AT FISH TISSUE SAMPLE COLLECTION AREAS

Purpose

The purpose of this standard operating procedure (SOP) is to describe procedures used for locating sampling stations at Fish Tissue Sample Collection Areas (FSCA).

Scope and Applicability

This SOP is applicable for determining the horizontal and vertical location of sample collection locations at each FSCA. Sample locations include stationary locations (e.g., gill nets locations) and moving targets (e.g., boat electroshock locations).

Equipment and Materials

The horizontal positioning equipment will consist of a differential global positioning system (DGPS) instrument, such as a CSI-Wireless DGPS MAX or a Trimble DSM 232, with Hypack (or equivalent) navigation software. The display will be capable of showing the present location of the vessel relative to the desired station location and will provide a bearing and distance to the station. The equipment will be capable of being pre-programmed with the appropriate National Oceanic and Atmospheric Administration (NOAA) nautical chart and sampling station locations. In the event normal GPS reception of four or more satellites is not available at a given location because of terrain blocking or other causes, alternative methods will be used to establish positions along a transect.

Vertical positioning will be done with the vessel fathometer and/or a lead line or weighted tape measure.

Station Positioning – Procedures

Horizontal Positioning

Horizontal positioning for fish tissue sampling stations will be accomplished using DGPS based on the U.S. Coast Guard (USCG) Maritime Differential GPS Service signal or GPS if the USCG differential signal cannot be received. The USCG operates a GPS remote broadcast site from

Spokane that broadcasts corrected GPS signals on marine radio beacon frequencies. Position errors with this system typically are within 1 to 3 meters (3.3 to 9.8 feet). The following requirements apply to the GPS instrument and will be verified initially by the Field Team Leader[1] (FTL) during the course of the work:

- The GPS unit will be configured such that satellites less than 8 degrees above the horizon will not be used in position computations (latitude and longitude, in NAD83 coordinate system).
- A minimum of four satellites will be used for computing all positions.
- If any samples are collected using the swing davit or A-frame, the GPS antenna will be mounted on the swing davit or top centerline of the A-frame. This will avoid the need for computing distance offsets for the antenna location.

Data Dictionary

A data dictionary and menu-driven data collection system will be developed and programmed into the GPS units to facilitate consistent data collection techniques and to minimize data entry errors. In case the GPS unit fails, handwritten field notebooks will also be used to duplicate data collected using the GPS units and make note of any other field observations. The coordinate data will be downloaded periodically from the GPS units, if necessary, differentially corrected, and projected from geographic coordinates to the state plane coordinate system. The handwritten field notebooks also will be collected from the field crew to accompany the downloaded GPS data. These data will be reviewed immediately after downloads to communicate and correct any data entry errors with the field crew.

Positional Data for Moving Targets

The area to be sampled by boat electrofishing and beach seining will include the collection of line data consisting of "vertices," or points of inflection, collected every 5 seconds and "nodes" collected at the beginning and end of each sampling run.

Positional Data for Stationary Targets

Positional data will be obtained using point coordinates for gill nets, burbot traps and minnow traps.

[1] The Field Team Leader (FTL) is defined as the lead for each vessel that is in service.

STANDARD OPERATING PROCEDURE SOP-2

SAMPLE LABELING

Scope and Applicability

This standard operating procedure (SOP) describes the general Parametrix procedures for sample labeling and specifically, the two different kinds of labels that will be used on the 2009 UCR fish tissue sampling project. These two types of labels are individual fish sample labels and composite fish sample labels. The 2009 Fish Tissue Sampling Quality Assurance Project Plan (QAPP) should be consulted regarding any questions on sample labeling.

Sample Identifier Labels

Sample identifiers will be established before field sampling begins and assigned to each sample as it is collected. Sample identifiers consist of codes designed to fulfill three purposes: 1) to identify related samples (i.e., composites) to ensure proper data analysis and interpretation; 2) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples; and 3) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. To accomplish these purposes, each container may have two different codes associated with it: the individual fish sample number(s), and the composite fish numbering. These codes and their uses are described below.

Individual Fish Sample Numbering

Each distinct sampling location (Fish Sample Collection Area [FSCA]) will be assigned a unique identifier. Sample IDs will be numbered sequentially beginning with the letters "TAI" (Teck American, Inc.), FSCA location, species abbreviation, size class designation, and tag number (e.g., TAI1-WE-S3-0001). The codes will include the following information:

FSCA(s)

- FSCA 1 – Reach 1 (RM 745 to RM 730) – Code = 1
- FSCA 2 – Reach 2 (RM 730 to RM 712) – Code = 2
- FSCA 3 – Reach 3 (RM 712 to RM 700) – Code = 3
- FSCA 4 – Reach 4 (RM 700 to RM 640) – Code = 4

- FSCA 5 – Reach 5 (RM 640 to RM 617) – Code = 5
- FSCA 6 – Reach 6 (RM 617 to RM 597) – Code = 6.

Species abbreviation(s) (note: below is a list of abbreviations for abundant species in the UCR, if another species is collected a new code will be created and applied to the sample labels and noted in the field logs)

- Black crappie – Code= BC
- Bluegill – Code= BG
- Bridgelip sucker – Code = BL
- Burbot – Code = BU
- Kokanee hatchery – Code = KOH
- Kokanee wild – Code = KOW
- Lake whitefish – Code = LW
- Largescale sucker – Code = LS
- Longnose sucker – Code = LN
- Mountain whitefish – Code = MW
- Pikeminnow – Code = PM
- Pumpkinseed – Code = PS
- Rainbow trout hatchery – Code = RBH
- Rainbow trout wild – Code = RBW
- Redside shiner – Code = RS
- Sculpin – Code = SN
- Smallmouth bass – Code = SB
- Walleye – Code = WE
- Yellow Perch – Code = YP.

Size Class Designation(s)

- Size class <15 cm – Code = S1
- Size class ≥15 to ≤30 cm – Code = S2
- Size class >30 cm – Code = S3.

Fish tag numbers will be expressed as four digits starting with 0001 (e.g., 0001 or 0002). An example of the coding scheme is provided below. For example, the 52nd fish collected during

the 2009 fish sampling event is a wild rainbow trout of 20 cm in length collected at FSCA 3. The resulting sample ID would be: TAI3-RBW-S2-0052.

Composite Fish Sample Numbering

Composites samples will be formed at the onshore sample processing site. A unique code (i.e., composite sample identification code) will be assigned to each composite sample. The code will include the following information:

FSCA(s)

- FSCA 1 – Reach 1 (RM 745 to RM 730) – Code = 1
- FSCA 2 – Reach 2 (RM 730 to RM 712) – Code = 2
- FSCA 3 – Reach 3 (RM 712 to RM 700) – Code = 3
- FSCA 4 – Reach 4 (RM 700 to RM 640) – Code = 4
- FSCA 5 – Reach 5 (RM 640 to RM 617) – Code = 5
- FSCA 6 – Reach 6 (RM 617 to RM 597) – Code = 6.

Species abbreviation(s) (note: below is a list of abbreviations for abundant species in the UCR, if another species is collected a new code will be created and applied to the sample labels and noted in the field logs)

- Black crappie – Code= BC
- Bluegill – Code= BG
- Bridgelip sucker – Code = BL
- Burbot – Code = BU
- Kokanee hatchery – Code = KOH
- Kokanee wild – Code = KOW
- Lake whitefish – Code = LW
- Largescale sucker – Code = LS
- Longnose sucker – Code = LN
- Mountain whitefish – Code = MW
- Pikeminnow – Code = PM
- Pumpkinseed – Code = PS
- Rainbow trout hatchery – Code = RBH
- Rainbow trout wild – Code = RBW
- Redside shiner – Code = RS

- Sculpin – Code = SN
- Smallmouth bass – Code = SB
- Walleye – Code = WE
- Yellow Perch – Code = YP.

Size class designation(s)

- Size class <15 cm – Code = S1
- Size class ≥15 to ≤30 cm – Code = S2
- Size class >30 cm – Code = S3.

Tissue type

- Whole body – Code = W
- Fillet – Code = F
- Remainder – Code = R.

Replicate number (e.g., 1 through 6)

Number of specimens in composite sample (e.g., must be at least five though more will be needed for smaller fish).

An example of the composite coding follows. For the third whole body composite formed for wild rainbow trout species ranging from 5 to 10 cm in length collected at FSCA 3 and comprised of ten individual fish, the resulting composite ID is: TAI3-RBW-S1-W310.

STANDARD OPERATING PROCEDURE SOP-3

FISH COLLECTION BY GILL NET AND ELECTROFISHING

Purpose

The purpose of this standard operating procedure (SOP) is to describe procedures for collecting fish using gill nets and electrofishing for the Upper Columbia River (UCR) Fish Tissue Study during Fall 2009. Methods described here were in part derived from the *Phase I Fish Tissue Sampling Quality Assurance Project Plan Upper Columbia River Site, CERCLA RI/FS* (USEPA 2005).

Scope and Applicability

This procedure applies to fish collection in the UCR in Fall 2009. This effort will involve two boat crews gillnetting and electrofishing for several target fish species consumed by people and wildlife. Because the sampling methods to be used are not species-specific, any of the target species may be captured (and collected) using these methods. SOPs for other sampling methods (e.g., beach seining nets) will also be employed as necessary to ensure collection of all target fish species. The Field Sampling Plan (FSP) Section 2.1 presents the target species (including backup species) that will be the focus of the fish sampling program.

Station Access

Prior to entering select areas such as private beaches, embayments or proximity to docks, it may be necessary to acquire property access permission from the landowner. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Equipment and Materials

- Variable-size gill nets (12, 200 x 10 feet [ft], 3- and 4-inch [stretch] mesh)
- Anchors (20 to 30 pounds [lb], two per net)
- Buoys (16-inch diameter or similar, two per net)
- Carabineers or clips for connecting float lines and anchors (up to eight per net)
- Tub or live well on board vessel for holding live fish (minimum of one per vessel)
- Coolers with wet ice (one cooler for each target species; at least eight total coolers per vessel)
- Carboy for lake water (three 5-gallon carboys per vessel)

- Fish clubs
- Measuring boards
- Boats equipped for gill netting and/or electrofishing
- Dip nets (two per electrofishing vessel)
- Rubber deck boots
- Heavy rubber gloves for electroshocking
- Disposable gloves for removing fish from nets
- Disposable cleanroom 100 certified nitrile gloves for handling fish carcasses
- Personal flotation devices
- Radios
- Global positioning system (GPS) receivers
- Depth finder
- Knife (one per crew)
- Maps (UCR)
- Sequential pre-numbered fish tags (individual fish numbering labels) and cable ties for attaching them
- Digital camera
- Field forms and notebooks
- Pens and pencils
- First aid kits, and health and safety manuals (one each per crew).

Procedures

The procedures described below will be employed by two separate crews employing electrofishing and gill nets daily over a two to three-day period in each UCR reach. However, it may be impractical or impossible for a single crew to employ multiple collection methods in a single day at every reach. Further, some methods may be impractical or unproductive in certain collection areas. Therefore, final decisions on the methods to be used each day will be made by the Field Team Leaders (FTLs) and Field Supervisor (FS)[2]. Where suitable gillnetting locations are limited due to current and shoreline characteristics, electrofishing may be the only feasible sampling method.

[2] The Field Supervisor (FS) is the overall supervisor for the field program.

If, after following the procedures described below, inadequate numbers of target fish for some or all species are collected from a specific sampling reach, the FS will consult with the Parametrix Project Manager (PM) to determine whether additional time or collection methods (i.e., angling) should be spent trying to obtain additional fish samples from these locations, or whether locations outside the reach should be sampled.

Day 1. Gill Nets and Electrofishing

1. Arrive at a selected boat ramp nearest to the target reach.
2. Mobilize sampling gear and vessels.
3. Decontaminate sampling equipment and fish holding containers by rinsing in lake water.
4. Review sampling objectives for the day.
5. Travel to the target sampling reach.
6. Identify specific sample locations within the target reach. Potential sampling locations may have been identified previously during site visits and/or conversations with biologists familiar with the species and collection area(s). Final collection locations will be at the discretion of the FTL (considering safety, wind, current, depth).
7. Conduct gill netting at each selected location as follows:
   - Deploy gill nets (as necessary) and record GPS coordinates, date, and time for each net set on a separate fish collection form (FCF).
   - Deep or shallow net sets could be used, but it is assumed net sets will be shallow (<20 feet). Each of the two sample crews will deploy four gill nets. The number of gill nets set in a reach during a single day will be determined by the available habitat and feasibility of setting nets in the reach. At downstream reaches, it is likely that up-to 12 nets will be set daily (total for all crews). At upstream sites, where suitable locations will be limited, it is likely that fewer nets will be set simultaneously.
   - Gill nets will generally be set in the afternoon or early evening, and pulled out the following morning[3]. Weather conditions and coordination with other boat crews and onshore teams may necessitate alternatives, but the FTL should avoid leaving nets unchecked for more than 12 hours.

[3] The permit may not allow overnight gill net sets. The nets may be required to be checked every few hours to avoid unnecessary mortality. This may require setting the nets in the late afternoon and pulling them about 3 hours after dark (checking them every two hours or so). Catch rates tend to be greater during the evening crepuscular period, than through the night.

- Gill netting will be conducted using the methods outlined in the Washington Department of Fish and Wildlife (WDFW) guidelines[4] to minimize impacts to salmonids, or otherwise specified in the WDFW sampling permit.

8. Conduct electrofishing, in the evening[5], at the first sampling location, as follows:

   - Record GPS coordinates, date, and time on the fish collection form (FCF) at the start of the electrofishing transect.

   - Electrofishing will be conducted using the methods outlined in the Washington Department of Fish and Wildlife (WDFW) guidelines (Bonar et al. 2000) to minimize impacts to salmonids, or otherwise specified in the WDFW sampling permit.

   - Deploy anode and navigate the vessel through littoral habitat, using straight direct current (DC) if possible, otherwise pulsed DC can be used. If straight DC is not an option, start by using lower frequencies (i.e., 30 Hz) and pulse rates and increase both as necessary to adequately stun the fish. No forms of alternating current (AC) will be used.

   - Collect stunned fish of the target species and target size range with dip nets. Avoid collection of non-target species.

   - Place targeted fish (that are measured to verify they are in the targeted size range) in designated cooler or live well.

   - Record GPS coordinates as a line feature from the beginning to the end of the electrofishing transect.

9. Move to additional sampling locations and repeat electrofishing procedure if needed. A separate FCF will be used for each electrofishing transect or location. Sampling crews will remain in regular contact to maximize fish collection efficiency and avoid collecting more than the target number of fish. When water levels are too shallow to allow boat access, electrofishing can be expanded by using backpack electrofishing methods (see SOP-4).

10. Following electrofishing, don a clean pair of disposable gloves (for each reach), sort fish according to species, recheck for target size, euthanize using a club or other method, tag

[4] The gillnet guidelines would be the stipulations likely to be included in the collection permit. This typically would include how long the nets would be fished between checks, and restrictions on overnight fishing.

[5] Electrofishing can be conducted during the day or at night depending on the fish to be targeted. However, as with other sampling methods, nighttime or crepuscular sampling periods are generally the most effective.

the fish using a pre-numbered plastic tag (described previously). Record the tag number on the FCF under the appropriate species heading.

11. Place the tagged fish on ice in coolers labeled according to reach and species for transport to the onshore sample processing station.
12. When sampling is finished, the sampling equipment (e.g., dip nets, lives wells, coolers) will be decontaminated by rinsing in lake water.
13. Additional water (10 to 15 gallons) will be collected away from shore at each reach to be used for rinsing fish and equipment at the onshore processing station.
14. Return to the boat ramp and deliver the fish and rinse water to the onshore processing station. The FTL or the Sample Processing Coordinator (SPC) will sign the chain-of-custody (COC) forms before the samples are shipped to the analytical laboratory.

Day 2. Gill Nets and Electrofishing

1. Return to and mobilize vessels the following morning to retrieve gill nets.
2. Travel to the target reach.
3. Retrieve gill nets at sampling locations.
4. Place targeted fish (that are measured to verify they are in the targeted size range) in designated cooler or live well. Fish that are retained will be processed onshore later where length and weight measurements will be made.
5. Return non-target species and unusable target species to the water. Dead fish will be removed from the gill net and will not be used in the analysis. Disposal of dead fish will be conducted by puncturing the swim bladder and returning fish to the water[6].
8. Following retrieval of gill nets, sort and label fish as described in Step 11, above, and place labeled fish on ice in coolers for transport to the onshore processing station.
9. Gill nets may be reset immediately if the FS and FTLs determine it is necessary. Gill nets may also be reset later in the day.
10. Electrofish using process described in Steps 8 to 12 for Day 1.
11. When sampling is finished, the sampling equipment (e.g., dip nets, lives wells, coolers) will be decontaminated by rinsing in lake water.
12. Additional water (10 to 15 gallons) will be collected away from shore at each reach to be used for rinsing fish and equipment at the onshore processing station.

[6] Although EPA had this in their SOP, permits may not allow this.

13. All crews return to the boat ramp and deliver the fish to the onshore processing station. Following processing, the FTL or the SPC will complete and sign the COC forms before the samples are shipped to the analytical laboratory.

Day 3 (required if additional fish collection is necessary)

1. Travel to target reach.
2. Retrieve gill nets set the previous day.
3. Remove captured fish and sort by target species and size, and sort out non-target species.
4. Return non-target species and unusable target species to the water. Dispose of dead fish by puncturing the swim bladder and returning fish to the water.
5. Following retrieval of gill nets at all locations, sort and label fish as described in Day 1, Step 11, above, and place labeled fish in coolers for transport to the onshore processing station.
6. The FTL and FS will confer to determine whether additional collections are necessary.
7. When sampling is finished, the sampling equipment (e.g., dip nets, lives wells, coolers) will be decontaminated by rinsing in lake water.
8. Additional water (10 to 15 gallons) will be collected away from shore at each reach to be used for rinsing fish and equipment at the onshore processing station.
9. Transport samples to the onshore processing station. Following processing, the FTL or the SPC will sign the COC forms before the samples are shipped to the analytical laboratory.

References

Bonar, S.A., B.D. Bolding, and M. Divens. 2000. Standard fish sampling guidelines for Washington State ponds and lakes. Washington Department of Fish and Wildlife Fish Program, Science Division, Inland Fisheries Investigations.

USEPA. 2005. Phase I fish tissue sampling quality assurance project plan Upper Columbia River site, CERCLA RI/FS. Region 10, United States Environmental Protection Agency.

STANDARD OPERATING PROCEDURE SOP-4

FISH COLLECTION BY BACKPACK ELECTROFISHING

Purpose

The purpose of this standard operating procedure (SOP) is to describe procedures for collecting fish using backpack electrofishing for the Upper Columbia River (UCR) Fish Tissue Study during Fall 2009. Methods described here were in part derived from the *Phase I Fish Tissue Sampling Quality Assurance Project Plan Upper Columbia River Site, CERCLA RI/FS* (USEPA 2005).

Scope and Applicability

This procedure applies to fish collection in the UCR in Fall 2009. This effort will involve one crew deploying a backpack electrofishing unit to collect several target fish species consumed by people and wildlife. Because the sampling methods to be used are not species-specific, any of the target species may be captured (and collected) using these methods. SOPs for other sampling methods (bottom trawls, seining nets, etc.) will also be employed as necessary to ensure collection of all target fish species. The Field Sampling Plan (FSP) Section 2.1 presents the target species (including backup species) that will be the focus of the fish sampling program.

Station Access

Prior to entering select areas such as private beaches, embayments or proximity to docks, it may be necessary to acquire property access permission from the landowner. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Equipment and Materials

- Tub or live well on board vessel for holding live fish (minimum of one per vessel)
- Coolers with wet ice (one cooler for each target species; at least eight total coolers per vessel)
- Carboy for lake water (three 5-gallon carboys per vessel)
- Fish clubs
- Measuring boards
- Boats equipped with backpack electrofishing units
- Backpack electrofishing units (two)

- Dip nets (three per vessel)
- Chest or hip waders (both should be available for backpack electrofishing).
- Heavy rubber gloves for electroshocking
- Disposable gloves for removing fish from nets
- Disposable cleanroom 100 certified nitrile gloves for handling fish carcasses
- Personal flotation devices
- Headlamps
- Radios
- Global positioning system (GPS) receivers
- Depth finder
- Knife (one per crew)
- Maps (UCR)
- Sequential pre-numbered fish tags (individual fish numbering labels) and cable ties for attaching them
- Digital camera
- Field forms and notebooks
- Pens and pencils
- First aid kits, and health and safety manuals (one each per crew).

Procedures

The procedures described below will be employed by a single crew employing backpack electrofishing to supplement other fish collection methods in each UCR reach. However, it may be impractical or impossible for a single crew to employ multiple collection methods in a single day at every reach. Further, some methods may be impractical or unproductive in certain collection areas. Therefore, final decisions on the methods to be used each day will be made by the Field Team Leaders (FTLs) and Field Supervisor (FS). Where suitable gillnetting locations are limited due to current and shoreline characteristics and boat based electrofishing may not be conducted in shallow areas, backpack elecectrofishing may be the only feasible sampling method.

If, after following the procedures described below, inadequate numbers of target fish for some or all species are collected from a specific sampling reach, the FS will consult with the Parametrix Project Manager (PM) to determine whether additional time or collection methods (i.e., angling) should be spent trying to obtain additional fish samples from these locations, or whether locations outside the reach should be sampled.

Backpack Electrofishing

A backpack electrofisher consists of a portable electrofishing unit and a power source (12v battery or mini generator) attached to a pack frame. It is equipped with a hand held, button-operated anode pole and a cathode plate which is left trailing in the water. The operator wears the pack unit and uses the button switch to activate the anode in order to stun fish while wading instream. One or more assistants wading next to the operator use dip nets to capture the stunned fish. The assistant also adjusts the electrofisher settings for the operator and monitors the electrical output. Sampling is normally conducted while moving upstream so that fish are not disturbed by the electrofishing activity.

Day 1. Backpack Electrofishing

1. Arrive at a selected boat ramp nearest to the target reach.
2. Mobilize sampling gear and vessels.
3. Decontaminate sampling equipment and fish holding containers by rinsing in lake water.
4. Review sampling objectives for the day.
5. Travel to the target sampling reach.
6. Identify specific sample locations within the target reach. Potential sampling locations may have been identified previously during site visits and/or conversations with biologists familiar with the species and collection area(s). Final collection locations will be at the discretion of the FTL (considering safety, wind, current, depth).
7. A backpack electrofishing unit is deployed by an operator and two assistants to collect stunned fish.
8. Most of this type of fishing will be conducted in the evening, therefore headlamps will be required.
9. At each sampling location record GPS coordinates, date, and time on the fish collection form (FCF) at the start of the electrofishing transect.
    - Backpack electrofishing will be conducted using the methods outlined in the Washington Department of Fish and Wildlife (WDFW) guidelines (Bonar et al. 2000) to minimize impacts to salmonids, or otherwise specified in the WDFW sampling permit.
    - Deploy the anode pole and a cathode plate and walk through the targeted shallow habitat, using straight direct current (DC) if possible, otherwise pulsed DC can be used. If straight DC is not an option, start by using lower frequencies (i.e., 30 Hz)

and pulse rates and increase both as necessary to adequately stun the fish. No forms of alternating current (AC) will be used.

- Collect stunned fish of the target species and target size range with dip nets. Avoid collection of non-target species.
- Place targeted fish (that are measured to verify they are in the targeted size range) in designated cooler or live well. Fish that are retained will be processed onshore later where length and weight measurements will be made.
- Record GPS coordinates at the end of the electrofishing transect.

10. Move to additional sampling locations and repeat backpack electrofishing procedure if needed. A separate FCF will be used for each electrofishing transect or location. Sampling crews will remain in regular contact to maximize fish collection efficiency and avoid collecting more than the target number of fish.
11. Following electrofishing, don a clean pair of disposable gloves (for each reach), sort fish according to species, recheck for target size, euthanize using a club, tag the fish using a pre-numbered plastic tag (described previously). Record the tag number on the FCF under the appropriate species heading.
12. Place the tagged fish on ice in coolers labeled according to reach and species for transport to the onshore sample processing station.
13. When sampling is finished, the sampling equipment (e.g., dip nets, lives wells, coolers) will be decontaminated by rinsing in lake water.
14. Additional water (10 to 15 gallons) will be collected away from shore at each reach to be used for rinsing fish and equipment at the onshore processing station.
15. Return to the boat ramp and deliver the fish and rinse water to the onshore processing station. The FTL or the Sample Processing Coordinator (SPC) will sign the chain-of-custody (COC) forms before the samples are shipped to the analytical laboratory.

Day 2. Backpack Electrofishing

1. Repeat all steps in day one as needed.

References

Bonar, S.A., B.D. Bolding, and M. Divens. 2000. Standard fish sampling guidelines for Washington State ponds and lakes. Washington Department of Fish and Wildlife Fish Program, Science Division, Inland Fisheries Investigations.

USEPA. 2005. Phase I fish tissue sampling quality assurance project plan Upper Columbia River site, CERCLA RI/FS. Region 10, United States Environmental Protection Agency.

STANDARD OPERATING PROCEDURE SOP-5

FISH COLLECTION USING BURBOT TRAPS

Purpose

The purpose of this standard operating procedure (SOP) is to describe procedures for collecting burbot using traps. Use of burbot traps is one method for the collection of target fish species as part of the Upper Columbia River (UCR) Fish Tissue Study conducted during Fall 2009. Methods described here were in part derived from the *Phase I Fish Tissue Sampling Quality Assurance Project Plan Upper Columbia River Site, CERCLA RI/FS* (USEPA 2005).

Scope and Applicability

This procedure applies to burbot collection using traps in the UCR in Fall 2009. The collection of burbot using this method will be conducted by one boat crew operating the traps, which will be baited. Therefore, the goal of the trapping effort is to collect large burbot (>30 cm), to acquire six burbot samples (each a composite of at least five fish) at different reaches in the UCR. Because the sampling methods to be used are not species-specific, additional target species may also be collected. The remaining target species will be collected using other methods (e.g., SOP-3).

Station Access

Prior to entering select areas such as private beaches, embayments or proximity to docks, it may be necessary to acquire property access permission from the landowner. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Equipment and Materials

- Four variable-size gill nets (200 x 10 feet [ft], 3- and 4-inch [stretch] mesh)
- 24 Burbot traps and bait, typical fishing bait or salmon eggs, or fish from other known sources
- Anchors (20 to 30 pounds [lb], two per net)
- Buoys (16-inch diameter or similar, two per net and one per burbot trap)
- Carabineers or clips for connecting float lines and anchors (up to eight per net)
- Tub or live well on board vessel for holding live fish (minimum of one per vessel)
- Coolers with ice (one cooler per vessel for each target species)

- Carboy for lake water (three 5-gallon carboys per vessel)
- Fish clubs
- Measuring boards
- Boats equipped for burbot traps, electrofishing and gill netting as needed for 1 crew
- Dip nets (two per electrofishing vessel)
- Rubber deck boots
- Disposable gloves for removing fish from nets
- Disposable cleanroom 100 certified nitrile gloves for handling and tagging fish carcasses
- Personal flotation devices
- Radios
- Global positioning system (GPS) receivers
- Depth finder
- Knife (one per crew)
- Maps (UCR)
- Sequential pre-numbered fish tags (individual fish numbering labels) and cable ties for attaching them
- Digital camera
- Field forms and notebooks
- Pens and pencils

Procedures

The procedure described below involves one crew employing burbot traps and gillnets each day for 3 days per reach. If inadequate numbers of fish of some or all species have been collected from a specific target reach after following the procedures described below, the Field Supervisor (FS) will consult with the Project Manager (PM) to determine whether additional time should be spent trying to obtain additional fish samples from these locations, or whether locations outside the reach should be sampled.

Day 1. Burbot Traps

1. Arrive at a selected boat ramp nearest to the target reach.
2. Mobilize sampling gear and vessel.
3. Decontaminate sampling equipment and fish holding containers by rinsing in lake water.
4. Review sampling objectives for the day.

5. Travel to the target reach.
6. Identify sample locations at the target reach. Potential sampling locations may have been identified previously during site visits and/or conversations with biologists familiar with this species and collection area. Final collection locations will be at the discretion of the Field Team Leaders (FTLs) (safety, wind, current, depth).
7. Deploy burbot traps (as necessary) and record GPS coordinates, date, and time on a separate fish collection form (FCF) for each trap.
   - Place bait (e.g., dead fish) in burbot trap and attach rope, weights, and buoy
   - Lower trap to the bottom.
8. Deploy gill nets (as necessary) as per SOP-3
9. Conduct electrofishing, in the evening, as per SOP-3 at the first sampling location.

Day 2. Burbot Traps

1. Return to and mobilize vessels the following morning to retrieve burbot traps and/or gill nets.
2. Travel to the target reach.
3. Retrieve burbot traps at first sampling locations.
4. Remove nontarget species and burbot of nontarget size ranges as quickly as possible and return to water if alive. Dead fish will be removed from the burbot trap and will not be used in the analysis. Disposal of dead fish will be conducted by puncturing the swim bladder and returning fish to the water[7].
5. Retrieve gill nets if needed as per SOP-3.
6. Following retrieval of gill nets and burbot traps, don a clean pair of disposable gloves (for each reach), sort fish according to species and size. Recheck for target size, euthanize using a club, tag the fish using a pre-numbered plastic tag[8] (described in SOP-3) and plastic cable tie attached through the gill and opercula. Record the tag number on the FCF under the appropriate species heading.
7. Place the tagged fish on ice in coolers labeled according to reach and species for transport to the onshore sample processing station. Fish that are retained will be processed onshore later where length and weight measurements will be made.

[7] Although EPA had this in their SOP, permits may not allow this.
[8] Numbering for the label is described in SOP-2.

8. Gill nets (as per SOP-3) and traps may be reset immediately if the FS and FTLs determine it is necessary, or they may also be reset later in the day.
9. When sampling is finished, the sampling equipment (e.g., dip nets, lives wells, coolers) will be decontaminated by rinsing in lake water.
10. Additional water (5 to 10 gallons) will be collected away from shore at each reach to be used for rinsing fish and equipment at the onshore processing station.
11. All crews return to the boat ramp and deliver the fish to the onshore processing station. The FTL or the Sample Processing Coordinator (SPC) will sign the chain-of-custody (COC) forms before the samples are shipped to the analytical laboratory.

Day 3 (required if additional fish collection is necessary)

1. Travel to target reach.
2. Retrieve traps set the previous day.
3. Remove captured fish and sort by target species and size, and sort out nontarget species.
4. Return nontarget species and unusable target species to the water. Dispose of dead fish by puncturing the swim bladder and returning fish to the water.
5. Following retrieval of traps at all locations, sort and label fish as described in Day 2, Step 8, above, and place labeled fish in coolers for transport to the onshore processing station.
6. The FTLs and FS will confer to determine whether additional collections are necessary.
7. When sampling is finished, the sampling equipment (e.g., dip nets, lives wells, coolers) will be decontaminated by rinsing in lake water.
8. Additional water (10 to 15 gallons) will be collected away from shore at each reach to be used for rinsing fish and equipment at the onshore processing station.
9. Transport samples to the onshore processing station. The FTL or the SPC will sign the COC forms before the samples are shipped to the analytical laboratory.

References

USEPA. 2005. Phase I fish tissue sampling quality assurance project plan Upper Columbia River site, CERCLA RI/FS. Region 10, United States Environmental Protection Agency.

STANDARD OPERATING PROCEDURE SOP-6

BEACH SEINES AND SHORE TRAPS FOR FISH COLLECTION

Purpose

The purpose of this standard operating procedure (SOP) is to describe procedures for collecting fish using beach seines and shore traps for the Upper Columbia River (UCR) Remedial Investigation/Feasibility Study (RI/FS). Methods described here were in part derived from the *Napa River Fisheries Monitoring Program Annual Report, 2002* and the *Draft 2004 Field Workplan for Teck Cominco Wide-Area Aquatic Ecological Risk Assessment* (USACE 2003; Golder Associates 2004).

Scope and Application

These procedures apply to fish collection on the UCR which will target smaller fish (<15 cm). This sampling will primarily target small sculpin and yellow perch, while other procedures will target the remaining species to be collected. This collection method will consist of one boat crew operating beach seines, shore traps, supplemented by electrofishing (see SOP-3) where necessary. The goal of this sampling effort is to collect small fish (<15 cm). Because the sampling methods to be used are not species-specific, additional target species captured may also be collected. The remaining target species should be collected following methods that use gillnets, boat and backpack electrofishing, and burbot traps (see SOP-3, SOP-4 and SOP-5).

Station Access

Prior to entering select areas such as private beaches, embayments or proximity to docks, it may be necessary to acquire property access permission from the landowner. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Equipment and Materials

- Chest or hip waders (both should be available for beach seining and trapping)
- Two beach seines
- 12 minnow traps and bait. Typical fishing bait or salmon eggs, or fish from other known sources
- Tub or live well on board vessel for holding live fish (minimum of one per vessel)

- Coolers with ice (one cooler per vessel for each target species)
- Carboy for lake water (three 5-gallon carboys per vessel)
- Fish clubs
- Measuring boards
- Boats equipped for beach seines and shore traps
- Dip nets (two per electrofishing vessel)
- Rubber deck boots (for use on vessels)
- Heavy leather gloves for net handling
- Disposable gloves for removing fish from nets
- Disposable cleanroom 100 certified nitrile gloves for handling and tagging fish
- Personal flotation devices
- Radios
- Global positioning system (GPS) receivers
- Depth finder
- Knife (one per crew)
- Maps (UCR)
- Sequential pre-numbered fish tags (individual fish numbering labels) and cable ties for attaching them
- Digital camera
- Field forms and notebooks
- Pens and pencils
- First aid kits, and health and safety manuals (one each per crew).

Procedures

The procedures for fish collection will vary by reach. However, at each reach it is anticipated that beach seines and shore traps will be used to capture fish. Many of these fish may be < 15 cm in length. For example, current and available habitat may necessitate the use of both beach seines and shore traps to complete the overall collection of target fish in the desired size categories. It is anticipated that beach seining will occur during nighttime hours. Alternatively, at locations that are limiting due to current and shoreline characteristics, electrofishing may be the only feasible sampling method within the reach. Beach seines and shore traps will be used to complement other fish collections methods addressed in SOPs. If required, beach seines and shore traps may be used outside of the designated reach. For example, if inadequate numbers of fish of some or all species have been collected from a specific target reach after following the procedures described in this SOP, the Field Supervisor (FS) will consult with the Project

Manager (PM) to determine whether additional time should be spent trying to obtain additional fish samples from these locations, or whether locations outside (and closely adjacent to) a reach should be sampled.

Beach Seine

Beach seines are used to target fish in shallow water habitats with low to moderate current (USACE 2003). When deployed, a beach seine creates a net wall extending from the surface with a floated line, to the bottom of the water column with a lead line. The mesh panels hanging from the float line to the lead line prevent fish from escaping. One sampling method involves use in shallow water, where the beach seine can be stretched out between two people and dragged through the water toward shore.

Alternatively, the beach seine may be deployed from the boat, which requires one end of the seine to be secured onto the bank and one end secured to the boat. The boat will be backed away from the shore, deploying the net, and then is driven back to the shore downstream or upstream of where the seine was secured on the bank. The seine will then pulled onto the shore, from both ends simultaneously by hand.

Beach seining can be conducted during the day or at night depending on the fish to be targeted. However, as with other sampling methods, nighttime or crepuscular sampling periods are generally the most effective and therefore, it is anticipated that the beach seining will occur during nighttime hours.

Shore Traps (Minnow Traps)

Minnow trapping is a passive sampling technique used to sample for the presence of minnow species and small life stages (i.e., fry) of larger species which can be difficult to capture using other techniques such as electrofishing or gill netting. The traps consist of two pieces which are clipped together to form a small cylinder slightly tapered at either end. Each end has a funnel entrance which leads into the centre of the trap which allows fish to enter but prevents them from escaping. The traps are generally placed on the substrate in the shallow shoreline areas of lakes and streams with the long axis of the trap parallel to the shoreline. A length of sideline is used to tie the trap to a stake or anchor on shore to keep it in place. The anchor site is usually flagged so that the site can be easily found when returning to check the trap. The traps will be baited to attract fish to the trap.

Day 1. Shore Traps and Beach Seine

1. Arrive at a selected boat ramp near the target reach.
2. Mobilize sampling gear and vessels.

3. Decontaminate sampling equipment and fish holding containers by rinsing with lake water.
4. Review sampling objectives for the day.
5. Travel to the target reach where beach seines and minnow traps will be deployed.
6. Identify candidate sample locations at the target reach. Candidate sampling locations may have been identified previously during site visits and/or conversations with biologists familiar with this species and collection area. Final selection of collection locations will be at the discretion of the FS and will be based on factors such as safety, wind, current, depth, and habitat suitability.
7. Deploy up to 12 shore traps within the reach for an overnight set. Shore trap deployment should occur before, and away from the location of beach seine activity.
8. For shallow water beach seine use, each person will grab one end of the net by holding the loop at the end of the float line in their hands. The net will have a spreader bar on either end, which allows easier maneuvering and also is easier to keep the bottom of the net in contact with the substrate. One person walks out from shore to a suitable depth. Both people then walk parallel to shore dragging the net between them. The lead line is kept in contact with the substrate to prevent fish from escaping under the net by dragging the foot looped to the lead line along the bottom. As they walk through the water, fish are herded in front of the net. The person near shore moves slower than the person further out where the person away from shore does not go deeper than their waist. When the offshore person has passed the near shore person he/she curves back to shore, meeting the near shore person at the waters edge and bringing the two ends of the net together forming a pen holding the captured fish. Both people then grab the lead lines and, positioned side-by-side, pull the net up on shore, ensuring that the lead line remains in contact with the substrate at all times. The float line and lead line are pulled at the same time to keep the net vertical as it is pulled to shore. The trapped fish will congregate in the end of the looped net and will be dragged up onto shore.
9. Following beach seining, don a clean pair of disposable gloves (for each reach), sort fish according to species and size. Recheck for target size, euthanize using a club, tag the fish using a pre-numbered plastic tag (described previously) and plastic cable tie attached through the gill and opercula. Record the tag number on the fish collection form (FCF) under the appropriate species heading.
10. Place the tagged fish on ice in coolers labeled according to reach and species for transport to the onshore sample processing station. Fish that are retained will be processed onshore.

11. Repeat beach seining as required. If beach seining unsuccessful at a reach, then conduct electrofishing at the sampling location (see SOP-3).
12. When sampling is finished, the sampling equipment (e.g., dip nets, lives wells, coolers) will be decontaminated by rinsing in lake water.
13. Additional water (5 to 10 gallons) will be collected away from shore at each reach to be used for rinsing fish and equipment at the onshore processing station.
14. Return to the boat ramp and deliver the fish and rinse water to the onshore processing station. The Field Team Leaders (FTLs) or the Sample Processing Coordinator (SPC) will sign the chain-of-custody (COC) forms before the samples are shipped to the analytical laboratory.

Day 2. Shore Traps and Beach Seine

1. Return to and mobilize vessels the following morning to retrieve shore traps.
2. Travel to the target reach.
3. Retrieve shore traps at sampling locations.
4. Remove captured fish and sort by target species and size.
5. Return non-target species and unusable target species to the water. Dead fish will be removed from the trap and will not be used in the analysis. Disposal of dead fish will be conducted by puncturing the swim bladder and returning fish to the water[9].
8. Following retrieval of shore traps, sort and label fish as described in Step 9 (Day One), above, and place labeled fish on ice in coolers for transport to the onshore processing station.
9. Shore traps may be reset immediately if the FS and FTLs determine it is necessary. Shore traps may also be reset later in the day.
10. If needed, return at night to beach seine using the process described above. If beach seining is unsuccessful at a reach, another vessel will need to conduct electrofishing at the sampling location (see SOP-3).
11. When sampling is finished, the sampling equipment (e.g., dip nets, lives wells, coolers) will be decontaminated by rinsing in lake water.
12. Additional water (5 to 10 gallons) will be collected away from shore at each reach to be used for rinsing fish and equipment at the onshore processing station.

[9] Although EPA had this in their SOP, permits may not allow this.

13. All crews return to the boat ramp and deliver the fish to the onshore processing station. The FTL or the SPC will sign the COC forms before the samples are shipped to the analytical laboratory.

References

Golder Associates Ltd. 2004. Draft 2004 field workplan for Teck Cominco wide-area aquatic ecological risk assessment. Prepared for Teck Cominco Ltd., P.O. Box 1000, Trail, BC.

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STANDARD OPERATING PROCEDURE SOP-7

SAMPLE PROCESSING FOR TARGET FISH SPECIES

Purpose

The purpose of this standard operating procedure (SOP) is to describe the procedures used for measuring fish length and weight, filleting certain target species and preparing composite samples and preparing samples for shipment to the analytical laboratory during the Upper Columbia River (UCR) Fish Tissue Study during Fall 2009.

Scope and Applicability

This SOP applies to all species of fish collected during all stages of sampling.

Equipment and Materials

- Freezers and thermometers
- Balance and calibration weight
- Measuring board
- Examination board (such as a plastic cutting board or stainless steel pan or tray)
- Cleanroom 100 certified nitrile gloves
- Heavy-duty aluminum foil
- Tubular, 4-mil, low-density polyethylene (LDPE), Food and Drug Administration (FDA)-approved plastic bags
- Various sizes of resealable plastic bags
- Cable ties
- Lake water (reach specific; 10 to 15 gallons per reach)
- Carboys for lake water and rinse liquids
- Spray bottle (containing lake water for rinsing equipment[10])
- Processing forms
- Secondary field tags
- Auxiliary light sources (lamps)
- Roll of plastic sheeting (for processing area)

[10] Lake water used in processing will come from the same reach where the fish were collected.

- Stainless steel utility knife
- Scalpel with replaceable stainless steel blades
- Stainless steel fillet knives
- Forceps
- Teflon-coated probe
- Tweezers
- Glass cutting boards
- Sample containers for fish otoliths
- Alcohol (for preservation of otoliths)
- Secondary sample labels (both preprinted and plain)
- Laminated picture sheets for fish identification and an identification book, Wydoski and Whitney, 2nd edition (2003).
- Scale (with calibration weights)
- Rinse solvent - methanol, pesticide quality or equivalent
- Type II Millipore water
- Phosphate-free detergent
- Twenty percent nitric acid prepared by adding one part concentrated nitric acid to four parts type II Millipore water
- Office supplies—computer(s), printer, copier, a file cabinet, pens and pencils
- Marine band radio and cell phone
- Digital camera
- Alconox soap and brushes

Procedures

The measurement, filleting, and sorting of fish will be performed in a trailer located in a recreational vehicle site (RV Site) or marina near each fish collection area. The trailer will remain at the RV site or marina for the duration of the fish sampling and will serve as a communications center, field office, and fish sample processing area.

The trailer will be divided into an office section and a working section. The office will be equipped with a computer, printer/fax machine, file cabinet, general office supplies, and necessary radio communications equipment to contact the personnel on board the sampling vessels. The work area will have a large roll-up door for access and ventilation. The work area will have positive pressure filtered air. The work area will be lined with plastic sheeting to keep the walls and floor clean and will contain two freezers, work tables/benches, the measuring equipment, and space for examining and processing the fish. Plastic sheeting will also cover the

processing tables. Additional equipment storage will be available in a truck, also located at the RV Site.

The onshore personnel (or crew) will be available to assist the fish sampling crews as necessary, including traveling to boat launch sites to collect fish from the fish sampling crews.

Fish Processing

Following are the procedures to be used for fish processing at the onshore station. Fish will be measured, examined, and processed on the same day that they are collected. Fish collected by electrofishing or other methods at night may be measured, examined, and processed the following day (see Attachment 3 for examples of all forms). ***Fish will be measured, examined, processed, and then frozen within 48 hours of collection.***

1. Receive fish from field sample crew. Fish will be on ice in coolers, sorted by reach and species. Check that coolers are clearly labeled in accordance with the specifications (previously described) and that ice in coolers is adequate to keep fish cold until measurements, examination and processing is complete. The Field Team Leader (FTL) or Sample Processing Coordinator (SPC) will sign chain-of-custody (COC) forms prior to shipping the fish to the analytical laboratory.
2. Prior to resection, hands will be washed with Ivory soap and rinsed thoroughly in tap water, followed by contaminant-free, deionized water. Wear cleanroom 100 certified nitrile gloves when handling fish. Gloves will be changed following processing of all of the fish from a given UCR reach (i.e., new gloves for each reach).
3. For each cooler, count all fish, confirm species identification, and check that each fish has been tagged. The field tag will be a plastic tag with a full code that will be recorded along with all collection information on the fish collection form (FCF). It will be attached to the resealable plastic bag or, if necessary, to the fish through the mouth and opercula and will remain attached to the fish until homogenization by the offsite analytical laboratory.
4. Check the field tag against the information on the FCF. If the FTL who collected the fish is present, the relevant FCFs from the FTL's notebook should be photocopied and the fish tag numbers checked against the fish in each cooler. If the FTL is not present due to scheduling logistics, the relevant pages from the notebook may be photocopied later.
5. Locate or prepare a length-weight form (LWF) for each cooler of fish and proceed as follows:
    - A separate LWF should be used for <u>each species</u> collected at each reach.

- A single LWF should be used for up to 25 individuals of a given species at a given reach; even if the fish were collected at different dates or times. If more than 25 fish of a species are collected from a reach, an additional LWF may be used.
- Record date and time on the LWF.

6. Prepare the measuring and examination area, as follows:

   a. At the beginning of each day, and after every 20 measurements, check the calibration of the fish-weighing scale using the calibration weight.

   b. Decontaminate the examination board or tray, cutting utensils and the measuring board by washing with laboratory detergent (Alconox) and water, then three rinses with pesticide grade methanol followed by three times with 20 percent nitric acid and finally with three rinses of Type II Millipore water. Discard all rinses into a carboy for waste liquids.

   c. If necessary, decontaminate the balance pan by rinsing with lake water. NOTE: this is unnecessary if the balance pan is covered with a clean piece of foil for each fish.

7. Rinse the surface of the fish by rinsing with deionized (DI) water to remove loose scales or other particles, dirt, or blood. Discard rinse water as described in Step 6b, above.

8. Record the fish tag number on the LWF for the reach and species identified by the label on the cooler. This information should be cross-checked with the information on the FCF filled out by the FTL at the time of collection.

9. Measure the length of the fish. Place the fish on the measuring board with the anterior end (nose) of the fish against the zero line on the board. Measure the length of the fish at its longest point, and record the value on the LWF. Record length to the nearest millimeter.

10. Measure the weight of the fish. Tare the balance (with foil liner) and place the fish on the foil liner on the balance. Make sure that any parts of the fish overhanging the balance pan are not touching the table or any other objects. Record the weight of the fish on the LWF. Record weight to the nearest gram (note that the balance used may read in 2-gram increments, in which case record to the nearest 2 grams).

11. Perform the external examination (according to Smith et al. 2002). Place the fish on the examination board or on the piece of foil that will be used to wrap the fish for storage and shipping. Fill out a fish external examination form, using a separate form for each fish. A detailed explanation of each step in the examination will be available in the examination area. Photographs will be taken on all sides of each of the fish examined. External abnormalities are noted for future reference in relation to locations of sharp-

edged slag, and are not intended to derive statistical relationships between contaminants and fish health. Following examination, the fish samples will be prepared for shipment to the offsite processing laboratory. Record the fish tag number, frame number and description in the fish processing logbook and the fish processing form (FPF).

12. If the otolith (or opercle) is to be removed, remove the otolith and store the otolith in the proper container with appropriate preservative (alcohol). Label the container with fish ID, date, time, and species of fish. If a otolith was removed, record in the fish processing log form. ***Otoliths should only be removed when a full set of fish are available for compositing.***

13. If the sex of the fish is to be determined, open the fish using a clean and decontaminated fillet knife, record the sex of the fish in the fish processing logbook and the FPF.

14. Determine if the fish is to be a "whole" sample or "filleted". Specifically, all fish >30 cm in length are filleted. ***Filleting of fish should only proceed when a full set of fish are available for compositing.***

    - If the composite sample is for whole fish, process as follows:
        - Fill out a secondary field tag. The secondary field tag will be used by the offsite analytical lab to identify the fish without unwrapping it. The information on the tag will be the same as the primary fish tag, reach, species, size group and field tag number (e.g., TAI3-RBW-S2-0052).
        - After filling out the tag, wrap each whole fish in aluminum foil with the dull surface of the foil against the fish.
        - Wrap fish in plastic bag or resealable plastic bag. Resealable bags may be more appropriate for the smaller fish. Pull from the roll a length of plastic tubing about 6 inches longer than the length of the fish. Place the fish inside the single bag and secure the ends of the bag with cable ties.
        - Place the secondary field tag on the outside of the plastic bag and secure with clear packing tape.
        - Group the whole fish sample with the other members of the species and size composite group.
            - Randomly select fish (sizes <15 cm or $\geq$15 to $\leq$30 cm) to be as close as possible to the same size; largest fish should be no more than 75 percent longer than the smallest fish in the sample.

- If the composite sample is for (separate) fillets and offal, first fillet the fish and separate the fillet from the offal (offal is all remaining fish parts including head, tail, guts, bones, organs, etc.) as follows:
  - Fillet fish by first removing the head (cut behind the gills).
  - Holding fish by the tail, and using a clean and decontaminated fillet knife (a clean and decontaminated fillet knife is used for each fish), make a vertical slice, close to the tail, until the knife is just touching the vertebral column (do not make the vertical cut with too much force or you will cut off the tail, which makes filleting less easy). Move the fillet knife parallel to the vertebral column along the full length of the fish toward the (removed) head area. Remove the skin-on fillet. Repeat the filleting procedure on the second side of the fish.
  - Walleye and smallmouth bass fillets will have individual total mercury analysis conducted prior to compositing. The field team will ensure that the COCs indicate that this should be conducted and coordinate with the lab to ensure that this analysis is performed.
  - For > 30 cm largescale sucker only, the gut must be removed from the carcass and cleaned before placing back with the offal portion of the sample.
    - The gut will be cut from the largescale sucker carcass after filleting by cutting the posterior end of the intestine first and anterior end of the esophagus second.
    - The gut will be removed from the fish body cavity, rinsed with deionized water, gently patted dry with a paper towel.
    - The gut will be cut along its full length and the contents of the stomach extruded into a pre-cleaned glass jar. Sucker gastrointestinal tracts typically do not have distinctive anatomical components (stomach, intestine), are long (approximately 3 m), and narrow.
    - The guts will then be rinsed clean with deionized water.
    - Once rinsed, the gut will be placed back with the offal sample.
    - Entire gut contents from each specimen will be combined for a composite.
  - Treat the fillet and offal as two separate samples for compositing purposes. ***Do Not Combine***.

- Fill out a secondary field tag as for each sub-part (i.e., fillet, offal) of the fish. Then wrap each set of fillets or offal in aluminum foil with the dull surface of the foil against the fish.
- Wrap the separate fillet and offal parts of the fish into separate plastic bags. Pull from the roll a length of plastic tubing about 6 inches longer than the length of the fish. Place the fillet and offal samples of the fish inside the second bag and close the ends of the bag with cable ties.
- Place the secondary field tag on the outside of the bag.
- Group the samples with the other members of the species and size composite group. Composites for >30 cm fish will be created using a random number generator. No size limitations will be applied to >30 cm fish composites, therefore each fish will have an equal chance of being included in the composite.

15. If the next fish to be filleted is for the same composite simply change the aluminum foil that covers the cutting board. If the fish to be filleted is for a new composite, rinse the cutting board and cutting utensils by washing with laboratory detergent and water, then three rinses with pesticide grade methanol followed by three times with 20 percent nitric acid and finally with three rinses of Type II Millipore water.
16. ***Place the fish that are to be composited together (either all whole fish, or fish that have been separated into offal and fillets) in another plastic bag, fill out the composite fish sample label (see SOP-2 for numbering) and tape to the outside of the bag, close the ends of the bag with cable ties.*** Record each of the individual fish numbers that make up a composite and the composite fish sample label number into the fish processing logbook and the FPF. Fish for composites may need to be stored for more than one day until enough fish is acquired to complete a composite.
17. Place the packaged fish in the freezer. If possible, fish of the same species and reach should be stored in the freezer together, either in a box or a large plastic bag. ***Seal the freezer with COC tape at the end of each day or if leaving the vicinity of the trailer.***
18. After fish have been processed for a reach, remove and replace plastic sheets used to cover the floors and tables.
19. Place two photocopies of the FCFs and LWFs in files in the onshore office trailer. One copy will remain in the file onshore for the duration of the project, and the second copy will be transported offsite for storage.

20. Add fish tag numbers to the electronic file stored in the computer. Input all data, including that in the Fish Processing Log, into the electronic file (at the instruction of the SPC) daily or as often as practical.

References

Wydoski, R.S. and R.R. Whitney. 2003. Inland fishes of Washington, 2nd edition. American Fisheries Society, Bethesda, Maryland and University of Washington Press, Seattle.

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STANDARD OPERATING PROCEDURE SOP-8

SAMPLE STORAGE, PACKING, AND SHIPPING

Scope and Applicability

Specific requirements for sample storage on-site, packaging of sample coolers, and shipment to the off-site analytical laboratory are addressed in this Standard Operating Procedure (SOP) for the UCR 2009 Fish Tissue Sampling Program.

Equipment and Materials

Specific equipment or supplies necessary to properly pack and ship fish tissue samples include the following:

- Quality Assurance Project Plan for 2009 Fish Tissue Study
- Freezer temperature logbook
- Freezers with thermometers
- Resealable plastic bags (assorted sizes)
- Wet ice in doubled, sealable bags; or dry ice
- Coolers
- Bubble wrap
- Fiber-reinforced packing tape and clear plastic packing tape
- Scissors or knife
- Chain-of-custody (COC) forms
- COC seals
- Large plastic garbage bags (preferably 3 mil thick) for cooler lining
- Paper towels
- "Fragile," "This End Up," or "Handle With Care" labels
- Mailing labels
- Air bills for overnight shipment

Procedures

In some cases, samples may be transferred from the field to a local storage facility where they can be either frozen or refrigerated. All shipping will utilize a commercial courier or shipping service.

As a courier service will be used, Parametrix field personnel will need to be aware of any potentially limiting factors to timely shipping (e.g., availability of overnight service and weekend deliveries to specific areas of the country, shipping regulations "restricted articles" [e.g., dry ice]) prior to shipping the samples.

On-Site Sample Storage

Samples will be placed in secure storage (i.e., locked room or vehicle) or remain in the possession of Parametrix sampling personnel before shipment. Any sample storage areas will be locked and secured to maintain sample integrity and COC requirements. In the onsite processing area samples will be maintained in coolers with wet ice at 4 degrees C until processing is completed, at which time they will be placed in locked freezers until they are packaged for shipping to the off-site analytical laboratory. A freezer temperature log will be maintained, where temperatures are taken and recorded in the morning.

Packing and Preparation

The following steps should be followed to ensure the proper transfer of samples from the field to the off-site analytical laboratory.

1. Check sample containers against the COC form to ensure all samples intended for shipment are accounted for.
2. Choose the appropriate size cooler (or coolers) and make sure that the outside and inside of the cooler is clean of gross contamination. If the cooler has a drain on the outside at the bottom of the cooler, the drain should be capped and thoroughly taped shut with duct tape.
3. The cooler should be lined with a large plastic bag (preferably a bag with a thickness of 3 mil) should be opened and placed inside the cooler.
4. Place the composite samples (which during the sample processing step had already been placed in plastic bags) into the large plastic bag in the cooler, leaving sufficient room for dry ice to keep the samples cold (i.e., 4°C).
5. Check sample containers against the COC form to ensure all of the samples that were collected are in the cooler.
6. As the samples have a required storage temperature, add enough dry ice to keep the samples refrigerated during overnight shipping (i.e., 4°C). Always over-estimate the amount of ice that you think will be required. Ice should be enclosed in a resealable plastic bag. After all samples and ice have been added to the cooler, use bubble wrap (or other available clean packing material) to fill any empty space to keep the samples from shifting during transport.

7. Sign and date the completed COC form and retain the pink (back) copy for project files. Place the rest of the signed COC form in a resealable bag and tape the bag containing the form to the inside of the cooler lid. Each cooler should contain an individual COC form for the samples contained in each respective cooler. If time constraints impact sample shipping and it becomes necessary to combine all of the samples onto a single set of COC forms and the shipment contains multiple coolers, indicate on the outside of the respective cooler "Chain-of-Custody Inside."

8. After the cooler is sufficiently packed to prevent shifting of the containers, close the lid and seal it shut with fiber-reinforced packing tape. The cooler should be taped shut around the opening between the lid and the bottom of the cooler and around the circumference of the cooler at both hinges.

9. As security against unauthorized handling of the samples, apply two COC seals across the opening of the cooler lid. One seal should be placed on the front right portion of the cooler and one seal should be placed on the back left portion of the cooler. Be sure the seals are properly affixed to the cooler so they are not removed during shipment. Additional clear packing tape across the seal may be necessary if the outside of the cooler is wet.

The sample processing coordinator should notify the laboratory contact and the Parametrix project quality assurance/quality control (QA/QC) coordinator that samples will be shipped and the estimated arrival time. The Sample Processing Coordinator (SPC) should also send copies of all COC forms to Parametrix's project QA/QC coordinator or project manager, as appropriate.

Shipping

1. Fish samples will usually be shipped the morning after processing. Use a mailing label and label the cooler with destination and return addresses, and add other appropriate stickers, such as "This End Up," "Fragile," and "Handle With Care." If the shipment contains multiple coolers, indicate on the mailing label the number of coolers that the testing laboratory should expect to receive (e.g., 1 of 2; 2 of 2). Place clear tape over the mailing label to firmly affix it to the outside of the cooler and to protect it from the weather. This is a secondary label in case the airbill is lost during shipment.

2. Fill out the airbill as required and fasten it to handle tags provided by the shipper (or the top of the cooler if handle tags are not available). The coolers will also be required to have the appropriate labeling for dry ice., which includes the weight of dry ice for each cooler (Class 9 Dangerous Goods Label [required by U.S. Department of Transportation for coolers containing dry ice that will be shipped by air].)

STANDARD OPERATING PROCEDURE SOP-9

FIELD DOCUMENTATION

Scope and Applicability

The integrity of each sample from the time of collection to the point of data reporting must be maintained throughout the study. Proper record keeping will be implemented in the field to allow samples to be traced from collection to final disposition.

All information pertaining to field operations during sample collection must be properly documented to ensure transparency (and reproducibility) of methods and procedures. Several types of field documents will be used for this purpose by field personnel.

Field Logbooks

During field sampling events, field logbooks are used to record all daily field activities on each vessel used for fish tissue collection. The purpose of the field logbook is to document events that occur during field activities and to record data measured in the field to ensure transparency and reproducibility.

The field logbook is the responsibility of, and maintained by the FTL for each vessel. The site logbook will be kept current by the Field Supervisor (FS) during field activities and will be placed in the project files at the conclusion of field activities.

The field logbook will be bound and waterproof with consecutively numbered pages. All entries will be made using indelible ink and no erasures will be made. Any necessary corrections in the logbook should consist of a single line-out deletion, followed by the author's initials and the date. The author will initial and date each page of the field logbook, sign and date the last page at the end of each day, and draw a line through the remainder (unused portion) of that page.

The project name, dates of the field work, site name, and location (city and state) should be written on the cover of the field logbook. If more than one logbook is used during a single sampling event, then the upper right hand corner of the logbook will be annotated (e.g., Volume 1 of 2, 2 of 2) to indicate the number of logbooks used during the field event. Field logbooks will be stored in a secure manner when not in use in the field.

At a minimum, the following information will be recorded in the field logbook:

- Project name and location.
- Purpose and description of the field task.
- Project start date and end date.
- Date and time of entry (24-hour clock).
- Time and duration of daily sampling activities.
- Weather conditions at the beginning of the field work and any changes that occur throughout the day, including the approximate time of the change (e.g., wind speed and direction, rain, thunder, wave action, vessel traffic, temperature of both the air and water).
- Name and affiliation of person making entries and other field personnel and their duties, including the times that they are present.
- The location and description of the work area, including sketches, map references, and photograph log, if appropriate.
- Level of personal protection being used.
- Onsite visitors (names and affiliations), if any, including the times that they are present (e.g., cultural resource personnel, agency observers, etc.).
- The name, affiliation, and telephone number(s) of any key field contacts.
- Notation of the coordinate system used to determine the station location information.
- The sample identifier and analysis code for each sample to be submitted for laboratory analysis, if not included on separate field data sheets (cross reference provided).
- All field measurements made (or reference to specific field data sheets used for this purpose), including the time that the measurement was collected and the date of calibration, if appropriate.
- The sampling location name, date, gear, water depth (if applicable), and sampling location coordinates, if not included on separate field data sheets.
- The type of vessel used (e.g., size, power, type of engine) (for aquatic sampling only).
- Specific information on each type of sampling activity.
- The sample type (e.g., fish tissue, surface sediment), sample number, sample tag number, and preservatives used (if any), if not included on separate field data sheets.
- Sample storage methods.
- Cross-references of numbers for duplicate samples.
- A description of the sample [for fish sampling this would include approximate number of target/non-target fish by species caught for each gear set or whether gear was unsuccessful; any debris caught in sample gear; unusual odors, etc.].
- Photographs (uniquely identified) taken at the sampling location, if any.

- Details of the work performed.
- Variations, if any, from the project-specific Quality Assurance Project Plan (QAPP) or standard operating protocols and reasons for deviation.
- Details pertaining to unusual events which might have occurred during sample collection (e.g., possible sources of sample contamination, equipment failure, unusual appearance of sample integrity).
- References to other logbooks or field forms used to record information (e.g., field data sheets, health and safety log).
- Sample shipment information (e.g., shipping manifests, COC form numbers, carrier, air bill numbers, time addresses).
- A record of quantity of investigation derived wastes (if any) and storage and handling procedures.

During the field day, as listed above, a summary of all site activities should be recorded in the logbook. The information need not duplicate anything recorded in other field logbooks or field forms (e.g., Site Health and Safety Officer's logbook, calibration logbook, field data sheets), but should summarize the contents of the other logbooks and refer to the page locations in these logbooks for detailed information.

If measurements are made at any location, the measurements and equipment used must either be recorded in the field logbook or reference must be made to the logbook and page number(s) on which they are recorded. All maintenance and calibration records for equipment should be traceable through field records to the person using the instrument and to the specific piece of instrumentation itself.

Upon completion of the field sampling event, the FS will be responsible for submitting all field logbooks to be copied. A discussion of copy distribution is provided below.

Sample Processing and Field Data Forms

Sample processing and field data forms will be generated during this field sampling event (e.g., fish length-weight form, fish collection form) to record the relevant sample information collected during a sampling event. For instructions regarding the proper identification of field data forms, sampling personnel should consult the Quality Assurance Project Plan (QAPP) (Appendix A Attachment 3).

Upon completion of the field sampling event, the FS will be responsible for submitting all field data forms to be copied. A discussion of copy distribution is provided below.

Photographs

In certain instances, photographs (print or digital) of sampling stations may be taken using a camera-lens system with a perspective similar to the naked eye. Photographs should include a measured scale in the picture, when practical (e.g., pencil, coin, ruler, etc.). Photographs may also be taken of sample characteristics and routine sampling activities. Telephoto or wide-angle shots will not be used because they cannot be used in enforcement proceedings. The following items should be recorded in the field logbook for each photograph taken:

1. The photographer's name or initials, the date, the time of the photograph, and the general direction faced (orientation).
2. A brief description of the subject and the field work portrayed in the picture.
3. For print photographs, the sequential number of the photograph and the film roll number (if applicable) on which it is contained.
4. For digital photographs, the sequential number of the photograph, the file name, the file location, and back-up Compact Disc (CD) number (if applicable).

Upon completion of the field sampling event, the FS will be responsible for submitting all photographic materials to be developed (prints) or to be copied (CDs), as appropriate. The prints or CDs (as appropriate) and associated negatives will be placed in the project files (at the Parametrix Project Manager's location). Photo logs and any supporting documentation from the field logbooks will be photocopied and placed in the project files with the prints or disks.

Equipment Calibration Records

Equipment calibration records, including instrument type and serial number, calibration supplies used, calibration methods and calibration results, date, time, and personnel performing the calibration, should be recorded in the field logbook. At a minimum, equipment used during the investigation should be calibrated daily in accordance with the manufacturers' recommendations.

Distribution of Copies

Two copies of all field logbooks and additional field data forms will be made at Parametrix. The first copy will be stamped with a "COPY" stamp. This copy will be placed in the project file and will be available for general staff use. The second copy will be stamped with a "FILE" stamp. This copy will be placed in the data management file with the laboratory data packages and will be used by the data management and quality assurance staff only. The original field logbooks and forms will be placed in a locked file cabinet at the Project Manager's location.

Set-up of Locking File Cabinet

Each project will have its own file folder in a locking file cabinet. The folder label will include the project name and contract number. As many as six kinds of files will be included in this folder for each project:

- Field logbook(s)
- Additional field data forms
- Photographs
- COC forms
- Acknowledgment of Sample Receipt forms
- Archive Record form (to be completed only if samples are archived at a Parametrix field storage facility or Parametrix laboratory).

STANDARD OPERATING PROCEDURE SOP-10

SAMPLE CUSTODY

Scope and Applicability

This SOP describes Parametrix procedures for custody management of environmental samples during the 2009 UCR fish tissue sampling program. The procedure outlined herein will be used in conjunction with SOP-8, which covers sample packaging and shipping; SOP-9, which covers the use of field logbooks and other types of field documentation; and SOP-2, which covers sample labeling.

Chain-of-custody (COC) forms ensure that samples are traceable from the time of collection through processing and analysis until final disposition. A sample is considered to be in a person's custody if any of the following criteria are met:

1. The sample is in the person's possession
2. The sample is in the person's view after being in possession
3. The sample is in the person's possession and is being transferred to a designated secure area
4. The sample has been locked up to prevent tampering after it was in the person's possession.

At no time is it acceptable for samples to be outside of Parametrix personnel's custody unless the samples have been transferred to a secure area (i.e., locked up and custody sealed). If the samples cannot be placed in a secure area, then a Parametrix field team member must physically remain with the samples (e.g., at lunch time one team member must remain with the samples).

Chain-of-Custody Forms

The COC form is critical because it documents sample possession from the time of collection through the final disposition of the sample. The form also provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped.

The COC form will be completed after each field collection activity and before the samples are shipped to the laboratory. Sampling personnel are responsible for the care and custody of the samples until they are shipped. When transferring possession of the samples, the individuals

relinquishing and receiving the samples must sign the COC form(s), indicating the time and date that the transfer occurs.

The COC forms each consist of 3-part carbon-less paper with white, yellow, and pink copies. The white sheet and the yellow sheet will be placed into a plastic sealable bag and secured to the inside top of each transfer container (e.g., cooler). The pink sheet will be retained by the field staff for filing at the Parametrix Project Manager's location. Each COC form has a unique number. This number and the samples on the form shall be recorded in the field logbook. Parametrix also uses computer-generated COC forms. If computer-generated forms are used, then the forms will be printed in triplicate, sequentially numbered, and all three sheets signed so that two sheets can accompany the shipment to the laboratory and one sheet can be retained on file at the Parametrix Project Manager's location. Alternatively, if sufficient lead time is available, the computer-generated forms will be printed on 3-part carbon-less paper.

The individual fish sample labels and composite fish sample labels will be recorded on the COC form. The COC form will also identify the sample collection date and time, the type of sample, the project, and the sampling personnel. In addition, the COC form provides information on the preservative or other sample pretreatment applied in the field and the analyses to be conducted by referencing a list of specific analyses or the statement of work for the laboratory. The COC form will be sent to the laboratory along with the sample(s).

Procedures

The following guidelines will be followed to ensure the integrity of the samples:

1. At the end of each sampling day and prior to shipping or storage, COC entries will be made for all samples and COCs will be filled out for all samples. Information on the COCs will be checked against field logbook entries.

2. At the bottom of each COC form is a space for the signatures of the persons relinquishing and receiving the samples and the time and date that the transfer occurred. Usually either the Sample Processing Coordinator (SPC) or Field Supervisor (FS) will relinquish the samples. The time that the samples were relinquished should match. Each COC form must be appropriately signed and dated by the sampling personnel. The person who relinquishes custody of the samples must also sign this form.

3. The COC form should not be signed until the information has been checked for inaccuracies by the FS. All changes should be made by drawing a single line through the incorrect entry and initialing and dating it. Revised entries should be made in the space below the entries. Any blank lines remaining on the COC form after corrections are

made should be marked out with single lines that are initialed and dated. This procedure will preclude any unauthorized additions.

4. At the bottom of each COC form is a space for the signatures of the persons relinquishing and receiving the samples and the time and date that the transfer occurred. The time that the samples were relinquished should match exactly the time they were received by another party. Under no circumstances should there be any time when custody of the samples is undocumented.

5. If samples are sent by a commercial carrier not affiliated with the laboratory, such as Federal Express (FedEx) or United Parcel Service (UPS), the name of the carrier should be recorded on the COC form. Any tracking numbers supplied by the carrier should be also entered on the COC form. The time of transfer should be as close to the actual drop-off time as possible. After the COC forms are signed and the "pink" copy has been removed, they should be sealed inside the transfer container.

6. If errors are found after the shipment has left the custody of sampling personnel, a corrected version of the forms must be made and sent to all relevant parties. Minor errors can be rectified by making the change on a copy of the original with a brief explanation and signature. Errors in the signature block may require a letter of explanation.

7. Samples that are archived internally at Parametrix or a Parametrix authorized laboratory must be accompanied by a COC form and an Archive Record form.

8. Upon completion of the field sampling event, the FS will be responsible for submitting all COC forms to be copied.

Custody Seal

As security against unauthorized handling of the samples during shipping, two custody seals will be affixed to each sample cooler. The custody seals will be placed across the opening of the cooler (front right and back left) prior to shipping. Be sure the seals are properly affixed to the cooler so they cannot be removed during shipping. Additional tape across the seal may be prudent.

Shipping Air Bills

When samples are shipped from the field to the testing laboratory via a commercial carrier (e.g., Federal Express, UPS), an air bill or receipt is provided by the shipper. Upon completion of the field sampling event, the FS will be responsible for submitting the sender's copy of all shipping air bills to be copied. The air bill number (or tracking number) should be noted on the

applicable COC forms or alternatively the applicable COC form number should be noted on the air bill to enable the tracking of samples if a cooler becomes lost.

Acknowledgement of Sample Receipt Forms

In most cases, when samples are sent to a testing laboratory, an Acknowledgment of Sample Receipt form is faxed to the project QA/QC coordinator the day the samples are received by the laboratory. It is the responsibility of the person receiving this form (designated by Project Manager) to review the form and make sure that all the samples that were sent to the laboratory were received by the laboratory and that the correct analyses were requested. If an error is found, the laboratory must be called immediately. Decisions made during the telephone conversation should be documented in writing on the Acknowledgment of Sample Receipt Form. In addition, corrections should be made to the COC form and the corrected version of the COC form should be faxed to the laboratory.

The Acknowledgment of Sample Receipt form (and any modified COC forms) will then be submitted to be copied.

Archive Record Forms

On occasion, samples are archived at a Parametrix office or a Parametrix authorized laboratory. If samples are to be archived, it is the responsibility of the project manager or analytical laboratory manager to complete an Archive Record form. This form is to be accompanied by a copy of the COC form for the samples, and will be placed in a locked file cabinet. The original COC form will remain with the samples in a resealable plastic bag.

ATTACHMENT A3

EXAMPLES OF VARIOUS FIELD FORMS

Fish Collection Form
Upper Columbia River (UCR) Fish Tissue Study

Reach _____ Collection Date (MM/DD/YYYY): Start_____ End_____

Gear Details: (circle one)

☐ E = Electrofishing	Run	1	2	3	4	5	6	_____
☐ N = Gillnetting	Net	1	2	3	4	5	6	_____
☐ T = Burbot trap	Trap	1	2	3	4	5	6	_____
☐ BS = Beach seine	Net	1	2	3	4	5	6	_____
☐ ST = Shore trap	Trap	1	2	3	4	5	6	_____
☐ SL = Set line	Run	1	2	3	4	5	6	_____
☐ BT = Bottom trawl	Run	1	2	3	4	5	6	_____

Sampling Information

Start Time : _____

Start Location:
Latitude (deg., min., sec.):_____ Longitude (deg., min., sec.):_____

End Time: _____

End Location:
Latitude (deg., min., sec.):_____ Longitude (deg., min., sec.):_____

Sampling depth:_____ Water depth (m):_____

Site Description:
_____
_____

Crew Information

Collectors' Names (print): _____

Field Team Leader (print and sign): _____

Notes and/or Sketch

Fish Collection Form Notes 1
Upper Columbia River (UCR) Fish Tissue Study

Reach _____

Fish No.	Walleye Individual Fish Sample Number (e.g.: WE-S2-052)	Burbot Individual Fish Sample Number (e.g.: BU-S3-062)	Smallmouth Bass Individual Fish Sample Number (e.g.: SB-S2-022)	Rainbow Trout Individual Fish Sample Number (e.g.: RBW-S2-056)	Kokanee Individual Fish Sample Number (e.g.: KH-S2-062)	Lake Whitefish Individual Fish Sample Number (e.g.: LW-S2-042)	Mountain Whitefish Individual Fish Sample Number (e.g.: MW-S2-042)	External Abnormalities? Y/N
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								

Fish Collection Form Notes 2
Upper Columbia River (UCR) Fish Tissue Study

Reach _____

Fish No.	Redside Shiner Individual Fish Sample Number (e.g.: RS-S1-062)	Black Crappie Individual Fish Sample Number (e.g.: BC-S1-062)	Bluegill Individual Fish Sample Number (e.g.: BG-S1-062)	Pumkinseed Individual Fish Sample Number (e.g.: PS-S1-062)	Largescale Sucker Individual Fish Sample Number (e.g.: LS-S1-062)	Longnose Sucker Individual Fish Sample Number (e.g.: LN-S1-042)	Bridgelip Sucker Individual Fish Sample Number (e.g.: BL-S1-042)	External Abnormalities? Y/N
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								

Length-Weight Form
Upper Columbia River (UCR) Fish Tissue Study

Reach _____ **Species** _____

Fish No.	Individual Fish Sample Number (e.g.: TC3-RW-S2-056)	Total Length (mm)*	Weight (g)	External Exam (√)	Date	Time
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

*Minimum individual size should be no less than 75 percent of the maximum individual size.

Length-Weight Form Notes
Upper Columbia River (UCR) Fish Tissue Study

Notes:

FISH EXTERNAL EXAMINATION FORM
Upper Columbia River (UCR) Fish Tissue Study

Date (MM/DD/YYYY): _____ **Reach:** _____ **Indiv. Fish Sample No.** _____

Species: _____ **Weight (g):** _____ **Length (mm):** _____

EXTERNAL EXAMINATION: ***(check all that apply)***

BODY SURFACE:

- ☐ normal
- ☐ raised growth(s)
- ☐ reddened lesion(s)
- ☐ spinal deformities
- ☐ hemorrhagic body
- ☐ focul discoloration
- ☐ body fungus
- ☐ parasites(s) *(specify):*
  - white spots ☐
  - leech(es) ☐
  - black spot(s) ☐
  - Anchor worm(s) ☐
- ☐ other (specify): _____

HEAD and ORAL CAVITY:

- ☐ normal head
- ☐ deformed head
- ☐ upper lip growth
- ☐ lower lip growth
- ☐ swollen nare

BARBELS:

- ☐ normal
- ☐ missing
- ☐ stubbed
- ☐ deformed
- ☐ other (specify): _____

EYES:

Left	Right
☐ normal	☐ normal
☐ exophalmic	☐ exophalmic
☐ opaque	☐ opaque
☐ missing	☐ missing
☐ hemorrhagic	☐ hemorrhagic
☐ emboli	☐ emboli
☐ other (specify): _____	☐ other (specify): _____

OPERCULA:

- ☐ normal
- ☐ slight shortening
- ☐ severe shortening
- ☐ other (specify): _____

GILLS:

Left:	Right:
☐ normal	☐ normal
☐ frayed	☐ frayed
☐ marginate	☐ marginate
☐ pale	☐ pale
☐ other (specify): _____	☐ other (specify): _____

FINS:

- ☐ normal
- ☐ mild erosion
- ☐ severe erosion
- ☐ frayed
- ☐ hemorrhagic
- ☐ emboli
- ☐ other (specify): _____

Fish Processing Form
Upper Columbia River (UCR) Fish Tissue Study

Composite Sample ID: _____ **Species Name:** _____ **Reach:** _____

Tissue Type: **Whole Body** ☐ **Fillet** ☐ **Offal** ☐

Number of Individuals: _____ **Processing Date:** _____

Fish	Individual Fish Sample Number	Otoliths Removed (√)	Sex	Abnormalities (√)	Photo taken (√) and Photo ID	Weight of Fish Used for Composite (g)
1						
2						
3						
4						
5						
6						
7						
8						

Total Composite Weight (g): _____

Notes: _____

ATTACHMENT A4

COPY OF STANDARD FISH SAMPLING GUIDELINES FOR WASHINGTON STATE PONDS AND LAKES

(Bonar et al. 2000)

Standard Fish Sampling Guidelines for Washington State Ponds and Lakes

by

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Fish Program
Science Division
Inland Fisheries Investigations
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Olympia, Washington

June 2000

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Abstract

Standardized sampling is necessary to compare growth, condition, and population sizes of various lacusterine fish species among years and among lakes. Use of standard techniques allows biologists to concentrate resources on improving fish populations instead of routine monitoring considerations. We present methods for standardizing Washington lake and pond sampling statewide. These methods are based on those used successfully in other areas and modified for the Pacific Northwest. Included in this report are guidelines for conducting gill netting, fyke netting and electrofishing surveys; standards for equipment; and techniques for selecting sample sizes to meet certain objectives.

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List of Tables and Figures

Introduction

Standardized sampling and data comparison methodologies are used in a wide variety of fields such as medicine, finance, education and agriculture. Standardized sampling methodologies are also extremely important in fisheries and are required to evaluate how a fish population changes over time, or is functioning compared to an "average" in a state or a region. This allows the biologist to identify problem fish populations, discover populations with exceptional angling opportunities, set regulations, or apply various management strategies and monitor their effects.

The following gives a short synopsis of standardized sampling procedures proposed to survey warmwater lake–fish populations in Washington state. These procedures are based on those used in other areas and have undergone both regional and national review, both by warmwater sampling experts and statisticians. This publication gives a step–by–step description, with examples, of how to conduct a standardized survey and calculate sample sizes. For clarity, we do not justify standard procedures in the text. Justification of specific reasons for certain standardized procedures appear as footnotes. This updates material found in Fletcher *et al.* (1993). Any questions or comments on this standardized procedure should be directed to Inland Fisheries Investigations, WDFW, Olympia.

These methods were developed to capture the largest number of fish of various species in a majority of these waters. It can be tempting to change sampling on a lake–by–lake basis to try to capture an even larger number of fish. However, the best results will be obtained by those biologists who adhere closely to standardized procedures so their data will be comparable to state averages where fish were collected in the a similar manner. Application of these techniques whenever possible, even when just determining species composition, will improve your ability to evaluate lakes, and build a robust state database for comparison purposes.

Standardized Survey Procedures

Timing the Survey[1]

- Time of survey can greatly affect sampling data (Bettross and Willis 1988, Guy and Willis 1991).

- Fall surveys—should occur between the last week of August and the first week of October.

- Spring surveys—should occur between the last week of April and mid–June.

- Choosing between Spring or Fall—Large largemouth bass can most easily be captured in the spring while they are staging for spawning[2]. However, yearling largemouth bass are still offshore during this time, and can be more easily captured in the fall. The biologist should determine which life history stage is of most interest and time the sampling accordingly. Never compare Spring to Fall samples and vice versa.

Initiating the Survey

- Obtain standardized survey equipment—Survey equipment will consist of an electrofishing boat, standardized gill net(s) and standardized fyke net(s)[3]. Consult Table 1 for net and electrofishing standards.

---

[1] Numerous surveys have found that CPUE of most warmwater species peaks in the spring and fall (Pope and Willis 1996). Betross and Willis (1988) concluded that largemouth bass surveys should occur between 16-22°C. Divens et al. (1996) compiled Washington Department of Ecology data from 90 Washington lakes and found that most Washington lakes had temperatures within this range during September and June. However, some species such as yellow perch caught in gill nets may have peaks in mid–summer.

[2] This is based on monthly electrofishing surveys we conducted year–round on three Western Washington lakes over a two–year period.

[3] Several researchers have tested the efficiency of various gear types for capturing the five most common warmwater fish species in Washington lakes: largemouth bass; bluegill; pumpkinseed; black crappie; and yellow perch. Electrofishing is most efficient for *centrachids* while gill netting is more efficient for yellow perch (Lewis et al. 1962, Hamley 1975, Hall 1986, Coble 1992, Divens et al. 1998) and fyke nets are efficient for crappie spp. (Willis' warmwater workshop notes from Warmwater fisheries sampling, assessment, and management). A combination of gears gives the greatest ability to sample all species effectively.

Table 1. Standardized sampling equipment for Washington State lake fish surveys.

Sampling Equipment	Standard for Washington State
Electrofishing Boat	Smith-Root GPP 5 boats with a six dropper spider array on each boom, and a cable "whisker" cathode array in front.
Gill Net	150' by 8' variable mesh monofilament with the following mesh size and panel length: 0.5" square - 25', 0.75" square - 25", 1" square - 50', 2" square - 50'.
Fyke Net	4' high, 3/8" diameter aluminum or stainless steel circular hoops with two 25' wings and up to an 100' lead. Mesh size is 0.25" (see Figure 1).

- Get map of the lake—this can be obtained from the WDFW GIS lakes database by contacting

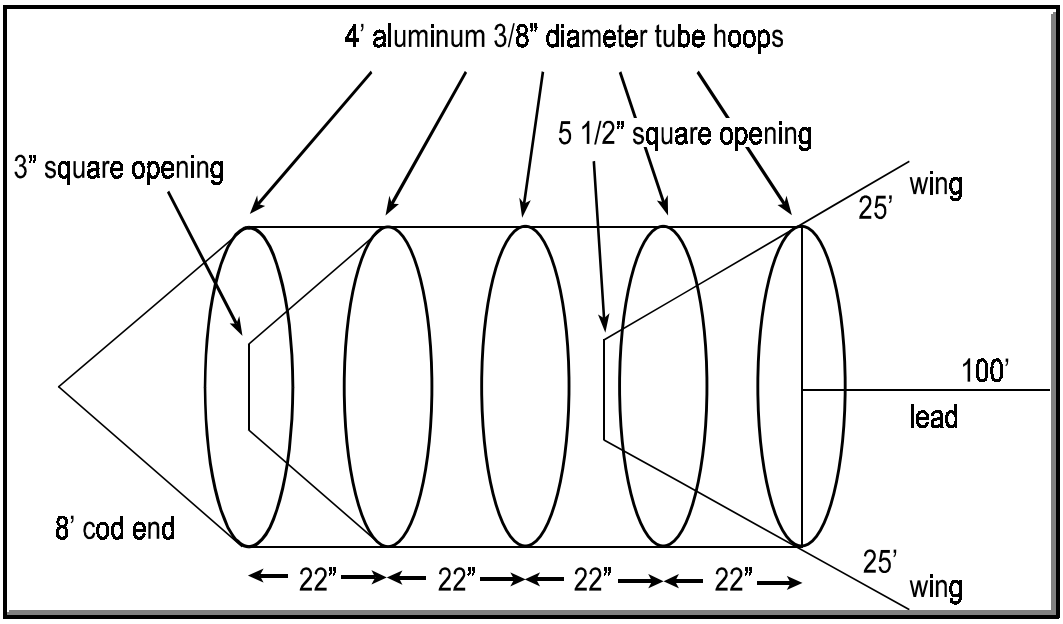

Figure 1. Standard fyke net measurements for Washington State warmwater fish surveys.

the warmwater database manager[4]; from several texts on Washington lakes including: Wolcott (1973); Dion et al. (1976); Sumioka and Dion (1985); or from the Washington Department of Ecology Lake Monitoring Program. Original full–sized maps of many lakes are also available from WDFW historical files (contact regional offices or the Inland Fisheries Division in Olympia). If no map is available, map the lake yourself using methods in a standard limnological methods text.

- Measure or obtain the shoreline perimeter—most easily available from maps of the lake printed out from the WDFW GIS lakes database, but can be obtained easily from a map of the lake with a scale.

[4] The Washington Department of Fish and Wildlife GIS lakes database contains of 40,000 lakes and ponds in Washington State. The database reports the perimeter and area of each lake or pond. Major lakes have the maximum depth.

- Randomly select a starting point on the lake.

- Decide if it is feasible to electrofish the entire shoreline during the time allotted for the survey.

  - **Entire shoreline *can* be sampled during the survey:** This is possible most often in small– and medium–sized lakes. Start from the randomly chosen starting point and move around the shore. Shock for 600 seconds, work up fish, shock again for 600 seconds, work up fish, and continue this procedure until the entire lake is covered. For the last section, cover the amount of distance to reach the starting point (e.g., 278 sec, 342 sec. etc.) and stop. Do not re–shock part of the first section again to get 600 seconds. For setting gill and fyke nets, randomly choose sites. On small lakes it is possible to have a substantial impact on the existing fish populations if enough gill net sets are placed to detect a certain percent change. The biologist should use judgement to decide when to stop setting gill nets if the population may be substantially impacted, with the understanding that change may not be detectable from the few gill net sets[5].

  - **Entire shoreline *cannot* be sampled during the survey:** This is likely in larger lakes. Use the following procedure:

    - Mark sampling points on map of lake—from that starting point, put a mark every 400 meters (1300 feet) along the shoreline perimeter on the map[6]. These will be the "sampling points" where you will *start* your electrofishing surveys and place nets. For a rough, but easy field estimate, take a piece of string, lay it on the map scale and mark it off at 400 m increments. Lay this string around the perimeter of the lake on the map and mark points on the map.

    - Choose to sample using simple random or stratified random sampling techniques[7].

---

[5] For small lakes or to measure small differences over time, it may be difficult to obtain enough CPUE samples to measure statistical differences. In these cases, the biologist may want to explore if a mark–recapture estimate of the actual population should be incorporated.

[6] Four hundred meters was the maximum distance of electrofishing boats could travel and effectively sample during 600 second time limits on two Kitsap County lakes (S. A. Bonar, B. Bolding, and M. Divens, Unpublished Data).

[7] Miranda et al. (1996) found that systematic sampling was useful in reservoirs showing a progressive change in littoral areas from the dam to the inflow(s). In these situations, simple random samples may be clustered near the inflow or the dam, and may not be representative of the whole reservoir. Simple random or stratified random sampling is more appropriate in waterbodies containing littoral areas with habitats that recur cyclically, such as in highly dendritic reservoirs with various similar arms. We chose simple or stratified random sampling because we felt that the former situation was not that common. However, in those instances where it does occur, the biologist should consider systematic sampling.

- **Simple Random:** Shoreline is not separated into different strata. Use this technique in the vast majority of lakes, such as those with homogenous shorelines or smaller lakes. (We have seen few lakes in western Washington that we would stratify; however, more in eastern Washington, especially in the Coulee areas). For number of sections (sampling points) to sample to obtain a catch per unit effort (CPUE) estimate with a specified degree of precision and confidence, refer to Appendix A[8].

- **Stratified Sampling:** Normally you should not stratify unless there are clearly major differences between CPUE in large sections of the lake. Some of the computational drawbacks will outweigh the advantages[9]. However, to reduce your variance and increase your ability to detect changes in CPUE, you can stratify the lake if it exhibits great differences in major habitat types. Larger lakes and those with wide variations in habitat such as cliffs, rocky rip–rap, and weedy coves are good candidates. If you decide to stratify, here are some guidelines:

---

[8] The first year of this program, we had no variances on Washington electrofishing and netting data. Therefore, we chose sample sizes (15 electrofishing samples, 8 net nights) based on surveys in other states (Miranda et al. 1996, D. Schupp, Minnesota DNR, personal communication). However, this year we have variances and can adjust our sample sizes accordingly.

[9] Stratification based on CPUE can lower CPUE variance for certain fish species. However, there are potential drawbacks that the biologist should consider before employing this technique. If there are several principal fish species, stratification based on the distribution of one may not lower the variance for another, since they may have different distributions. Also growth, condition, or length frequencies may vary between strata, especially in larger reservoirs (Mesa and Duke 1990). If more fish from one strata are sampled on another, these measures may be biased towards that one strata and not representative of the lake overall. In these situations, the researcher will want to test if these measures are significantly different between strata to determine if they can be pooled. If not, the researcher may want to report both these indexes and CPUE separately by strata, or use procedures described in Cochran (1977) or Scheaffer et al. (1986) to develop stratified random estimates for growth, condition, stock density indexes, as well as CPUE in the lake overall. Whatever the case, scales, weights, and lengths should be obtained from fish from both strata. Collection of five per cm group from just one strata may not represent the lake overall.

- Determine what fish specie(s) are of greatest interest or those which are the principal players.
- Determine how to stratify based on habitat where CPUE of the "principal player(s)" would probably be highest (e.g., weedy coves, largemouth bass; rock rubble, smallmouth bass, etc.).
- Designate strata locations on the map—for example ⅓ of shoreline is highlighted as cliff (where biologist feels that largemouth bass CPUE would be low) and ⅔ of shoreline is highlighted as weedy habitat (where biologist feels that largemouth bass CPUE would be high).
- Select needed sample size from Appendix A. These sample sizes are designed for simple random sampling and should, therefore, be more than adequate for stratified sampling.
- Use one of two types of allocation methods to assign sampling sections to strata.
  - If you or the regional biologists can make an educated guess about the ***degree*** catch rates will be higher in one strata versus the other, use ***nonuniform probability allocation*** based on the degree catch rates might be different. For instance, suppose you are most interested in largemouth bass. If you think samples taken in weedy habitats will have twice the catch rates of bass (fish/hour) as samples in cliff habitats, and you have a total needed sample size of 21-600 second sections, put 14 of the samples in weedy habitat and 7 in cliff habitat. Make sure there are at least two samples, preferably more, in the unpreferred habitat so strata variance can be calculated.
  - If you have no idea how much the catch rates will vary from one strata to another, ***proportionally*** allocate samples to strata based on size or "weight" of strata. For instance if ⅓ of shoreline is cliff and ⅔ of shoreline is shallow weedy habitat, put ⅓ of samples along the cliff shore in randomly chosen locations (i.e., the 400 m spaced sampling points discussed earlier) and ⅔ of samples in the weedy habitat in randomly chosen locations. This will ensure that the areas with high CPUE of the species of interest will be sampled[10].

[10] Optimal allocation is not possible without a previous estimate of variance within strata for that particular lake. Therefore, two options are available for allocation in our lakes where previous surveying has not been conducted: proportional allocation and nonuniform probability sampling. Although nonuniform probability sampling is used most often in creel surveys, Mississippi researchers (L. E. Miranda, Mississippi State University, personal communication) are developing this for use in standardized electroshocking surveys. Expert opinion has been used to allocate samples for creel surveys in nonuniform probability sampling (Stanovick and Nielsen 1991). See Cochran (1977), Scheaffer et al. (1986), and Brown and Austen (1996) for general statistical procedures on stratification and proportional allocation. See Malvestuto et al. (1978) and Malvestuto (1996) for information on nonuniform probability sampling.

- **Special considerations for net sampling**—for net sampling, exclude those randomly–chosen sampling points where it is impossible to set nets (i.e., no sheer cliff faces, boat launches, areas where turbines are, etc.). Then randomly select other sampling points to make up for those excluded.

Standardizing Techniques on the Lakes

Gill Nets

- Gill nets should be set in the evening before electrofishing starts and retrieved the next morning;
- Nets should be set perpendicular to shore;
- Smallest mesh size should be closest to shore; and
- Although net–nights will be the unit of interest, record set time and pick up time.

Fyke Nets

- Fyke nets should be set perpendicular to shore;
- Nets should be set in the evening/late afternoon before electrofishing starts and retrieved the next morning;
- Record set time and pick up time; and
- Try to set the net so the top of the first hoop is no more than about 1 foot under the water's surface[11].

Electrofishing

- Electrofishing should be conducted with pulsed DC, high range 100-1000 volts, 120 cycles per second;
- Standardize power output of the electrofishing unit based on the conductivity of each lake (See Appendix C);

[11] See Fletcher et al. (1993) and Hubert (1996) for fyke netting procedures. D. Willis, South Dakota State University (personal communication) knows of no depth standard on midwestern fyke net sets, although the "1 foot under the water approach" has worked well for him. However, Missouri Department of Conservation biologists sometimes set their modified fyke nets where 20 or 30 ft of water may be over the first frame. Their white crappie CPUE data seemed quite comparable to Kansas CPUE data collected in shallower sets. However, the age–0 CPUE values were much lower for the Missouri data than for the Kansas data.

- Electrofish starting at each randomly chosen sampling point for 600 seconds as measured by the timer on the electrofishing unit[12]. Always record on data sheets the actual number of seconds shocked (e.g., 578 sec, 600 sec, 605 sec, etc.);
- Electrofish in the same direction from the sampling point for all samples;
- Electrofish petal operations (continuous or intermittent) are at the discretion of the operator, and should be designed to capture the highest number of fish. Use intermittent shocking when approaching structure such as beaver lodges, downed trees, docks and weed patches. Stay off the pedal until close to structure, then hit the pedal;
- A minimum of two dippers and one driver should be in each electrofishing boat. **Dippers should go for everything, even young–of–year (YOY)**[13],[14];
- We have found that catch rates go down if you electrofish the same section over again. Never cover the same section that you have electrofished over again[15];
- Make sure that when fish are worked up, they are released back at the start of the section, and not near the end where they can stray into the next section to be electrofished again; and
- Electrofish at night to have the highest catch rates.

Processing the Catch

- **IMPORTANT: Data from each 600 second electrofishing section, and each net set should be recorded separately. DO NOT POOL DATA FROM DIFFERENT NET SETS OR ELECTROFISHING SECTIONS!**[16]

---

[12] See Miranda et al. (1996) for a discussion of the length of electroshocking time sections on standardized lake surveys. He tested precision of electrofishing samples lasting from 300 seconds to 3600 seconds. They found that for sections spaced closer than 30 minutes apart travel time, shorter sections were more efficient than longer sections. We selected 600 second sections instead of 300 second sections because of the high likelihood of many "zero" measures of CPUE for individual sections in 300 second sections, skewing the data to a non–normal distribution and affected the ability to calculate confidence intervals.

[13] We found that non–standard, selective dipping of different sized fish or various species of fish was one of the major factors which made it difficult to analyze and compare historical WDFW warmwater fisheries data from over 60 Washington lakes.

[14] No question about it, YOY are inconvenient to sample. However, last year I found how important these data were when I examined first–year growth of YOY of various species. When we will conduct recruitment studies, YOY information will also be very important.

[15] During data collection on Bolding et al. (1998) and Bolding et al. (1997), it was found that electroshocking the same areas again resulted in lowered catch rates. Cross and Stott (1975) found that the effect lasted between 3 and 24 hours on roach and gudgeon after they had been electroshocked in English ponds.

[16] If all sample data are pooled, it would be impossible to calculate a variance.

- **Measure fish lengths**—Take **total** lengths to nearest mm, caudal fin compressed[17]. **Do this on ALL captured fish when possible**. It makes your later data analysis much cleaner and easier. When it is not feasible to measure all fish, such as when there are thousands of YOY or huge numbers of carp, measure a random subsample of these groups (30-50 fish) and count the rest.

- **Special note on lengths**—When preparing length-frequency histograms, fish should **not** be rounded off to the nearest cm, but rather should include fish from that cm length to the next. For example, the 10 cm group should include fish from 10.00 to 10.99 cm, **not** those from 9.50 to 10.49 cm[18].

- **Obtain needed sample sizes**—Note that 55 stock size fish are required for a workable PSD estimate and 100 "adult" fish are required to develop a useable length frequency (Table 2). To determine if a significant change has occurred in PSD, more stock size fish may be required. See Miranda (1993) and Willis' (1998) warmwater fisheries sampling, assessment, and management, Section H7, for needed sample sizes and calculations to detect significant differences in PSDs between years or lakes.

Table 2. Basic data to collect on principal fish species.

Data	Units	Use	Sample Size
Length	mm total length; Compress Caudal Fin	Stock Density Indices (PSDs etc.), Length Freq. Histograms, Wr, Growth, Relative Composition, Population Estimates	All fish—need to get at least 100 of the major species (for PSDs > 55 stock size)[a,b,c]. For measuring changes in stock density indexes, sample sizes may need to be larger. See Miranda (1993) and H7 in Willis' (1998) warmwater fisheries sampling, assessment, and management.
Weight	g	W*r*	Five fish sampled per cm group.
Scales	Number	Growth	Five to ten scales per fish, five fish sampled per cm group[d].
Electroshocking CPUE	Fish/hr	Electroshocking CPUE and C.I.	Shock in 600 second increments[e], working up fish between sections. If CPUE variance available, see Appendix A for sample sizes. If variance not available, use Appendix B.
Gill Net, Trap Net CPUE	Fish/net night	Gill Net, Trap Net CPUE and C.I.	Use net nights as the unit of interest. See Appendix A for sample sizes if CPUE variance available. If variance not available, use Appendix B.

[a] Anderson and Neumann 1996
[b] Gustafson 1988
[c] Divens et al. 1998
[d] DeVries and Frie 1996
[e] Miranda et al. 1996

[17] Use of total length makes survey data comparable to historical data from and many other areas of the country. Measuring total length with a compressed caudal fin is the standard for North America (Anderson and Neumann 1996).

[18] This method of grouping length data is recommended by Anderson and Neumann (1996) in Fisheries Techniques, 2nd edition, page 449, 4th paragraph.

- **For length frequencies, PSD estimates, and CPUEs do not combine samples from different gear types**[19].

- **Obtain weights on five fish from each cm length group**[20]—It does not matter which gear type caught the fish. If you obtained weights on five per cm group of pumpkinseed by electrofishing, you do not have to start over again with the nets and weigh an additional five per cm group. Once you have five per cm group of adult fish of a particular species, you can stop taking weight data on that species (Table 2). However, remember the exception to this when you stratify. If the strata in the lake have different growth rates or conditions (you can test to see if samples can be pooled), you will have to take a sample from each strata to obtain the mean estimate for the lake.

- Take scales on five fish of each species from each cm length group (these might be the same fish which were weighed). Use tally sheet to determine when enough scales have been obtained (Table 2). To validate scale readings, you may want to sacrifice a small number of fish for otoliths. On warmwater fish, otoliths may be easily obtained by snipping the isthmus caudal to the lower jaw and gills on the ventral side of the fish using a pair of dykes or wirecutters. The head is then popped back and the otoliths will be found in two pockets behind the head. For more information contact Inland Fisheries Investigations. Also, for stratified sampling, the biologist will need to take samples from each strata if strata length–at–age is significantly different (see 5 above).

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[19] See Ricker (1975), page 19, 2nd paragraph. Since each gear has its own individual bias, combining gear types when estimating stock density indexes and CPUE leads to estimates that usually cannot be compared among lakes. For instance, how does one compare a CPUE calculated using one hour of gill netting and one hour of electroshocking to another CPUE collected with two hours of electroshocking and one–half hour of gill netting? One would expect more littoral species such as largemouth bass in the second CPUE calculation than the first, which has nothing to do with management actions, habitat, or other factors. While studies can remain consistent if the same ratio of effort from one gear type to another is used, it is usually much easier to always make separate estimates for each gear type.

[20] Some of the reviewers in other areas of the country used this technique to ensure that a wide variety of weights were collected to represent the entire range of fish lengths.

Appendices

Appendix A. Using Sequential Sampling or Previous Year's Data to Calculate CPUE Sample Size During a Survey

To determine an appropriate sample size for the survey, first reach a decision about survey objectives. Is the survey purpose to get a point estimate of a value or to measure change? What degree of confidence is required in the results (e.g., 70%, 80%, 95%)? If change is to be measured, what degree of change should be detected? Then select a sample size for electrofishing, gill netting, and fyke netting which will be appropriate to meet these goals.

The best method to calculate CPUE sample sizes so they will be tailored to individual lakes is to use previous estimates of variance are available from the specific lake, taken at the same time of year. These estimates can be obtained either through sequential sampling or through previous year's sampling.

A. 1. Calculating a Sample Size to Estimate CPUE Within Certain Bounds

If the biologist wants to measure CPUE within certain bounds, use the following equation to calculate needed sample sizes: (from Willis' (1998) warmwater fisheries sampling, assessment, and management, also see Cochran (1977)).

$$n = \frac{(t^2)(s^2)}{[(a)(x)]^2}$$

Where:

n = sample size required
t = t value from a t- table at n-1 degrees of freedom for a desired sample size (1.96 for 95% confidence; 1.26 for 80% confidence; and 1.04 for 70% confidence)
s^2 = variance
x = mean CPUE
a = precision desired in describing the mean expressed as a proportion.

Simply plug in values obtained from last year's survey or while the survey is in progress to calculate how many samples are needed to get the precision required. This method can best be illustrated by the following example:

Example A.1.

The biologist samples six randomly chosen electroshocking sections over a two–day period in Black Lake. The next morning in the motel room, he counts up the largemouth bass per section, and figures the mean and variance with a pocket calculator. He finds that the average largemouth bass CPUE is 42 fish per hour with a variance of 999. He is interested in sampling enough sections to determine CPUE with 80% confidence limits which are $\pm$ 30% of the mean. Plugging these values in the above equation (t = 1.26, s^2=999, x = 42, a = 0.30) gives a needed sample size of 9.98 or 10 sections. Since 6 have been completed already, he only has to sample an additional 4. Of course, this assumes that enough of the fish have been captured for growth, length frequency, and relative weight sample size requirements (Table 2).

A. 2. Calculating a Sample Size for CPUE, Growth or Condition to Measure a Degree of Change

To determine if a certain percent change occurred in CPUE over time, more samples are needed. Parkinson *et al.* (1988) developed simple procedures to estimate changes in CPUE, growth, angling effort and fish age over time in small trout lakes in British Columbia. Basically, sample size can be calculated by:

$$n = \frac{100^2 k \left(\frac{s}{x} \right)^2}{A^2}$$

Where:

n = sample size required

k= multiplication constant from Table A1
s = standard deviation (square root of the variance)
x = mean CPUE (could also be length-at-age, condition, etc.)
A = percent change to be detected.

These are sample sizes for independent one– and two–tailed t-tests, and are useful for measuring differences between two different times. One–tailed tests have lower required sample sizes and can be used if the direction of change can be predicted (up or down). Two–tailed tests should be used if the direction of change is not known. To include several different times in the analysis, use sample size calculations for one–way ANOVA presented in Zar (1984).

Both the power of the test and degree of confidence in the results are reflected in the "k" value (Table A.1.). We will not discuss the exact meaning of k and its derivation here; however, see Snedecor and Cochran 1980, Zar (1984), and Parkinson *et al.* (1988) for more information.

Power of the test is an important consideration. A test with low power has a good chance of not being able to detect differences, even if they occur. A test with high power is much better able to detect differences. We recommend a power (1-β) of 0.80 (therefore β = 0.20) for most warmwater surveys, but Table A.1. gives other alternatives also. Alpha (α) is simply the confidence in the results (e.g., 0.30, 0.10, 0.05 etc.).

Table A. 1. Values of *k* for various combinations of β and α for two–tailed tests. Values of *k* in parentheses are for one–tailed tests.

	α									
β	**0.30**		**0.20**		**0.10**		**0.05**		**0.01**	
0.20	7.05	(3.73)	9.02	(5.67)	12.37	(9.02)	15.70	(12.37)	23.36	(20.07)
0.10	10.74	(6.52)	13.14	(9.02)	17.13	(13.14)	21.02	(17.13)	29.76	(26.04)
0.05	14.38	(9.41)	17.13	(12.37)	21.65	(17.13)	25.99	(21.65)	35.63	(31.55)

A very important point is, that while change can be documented between two surveys taken at different times, it is impossible to say that this change was definitively the result of the management action as opposed to environmental variability. Therefore, the biologist has to qualify his results after a two–point survey to say change occurred, and he suspects it was or was not related to the management action based on some other supporting evidence. Samples taken several years before and several years afterwards, to measure trends in both "treatment" and "control" lakes are necessary to statistically validate that the change was related to the management action. This is most definitely the preferred situation if money and manpower are available.

Example A. 2.

A slot limit will be put into effect on Black Lake in 2001. The biologist in the example above wants to be able to detect a 30% increase in CPUE with 80% confidence between 1999 and 2005. Plugging in values from the above example (k = 5.66 from Table A.1. for β = 0.20 and α = 0.20; s = 31.61 (s^2=999); x = 42; A = 30,) gives a needed sample size of 35.62 or 36 sections for *each* survey. Since 6 have been completed already, he has to sample an additional 30. Of course, this assumes that enough of the fish have been captured for growth, length frequency, and relative weight sample size requirements (Table 2). Unfortunately, because of time constraints, the biologist realizes he cannot sample 36 samples in this lake. Therefore, he is willing to put up with 70% confidence (α = 0.30) in the results, to measure a 50% increase in CPUE. He enters the values for 70% confidence and 50% increase into the equation and which gives a needed sample size of 8.46 or 9 samples. He has taken 6 already, so he needs an additional 3.

Appendix B. Sample Size Tables for CPUE

We recommend that sequential sampling or previous year's data from a particular lake be used to calculate sample sizes whenever possible (Appendix A). However, if this data is unavailable, the following tables can give a rough approximation of average sample sizes for varying degrees of confidence, power and precision. Fewer samples are needed to estimate CPUE within certain bounds (Tables B. 1.-B. 4.) than to measure a change in CPUE (Tables B. 5.-B. 8.). The following are average needed sample sizes for specific degrees of confidence. Those sample sizes for measuring change (Tables B. 5.-B. 8.) assume that the direction of change can be estimated (one–tailed test) and a power (1- β) of 0.80 is used. Sample sizes appearing in the tables were calculated based on 1998 data. The following examples show how the tables can be used to calculate sample sizes.

Example B. 1. Potholes Reservoir is receiving tiger muskies to control stunted yellow perch. The biologists expects that CPUE of yellow perch will go down following stocking, and he guesses that the change will be 50%. Therefore, the biologist looks at Table B. 8. to find the intersection between 50% change and 80% confidence intervals. A rough approximation of the needed number of net nights would be 23.

Example B. 2. The electrofishing CPUE of largemouth bass in Munn Lake is being calculated with 80% confidence intervals to compare to the state averages. The biologist wants to get his estimate within 30% of the actual mean. Therefore, he determines from Table B.1. that 15 samples would be reasonable.

Table B. 1. Median needed sample sizes (600 second sections) for mean CPUE, using simple random electrofishing sampling, for largemouth bass and bluegill in western Washington lakes. Sample sizes were calculated from variances provided from 1998 surveys. Biologists should choose sample size based on the level of confidence wanted in the results (usually 80% for management and 95% for research), and the precision desired in the CPUE estimate. Use of stratification will usually give biologists more precision with these sample sizes.

Precision Desired in Describing the Mean (%)	Confidence (%)		
	70	80	95
100	2	2	3
50	4	6	13
30	10	15	36
25	15	22	52
10	91	138	325

Table B. 2. Median needed sample sizes (600 second sections) for mean CPUE, using simple random electrofishing sampling, for largemouth bass and bluegill in eastern Washington lakes. Sample sizes were calculated from variances provided from 1998 surveys. Biologists should choose sample size based on the level of confidence wanted in the results (usually 80% for management and 95% for research), and the precision needed in the CPUE estimate. Use of stratification will usually give biologists more precision with these sample sizes.

Precision Desired in Describing the Mean (%)	Confidence (%)		
	70	80	95
100	2	2	3
50	3	4	10
30	8	12	29
25	12	18	42
10	73	112	262

Table B. 3. Median needed sample sizes (net nights) for mean CPUE, using simple random gill net sampling, for yellow perch in western Washington lakes. Sample sizes were calculated from variances provided from 1998 surveys. Biologists should choose sample size based on the level of confidence wanted in the results (usually 80% for management and 95% for research), and the accuracy needed in the CPUE estimate. Use of stratification will usually give biologists more precision with these sample sizes.

Precision Desired in Describing the Mean (%)	Confidence (%)		
	70	80	95
100	2	2	4
50	5	7	18
30	14	21	49
25	20	30	70
10	123	187	439

Table B. 4. Median needed sample sizes (net nights) for mean CPUE, using simple random gill net sampling, for yellow perch in eastern Washington lakes. Sample sizes were calculated from variances provided from 1998 surveys. Biologists should choose sample size based on the level of confidence wanted in the results (usually 80% for management and 95% for research), and the precision needed in the CPUE estimate. Use of stratification will usually give biologists more precision with these sample sizes.

Precision Desired in Describing the Mean (%)	Confidence (%)		
	70	80	95
100	2	2	2
50	2	4	9
30	7	10	24
25	10	15	35
10	61	92	217

Table B. 5. Approximate needed sample sizes (600 second sections) for detecting changes in mean CPUE, using simple random electrofishing sampling, for largemouth bass and bluegill in western Washington lakes. Sample sizes were calculated from variances provided from 1998 surveys. Biologists should choose sample size based on the level of confidence wanted in the results (usually 80% for management and 95% for research), and the percent change in CPUE needed to be detected. Use of stratification will give biologists the ability to detect a smaller change with these sample sizes.

	Confidence (%)		
Change Detected(%)	**70**	**80**	**95**
100	4	7	14
50	16	25	53
30	45	68	146
25	64	98	210
10	400	607	1310

Table B. 6. Approximate needed sample sizes (600 second sections) for detecting changes in mean CPUE, using simple random electrofishing sampling, for largemouth bass and bluegill in eastern Washington lakes. Sample sizes were calculated from variances provided from 1998 surveys. Biologists should choose sample size based on the level of confidence wanted in the results (usually 80% for management and 95% for research), and the percent change in CPUE needed to be detected. Use of stratification will give biologists the ability to detect a smaller change with these sample sizes.

	Confidence (%)		
Change Detected(%)	**70**	**80**	**95**
100	4	6	13
50	16	24	50
30	44	66	138
25	63	95	198
10	391	594	1235

Table B. 7. Approximate needed sample sizes (net nights) for detecting changes in mean CPUE, using simple random gill netting sampling, for yellow perch in western Washington lakes. Sample sizes were calculated from variances provided from 1998 surveys. Biologists should choose sample size based on the level of confidence wanted in the results (usually 80% for management and 95% for research), and the percent change in CPUE needed to be detected. Use of stratification will give biologists the ability to detect a smaller change with these sample sizes.

	Confidence (%)		
Change Detected(%)	**70**	**80**	**95**
100	4	6	14
50	16	24	53
30	44	67	146
25	64	97	210
10	396	601	1311

Table B. 8. Approximate needed sample sizes (net nights) for detecting changes in mean CPUE, using simple random gill netting sampling, for yellow perch in eastern Washington lakes. Sample sizes were calculated from variances provided from 1998 surveys. Biologists should choose sample size based on the level of confidence wanted in the results (usually 80% for management and 95% for research), and the percent change in CPUE needed to be detected. Use of stratification will give biologists the ability to detect a smaller change with these sample sizes.

	Confidence (%)		
Change Detected(%)	**70**	**80**	**95**
100	4	6	13
50	15	23	50
30	42	63	138
25	60	91	198
10	373	566	1235

Appendix C. Standardizing Electrofishing Boat Power Output

The amount of power transferred from the water to the fish has been described as the critical electrical factor affecting the behavior of fish (Kolz 1989, Kolz and Reynolds 1989). Power (watts) is equal to the product of amps and voltage. Variation in power output from electrofishing boats explained an average of 14.9% of the variance in night electrofishing catches in surveys on the Mississippi and Illinois Rivers (Burkhardt and Gutreuter (1995). This variation can be considerably reduced at no cost by standardizing power based on the conductivity of the water. Standardization of power is rapid and simple to conduct. The following is based on the procedures of Burkhardt and Gutreuter (1995) and Koltz et al (1998).

We recommend a specific power which should be the goal for each level of conductivity. To arrive at these power goals, we shocked using several different power settings in three Western Washington lakes with two Smith-Root GPP5 electrofishing boats. We selected the lowest power setting which rolled fish but did not cause spinal injury or hemorrhaging. Injury was determined by dissection and internal examination of salmonids (trout, coho salmon) captured using the various power settings. Salmonids were dissected instead of warmwater fish because of their higher susceptibility to electrofishing injury.

To standardize the power output of your boat, conduct the following steps. **REMEMBER TO BE EXTREMELY CAUTIOUS STANDARDIZING YOUR BOAT BECAUSE YOU ARE WORKING WITH POWERFUL CURRENT.**

1. To standardize, you will need the following: two biologists, a voltmeter, a conductivity meter, and the three tables in this appendix.

2. Launch the boat, and deploy droppers as if sampling.

3. Adjust tips of electroshocking booms so they are about one netting pole length apart (approximately 124").

4. Obtain specific conductance of the water (Conductivity of the water standardized for 25°C) using hydrolab or ambient conductivity using some other instrument.

5. If specific conductance was obtained, convert it to ambient conductivity (conductivity uncorrected for temperature) using Table C. 1.

6. Look on Table C. 2. to obtain power goal for the ambient conductivity of the lake.

7. Turn on the generator. Use your usual shocking settings (120 hz and high voltage).

8. If using a Smith-Root shockboat, open the fuse compartment on the front of the console.

9. You should see four jacks, two with black heavy duty wires, and two with red wires. These are the anode and cathode jacks.

10. **THIS IS A HIGH CURRENT AREA. BE VERY CAREFUL NOT TO TOUCH THE METAL ON THE JACKS WITH YOUR SKIN.** Pull one red and one black jack out slightly, so a small bit of metal on the jack is showing[21].

11. Touch the red lead to the red jack and the black lead to the black jack. Have voltmeter set on high (1000v). Read voltage.

12. Obtain amperage from meter on console.

13. Adjust percent of range knob until power goal (voltage x amperage) is obtained[22]. Table C. 3. can be used to find an appropriate amperage and voltage combination for the required power goal. The power output is now standardized.

[21] A voltmeter can be wired in permanently to the jacks for convenience and safety.

[22] Peak power is the factor which has the most effect on fish behavior. Peak power is the product of peak amps and peak volts. Multiplying volts given by the multimeter (which is average volts) and amps given by the boat's ampmeter (which is average amps) does not provide an estimate of peak power. However, meters designed to measure peak volts and amps are quite expensive and not widely available. Using the boat's ampmeter and a multimeter, one can obtain an index which is highly correlated to the actual peak power. Based on field tests in a Washington lake, we found that the correlation between actual peak power determined by a peak voltmeter–peak ampmeter and the readings given by the boat's ampmeter and a voltmeter measuring average volts was r=0.99. The "power" goals presented in this manual were developed for average amps x average volts. If average power goals (peak volts x average amps) or peak power goals (peak volts x peak amps) are desired, other tables must be developed.

Table C. 1. Ambient conductivity (µs) at various specific conductance (µs) x water temperature (°C) combinations.

	Specific Conductance (µs)																		
°C ⇓	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
1	11	17	23	28	34	40	45	51	57	62	68	74	79	85	91	96	102	107	113
2	12	17	23	29	35	41	47	52	58	64	70	76	81	87	93	99	105	111	116
3	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
4	12	18	25	31	37	43	49	55	62	68	74	80	86	92	99	105	111	117	123
5	13	19	25	32	38	44	51	57	63	70	76	82	89	95	101	108	114	120	127
6	13	20	26	33	39	46	52	59	65	72	78	85	91	98	104	111	117	124	130
7	13	20	27	33	40	47	53	60	67	73	80	87	93	100	107	113	120	127	134
8	14	21	27	34	41	48	55	62	69	75	82	89	96	103	110	116	123	130	137
9	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	127	134	141
10	14	22	29	36	43	50	58	65	72	79	86	94	101	108	115	123	130	137	144
11	15	22	30	37	44	52	59	66	74	81	89	96	103	111	118	126	133	140	148
12	15	23	30	38	45	53	61	68	76	83	91	98	106	114	121	129	136	144	151
13	16	23	31	39	47	54	62	70	78	85	93	101	109	116	124	132	140	147	155
14	16	24	32	40	48	56	63	71	79	87	95	103	111	119	127	135	143	151	159
15	16	24	32	41	49	57	65	73	81	89	97	106	114	122	130	138	146	154	162
16	17	25	33	42	50	58	66	75	83	91	100	108	116	125	133	141	149	158	166
17	17	25	34	42	51	59	68	76	85	93	102	110	119	127	136	144	153	161	170
18	17	26	35	43	52	61	69	78	87	95	104	113	121	130	139	147	156	165	173
19	18	27	35	44	53	62	71	80	89	97	106	115	124	133	142	151	159	168	177
20	18	27	36	45	54	63	72	81	90	100	109	118	127	136	145	154	163	172	181
21	18	28	37	46	55	65	74	83	92	102	111	120	129	139	148	157	166	175	185
22	19	28	38	47	57	66	75	85	94	104	113	123	132	141	151	160	170	179	188
23	19	29	38	48	58	67	77	87	96	106	115	125	135	144	154	163	173	183	192
24	20	29	39	49	59	69	78	88	98	108	118	127	137	147	157	167	176	186	196
25	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
26	20	31	41	51	61	71	82	92	102	112	122	133	143	153	163	173	183	194	204
27	21	31	42	52	62	73	83	94	104	114	125	135	145	156	166	177	187	197	208
28	21	32	42	53	64	74	85	95	106	116	127	138	148	159	169	180	191	201	212
29	22	32	43	54	65	76	86	97	108	119	129	140	151	162	173	183	194	205	216
30	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220

Table C. 1. Ambient conductivity (µs) at various specific conductance (µs) x water temperature (°C) combinations (continued).

		Specific Conductance (µs)																			
°C ⇓	F(T)	**210**	**220**	**230**	**240**	**250**	**260**	**270**	**280**	**290**	**300**	**310**	**320**	**330**	**340**	**350**	**360**	**370**	**380**	**390**	**400**
1	1.77	119	124	130	136	141	147	153	158	164	170	175	181	187	192	198	204	209	215	221	226
2	1.72	122	128	134	140	146	151	157	163	169	175	180	186	192	198	204	210	215	221	227	233
3	1.67	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	239
4	1.62	129	135	142	148	154	160	166	172	179	185	191	197	203	209	215	222	228	234	240	246
5	1.58	133	139	146	152	158	165	171	177	183	190	196	202	209	215	221	228	234	240	247	253
6	1.54	137	143	150	156	163	169	176	182	189	195	202	208	215	221	228	234	241	247	254	260
7	1.50	140	147	154	160	167	174	180	187	194	200	207	214	220	227	234	240	247	254	260	267
8	1.46	144	151	158	164	171	178	185	192	199	206	212	219	226	233	240	247	254	260	267	274
9	1.42	148	155	162	169	176	183	190	197	204	211	218	225	232	239	246	253	260	267	274	281
10	1.39	151	159	166	173	180	187	195	202	209	216	223	231	238	245	252	259	267	274	281	288
11	1.35	155	163	170	177	185	192	199	207	214	222	229	236	244	251	259	266	273	281	288	296
12	1.32	159	167	174	182	189	197	204	212	220	227	235	242	250	257	265	273	280	288	295	303
13	1.29	163	171	178	186	194	202	209	217	225	233	240	248	256	264	271	279	287	295	302	310
14	1.26	167	175	182	190	198	206	214	222	230	238	246	254	262	270	278	286	294	302	309	317
15	1.23	170	179	187	195	203	211	219	227	235	244	252	260	268	276	284	292	300	308	317	325
16	1.20	174	183	191	199	208	216	224	232	241	249	257	266	274	282	291	299	307	316	324	332
17	1.18	178	187	195	204	212	221	229	238	246	255	263	272	280	289	297	306	314	323	331	340
18	1.15	182	191	199	208	217	226	234	243	252	260	269	278	286	295	304	312	321	330	338	347
19	1.13	186	195	204	213	221	230	239	248	257	266	275	284	292	301	310	319	328	337	346	354
20	1.11	190	199	208	217	226	235	244	253	262	271	280	290	299	308	317	326	335	344	353	362
21	1.08	194	203	212	222	231	240	249	259	268	277	286	296	305	314	323	332	342	351	360	369
22	1.06	198	207	217	226	236	245	254	264	273	283	292	302	311	320	330	339	349	358	368	377
23	1.04	202	212	221	231	240	250	260	269	279	288	298	308	317	327	336	346	356	365	375	385
24	1.02	206	216	226	235	245	255	265	275	284	294	304	314	324	333	343	353	363	373	382	392
25	1.00	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400
26	0.98	214	224	234	245	255	265	275	285	296	306	316	326	336	347	357	367	377	387	398	408
27	0.96	218	229	239	249	260	270	281	291	301	312	322	332	343	353	364	374	384	395	405	416
28	0.94	222	233	244	254	265	275	286	296	307	318	328	339	349	360	371	381	392	402	413	424
29	0.93	227	237	248	259	270	281	291	302	313	324	334	345	356	367	378	388	399	410	421	432
30	0.91	231	242	253	264	275	286	297	308	319	330	341	352	363	374	385	396	407	418	429	440

Table C. 2. Electrofishing power goals (watts) at various ambient conductivities (µs). Developed in western Washington.

Ambient Conductivity	Power Goal	Ambient Conductivity	Power
20	845	155	351
25	717	160	351
30	632	165	352
35	572	170	352
40	528	175	353
45	494	180	354
50	468	185	355
55	447	190	356
60	430	195	357
65	416	200	358
70	404	205	360
75	395	210	361
80	387	215	362
85	380	220	364
90	374	225	366
95	370	230	367
100	366	235	369
105	362	240	371
110	360	245	373
115	357	250	374
120	355	255	376
125	354	260	378
130	353	265	380
135	352	270	382
140	351	275	384
145	351	280	386
150	351	285	388

Table C. 3. Power at various volts x amps combinations.

	Volts										
Amps ⇓	**50**	**75**	**100**	**125**	**150**	**175**	**200**	**225**	**250**	**275**	**300**
1	50	75	100	125	150	175	200	225	250	275	300
1.5	75	113	150	188	225	263	300	338	375	413	450
2	100	150	200	250	300	350	400	450	500	550	600
2.5	125	188	250	313	375	438	500	563	625	688	750
3	150	225	300	375	450	525	600	675	750	825	900
3.5	175	263	350	438	525	613	700	788	875	963	1050
4	200	300	400	500	600	700	800	900	1000	1100	1200
4.5	225	338	450	563	675	788	900	1013	1125	1238	1350
5	250	375	500	625	750	875	1000	1125	1250	1375	1500
5.5	275	413	550	688	825	963	1100	1238	1375	1513	1650
6	300	450	600	750	900	1050	1200	1350	1500	1650	1800
6.5	325	488	650	813	975	1138	1300	1463	1625	1788	1950
7	350	525	700	875	1050	1225	1400	1575	1750	1925	2100
7.5	375	563	750	938	1125	1313	1500	1688	1875	2063	2250
8	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400
8.5	425	638	850	1063	1275	1488	1700	1913	2125	2338	2550
9	450	675	900	1125	1350	1575	1800	2025	2250	2475	2700
9.5	475	713	950	1188	1425	1663	1900	2138	2375	2613	2850
10	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000

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