A Field Manual of Scientific Protocols for Underwater Observations within the Upper Columbia Monitoring Strategy

2008 Working Version 1.0

June 30, 2008

Prepared by:

Keely Murdoch
Yakama Nation
Fisheries Resource Management
Toppenish, WA

R.D. Nelle
U.S. Fish and Wildlife Service
Fisheries Resource Office
Leavenworth, WA

Published by:

Terraqua, Inc.
Wauconda, WA

Prepared for and funded by:
Bonneville Power Administration's
Integrated Status and Effectiveness Monitoring Program

ACKNOWLEDGEMENTS

This document was prepared for and funded by the Bonneville Power Administration's Integrated Status and Effectiveness Monitoring Program. Many thanks go to all those who contributed to and reviewed this field manual, including Jeremy Moberg, Terraqua Inc., Justin Call, U.S. Forest Service, and all those who attended meetings and provided expertise and insight that helped develop this manual.

TABLE OF CONTENTS

LIST OF TABLES

Section 1: Introduction

Columbia River Basin anadromous salmonids have exhibited precipitous declines over the past 30 years, with several populations now protected under the Endangered Species Act (ESA) (Schaller et al. 1999; McClure et al. 2002). A comprehensive monitoring strategy needs to be implemented to reduce the uncertainties surrounding the declines and the actions required to reverse this trend. Data collected from current and historical monitoring programs are generally not adequate or reliable enough for the purposes of ESA assessments and recovery planning (Tear et al. 1995; Campbell et al. 2002; Morris et al. 2002). In addition, monitoring programs for anadromous salmonids in the Columbia River Basin have typically been initiated to evaluate the effects of specific management actions, such as the demographic effects of hatcheries. As such, data are most appropriately viewed at the scale of the subpopulations and populations for which they were derived. However, the ESA requires assessments of species and their habitat at multiple spatial scales – from specific reaches, to subpopulations, populations, and the ESA management unit of Pacific salmon, the Evolutionary Significant Unit (ESU), which is a distinct population or group of populations that is an important component of the evolutionary legacy of the species.

Current monitoring programs for Pacific salmon did not develop as a cohesive design, thus aggregating existing data from a myriad of independent projects creates challenges in addressing these spatially complex questions. These problems arise because information is often not collected in a randomized fashion (Larsen et al. 2004); sampling techniques and protocols are not standardized across programs; and abundance, distribution, population dynamic, and demographic data for species and their habitat is often not available (Tear et al. 1995; Campbell et al. 2002; McClure et al. 2002). As recovery planning has focused more effort on tributary habitat restoration to mitigate for the mortality resulting from the Federal Columbia River Power System (FCRPS) the limitations of historic and ongoing sampling programs have become increasingly apparent.

The Integrated Status and Effectiveness Monitoring Program (ISEMP – Bonneville Power Administration (BPA) project #2003-0017) was created as a cost effective means of developing protocols and new technologies, novel indicators, sample designs, analytical, data management and communication tools and skills, and restoration experiments. These tools are designed to support the development of a region-wide Research, Monitoring and Evaluation (RME) program to assess the status of anadromous salmonid populations, their tributary habitat, and restoration and management actions.

The ISEMP has been initiated in three subbasins: Wenatchee/Entiat, WA, John Day, OR, and Salmon River, ID, with the intent of designing monitoring programs that can efficiently collect information to address multiple management objectives over a broad range of scales. This includes:

• Evaluating the status of anadromous salmonids and their habitat;

• Identifying opportunities to restore habitat function and fish performance, and

• Evaluating the benefits of the actions to the fish populations across the Columbia River Basin.

The multi-scale nature of this goal requires the standardization of protocols and sampling designs that are statistically valid and powerful, properties that are currently inconsistent across the multiple monitoring programs in the region. The Upper Columbia Monitoring Strategy (UCMS, Hillman 2006) is the guiding document under which the ISEMP develops its monitoring and implementation strategies and protocols. The UCMS (Hillman 2006) outlines a monitoring strategy specific to the Upper Columbia Basin that was based on monitoring approaches adopted by the Independent Scientific Advisory Board of the Northwest Planning council (ISAB), Action Agencies/NOAA Fisheries, and the Salmon Recovery Funding Board (SRFB). This approach includes monitoring current conditions (status monitoring), monitoring changes over time at the same sites (trend monitoring), and monitoring the effects of restoration actions on fish populations and habitat conditions (effectiveness monitoring). In addition to reviewing methods for underwater observation (Thurow 1994) this document is intended to clearly describe the field protocols, metadata, and communication lines specific to the ISEMP study design. Currently, these protocols are limited to snorkel surveys; electrofishing protocols will be added at a later date.

Although the UCMS (Hillman 2006) identifies the project area as the Wenatchee, Entiat, Methow, and the Okanogan River subbasins, this and other ISEMP protocols have been implemented as pilot projects in the Wenatchee and Entiat River subbasins. Monitoring in the Okanogan River subbasin is conducted by the Colville Tribe under the Okanogan Basin Monitoring and Effectiveness Plan (OBMEP) using protocols similar to, but differing in some areas, ISEMP protocols. A comprehensive and coordinated monitoring in the Methow River is under development.

The ISEMP program has taken an experimental approach to the development of scientific monitoring protocols. Hence, this document is best viewed as a working draft that is subject to change as the ISEMP program adds, subtracts, or modifies portions of these methods. Changes to methods are adopted at the beginning of the field season and adhered to until the next year's manual is completed. However, because another purpose for this document is to prepare for the development of a final field manual when ISEMP is ready to propose standardized monitoring program elements, this manual also serves as a draft template for future ISEMP field manuals. This snorkeling protocol is a component of the overall ISEMP, and while it stands alone as an important contribution to the management of anadromous salmonids and their habitat, it also plays a key role within ISEMP as it is built on a standardized format following Oakley et al. (2003) that all of the ISEMP protocols adhere to.

This document was created as an internal guide for field practitioners working within BPA's ISEMP in 2006. This draft document has been updated and revised for the 2008 field season. The ISEMP program has taken an experimental approach to the development of scientific monitoring protocols. Hence, this document is best viewed as a working draft that is subject to change as the ISEMP program adds, subtracts, or modifies portions of these methods. Changes to methods are adopted at the beginning of the field season and adhered to until the next year's manual is completed. This field manual also incorporates into these procedures knowledge gained from practical field experience and experimentation carried out since the inception of the Upper Columbia Monitoring Strategy (UCMS, Hillman 2006). These changes are tracked on the Protocol Revision Log in Appendix D.

This manual is designed for quick reference in the field, and is arranged in the order that crews would be generally expected to follow. Detailed descriptions of how to measure indicators have been included to reduce observer variation. It is appropriate to use this manual when performing status/trend monitoring or effectiveness monitoring in the Upper Columbia Basin, although study design requirements for specific effectiveness monitoring projects may require that aspects of these protocols be modified.

Section 2: Sampling Design and Site Selection

This protocol is designed to standardize fish abundance data collection procedures in the Upper Columbia Basin. The UCMS (Hillman 2006) serves as the primary reference for sampling designs at the basin and subbasin scale, such as site selection. In addition, it may be appropriate to modify these sampling designs in order to address specific questions within any particular subbasin of the Upper Columbia Basin. The snorkeling methods recommended by the UCMS (Hillman 2006) are intended to measure biological and physical/environmental indicators and have been performed by field practitioners in the Upper Columbia Basin since 2003. This field manual is based primarily upon procedures and modifications of procedures from Thurow (1994).

Under the ISEMP, habitat, fish abundance, and macroinvertebrate surveys are conducted at the same sites. Fish abundance status and trend monitoring is intended to characterize status and trends at the watershed level using randomly selected sites. Sites used primarily for status/trend are chosen according to the Environmental Protection Agency's generalized random tessellation stratified (GRTS) sample design (Stevens and Olsen 2003; Stevens and Olsen 2004). Snorkel surveys are also conducted as a part of effectiveness monitoring in the Entiat River subbasin, where a Before-After-Impact-Control (BACI) sample design characterizes changes in fish abundance in response to localized restoration activities. Effectiveness monitoring takes place three times a year: summer (August), fall (October), and winter (February/March).

Integrating status and trend monitoring with effectiveness monitoring allows comparison of trends at the watershed scale to trends seen at the reach scale, and helps establish the degree to which causal inferences can be made to explain trends resulting from local restoration actions. Details of the site selection process for both status and trend and effectiveness monitoring can be found in the "A Field Manual of Scientific Protocols for Selecting Sampling Sites used in the Integrated Status and Effectiveness Monitoring Program" (Moberg and Ward 2008).

Section 3: Scheduling Site Visits

Concept:

This protocol is designed to collect fish abundance and species composition data so that, when used in conjunction with habitat data, fish densities can be estimated. Habitat surveys precede snorkel fish abundance surveys so that habitat units can be established and clearly marked. Habitat surveys should be conducted just prior to snorkel surveys and should occur as close together as possible (no greater than 10 calendar days apart) to minimize potential changes in habitat over time (e.g., seasonal flow changes, storm events etc.). Effectiveness monitoring is designed to collect the fish abundance and species composition data necessary to estimate fish densities at the habitat unit level. Habitat protocols are described in "A Field Manual of Scientific Protocols for Habitat Surveys within the Upper Columbia Monitoring Strategy" (Moberg 2008).

Procedure:

Status and Trend Monitoring

Step 1: A site visit schedule for the working draft of the site list should be developed no later than June 1st each year. Developing a site visit schedule can be complex due to the number of contractors and crews, and because sites must be sampled by both a habitat crew and snorkel crew within 10 days of each other.

Step 2: The snorkel coordinator will facilitate schedule development by convening a meeting with the lead coordinators from each contractor involved in snorkel and habitat surveys (currently USFWS, USFS, YN, WDOE, & Terraqua, Inc.) before the start of the field season (June 1). The lead coordinators from each habitat and snorkel crew will work together to create a compatible schedule. The snorkel coordinator may make changes to the schedule prior to releasing a final draft if schedule incompatibilities are identified.

Step 3: The snorkel coordinator will ensure that a final schedule is created and that all contractors receive a copy of the schedule and that the schedule is posted on the Oracle Collaboration Suite website at https://sso.nwfsc.noaa.gov before the start of the field season. However, due to the unpredictable nature of field work the schedule may need to be revised in-season. The schedule is essentially a plan and all contractors need to recognize that a degree of flexibility may be required for implementation. This need for flexibility means that lines of communication between crews need to be open and clearly defined (see Section 5: Communication).

Privately owned sites

Step 1: The Cascadia Conservation District (CCD) will work to obtain permission to access privately owned sites identified in the list of sites generated by GRTS in the site selection process (A Field Manual of Scientific Protocols for Selecting Sampling Sites used in the Integrated Status and Effectiveness Monitoring Program, Moberg and Ward 2008). The snorkel coordinator will communicate with the CCD regarding landowner permissions and denials and adjust the site visit schedule accordingly.

Step 2: Prior to visiting a site, crew leaders should review the landowner access maps and follow any specific instruction provided by the landowner, such as contact prior to the site visit, where to access the river, etc.

Effectiveness Monitoring

Step 1: The lead coordinators of the snorkel and habitat crews should coordinate so that a habitat survey to identify habitat units are conducted just prior to snorkel surveys. After the snorkel survey is finished a complete habitat survey should be carried out no greater than 5 calendar days apart to minimize potential changes in habitat over time (e.g., seasonal flow changes, storm events etc.). Habitat and snorkel surveys conducted outside the base flow season (i.e., fall and winter), should be as close together as possible as conditions change quickly during the fall and winter months.

Section 4: Site Reconnaissance

Concept:

To maintain cost efficient budgets, minimal site reconnaissance will be conducted by snorkel crews. A snorkel crew leader may visit a site prior to the snorkel survey; however, pre-snorkeling reconnaissance by the snorkel crew should be kept to a minimum.

Procedure:

Step 1: At each site visited, the habitat survey crew will complete a reconnaissance check list (Appendix C). This check list will include information on data necessary to verify the number of observers needed at a site, flow levels, dangerous conditions, and accessibility.

Step 2: The reconnaissance check list will be provided to the snorkel coordinator or designated contact before the snorkeling survey is due. Unless a site meets recognized replacement criteria outlined in the "A Field Manual of Scientific Protocols for Selecting Sampling Sites used in the Integrated Status and Effectiveness Monitoring Program" (Moberg and Ward 2008) it should be sampled all or in part.

Section 5: Communication

Equipment:

Reconnaissance Check List, Appendix C

Concept:

Due to the unpredictable nature of field work, the site visit schedule can be subject to change in-season. In addition, snorkel survey crews are often composed of crew members from more than one agency that requires additional coordination to ensure adequate staffing levels and landowners often request notification in advance of a survey. In order that all sites are surveyed in a timely manner in the most time and cost efficient way it is important that good lines of communication are maintained throughout the field season between all parties involved.

Status and Trend Monitoring

Step 1: Communication between snorkel contractors utilizing crew members from several agencies may occur directly or through the snorkel coordinator. Necessary changes to the site visit schedule, including the number of people required per site or dates of site visits, should occur through the coordinator. At a minimum the coordinator needs to be advised of the changes.

Step 2: Communication between snorkel crews and habitat crews should include an agreement on the site visit schedule to ensure that they are sampled within 10 days of each other. If scheduling difficulties arise, the snorkel coordinator should be advised of the situation.

Step 3: The lead contact from the habitat crew will provide the snorkel coordinator or designated contact from the snorkel crew completed reconnaissance check lists (Section 4; Appendix C). The lead contact from the habitat crew and snorkel crews should confer weekly during the field season to discuss reconnaissance, site lay-out, and to determine future sampling plans. In the event that significant changes in sampling plans occur the habitat lead and snorkel coordinator (or designated contact) will discuss in-person or by phone how best to proceed to ensure adequate coordination of snorkel and habitat surveys.

Effectiveness Monitoring

Step 1: The snorkel crew leader or coordinator is responsible for developing a schedule that outlines the date that each effectiveness monitoring site will be surveyed for each survey period (summer, fall, winter). The site visit schedule should be developed with the habitat crew leader or coordinator to ensure that there is adequate time for the habitat crew to survey the site before the snorkel survey to identify habitat units.

Step 2: Provide the schedule to the CCD in sufficient time to allow affected landowners notification at least 24 hours in advance of the survey. In the event that weather or other circumstances force a change in the schedule, the snorkel crew leader or coordinator should notify the CCD as soon as possible so that the CCD can alert landowners to the change in plan.

Section 6: Snorkel Surveys

Reference:

Thurow (1994)

Equipment:

See Appendix B

Concept:

The biological and physical/environmental indicators identified by the UCBMS (Hillman 2006) require sampling a certain proportion of stream to obtain a representative picture of the ecological conditions in the whole stream network. Probalistically-based random sampling is used to ensure that the results from sampled sites can be generalized to the entire stream network. To ensure that sites are selected without bias, a generalized random tessellation stratified (GRTS) design is used for status/trend monitoring, whereas other designs may be used for effectiveness monitoring depending on specific study needs. The GRTS process generates a sample of "X-sites" located on the stream network. Snorkel surveys, conducted over a specified stream reach, are meant to characterize fish abundance and species present at these X-sites. Status and trend monitoring is designed to describe current conditions and detect changes to the habitat that occur over time. This is complicated by the fact that changes in stream conditions may result in bankfull widths that are different than when they were first surveyed, or bankfull widths may be the same, but the site lengths may change as a result of a reconnected oxbow or straightening of the channel. Consequently, changes detected in the metrics collected may be the result of a different site length rather than an actual change for that metric. This poses a significant challenge of how to collect data that is comparable to past surveys while at the same time capturing changes to the reach that may have resulted in a different channel length or bankfull widths. Practitioners and strategy designers met in November 2006 and decided trend sites (i.e., annual panel sites) will be laid out according to the site length established at the initial survey and will not change because of changes in bankfull width or changes in channel configuration.

All status and trend monitoring snorkeling should occur during the summer low flow period. To ensure a sufficient amount of time to visit all sites, the field season will extend from July 1 through September 15th. Sites should be visited in order of accessibility due to snow levels and discharge. Mid-elevation sites may be sampled in July, while high-elevation and mainstem sites may not be accessible until August or September. All sites will be snorkeled during daylight hours only.

Effectiveness monitoring snorkeling will occur during three time periods: summer (July 16 – Sept 1), fall (October 15 – December 1), and winter (January 28 – March 31). Actual dates within this time frame be determined by the contractor (USFWS) and may depend upon river and weather conditions. Summer snorkel surveys will be conducted during the day, while winter and fall surveys will occur at night.

Procedure:

Step 1: The stream name and the complete site number (ex. WENMASTER-0222, or CBW05583-040619) should be clearly identified on each data sheet. **Do not abbreviate** site numbers on data sheets. Abbreviated site numbers can cause confusion as more data sets are added to the ISEMP program.

Step 2: If multiple data sheets are used at one site, write the stream name and site number on each sheet. Number each sheet 'page ___ of ____' so that during data entry, or if hard copies needed at a later date, there will be no question whether or not the data set is complete.

Step 3: Enter the date the site was sampled, start time and stop time on every data sheet. Start and stop time should be recorded in '24-hour' or military time.

Step 4: Take water temperatures at the start and end of each snorkel. The bank tender (when applicable) or the crew leader will collect a temperature reading at the beginning and end of the snorkel survey using an alcohol based or digital (do not use a mercury thermometer) thermometer accurate to 1.0°C.

Step 5: Describe the ambient light conditions during the snorkel event by characterizing cloud and light conditions as rainy, overcast, partially cloudy, or sunny.

Step 6: Visibility should be measured at each site snorkeled using a 100 mm Rapala Model # XRD-10RT rainbow trout lure with hooks removed. The lure should be fastened to a string and placed in the mid-water column. A snorkeler should enter the water, move away from the lure perpendicular to the bank until the lure is not identifiable as a fish, then move back towards the lure until lure is visible. At this point the distance from the snorkeler to lure is measured in cm using a tape. This is repeated for a total of three snorkelers and distance recorded on the datasheet. For streams narrower than the maximum visibility, use the wetted width at transect A as the maximum visibility for that site.

To measure turbidity, a water sample is collected in 250 mm dark bottle at the location and time visibility is measured. Water samples for turbidity should be processed as soon as possible, but within a 12 hr period if samples are kept out of the sunlight and in a cool environment. Subsamples should be poured from the agitated 250 mm bottle into the 3 glass vials. Vials should be wiped clean with a Kem-wipe and wiped with a silicone lotion to prevent fogging on the bottle. Process each sample to the nearest 0.01 NTU using a turbidity meter and record measurements on the datasheet. The turbidity meter should be calibrated routinely as directed by manufacturer.

Step 7: Observers should enter the river approximately 5 meters downstream of the reach start and position themselves across the channel so that all fish can be seen. Bank tenders or the crew leader should make sure that observers are all ready and spread out evenly across the channel before beginning survey. Stream width, water clarity, and habitat complexity will determine the number of observers needed to complete the survey. Observers should not start counting fish until they have snorkeled past the flagging marking the start of the site.

Note: Night snorkeling will commence at the end of civil twilight for the official sunset for the town closest to the site (i.e., Enitat, Leavenworth, Wenatchee) from the U.S. Naval Observatory estimates or the observation of the first celestial body except the moon. The end of civil twilight for any particular location can be found at http://aa.usno.navy.mil/data/docs/RS_OneDay.html.

Step 8: Whenever possible snorkeling will proceed in an upstream direction. Looking upstream, observers should count fish that pass downstream to their left and coordinate with adjacent snorkelers to ensure that fish are not counted more than once, especially on adult fish. The far right bank snorkeler should count fish to both the left and right. If it is necessary to deviate from this design, the crew leader should ensure that all observers understand the change in the direction that fish are counted (i.e., counting fish that pass to the right instead of left). If bank tenders are used they should count fish in stream margins too shallow to snorkel. Fish should not be counted until the observer passes them. Counting fish ahead of the observer can result in inaccuracies and double counts.

Fish should be identified and counted by species and size increments of 2 cm in odd numbers (e.g., 3, 5, 7…). Fish categorized as 1 cm will be from 0.1 cm to 2 cm, 3 cm size class will be from 2.1 cm to 4 cm, and so on. Unidentified species should be noted with estimated size. Write information on cuff or board. A list of species names, species codes, and commonly encountered size ranges are listed in Table 1. The commonly encountered size ranges are reported for salmonid juveniles only. While it is possible to observe a salmonid outside of these size ranges, the observer should closely scrutinize the fish to ensure that it is being properly identified. Sizes for adults can be highly variable. Identify trout and salmon to species; dace, suckers, whitefish, and sculpins should be identified to genus.

Table 1. Species, codes and common size range used in status/trend and effectiveness snorkel surveys in the Wenatchee and Entiat subbasins under the ISEMP.

Species	**Data Codes**	**Common Sizes (cm)**
Chinook *Oncorhynchus tshawytscha*	CHIN	3 – 7
Chinook (hatchery residual) *Oncorhynchus tshawytscha*	H-CHIN	17-30
Steelhead/RBT *Oncorhynchus mykiss*	STHD	3-30
Hatchery Steelhead residuals[1] *Oncorhynchus mykiss*	H-STHD	20-30
Coho *Oncorhynchus kisutch*	COHO	3-7
Coho (hatchery residual) *Oncorhynchus kisutch*	H-COHO	17-30
Sockeye	SOCK	Unlikely to see juveniles, possible to see adults
Bull Trout *Salvilinus confluentus*	BULL	5-60
Cutthroat Trout *Oncorhynchus mykiss*	CUTT	3-30
Brook Trout *Salvelinus fontinalis*	BROOK	3-30
Sculpin *Cottus sp.*	SCULP	1-15
Dace *Rhinichtys sp.*	Dace	5-13
Sucker *Catostomas sp.*	SCKR	5-45
Whitefish	WHTF	5-35
Red-Side Shiner *Richardsonius balteatus*	RSS	5-13
Other: Catostomid and/or cyprinid fry less than 3 cm	CC Fry	1, 3

[1] Residual hatchery steelhead may be common in Nason Creek, Chiwawa River and the Wenatchee River. They can be identified by the presence of a elastomer mark just behind the right or left eye, or by the presence of an eroded or semi-eroded dorsal fin.

Step 9: At status and trend sites observers will relay information to the bank tender at periodic intervals, or stop at break points to relay the data to the crew leader for recording onto an appropriate datasheet. Fish numbers are recorded by habitat unit during effectiveness monitoring surveys. Example data sheets are provided in Appendix A.

Step 10: The snorkel survey should stop at the end of the site, i.e., at A or K, and should not be carried beyond the site boundaries.

Step 11: When snorkeling a reach with multiple channels (such as braids, or side channels) communication with the habitat crew prior to the snorkeling event is essential. The observers should snorkel the same reach that was measured by the habitat crew. If multiple channels are included in the habitat data, then they should be snorkeled. If a side channel is excluded from the habitat data, it should not be snorkeled. However, if there is doubt about a side channel, side channels with more than 16% of the total flow should be snorkeled.

Step 12: In the event that water depth prohibits snorkeling upstream, the site may be snorkeled in a downstream manner following the same steps 1 - 11. Snorkelers must enter the water upstream of the site and float down with the current. When snorkeling downstream a pole (PVC pipe) is beneficial for keeping the crew in alignment (Thurow 1994).

Step 13: After the snorkel survey is complete the bank tenders or crew leaders should ensure that all flagging or glow sticks (night snorkeling) are removed from the site.

Section 7: Data Management

Data management framework

The ISEMP Data Management effort is designed to develop standardized tools and procedures for the organization, reduction, and communication of monitoring data and methods within ISEMP pilot basins located in the Wenatchee and Entiat subbasins, WA, John Day, OR, and Salmon River, ID. Beginning in 2004, a pilot project has been under development aimed at integrating four primary data management tools: Automated Template Modules (ATMs), the Status Trend and Effectiveness Monitoring Databank (STEM databank), Protocol Editor (PE), and the Aquatic Resources Schema (ARS). The STEM Databank is the central data repository for the ISEMP project. It was developed by the Scientific Data Management Team at NOAA-Fisheries to: (1) accommodate large volumes of data from multiple agencies and projects; (2) summarize data based on how, when, and where data were collected; (3) support a range of analytical methods; (4) develop a web-based data query and retrieval system, and (5) adapt to changing requirements. This fully-normalized database structure allows the incorporation of new attributes or removal of obsolete attributes without modification of the database structure. Data can be summarized in a variety of formats to meet most reporting and analytical requirements.

Successful data management systems require a user interface that is intuitive to the user and that increase the efficiency of the user's workflow. The Automated Template Modules (ATMs) are a collection of forms that allow users to enter and view data in a format that is familiar to biologists. Each ATM has forms for entering new data, reviewing existing data, and updating existing data. Additionally, each ATM has a switchboard to help guide the user to the correct forms.

Data entry forms perform the critical function of validating data at the time of data entry. For categorical attributes, users are only allowed to select from acceptable categories as defined by the protocol. Similarly, values entered for continuous attributes are checked to ensure values are within the expected range. Data entry forms are “protocol aware”. The database includes tabular data that specifies details about the protocol. All categorical fields on data entry forms have pull-down lists that limit the values a user can enter for the field. The pull-down lists reference the protocol documentation tables and only display values that are defined for the active protocol. Similarly, for continuous values, the forms check the expected range as defined in the protocol and warn the user if the entered value falls outside of the expected range. Users can choose to modify the value or accept the value as it was entered. The use of “soft” bounds on continuous values is an effective validation strategy for ecological data, where data often follows a normal distribution with long tails as opposite to a discrete distribution common to financial data.

Protocol Editor is a data dictionary, user-friendly tool for describing the list of all attributes collected by a given protocol that includes a description of the data type, units of measure, number of characters or digits, number of decimal places, and list of acceptable values for all attributes collected by a protocol. Protocol Editor allows the ATM to be calibrated to a given protocol and allows the ATM to ensure consistency between the protocol and the data entered for that protocol. Protocol Editor follows the same rules established by Protocol Manager (a protocol documenting tool being developed by USBOR). A protocol is defined as a collection of methods, where each method consists of the list of attributes to be recorded by the data collector. The name of attributes is restricted to attributes defined by the ARS; however, users are allowed to create an alias name for the attributes. Metadata entered into Protocol Editor can easy be exported in a tabular format for importing into Protocol Manager.

The ARS is the collection of database tables that store data entered into the ATM forms. The ARS was developed to support agencies within the Columbia River Basin manage, document, and analyze aquatic resources data. The ARS aims to define a standardized data structure for storing and processing water quality, fish abundance, and stream habitat data. The ARS is robust against variations between data collection protocols, supports procedures for increasing data integrity at the time of data entry, and supports proper analysis and summarization of aquatic resources data.

Data handling

The field practitioners should be careful to avoid transposing errors when writing and entering data, and should be sure that all data is clearly legible. Practitioners should be in the practice of making photocopies of data sheets, and designating a copy as the Master Copy. The Master Copy can be edited by reviewers using red ink who should initialize and date any edits. Future copies of the Master Copy should either be made in color or clearly show these post-survey edits.

Data should be entered into the ATM provided by ISEMP on a regular basis by the data collectors and should undergo AQ/QC before being sent to the ISEMP coordinator and the Upper Columbia Data Steward for uploading into the STEM Databank.

Data Analysis

This section is under development by the ISEMP data analysis team and will be included in the next revision of this working version.

Data reporting

Each agency is responsible for preparing an annual report that will follow the outline below covering the habitat data collection period:

1. Brief abstract (limit 600 words).

2. Standard introduction provided by ISEMP plus brief description of specific project(s) covered in report.

3. Concise description of project area/map.

4. Description of methods and materials used to perform tasks.

5. Summary of results and brief discussion of results by task (problems encountered, suggestions for future work).

6. If necessary, supplemental electronic copies of summarized field data in spreadsheet or GIS format.

The annual report shall be submitted to the BPA Project Manager/COTR and the ISEMP coordinator. Guidelines for preparing the report can be found at http://www.efw.bpa.gov/Integrated_Fish_and_Wildlife_Program/ReportingGuidelines.pdf. The Upper Columbia Data Steward is responsible for generating an annual report to the Watershed Action Teams, Project Sponsors and monitoring agencies that will include a summary of the macroinvertebrate data.

Section 7: Personnel requirements and training

The snorkel coordinator will be responsible for ensuring that all ISEMP snorkel contractors understand ISEMP snorkel protocols. An annual pre-season coordination meeting will be held with the lead contact and crew leaders from each agency. This meeting will review the protocols, highlight any changes of protocol, answer questions, and may include in-water practice. Ensuring that field crews are properly trained is the responsibility of each individual contractor. We recognize three levels of training that each member of a field crew needs to be able to complete with competence:

1) Species identification and size estimation
2) Basic snorkeling methods as described by Thurow (1994)
3) ISEMP specific protocols

Species Identification

Species identification is the most basic level of training. A crew member needs to be able to quickly identify a fish in the water since often a quick glimpse from an odd angle is all that is possible. The level of training required will depend on the experience of the individual crew member, but will likely include both in-water and out-of-water practice. Out of water practice can be gained through pictures, quizzes and handling of live fish. Out-of-water species identification training can be arranged at ISEMP smolt traps. To arrange species identification training at a smolt trap please contact the trap operator or the snorkel coordinator. It is unlikely that catch at a trap will represent the species diversity that will be observed in river, but can be a useful tool for identification of Chinook salmon, coho salmon, and steelhead.

Out-of water practice should not replace in-water practice. In-water fish identification in many cases must be made quickly and all sides or angles of the fish cannot be examined. Identifying features often have a different appearance in and out the water. The range of sizes and species observed will be greater in water than at a smolt-trap. Accurately estimating the size of fish underwater requires practice. Even experienced observers should practice size estimation on a regular basis. Fish and objects viewed under water are magnified 30% (Thurow 1994). One way to estimate size is to align the fish's snout and tail with adjacent objects underwater and measure that distance with a ruler (Cunjack and Power 1986). It is recommended that snorkelers carry a ruler or dowel of known size as an aid in fish size estimation. For more details on this subject and methods for practice and training see Thurow (1994). Prior to the beginning of the field season the crew leader should spend time snorkeling with each crew member to verify that they are correctly identifying and sizing fish.

If any crew members are new to snorkeling, sufficient practice in the water should occur prior to the beginning of the season, or prior to asking to the crew member to collect data. Some people are able to quickly develop river snorkeling techniques, while others may need more practice. It is the responsibility of the crew leader to ensure that each snorkeler can move and navigate currents with confidence both upstream and downstream; they should be able to read and understand the currents of the river and gauge their movements accordingly. If a crew member is spending an excessive amount of time trying to navigate themselves through the flow their attention to locating and properly identifying fish will be reduced. In extreme examples, fear or even panic can occur in very new observers. Ensure that all crew members have gained the necessary in-water confidence to focus their attention on species identification, counts and size estimation prior to collecting data on an ISEMP crew.

Each crew member should have a copy of, read, and become familiar with the snorkel protocols described by Thurow (1994), which are the basic sampling technique used by the ISEMP program.

ISEMP specific protocols include the duration of field season, site selection, data collection, metadata, reporting, and communication between snorkel and habitat crews. ISEMP specific protocols may differ slightly for effectiveness and status and trend sites where designated in this document. Each crew member and the crew leaders should understand the ISEMP specific protocols defined in this document. ISEMP protocol training will occur once per season and may be adapted as additional data is collected. Questions regarding these protocols should be directed towards the snorkel coordinator or Terraqua, Inc.

For both safety and data quality reasons a bank tender will be required for all night snorkels and for sites that require 5 or more observers in the water at a time. Crew leaders should ensure that all crew members have the skills to safety navigate in the water and around objects. Upon arrival at a site, the crew leader should identify any potential safety hazards and make a decision whether the hazard in question (e.g., log jam, waterfall, etc) can be safely snorkeled. If the hazard cannot safely be snorkeled, snorkel as much of the site as possible and clearly indicate on your data sheet the length and width of the skipped section and why it was not snorkeled.

In addition to ISEMP safety guidelines, each contractor should consult with and abide by the safety regulations of their own agency. Each monitoring agency is responsible for training the personnel who will be carrying out the snorkel surveys, including water safety courses.

Section 8: References

Campbell, S. P., A. Clark, L. H. Crampton, A. D. Guerry, L. T. Hatch, P. R. Hosseini, J. J. Lawler, and R. J. O'Connor. 2002. An assessment of monitoring efforts in endangered species recovery plans. Ecological Applications 12: 674–681.

Hillman, T. W. 2006. Monitoring strategy for the upper Columbia Basin, second draft report. *Prepared for* Upper Columbia Salmon Recovery Board, Chelan WA, Bonneville Power Administration, Portland OR, and National Marine Fisheries Service, Seattle WA. 107 p.

Larsen, D. P., P. R. Kaufmann, T. M. Kincaid, and N. S. Urquhart. 2004. Detecting persistent change in the habitat of salmon-bearing streams in the Pacific Northwest. Canadian Journal of Fisheries and Aquatic Sciences 61: 283-291.

McClure, M. M., E. E. Holmes, B. L. Sanderson, and C. E. Jordan. 2002. A large-scale, multispecies status assessment: Anadromous salmonids in the Columbia River Basin. Ecological Applications 13: 964-989.

Moberg J.M. 2008. A Field Manual of Scientific Protocols for Habitat Surveys within the Upper Columbia Monitoring Strategy. 2008 Working Version. Terraqua, Inc., Wauconda, WA. *for* Bonneville Power Administration's Integrated Status and Effectiveness Monitoring Program.

Moberg, J.M., and M.B. Ward. 2008. A Field Manual of Scientific Protocols for Selecting Sampling Sites used in the Integrated Status and Effectiveness Monitoring Program. 2008 Working Version. Terraqua Inc., Wauconda, WA. *for* Bonneville Power Administration's Integrated Status and Effectiveness Monitoring Program.

Morris, W. F, P. L. Bloch, B. R. Hudgens, L. C. Moyle, and J. R. Stinchcombe, 2002. Population viability analysis in endangered species recovery plans: past use and future improvements. Ecological Applications, 12: 708–712.

Oakley, K.L., L.P. Thomas, S.G. Fancy. 2003. Guidelines for long-term monitoring protocols. Wildlife Society Bulletin 2003, 31(4):1000-1003.

Peitz, D.G., S.G. Fancy, L.P. Thomas, and B Witcher. 2002. Bird monitoring protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Prairie Cluster Prototype Monitoring Program, National Park Service, U.S. Department of the Interior.

Schaller, H. A., C. E., Petrosky, and O. P. Langness. 1999. Contrasting patterns of productivity and survival rates for stream-type chinook salmon (Oncorhynchus tshawytscha) populations of the Snake and Columbia Rivers. Canadian Journal of Fisheries and Aquatic Sciences 56: 1031–1045.

Stevens, Jr., D.L. Anthony R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. Environmetrics. 14:593-610.

Stevens, Jr., D.L., and A. R. Olsen. 2004. Spatially-Balanced Sampling of Natural Resources. Journal of the American Statistical Association. 99:262-277

Tear, T. H., J. M. Scott, P. H. Hayward, and B. Griffith. 1995. Recovery plans and the endangered species act: are criticisms supported by data? Conservation Biology 9: 182-195.

Thurow, R. F. 1994. Underwater methods for study of salmonids in the Intermountain West. General Technical Report INT-GTR-307. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 28 p.

Appendix A: Snorkel Survey Datasheet

2008 ISEMP Status and Trend Snorkel Dataform

DCE:								Page:	#	of		#
Site Name			Shore Tender			Rapala visibility:		(m)	(m)	(m)		
Weather	(R) (O) (PC) (S)		Wetted Width A:		(m)	Turbidity (0.01 NTU)						
End time			Wetted Width K:		(m)	Site Notes:						
Start Temp		(°C)	Habitat unit:									
End Temp		(°C)	% of site sampled:									
Survey Direction:	Upstream / Downstream		Reason % unsampled:									
Diver Name:												
Species	Size	LB tender	Diver 1	Diver 2	Diver 3	Diver 4	Diver 5	Diver 6	Diver 7	Diver 8	Diver 9	RB tender

2008 ISEMP Status and Trend Snorkel Dataform												
DCE:						Habitat Unit			Page:	#	of	#
Diver Name:												
Species	Size	LB Tender	Diver 1	Diver 2	Diver 3	Diver 4	Diver 5	Diver 6	Diver 7	Diver 8	Diver 9	RB Tender

Appendix B: Equipment List

Crew Equipment

Item	Comments
Data Sheets	Example snorkel and electrofishing data sheets are provided in Appendix A. Data sheets should be printed on waterproof paper such as 'rite-in-the-rain'. Extra data sheets should always be prepared prior to heading into the field.
Tatum	A clipboard or preferably a tatum should be used to organize and protect data sheets while in the field.
Wood Pencils	Wood pencil should always be included in your field kit. If you prefer mechanical pencils they may be used; however, they should not replace wood pencils entirely.
Thermometer	Digital or alcohol-based thermometer accurate to 1°C
Collection permits	Copies of permits should accompany each filed crew: Scientific Collection Permit (WDFW or YN) USFWS NOAA Fisheries
First Aid Kits	
Glow Sticks	Night snorkel: to mark the start and end of each site.
Extra Ruler	
Dry suit repair kit	Particularly important for overnight trips, so that minor repairs can be made in the field
Extra Batteries	Extra batteries for flashlights
Dive Light	A minimum of one spare dive light should be carried with each crew.
Flagging	All non-essential flagging should be removed when it is no longer needed.
Permanent Marker	
GPS and maps	Navigation aids including GPS, access maps landowner permission maps, etc.
Cell Phone, Satellite Phone, or Radio	
Throw Bag	
Duct Tape	
Multi-purpose tool	Such as a 'Leatherman' or 'Swiss Army Knife'

Personal Equipment

Item	Comments
Dry Suit or Wet Suit	All dry suits should be check for leaks prior to and at the end of each field season. Dry suits should be maintained leak free throughout the field season. Each contractor should own up to two extra dry suits so that if a dry suit needs to be repaired mid-season, data can still be collected on schedule. During the summer wet suits may be used in place of dry suits. We recommend diving quality wet suits with a minimum of 6mm neoprene on extremities and 12mm on the torso. Depending on water/air temperatures, some observers prefer wet suits. Wet suits have the added advantage of 'no leaks'. Dry suits and wetsuits should have cryptic coloration (brown or black). Bright colors should be avoided.
Mask and Snorkel	Mask and snorkels should be properly fitted to each snorkeler. An extra mask and snorkel should always be available. Masks and snorkels should either be clear or black in color.
Boots and Neoprene Socks	Felt soled wading boots and neoprene socks should be worn over the silicone feet of dry suits. If your dry suit is equipped with neoprene feet you may be able to skip the neoprene socks.
Gaiters	Rock gaiters are often built into the dry suit, but if not a set of rock gaiters will prevent rocks from entering your boots and extend the life of your dry suit feet.
Neoprene Gloves/Dry Gloves	Summer: Neoprene Gloves Winter: Dry Gloves
Neoprene hood	Properly fitted
Data Cuff and Pencils	Data cuffs can be made from PVC pipe and rubber tubing
Ruler/or Dowel	Small rulers or dowels should be carried by each observer to aid in fish size estimation
Henderson Ice Mask	Optional equipment for winter surveys
Knee Pads	For protection of knees and dry suits while crawling through shallow reaches
Shin Pads	Optional
Dive Lights	Night Sites: one per person plus a spare Day Sites: one per crew
Ear plugs and ear drops	
Food and Water	

Spare Clothing and Towel	

Bank Tender Equipment List

Item	Comments
Waders	In summer, quick-dry shorts and neoprene socks can be substituted for waders.
Wading Boots	Felt-soled
Backpack or dry bag	This can be the same pack listed under 'General Equipment'
Flashlight	Night Snorkels: A flashlight in addition to the spare flashlight listed under 'General Equipment'
Whistle	
Head Lamp	
Sunglasses	
Food and Water	

Additional equipment required for winter snorkel surveys at effectiveness sites

Item	Comments
Thermos with hot water	
Blankets	
Propane Heater	

Appenidx C: Reconnaissance Check List

Snorkeling/Electrofishing Pre-Survey Form

Date: **Crew:** **Site Name:** **Site #:**

Miles away from road (hike distance):

Stream Hazards Present (diversions, debris jams, metal objects, glass, wire, etc.):

Dominant substrate type:

Max Depth:
Average Depth:

Max Width:
Average Width:

Estimated Gradient:

Stream velocity:

Culverts Present?
Culvert type (metal pipe, open arch, concrete bottom)
Culvert size

		Poor				Excellent	Comments
General water clarity:	**1**	**2**	**3**	**4**	**5**		
General water quality	**1**	**2**	**3**	**4**	**5**		
		Abundant				**None**	**Comments**
Brushiness		**1**	**2**	**3**	**4**	**5**	
Wood in Channel		**1**	**2**	**3**	**4**	**5**	
Undercut Banks	**1**	**2**	**3**	**4**	**5**		

General comments, observations, etc. (proximity to orchards, houses, dead animals, etc. i.e. would you put your face in the water?):

Appendix D: Protocol Revision Log

As new information becomes available and fish abundance monitoring efforts are refined, the protocol will be revised. Effectively tracking past and current protocol versions are important for data summaries and analyses that utilize data collected under different protocol versions. Protocol Editor will house previous and current protocol versions and the dates of their implementation. Reviews will be performed for all proposed changes to the protocol and the Upper Columbia Data Steward notified so the version number can be recorded in the project metadata and any necessary changes can be made to database structure (Peitz et al. 2002). Consistent with the recommendations of Oakley et al. (2003) this protocol includes a log of its revision history. The revision history log (adapted from Peitz et al. 2002) will track the protocol version number, revision dates, changes made, the rationale for the changes, and the author that made the changes. Revisions or additions to existing methods will be reviewed by ISEMP staff prior to implementation. Major revisions such as a complete change in methods will necessitate a broader review by outside technical experts. When the protocol warrants significant changes the protocol version and date on the title page should be updated to reflect the new version. Version numbers should increase incrementally by hundredths (e.g., Version 1.01, 1.02 etc.) for minor changes and by the next whole number (e.g., version 2.0, 3.0 etc.) for major changes (Peitz et al. 2002).

Protocol Revision History Log

Previous Version #	New Version #	Revision Date	Author	Changes made	Reason

(adapted from Peitz et al. 2002)