DRAFT – Version 2

Aquatic Research, Monitoring and Evaluation Plan

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Note: This plan has been reviewed by CTUIR, WWBWC, and ODFW technical staff, but not by other entities in the Subbasin.

Local and regional efforts have begun to achieve a coordinated approach in the Columbia River subbasins to recover ESA listed salmon and steelhead. A part of those efforts is the development of Research, monitoring and Evaluation (RME) plans that will help direct limited funds to accomplishing the most critical work.

Within the Walla Walla subbasin, a coordinated multi-agency effort has recently begun to develop just such a comprehensive RM&E plan. The plan will pull from regional RME efforts such as the FCRPS Biop plan being developed under the direction of NOAA, the Washington Comprehensive Monitoring Strategy for Watershed Health and Salmon Recovery (CMS), the Pacific Northwest Aquatic Monitoring Partnership (PNAMP), and other similar strategies and plans currently under development.

The RME plan that follows is an attempt to identify priorities in concepts for implementation in the next three to six years. While it would be desirable to have a completed comprehensive RME plan now, the time allowed for its development under the subbasin planning effort is inadequate. This plan will serve as an interim set of guidelines that will assure a systematic approach to directing and funding RME. Further, this interim plan will serve to facilitate coordination of RME in the Walla Walla among management entities, and to help dovetail Walla Walla basin actions within the broader Columbia Basin RME effort. The plan will be expanded and revised in a collaborative forum, and presented for ISRP review during the 2005 provincial review process.

1.1 Guiding Principles and RM&E Priorities

The Walla Walla Subbasin Planning Team and technical staff recognize the following RM&E objectives as paramount to adaptive management in the subbasin:

1. Fill EDT data gaps and establish baseline habitat conditions
2. Verify habitat attribute values to validate EDT modeling runs
3. Establish firm baseline of habitat conditions to track change over time and to assess the watershed response to habitat improvement actions undertaken in the basin

4. Use systematic habitat characterization provided by EDT as basis for future validation monitoring.
5. Focus RME efforts on critical data needs for VSP attributes, ESA evaluation, and Power Act Implementation.
6. Conduct long-term monitoring and evaluation of population, environmental, and ecological conditions for all salmonid life stages and rearing types
7. Conduct effectiveness monitoring of restoration actions at the watershed scale
8. Address critical uncertainties in the relationships between habitat attributes, ecological conditions, stochastic variability, and salmonid production.
9. Coordinate with regional Tier 1 and Tier 2 protocols, data management, and coordination efforts
10. Coordinate with regional basic science efforts (Tier 3 studies)
11. Validate EDT model as a reliable measure of habitat and population response to recovery actions taken in the Walla Walla subbasin using regionally standardized survey and analysis methodologies.

1.2 Research Agenda

Numerous efforts are presently ongoing within the Columbia Basin to recover ESA listed salmonid. Research is underway to document population response to habitat, hatchery, harvest and hydro modifications. During these actions the general understanding of the biology and ecology of salmon and steelhead populations is increasing. There remain significant data gaps and critical uncertainties regarding recovery actions. Limited funds must be used wisely to help ensure ESA populations receive maximum benefit from actions. Many critical uncertainties remain throughout the region, and within the subbasin. These uncertainties must be answered if populations are to be rebuilt and delisted. Such uncertainties may include habitat/life history stage relationships, causal relationships for degraded habitat and depressed or extirpated populations, and understanding the relationship between resident and anadromous *O. mykiss* subpopulations. These critical uncertainties will be identified in forums such as: Regional salmon recovery planning; Region wide (Columbia Basin) critical needs lists developed by management agencies; NOAA’s Comprehensive FCRPS BiOp RME plan; and Washington State’s Comprehensive Monitoring Strategy; and the Walla Walla Subbasin Comprehensive RME Plan.

The Walla Walla Subbasin research agenda was developed in response to specific cause-effect relationships in Walla Walla Subbasin salmonid production that cannot be extrapolated from previously published research or derived from prior Walla Walla RM&E. The critical uncertainties were selected in part due to their importance in the Walla Walla Subbasin in particular, but also due to their regional management applicability. This research agenda represents a draft template that will be used for further planning. Within the next six months the co-managers will reassemble to produce a detailed comprehensive RM&E plan for the subbasin.

For the comprehensive RM&E plan, a systematic approach to project selection and funding will be used that is consistent with and complementary to other RME efforts within the Columbia Basin. The Walla Walla Subbasin Technical Working Group will review research initiatives and endorse funding requests that most directly address management information needs in the Walla Walla and Columbia Basins. The following critical uncertainty research will be pursued collaboratively via the Walla Walla Technical Working Group. This list will be assessed and revised annually as projects come on line, and information needs change.

1.2.1 Test the EDT Working Hypotheses

Status: Partially funded (BPA)

Purpose and Scope:

EDT was developing to provide a spring-board for quantitative decision making in the habitat and fisheries management arena. The model is theoretically well supported, and provides a set of working hypotheses for habitat restoration and off-site salmonid mitigation. Although EDT is populated using real habitat data, the response predicted by fish populations is generally theoretical and associative in nature and has little supporting documentation for the Walla Walla Subbasin. The fish population component of EDT does not consider the antagonistic, additive, or synergistic effects of restoring multiple species at once, and it does not consider the density dependent complications associated with restoring populations with relatively small numbers of individuals. Therefore EDT could over or underestimate the benefits of habitat restoration in the Walla Walla Subbasin. The purpose of this ten year project is to test the following null and alternative hypotheses:

> Ho: The restoration of habitat, as described in the EDT working hypotheses, will result in salmonid production that is equal to that predicted by EDT.
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> Ha1: The restoration of habitat, as described in the EDT working hypotheses, will result in salmonid production that is more than that predicted by EDT.
>
> Ha2: The restoration of habitat, as described in the EDT working hypotheses, will result in salmonid production that is less than that predicted by EDT.

The federal management agencies are working closely together to improve Columbia mainstem passage conditions, and to reduce the impacts of marine harvest on endangered salmonids. If the habitat restoration actions described in the working hypotheses are achieved in the Walla Walla Subbasin, one might anticipate that Ha1 will be most strongly supported. However, as more and more people relocate to the region, and water resources become increasingly strained, the chances for recovery continue to diminish. Statistical support of the working hypothesis will help guide the nature and intensity of future habitat protection and restoration actions in the Walla Walla Subbasin.

Approach:

Most of the work needed to address this critical uncertainty will take place in the context of long-term monitoring. The experimental approach is to conduct an observational study of the Walla Walla Subbasin using collaborative monitoring of fish and their environment; e.g. (Hillman 2003; ISAB and ISRP 2004; Jordan et al. 2003; USACOE et al. 2003). Collectively the Walla Walla Subbasin RM&E projects will:

- Conduct long-term monitoring and evaluation of stream, watershed, and aquatic conditions
- Conduct long-term monitoring and evaluation of population, environmental, and ecological conditions for all salmonid life stages and rearing types
- Conduct effectiveness monitoring of restoration actions at the watershed scale

These monitoring efforts will take place subbasin-wide for the next ten years. A holistic analysis of the relative impacts of habitat restoration, ecological interactions, stochasticity, climate, and out-of-basin effects will be conducted every three to five years using a modified EDT model. Strategy implementation will be assessed under regular Tier 1 monitoring. Action effectiveness will be evaluated using Tier 2 habitat, water quality, and fish population monitoring results. The interaction of project implementation and system response will be evaluated using EDT.

Currently EDT is not fully capable of incorporating the suite of forcing functions that drive salmonid production. There are limitations in the model in terms of regional habitat nuances and population responses (the biological rules) that must be addressed. CTUIR, WDFW, ODFW and WWBWC will work with Mobrand Biometrics and the University of Washington Columbia Basin Research Center to develop a version of EDT that addresses all sources of production and loss in Walla Walla salmonids. The biological rules will be updated annually as new habitat and population response data becomes available.

Once the working hypothesis strategies have been implemented, the predicted (EDT) and realized (M&E) salmonid production levels will be compared. The quantity and rate of predicted and realized responses will be compared using univariate and multivariate statistics. The results of this analysis will be used to better inform EDT on a regional scale, and to better predict the average benefits of habitat restoration work in the Walla Walla and Columbia Basins.

1.2.2 Estimate Connectivity of Resident Walla Walla Salmonid Populations within the Subbasin, and among Neighboring Populations

Status: Partially funded (USFWS)

Purpose and Scope:

The construction of McNary Dam and subsequent formation of Wallula Lake dramatically altered the routes and conditions resident salmonids must undertake to connect with neighboring populations. These hurdles are amplified by the acute and chronic stressors that resident and fluvial bull trout and mountain whitefish face within each subbasin. The culmination of these chronic stressors, coupled with direct mortality, have resulted in an ESA listing for bull trout, and increasing concern for the status of mountain whitefish.

Population connectivity is a measurement of interbreeding among arbitrary or allopatric populations. Connectivity can increase the average fitness of a population by increasing heterozygosity and genetic diversity. The mouth of the Walla Walla River is most directly juxtaposed to the John Day, Umatilla, Yakima, and Snake River basins. Connectivity between Walla Walla populations and these neighboring populations is unknown. An understanding of connectivity will help guide mainstem management, and will greatly inform the ESA delisting process. Increased connectivity generally results in decreased jeopardy, and is therefore a critical metric of species conservation. The purpose of this five year project will be to test the following null and alternative hypotheses:

> Ho: Gene flow (F) in Columbia Plateau bull trout and mountain whitefish populations is less than 0.1, and connectivity (Nm) is less than 10 immigrants per generation.
>
> Ha: Gene flow (F) in Columbia Plateau bull trout and mountain whitefish populations is greater than 0.1, and connectivity (Nm) is more than 10 immigrants per generation.

Approach:

The Bull Trout Recovery Team advises critical uncertainties research on this species. A collaborative effort is underway to examine the current status and population trajectory of bull trout in the Walla Walla and Umatilla Subbasins. These efforts put personnel on the ground, and provide substantial opportunities for data collection. The co-managers will work with this collaboration and similar efforts in the John Day, Grande Ronde and Yakima Subbasins to develop a regional program for resident fish genetic sampling. Fin clips will be selected from reproductively active male and female bull trout and mountain whitefish in all four subbasins, and in all three major Walla Walla watersheds, during normal monitoring activities. These samples will be analyzed using micro-satellite markers to determine the number of immigrants to each subbasin per generation for both species.

1.2.3 Impacts of Spring Chinook Reintroduction on ESA Listed Salmonids

Status: Partially funded (BPA)

Purpose and Scope:

After eighty years of extirpation CTUIR is sponsoring an experimental reintroduction of spring Chinook in the Walla Walla Subbasin. Adult spawners were out-planted during 2000-2004 in the Mill Creek, Touchet, and upper Walla Walla watersheds. Since 2002 out-planting was restricted to the upper Walla Walla watershed. Out-plants were released just prior to spawning, so the full impacts of their summer-time presence were not experienced by their cohabitants.

The first adult progeny from those out-plants should return in the spring of 2004. Given adequate flow and passage conditions, they will enter the upper Walla Walla, Mill Creek, and Touchet watersheds in May to June. Those fish will hold through the summer, and spawn in August and September. Due to passage constraints Chinook returns to the Mill Creek watershed will be limited.

Chinook, steelhead, and bull trout have co-existed in the Columbia Basin for thousands of years. Their life-history strategies do not limit competition or interspecific predation entirely, but they do spawn at slightly different times of the year and in different portions of the watershed with limited overlap. The deposition of marine nutrients from carcasses most definitely benefits salmonid habitat {Helfield, 2001 #908; Chaloner, 2002 #860; Chaloner, 2002 #818}, so one might predict a positive interaction between these species.

Conversely, the current population and ecosystem status in the Walla Walla may present specific challenges to the coexistence of these species. Chinook holding in deep pools during the summer may marginalize adult or juvenile bull trout and rearing steelhead. This spatial reordering may marginalize rearing ESA species to sub-optimal habitat. The resulting direct mortality and decreased productivity may impact population recovery rates of both species. Under healthy population conditions these interactions may have little affect or may be beneficial to salmonid communities, but in a depressed population they may be detrimental. These direct and indirect interactions are theoretical in nature, but are worth investigating due to the high stakes associated with ESA species recovery. The purpose of this three year project is to test the following null and alternative hypotheses:

> Ho: The presence of spring Chinook will not impact juvenile bull trout and steelhead growth rates or survival

Ha1: The presence of spring Chinook will result in increased juvenile bull trout and steelhead growth rates or survival

Ha2: The presence of spring Chinook will result in decreased juvenile bull trout and steelhead growth rates or survival

Approach:

The experimental approach will be to assess the density, distribution, and growth rates of juvenile bull trout and steelhead at the macro-scale: e.g. in watersheds with and without spring Chinook spawners. Anadromy is limited in the Mill Creek watershed due to limited passage at Bennington Dam, and this provides a unique opportunity for a partially controlled observational experiment. Although EDT suggests that the overall capacities of the upper Mill Creek, upper Walla Walla, and upper Touchet watersheds are markedly different, these differences do not stem from variability in the headwater habitat qualities. Since the headwaters of all three systems reside in the Umatilla National Forest, they do not receive markedly different land use treatments. Hence we would not expect to observe different growth rates in bull trout or steelhead from those three systems due to micro-habitat variability. The density and distribution of Chinook adults, and Chinook, steelhead, and bull trout juveniles will be assessed on the rearing grounds using snorkeling surveys, seines, and traps, and following a modified EMAP design. Scale samples will be collected from each sub-population during juvenile abundance surveys. Scales will be analyzed using light-microscopy to elucidate daily growth rings. The relationships between fish age, length, and weight will be estimated using non-linear regression, and compared between populations using univariate and discriminant analysis. The density and distribution of spawners and rearing juveniles will be compared among watersheds using geostatistical and multivariate models. The strength of species interactions will be assessed using interaction coefficients. A detailed methodology for this study will be developed within six months by the co-management agencies.

1.2.4 Impacts of Watershed Restoration on Bed Scour

This section was contributed by Bob Bower, Walla Walla Basin Watershed Council, on April 24, 2004.

Status: Unfunded.

Purpose and Scope: During the historical development of the Walla Walla Valley, there has been an extensive amount of artificial channel stabilization and straightening. These channel manipulations have, over time, resulted in a much less sinuous and functioning channels for much of the watershed. Besides the obvious flooding and riparian health issues, these changes have also influenced the natural movement of channel bed materials. "The consequences of stream channel adjustments often lead to additional sediment supply due to accelerated stream bed and bank erosion. The cumulative effects of stream channel dis-equilibrium often results in

aggradation, degradation, accelerated lateral accretion, increased flood stage for the same magnitude flood, loss of fish habitat, increased land loss, downstream impacts due to sediment supply, change in morphological stream types and adverse short and long-term loss of physical and biological function. Sediment impacts cannot be isolated from streamflow changes. The consequence of increased magnitude, duration, and timing of streamflows can also lead to channel instability and
associated adverse impacts." (Rosgen, 2001)

An investigation to assess the watershed restoration activities and their impacts in the reduction of bed scour is needed. The study would focus specifically on the following hypothesis:

Ho: Decreased bed scour achieved through increased sinuosity and habitat variability will improve survival rates of salmonid eggs and fry.

To date, some Rosgen Level II surveys conducted on several areas of the watershed that provided the baseline information on channel form and function in parts of the basin. Some site specific information has been collect as specific instream structures including bridges, diversions and fish passage facilities. Other more anecdotal information has indicated that significant bedload movement occurs throughout our subbasin, Some spawning reaches are impacted, while other reaches need further monitoring and evaluation. We would anticipate that restoration activities that decrease the amount of channel bank control, decrease hydraulic velocities, and encourage the recover of natural sinuosity and riparian functions would assist in the improving the survival rates for salmonid eggs and fry in the Walla Walla Basin.

Some of the potential management applications would be to increase projects that increase the sinuosity and channel complexity (more pools and LWD) habitat projects. While the specific experimental design is yet to be determined, a strong component would be bed scour monitoring stations placed to verify presence absence and depth of bed scour in relation to channel habitat analysis and redd counts and fry counts. Sampling techniques will be used to insure statically robust segment results that could then be used throughout the Basin. As funding allows a baseline will be established ver a 3 year period with habitat improvements effect on bed scour and redd fry survival monitored over a longer period. .Data,, analysis and final reports will be shared with other basin partners and distributed via both state, federal and local web-based data bases. Federal metadata standards would be applied.

1.3 Monitoring and Evaluation Plan

1.3.1 Monitoring and Evaluation Framework

The EDT model was populated without extensive empirical data for the Walla Walla subbasin. In all cases empirical data were used if available. However many habitat attributes were rated based on local knowledge and best scientific judgment. It is clear that such data may inadequately represent habitat and fish assemblage conditions. The predictive capacity of EDT to help direct recovery actions and assess their potential beneficial effect could be substantially limited by the data quality. Improved data quality can be achieved by collecting the following empirical data:

- Those attributes with the greatest leverage on EDT model outputs (e.g. max width, gradient, habitat type inventories, large wood, bed scour) (From: *Mobrand Biometrics Quick Guide to Developing the Stream Reach Editor*, 2003)
- Those that are within priority protection or restoration stream reaches
- Data that is limited for attributes that have a broad (subbasin wide) effect on population or habitat status (passage at obstructions, water quality, others)
- Data identified in the Hypotheses and Objectives within the subbasin plan
- Attributes identified in the context of Walla Walla management information requirements, and listed in table A1.

The general M&E framework for the Walla Walla Subbasin will be to fill EDT data gaps and establish a better understanding of the baseline habitat conditions including the characteristics of passage, flow, substrate, and ecological interactions that most directly impact the production of resident and anadromous salmonids. The overall goal of monitoring and evaluation efforts will be to address, at a minimum, those critical areas for Viable Salmonid Population Analysis as described by NOAA Fisheries. Presently an evaluation and rating system for populations within ESUs is being developed by the Interior Columbia TRT. Once the methodology is complete, completing a rating exercise for the basin will be necessary. Beyond that action, specific attribute requirements have been identified for each of the four areas of VSP:

Abundance

Adult: Run size to the basin (This can be greatly impacted by out-of-subbasin effects but is critical to monitoring population status). Estimates or enumeration of escapement to the spawning grounds, including hatchery interactions in natural spawning areas, is crucial. Harvest within the subbasin including hatchery harvest and incidental hooking mortality of wild fish. Out-of-basin harvest and mortality (up-river subbasins may be prevented from recovering if out-of-basin effects limit adult escapement.

Juvenile - smolt production at the subpopulation level to reflect freshwater survival and production within the basin. It will be critical in modeling population response to habitat restoration actions.

Diversity: Genetic characterization, life history pathways (juvenile and adult), artificial propagation effects (hatcheries)

Spatial Structure Distribution of juveniles and adults within the subbasin, habitat limiting factors.

Productivity Population Growth rate or potential – juvenile and natural return ratio (NRR) for adults (should be above replacement or 1.0). Hatchery effects should not reduce NRR below 1.0

1.3.2 Monitoring Objectives

Walla Walla Subbasin monitoring objectives were developed in a collaborative setting with state, federal, and tribal co-managers using minimal-statistical analysis. First, a set of common performance indicators was developed to describe the pertinent population and environmental information for all salmonid species at all life stages. Next, a set of management information questions was developed to define specific monitoring and evaluation questions that are necessary to achieve salmonid recovery.

1.3.2.1 Performance Indicators

Table A1 describes a set of minimal performance indicators needed to describe the population and environmental status of Walla Walla Subbasin salmonids. Many of these indicators are currently assessed under long-term monitoring programs, however the scale and intensity of sampling must be expanded for most variables. It should be noted that most performance indicators that are currently assessed are supported by a variety of funding sources. Although there are advantages to this funding structure it generates a false estimate of the real cost of monitoring work in the Walla Walla Subbasin. Table A1 clearly shows, significant increases in support are needed to address several pertinent data gaps, and to answer the identified Walla Walla Subbasin information needs. At the same time ***PNAMP, CSMEP, and similar efforts have shown that most of the performance metrics described in table A1, and the information needs described below, are essential to an effective salmonid monitoring and evaluation program.*** Prioritization of the information needs will take place in a collaborative context with regional comanagers and funding agencies.

1.3.2.2 Management Information Needs

Management information needs were developed in a collaborative setting by members of the Walla Walla Subbasin Technical Work Group (TWG). The following tasks and critical uncertainties were developed in 2003, and updated by TWG in March of 2004 for the Subbasin Plan and the comprehensive salmonid RM&E plan that is currently under development. The list has not yet been prioritized, and represents an extensive wish-list of RM&E data. Some tasks will be addressed directly by TWG membership under on-going monitoring. Other objectives will be addressed through collaborative endeavors using multiple funding sources. Some questions are currently being addressed by targeted research programs. A detailed plan of action for Walla Walla Subbasin monitoring, including a detailed methodology, sample and power analysis, and budgetary considerations will be developed in the context of a comprehensive salmonid RM&E plan within the next six months.

1.3.2.2.1 Population and Environmental Status Monitoring

1.3.2.2.1.1 Adult Returns/Population Estimates

1.3.2.2.1.1.1 How many adult salmon and steelhead return each year to the Walla Walla, Touchet and Mill Creek watersheds by species and stock?

1.3.2.2.1.1.2 How many bull trout and mountain whitefish are present in each watershed?

1.3.2.2.1.1.3 What is the run timing of each species and stock for each year?

1.3.2.2.1.1.4 What are the sizes and ages of adult returns?

1.3.2.2.1.1.5 What is the final disposition of adult steelhead and salmon returning to each watershed

1.3.2.2.1.2 Spawning Surveys

1.3.2.2.1.2.1 What is the annual distribution and abundance of spawners and redds in each watershed for spring Chinook, steelhead and bull trout?

1.3.2.2.1.2.2 What is the spawn timing of each species?

1.3.2.2.1.2.3 What proportion of redds were made by hatchery females?

1.3.2.2.1.2.4 What proportion of the steelhead/rainbow and bull trout spawners had resident, fluvial or anadromous life histories each year?

1.3.2.2.1.2.5 What is the size and age of salmon, steelhead, bull trout and rainbow trout spawning naturally in the basin?

1.3.2.2.1.2.6 What was the egg retention and proportion of pre-spawn mortalities by reach?

1.3.2.2.1.3 Spring Chinook Carcass Surveys for Adult Out-Plan Evaluations

1.3.2.2.1.3.1 Were there any naturally produced adult spring Chinook spawners?

1.3.2.2.1.3.2 What was the egg retention and proportion of pre-spawn mortalities by reach?

1.3.2.2.1.4 Juvenile and Resident Salmonid Abundance Surveys

1.3.2.2.1.4.1 What is the relative abundance and distribution of salmonids, by species, seasonally, throughout the basin?

1.3.2.2.1.4.2 What are the summer densities of salmonids, by species, throughout the basin?

1.3.2.2.1.4.3 What are the sizes, age and growth rates of salmonids, by species throughout the basin?

1.3.2.2.1.5 Smolt and Parr Outmigration Monitoring

1.3.2.2.1.5.1 What is the timing of parr and smolt outmigrations, by species and stock?

1.3.2.2.1.5.2 What is the total abundance of salmonid outmigrants, by species and stock?

1.3.2.2.1.5.3 What is the survival of salmonid outmigrants to McNary Dam and the lower Columbia River, by species and stock?

1.3.2.2.1.5.4 What is the size of parr and smolt outmigrants, by species and stock?

1.3.2.2.1.5.5 What is the condition of parr and smolt outmigrants, by species and stock?

1.3.2.2.1.5.6 What is the arrival timing for parr and smolt outmigrants to McNary Dam and the lower Columbia River, by species and stock?

1.3.2.2.1.6 Fish Habitat Surveys

1.3.2.2.1.6.1 What are the conditions, trends, quantities and connectivity of various salmonid habitat types in the basin?

1.3.2.2.1.6.2 Are fish habitat conditions improving or degrading and what are the rates of change by stream and reach?

1.3.2.2.1.7 Water Temperatures and Instream Flows

1.3.2.2.1.7.1 What are the water temperatures in the basin from the mouth to the headwaters, May through October?

1.3.2.2.1.7.2 What are the water temperatures in the basin during the winter? (reference to MIN 12.5)

1.3.2.2.1.7.3 Are instream water temperatures adequate for steelhead, chinook salmon, or bull trout during spawning?

1.3.2.2.1.7.4 Are instream flows adequate for instream fish productivity and passage?

1.3.2.2.1.8 Genetic Studies

1.3.2.2.1.8.1 What are the general genetic characteristics and geographic stock structures of steelhead, Chinook, bull trout and whitefish in the Walla Walla and surrounding subbasins?

1.3.2.2.1.8.2 What is the contribution of RBT to STS production in the Walla Walla?

1.3.2.2.1.8.3 What is the rate of hybridization between endemic wild and out-of-basin hatchery reared stocks?

1.3.2.2.1.8.4 What is the rate of hybridization between bull trout and introduced brown trout?

1.3.2.2.1.8.5 What is the origin and ESU of lower Walla Walla coho and fall Chinook?

1.3.2.2.1.8.6 What is the rate of change in the genetic characteristics (drift and flow) in the various steelhead and Chinook stocks through time?

1.3.2.2.1.8.7 Are there negative or deleterious changes (based on current genetic theory) to the genetic characteristics of Walla Walla steelhead and Chinook stocks?

1.3.2.2.2 Natural Production

1.3.2.2.2.1 Salmonid Productivity, Fitness and Survival Rates

1.3.2.2.2.1.1 What are the limiting factors that influence adult to adult production and survival rates?

1.3.2.2.2.1.2 What are the rates of steelhead kelting?

1.3.2.2.2.1.3 What are the limiting factors that influence the egg to smolt (or parr) survival rates?

1.3.2.2.2.1.4 What are the limiting factors that influence smolt (or parr) to adult survival rates?

1.3.2.2.2.1.5 What are the natural production capacities for each sub-watershed in the basin?

1.3.2.2.2.1.6 What is the optimum adult escapement for natural production for each species?

1.3.2.2.2.1.7 How does salmonid natural productivity and capacity in the basin compare to neighboring basins?

1.3.2.2.2.2 Interactions between Fish and Habitat Using EDT Model

1.3.2.2.2.2.1 What are the primary physical, chemical, and climatic factors and relationships that influence survival, productivity, condition, abundance and distribution of each species, stock and life history stage?

1.3.2.2.2.2.2 What are the most statistically powerful EDT metrics?

1.3.2.2.2.2.3 What EDT metrics are most easily measurable given local programmatic, social, and environmental constraints?

1.3.2.2.2.2.4 How effective are various physical habitat management and restoration actions and strategies in improving survival, productivity, condition, abundance and distribution of each species and stock, by life history stage and reach?

1.3.2.2.2.2.5 What habitats are the most important to rehabilitate, maintain and preserve?

1.3.2.2.2.2.6 What are the most cost effective and most reliable management actions that restore and preserve critical habitats?

1.3.2.2.2.2.7 What and where are the landscape scale problems affecting fish habitat?

1.3.2.2.3 Hatchery Programs

1.3.2.2.3.1 Hatchery Program Monitoring

1.3.2.2.3.1.1 How many broodstock were collected, where, when and how, including sizes and condition? What is their age structure and origin?

1.3.2.2.3.1.2 How, where and when were adult broodstock held prior to spawning, including numbers, sizes and condition?

1.3.2.2.3.1.3 How, where and when were broodstock artificial spawned, including numbers, sizes and condition?

1.3.2.2.3.1.4 What are the origins and marks of all Chinook outplants?

1.3.2.2.3.1.5 How, where and when were eggs incubated?

1.3.2.2.3.1.6 How, where and when were fry and parr reared, including numbers, sizes and condition?

1.3.2.2.3.1.7 How, where and when were parr and smolts acclimated and/or liberated, including numbers, sizes, and condition?

1.3.2.2.3.1.8 What are the marks and tags used to identify each release group?

1.3.2.2.3.1.9 What was the disease and treatment history of each life history stage?

1.3.2.2.3.2 Optimal Hatchery Practices

1.3.2.2.3.2.1 What are the processes, standards and criteria needed to develop hatchery practices that balance the needs to be efficient, cost effective and minimize ecological and genetic risks to natural and hatchery stocks?

1.3.2.2.3.2.2 What are the best stocks to use for each species for the hatchery programs?

1.3.2.2.3.2.3 Are we effectively isolating the out-of-basin stock, and minimizing the ecological impacts on wild fish?

1.3.2.2.3.2.4 What are the ecological and genetic interactions of wild and hatchery STS?

1.3.2.2.3.2.5 Are hatchery STS achieving harvest mitigation goals?

1.3.2.2.3.2.6 What is the long-term reproductive success of endemic hatchery reared STS?

1.3.2.2.3.2.7 What are the best strategies and methods to collect broodstock for hatchery programs for each species and stock?

1.3.2.2.3.2.8 What are the best methods to hold and spawn broodstock for each species and stock?

1.3.2.2.3.2.9 What are the optimal breeding practices for each species and stock?

1.3.2.2.3.2.10 What are the optimal incubation practices for each species and stock?

1.3.2.2.3.2.11 What are the optimal rearing methods for each species, stock and life history stage?

1.3.2.2.3.2.12 What are the optimal growth and feeding rates for each species, stock and life history stage?

1.3.2.2.3.2.13 What are the optimal times, methods, and protocols for tagging hatchery reared fish for each species and stock?

1.3.2.2.3.2.14 What are the optimal sizes, times, locations and conditions to liberate hatchery reared fish into the basin.

1.3.2.2.3.2.15 For each relevant disease, what is the best disease management practices for the prevention and treatment of each species, stock and life history stage?

1.3.2.2.3.2.16 What are the vertical and horizontal transmission rates of dominant diseases in natural and supplemented populations?

1.3.2.2.3.3 Evaluate Similarities and Differences between Hatchery and Natural Fish

1.3.2.2.3.3.1 What are the similarities and differences in the sex ratio, fecundity, run timing and spawning time of adult hatchery and natural steelhead and Chinook?

1.3.2.2.3.3.2 What are the similarities and differences in size, age, migration timing, migration survival and smoltification of hatchery and natural steelhead and Chinook?

1.3.2.2.3.3.3 What are the similarities and differences in genetic characteristics of hatchery and natural steelhead and Chinook?

1.3.2.2.3.3.4 What are the similarities and differences in the types, incidence and severity of diseases in hatchery and natural steelhead and Chinook?

1.3.2.2.3.4 Straying

1.3.2.2.3.4.1 What are the stray rates of Walla Walla Basin steelhead and salmon into other basins?

1.3.2.2.3.4.2 How many salmon and steelhead stray into the Walla Walla Basin each year from other basins, by species and stock?

1.3.2.2.4 Flow and Passage

1.3.2.2.4.1 Migration Evaluations of Steelhead, Salmon, Bull Trout, and Whitefish

1.3.2.2.4.1.1 Are there delays at passage facilities for spring Chinook, and if so, how many, where, when and under what conditions?

1.3.2.2.4.1.2 What is the average passage time for spring Chinook at each passage facility and between facility reaches?

1.3.2.2.4.1.3 What are the migratory patterns, distributions and maximum upstream ranges of spring Chinook migrants?

1.3.2.2.4.1.4 What is the average daily movement by species, month and reach?

1.3.2.2.4.1.5 How do flows, temperatures, seasons, facility operation and other factors affect adult migration?

1.3.2.2.4.1.6 How well do salmonids negotiate the passage facilities, especially through the lower Mill Creek-Yellowhawk Creek complex?

1.3.2.2.4.1.7 Is Yellowhawk Creek used as spawning habitat, or purely as a migration corridor?

1.3.2.2.4.1.8 Were Nursery Bridge, Bennington Dam, and Gose St. passage restoration efforts successful?

1.3.2.2.4.1.9 Is the Yellowhawk weir an effective monitoring facility?

1.3.2.2.4.1.10 Does the Hofer irrigation diversion provide sufficient downstream passage?

1.3.2.2.4.1.11 Does Dry Creek provide passage past Dixie during low flows?

1.3.2.2.4.1.12 Are current flows sufficient to provide adult passage during May through December?

1.3.2.2.4.1.13 Does the Burlingame Diversion impact passage?

1.3.2.2.4.1.14 Does the Couse Creek Konnen gravel pit inhibit migration?

1.3.2.2.4.1.15 Is the Little Walla Walla Diversion an attractant?

1.3.2.2.4.2 Juvenile Passage Facility Evaluations

1.3.2.2.4.2.1 How well do downstream migrants negotiate the passage facilities?

1.3.2.2.4.2.2 Are there delays, injuries and mortalities at passage facilities, and if so, how many, where, when and under what conditions?

1.3.2.2.4.2.3 What are the passage times, injury rates and mortality rates at each passage facility and between facility reaches?

1.3.2.2.4.2.4 What is the average daily downstream movement by species, month and reach?

1.3.2.2.4.2.5 How are out-migration patterns influenced by flows, temperatures, seasons, facility operation and other factors?

1.3.2.2.4.2.6 Can smolts and parr pass successfully through the Mill Creek complex?

1.3.2.2.4.2.7 Does the Walla Walla city water intake inhibit downstream migration of juveniles?

1.3.2.2.4.2.8 How many fish are being diverted into the Bennington Lake Diversion?

1.3.2.2.4.2.9 What are the impacts of Nursery Bridge Dam on out-migrants?

1.3.2.2.4.2.10 Are the new city water intake screens effectively excluding salmonids?

1.3.2.2.4.2.11 Are Titus and Garrison creeks potential salmonid producers?

1.3.2.2.5 Fisheries

1.3.2.2.5.1 Harvest

1.3.2.2.5.1.1 What and where? was the annual sport harvest of salmonids by species in the basin?

1.3.2.2.5.1.2 What and where? was the annual tribal harvest of salmonids by species in the basin?

1.3.2.2.5.1.3 What and where? was the annual out-of basin harvest of Walla Walla Basin origin salmon and steelhead?

1.3.2.2.5.2 Harvest Related Evaluations

1.3.2.2.5.2.1 What are the cumulative affects of harvest management on wild steelhead, bull trout, and mountain whitefish?

1.3.2.2.5.2.2 What are the most cost effective and statistically robust harvest monitoring strategies and protocols for the sport and tribal fishing seasons?

1.3.2.2.5.2.3 What are rates of out-of-basin vs. in-basin harvest?

1.3.2.2.5.2.4 What are the rates of hooking and handling mortality?

1.3.2.2.5.2.5 What are the rates of redd BT redd disturbance by trout fishers?

1.3.3 Spatial and Temporal Scales

Given the relative importance of habitat restoration efforts to the development of the EDT working hypothesis, it is imperative that the spatial and temporal scales of monitoring be structure so as to simultaneously address Tier 1 and Tier 2 habitat restoration effectiveness issues simultaneously. The watershed concept has been used to successfully associate salmonid production and habitat covariates in western tributaries (Beschta and Taylor 1988; Bilby et al. 2003; Hall 1977; Hicks et al. 1991; Moring and Lantz 1975; Nakamoto 1998; Regetz 2003; Ringler and Hall 1975; Stednick and Kern 1994; Thompson and Lee 2002; Tschaplinski 2000). Figure X shows the spatial coverage of several habitat and environmental monitoring efforts in the Walla Walla Subbasin. In general the spatial coverage of population monitoring efforts is similarly robust. However, as Table A1 describes, the sampling intensity and sampling regime of most population monitoring efforts, and some habitat monitoring efforts, are far below the regional standard for a subbasin that supports two ESA listed species and a re-introduced salmon.

Proper sampling designs can greatly increase the power of replicates in a comprehensive monitoring strategy. This does not fully make up for the lack of RM&E resources in the subbasin, but it can help reduce error associated with modeling results based on small sample sizes. A spatial hierarchy will be used to stratify sampling effort throughout the subbasin and to aggregate results to the watershed scale. Physical and biological habitat attributes and fish population information will be collected at the EDT sub-reach scale. Geospatial and geostatistical analysis will be used to aggregate reach information with point-source measures of water quality and quantity. These results will be compared to population-scale data such as harvest rates, genetic characteristics, and production variables at the subbasin scale.

Annual estimates or vectors of most performance metrics will be produced. For temporally dynamic metrics such as flow, temperature, and migration rates annual estimate of daily, weekly, or monthly averages will be developed. In-stream habitat information will be collected for each reach every ten years, except where targeted restoration actions have been implemented. A holistic model of the Walla Walla Subbasin will be updated bi-annually with these results. The final research agenda and monitoring & evaluation plan (to be reviewed during the provincial review) will be updated every three years, or as new information needs become apparent.

1.3.4 Data Management

A variety of agencies with diverse responsibilities are responsible for RM&E in the Walla Walla Subbasin. Due to the large number of people and projects in the subbasin, a centralized data management system has not been developed. At this point it is unclear if such a system is wanted or needed, and it is unclear what benefits would be derived from centralized data archiving.

However, the subbasin planning process made clear that there is a need for regular centralized data compilation and analysis, and that collaborative access to data is critical. The co-managers will work to develop a hardware-software solution for regular compilation and analysis of Walla Walla RM&E data. The product will be developed as part of the Habitat Conservation Planning Process. The solution will consist of a relational database that links directly to project archives using Federal Geographic Data Committee (FGDC) ISO standards. The nexus will allow project managers and institutional representatives to maintain QA/QC, and will not place additional posting or QA/QC requirements upon individual projects. At the same time the FGDC standards will provide for meaningful comparisons of results, and for interactive modeling and evaluation of data from divergent projects or techniques. This nexus will operate at multiple spatial scales, and will incorporate data that is managed out of basin by state or federal agencies.

The nexus will be updated regularly as new projects or collaborations are developed. Every five years the co-managers will re-engage in the context of testing the working hypothesis and conducting a subbasin review. This will provide an opportunity for comprehensive results reporting and evaluation, and will greatly facilitate the adaptive management process.

1.3.5 Evaluation

The five year Subbasin Review process will provide an opportunity for scientists and managers to re-assemble and thoroughly re-evaluate progress in the subbasin. The goal of the Subbasin Review will be to evaluate progress in meeting the goals and objectives of the Subbasin Plan. The review will be conducted by the core participants that developed the Subbasin Plan. The evaluation component of the Subbasin Review will consist of a scientific, decision-making, and public evaluation.

TWG will conduct scientific evaluation of the strengths and weaknesses of the current information status, and will produce a technical interpretation of the achieved progress towards the subbasin plan objectives. Progress towards strategy implementation will be evaluated in terms of changes in habitat quality and quantity, in-stream conditions, passage, etc.. The population response will be evaluated in terms of the total production in each geographic area, survival throughout the subbasin, and observed and projected returns of anadromous adults.

The co-managers will conduct decision-making evaluation of the current utility and transparency of the current information status, progress towards achieving the subbasin objectives, and the potential responses to the scientific evaluation. The quality of scientific information will be evaluated in terms of the ability of scientists to make technical evaluations with an appropriate level of statistical confidence, and to present that information to the management community. Progress towards strategy implementation will be evaluated in terms of programmatic effectiveness and action achievements. Potential responses to scientific evaluation will be evaluated in terms of the perceived effectiveness of the current management actions, and the potential utility and attainability of revised actions.

The public will conduct evaluation of the program as a whole, and the perceived and observed effectiveness of particular and total actions in the subbasin. The achievement of harvest opportunities, restoration of water quality and quantity, and recovery of diminished stocks will be addressed. The ability of the co-managers to work and communicate effectively with the public will be evaluated. Community knowledge and participation in management decisions and action implementation, including volunteerism and activism, will be considered. This public evaluation will take place in the context of town, city, and county meetings with political and management authorities.

RM&E Conclusions and Recommendations (I LEFT AS IS: We should revisit after completion of the other sections)

The Walla Walla subbasin managers and stakeholders have implemented efforts to coordinate recovery and RME actions within the subbasin. Included in these efforts was an extensive assessment of ongoing and needed RME actions (Table A1). The managers attempted to identify the current level of effort, and a subjective assessment that effort's progress toward meeting data needs within the subbasin. A complete prioritization of actions within the table has not been accomplished. However, all involved parties committed to completing an RME plan that would, eventually address priority actions. Following are broad conclusions and recommendations based on guiding principles and priorities, and the items listed in Table A1. These will serve as generalized high priority (in principle) actions that should be pursued while the more comprehensive RME plan is completed.

1. *Conclusion:* The quality of data used within the EDT attributes and modeling exercise is inadequate. Empirical data of know accuracy and precision is needed for priority areas (habitat inventory using standardized protocols from region that will fit EDT) of the subbasin. These data will be used to evaluate the efficacy of EDT in modeling habitat and population response to actions taken within the subbasin, and to evaluate the hypotheses and objectives presented in the subbasin plan.
Recommendation: Fund habitat inventories to collect data necessary to fill data gaps for attributes with high EDT model leverage and evaluation of progress toward subbasin plan objectives.

2. *Conclusion:* Population status monitoring must occur in a systematic manner that will allow managers to evaluate their progress toward delisting from ESA. Criteria established by NOAA and the TRTs under VSP will be used within the subbasin. These metrics will be useful within EDT, and provide a direct relationship between the habitat and population monitoring efforts, through model outputs.
Recommendation: Continue to fund existing monitoring and evaluation actions within the subbasin that fulfill critical VSP data needs.

Recommendation: Fund additional actions to complete basic population status monitoring needs for the subbasin (e.g. Monitor adult escapement into the three major basins of the Walla Walla (Touchet R, Mill Creek and Walla Walla above Mill Creek), and the smolt emigration from those basins)
To fulfill this example, the specific actions or improvements listed below may be needed.

1. Adult counting or trap at Bennington Dam
2. Improved counting or trap at Dayton
3. Fix trap/ladder/passage at Nursery Bridge
4. Smolt trap in Touchet and Walla Walla Systems

Additional VSP related action may be required/recommended as the full RME plan is completed.

3. *Conclusion*: Basic monitoring of restoration actions undertaken within the subbasin needs to occur to ensure that they were completed in accordance with expectations (Implementation monitoring). However, the effects of those actions on the

habitat and salmonid populations (Effectiveness monitoring) is costly and should be done on only a portion of completed projects.
Recommendation: Accountability for restoration actions needs to occur for each project. Basic documentation should be completed in a cost efficient manner. A systematic approach to documenting effectiveness is required that provides sufficient accountability without unnecessary redundancy. (e.g. classes of actions my be represented by monitoring a small portion of similar projects)

4. *Conclusion:* Critical uncertainties will be identified in the Comprehensive RME plan and coordinated with other regional forums. Uncertainties must be understood and answered if population recovery is to occur. ESU wide uncertainties may be addressed in the subbain as part of a regional RME effort. Subbasin specific factors may need localized RME efforts to answer.
Recommendation: Fund research on critical uncertainties unique to the Walla Walla as a priority for recovery actions in the subbasin. (direct need)

Recommendation: Fund research on critical uncertainties represented in the Walla Walla for a broader ESU relevance if not being funded or conducted in other subbasins. (opportunity for coordinated regional effort)

Conclusion: The managers have not established comprehensive population abundance goals for the subbasin. Interim escapement and spawning goals are inconsistent in definition and basis. The subbasin plan and its RME section can provide critical data for establishing these goals in a coordinated and scientifically defensible fashion.

Recommendations: Fund and implement RME that shows a clear link to resolving uncertainty regarding population abundance and management goals.

Table A1. Identified RME opportunities in the Walla Walla Subbasin, 2004.

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
Abundance	Adult	Adult returns to Walla Walla River	WDFW, ODFW, CTUIR, USFS, USACOE, TSS	Counts are made at ladders and weirs throughout the subbasin. Some passive detection stations have been established	Direct observations should be replaced with passive detections throughout the subbasin. A passive detection system should be established at the confluence with the Columbia.	BPA, LSC, volunteers & cost-share
		Run to mainstem dams	USACOE and Columbia River compact	Passive detections and radio detections are made at all mainstem dams and the estuary.	The current effort is sufficient.	BPA, LSC
		CHS Broodstock Collection	CTUIR	Collected from Umatilla River Run CHS	Broodstock should come from locally adapted naturally producing CHS run	BPA and US v Oregon
		STS Broodstock Collection	WDFW	Collected from Lyon's Ferry and Dayton ladder	If experimental hatchery program is deemed sustainable, broodstock should be collected from endemic run to Dayton and Nursery Bridge ladders.	LSC
		Spawner Escapement	CTUIR, USFS, USFWS, ODFW, WDFW	Standardized spawner surveys are divided across geographical boundaries, and conducted with low intensity.	Stratified randomized georeferenced surveys.	BPA, USFWS, LSC, ODFW
		Run Prediction	CTUIR	none	Run prediction models should be developed for CHS and STS	none

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
	Juvenile	Parr and pre-smolt Abundance	USFWS (BT), CTUIR (STS, CHS), WDFW (Touchet STS, CHS)	Electrofishing, seines, snorkel, and baited trap surveys are conducted by multiple agencies with some coordination.	Stratified randomized georeferenced survey design with increased collaboration and coordination.	BPA, USFS, USFWS, LSC, ODFW
		Smolt Abundance	USFWS (BT), CTUIR (STS, CHS)	Screw-trap collections for upper Mill Creek and Walla Walla systems, plus two Walla Walla mainstem traps.	Additional screw-trap or PIT-tagging effort in the Touchet system, plus increased effort in the mainstem to develop total outmigration estimate.	USACOE, USFWS, BPA, LSC
		Residual Abundance	WDFW, CTUIR	Limited coverage using hook and line and electrofishing.	Stratified randomized georeferenced assessment using hook and line and baited traps.	LSC, BPA
Survival and Productivity	Adult	Broodstock Survival	WDFW, CTUIR	Monitored in-hatchery.	The current effort is sufficient.	LSC, BPA
		Smolt-to-Adult Return	USFWS, CTUIR, ODFW, WDFW, TSS, USFS	Metric derived from independent assessments of smolt survival, age at return, adult mortality, and spawner densities.	Increased PIT-tagging effort for hatchery and wild fish to develop SURPH and CRiSP models.	USFWS, BPA, ODFW, WDFW, PSMFC, volunteers
		Smolt-to-Adult Survival	USFWS, CTUIR, ODFW, WDFW, TSS, USFS	Metric derived from independent assessments of smolt survival, age at return, adult mortality, and spawner densities.	Increased PIT-tagging effort for hatchery and wild fish to develop SURPH and CRiSP models.	USFWS, BPA, ODFW, WDFW, PSMFC, volunteers
		Parent Progeny Ratio	USFWS, CTUIR, ODFW, WDFW, TSS, USFS	Metric derived from independent assessments of smolt survival, age at return, adult mortality, and spawner densities.	Increased PIT-tagging effort for hatchery and wild fish to develop SURPH and CRiSP models.	USFWS, BPA, ODFW, WDFW, PSMFC, volunteers

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
		Pre-spawn Mortality	CTUIR, WDFW, USFWS, TSS, WWBWC	Expanded from carcass surveys and telemetry study.	Stratified, randomized, georeferenced carcass surveys with increased coverage.	BPA, USFWS, OWEB
		Recruit /spawner (adult to adult)	USFWS, CTUIR, ODFW, WDFW, TSS, USFS	Metric derived from independent assessments of smolt survival, age at return, adult mortality, and spawner densities.	Increased PIT-tagging effort for hatchery and wild fish to develop SURPH and CRiSP models.	USFWS, BPA, ODFW, WDFW, PSMFC, OWEB, volunteers
	Juvenile	Egg to Fry Survival	not assessed	not assessed	Should be derived from higher resolution studies of spawners, parr, and smolts.	unfunded
		Fry to parr and parr to smolt survival	not assessed	not assessed	Derived from higher resolution studies of spawners, parr, and smolts.	unfunded
		Smolt Survival to McNary Dam	CTUIR, WDFW, USFWS, USACOE	Derived from PIT-tag detections	Increased PIT-tagging effort to develop SURPH and CRiSP models, plus increased screw-trap effort to estimate total smolt outmigration from WWR.	LSC, BPA
		Smolt Survival through Mainstem Columbia River	CTUIR, WDFW, USFWS, USACOE	Derived from PIT-tag detections	Increased PIT-tagging effort to develop SURPH and CRiSP models, plus increased screw-trap effort to estimate total smolt outmigration from WWR.	LSC, BPA

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
Distribution and Movement	Adult	Spawner Spatial Distribution	CTUIR, WDFW, ODFW, USFS, USFWS	Standardized spawner surveys are divided across geographical boundaries, and conducted with low intensity.	Stratified randomized georeferenced surveys.	BPA, USFWS, LSC, ODFW, OWEB
		Stray Rate	WDFW, PSMFC, CTUIR, U of I	Passive detections and radio detections are made at all mainstem dams and the estuary, plus CWT recoveries from creel, volunteers, and carcass surveys, and scale analysis.	The current effort is sufficient.	LSC, BPA, OWEB
	Juvenile	Rearing Distribution	USFWS (BT), CTUIR (STS, CHS), WDFW (Touchet STS, CHS)	Electrofishing, seines, snorkel, and baited trap surveys are conducted by multiple agencies with some coordination.	Stratified randomized georeferenced survey design with increased collaboration and coordination.	BPA, USFS, USFWS, LSC, ODFW
		Residual Distribution	WDFW, CTUIR	Limited coverage using hook and line and electrofishing.	Stratified randomized georeferenced assessment using hook and line and baited traps.	LSC, BPA
Life History	Adult	Run Timing	WDFW, CTUIR, ODFW, PSMFC, USACOE	PIT-tag detections, ladder counts, creel surveys, radio telemetry, and spawning surveys.	The current effort is sufficient.	BPA, LSC, OWEB, USACOE
		Passage efficiency	CTUIR, WWBWC, WDFW, ODFW, TSS, USACOE, UI	Telemetry, ladder counts, PIT-tag detections, and spawner surveys.	The current effort is sufficient.	BPA, USACOE, OWEB, ODFW, WDFW

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
		Age of spawners	ODFW, WDFW,CTUIR, USFWS	PIT-tag detections, CWT recoveries, scale and otolith analysis.	Increased PIT-tagging efforts and scale and otolith analysis with greater coverage and coordination.	BPA, LSC, USFWS
		Size of spawners	WDFW, ODFW, CTUIR, USACOE, USFS, TSS, USFWS	PIT-tag detections, CWT recoveries, ladder counts, creel surveys, and carcass surveys.	The current effort is sufficient.	BPA, LSC, ODFW, WDFW, USFS, volunteers, USFWS
		Sex Ratio of spawners	WDFW, ODFW, CTUIR, USACOE, USFS, TSS, USFWS	PIT-tag detections, CWT recoveries, ladder counts, creel surveys, and carcass surveys.	The current effort is sufficient.	BPA, LSC, ODFW, WDFW, USFS, volunteers, USFWS
		Fecundity	USFS, ODFW, USFWS, WDFW, CTUIR	Fecundity is measured in the hatchery and by ultrasound at the Walla Walla city water intake.	Fecundity estimates should be linked directly with age and growth estimates for all species.	LSC, BPA, USFS
		Spawn-timing	CTUIR, ODFW, WDFW, WWBWC, USFWS, USFS, Uof I	Telemetry, spawner surveys, and carcass surveys.	The current effort is sufficient.	BPA, LSC, USFS, USACOE, OWEB
	Juvenile	Size at Release	CTUIR, WDFW	Monitored in-hatchery.	The current effort is sufficient.	BPA, LSC
		Release Location	CTUIR, WDFW	Monitored in-hatchery.	The current effort is sufficient.	BPA, LSC

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
		Emigration Timing	USFWS (BT), CTUIR (STS, CHS)	PIT-tag detections and screw-trap collections for upper Mill Creek and Walla Walla systems, plus two Walla Walla mainstem traps.	Additional screw-trap or PIT-tagging effort in the Touchet system, plus increased effort in the mainstem to develop total outmigration estimate.	USACOE, USFWS, BPA, LSC
		Age at Emigration	CTUIR, USACOE, WDFW, Batelle, USFWS	PIT-tag detections and screw-trap collections for upper Mill Creek and Walla Walla systems, plus two Walla Walla mainstem traps.	Additional screw-trap or PIT-tagging effort in the Touchet system, plus increased effort in the mainstem to develop total outmigration estimate.	BPA, LSC, UACOE, USFWS
		Size at Emigration	CTUIR, USACOE, WDFW, Batelle, USFWS	PIT-tag detections and screw-trap collections for upper Mill Creek and Walla Walla systems, plus two Walla Walla mainstem traps.	Additional screw-trap or PIT-tagging effort in the Touchet system, plus increased effort in the mainstem to develop total outmigration estimate.	BPA, LSC, UACOE, USFWS
		Condition at Emigration	CTUIR, USACOE, WDFW, Batelle, USFWS	PIT-tag detections and screw-trap collections for upper Mill Creek and Walla Walla systems, plus two Walla Walla mainstem traps.	Additional screw-trap or PIT-tagging effort in the Touchet system, plus increased effort in the mainstem to develop total outmigration estimate.	BPA, LSC, UACOE, USFWS

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
Fish Health	Adult and Juvenile	Disease Incidence	WDFW, ODFW, CTUIR, USFWS	Monthly disease checks in hatchery. No coverage in natural populations and no assessment of hatchery-to-natural transmission.	Coordinated surveys of mortalities and carcasses, plus small sub-sample of "healthy" wild fish.	BPA, LSC, USFWS
		Disease Severity	WDFW, ODFW, CTUIR, USFWS	Monthly disease checks in hatchery. No coverage in natural populations and no assessment of hatchery-to-natural transmission.	Coordinated surveys of mortalities and carcasses, plus small sub-sample of "healthy" wild fish.	BPA, LSC, USFWS
Genetic	Adult and Juvenile	Genetic Diversity and Integrity	CTUIR, ODFW, WDFW, USFWS	not assessed	Coordinated assessment of genetic characteristics for all supplemented, reintroduced, and listed species.	unfunded
		Reproductive Success	CTUIR, ODFW, WDFW, USFWS	not assessed	Experimental assessment of reproductive success of BT, STS, and CHS at Nursery Bridge Dam.	unfunded
		Effective population size	CTUIR, ODFW, WDFW, USFWS	Assessment of BT connectivity and spatial heterogeneity.	Standardized monitoring of effective population size measured as the rate of decline in genetic heterozygosity	USFWS
Fisheries	Adult	In-basin harvest	WDFW, ODFW	Limited coverage using creel surveys plus catch records from volunteers.	Stratified randomized creel surveys of entire subbasin plus increased volunteer involvement.	WDFW, ODFW

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
		Out-of-basin harvest	LSC, PSMFC	Randomized creel surveys plus CWT and PIT-tag estimates of harvest.	Increased spatial and temporal coverage and consistency in survey methodologies.	LSC, NOAA
		Hooking rate	WDFW, ODFW	Limited coverage using creel surveys plus catch records from volunteers.	Stratified randomized creel surveys of entire subbasin plus increased volunteer involvement.	WDFW, ODFW
		Handling mortality	CTUIR, WDFW, USACOE, WWBWC	Derived from telemetry mortalities.	The current effort is sufficient.	BPA, LSC, OWEB, USACOE
Habitat	Adult and Juvenile	Instream flow	WWBWC, OWRD, WDOE, T, WDFW, USGS	Gauge stations, manual msmt	Increase spatial and temporal coverage	OWEB, OWRD, WDOE, WDFW, USGS, BPA
		Water temperature	WDOE, USFS, WWBWC, WDFW, CTUIR,	Temp loggers with traceable thermometer field audits. FLIR flights up to N.F. Touchet.	Increase spatial and temporal coverage. FLIR flights throughout subbasin.	OWEB, WDFW, WDOE, USFS, EPA
		Water quality	WDOE, WWBWC, WDFW	Grab samples using calibrated equipment	Increase spatial and temporal coverage	WDOE, EPA, OWEB
		Physical habitat conditions	USFS, WDFW, ODFW, WWBWC, USFWS	Modified Hankin & Reeves or Rosgen surveys, TMDL morphology, sinuosity analysis.	Addition of EDT-derived metrics such as bed-scour and embeddedness, plus georeferenced survey design.	BPA, LSC, USFS, USFWS, WWBWC, EPA, OWEB

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
		Biological habitat conditions	USFS, WDFW, ODFW, WWBWC, USFWS, OSU	For riparian conditions, modified Hankin & Reeves or Rosgen surveys. Some reaches have ongoing macroinvertebrate sampling and analysis.	Increase spatial and temporal benthic macroinvertebrate sampling and analysis	BPA, LSC, USFS, USFWS, EPA, OWEB,
		Habitat Quantity	USFS, WDFW, ODFW, WWBWC, USFWS	Modified Hankin & Reeves or Rosgen surveys.	Addition of EDT-derived habitat types, plus georeferenced survey design.	BPA, LSC, USFS, USFWS, WWBWC
		Passage barriers and diversions	CTUIR, WWBWC, WDFW, ODFW, TSS, USACOE, UI	Telemetry, ladder counts, PIT-tag detections, and spawner surveys.	The current effort is nearly sufficient. Habitat surveys should be expanded to include geolocation of waterfalls and natural barriers.	BPA, USACOE, OWEB, ODFW, WDFW
		Habitat utilization	CTUIR, WDFW, ODFW, USFS, USFWS	Derived from juvenile and adult abundance and distribution surveys.	Georefenced survey design for fish population studies	BPA, LSC, USFS, USFWS
		Smolt production of habitat	CTUIR, WDFW, ODFW, USFS, USFWS	Derived from juvenile and adult abundance and distribution surveys.	Georefenced survey design for fish population studies	BPA, LSC, USFS, USFWS
Ecosystem	Juvenile and Adult	Trophic relationships	CTUIR, WDFW, ODFW, USFS, OSU, USFWS	not assessed	Stable isotope assessments plus mass-balance models	unfunded

Metric	Life Stage	Performance Measure	Collaboration	Current Effort	Desired Future Effort	Current Funding
		Competition	CTUIR, WDFW, ODFW, USFS, OSU, USFWS	not assessed	Stable isotope assessments plus mass-balance models	unfunded
		Natural mortality	CTUIR	not assessed	Stable isotope assessments plus mass-balance models	unfunded
		Marine ecology	CTUIR, CRITFC, OSU	not assessed	Archival tag studies	unfunded
		Redd impacts	CTUIR, WDFW, ODFW, USFS, OSU, USFWS	not assessed	Stable isotope assessments plus mass-balance models	unfunded
		Carcass impacts	CTUIR, WDFW, ODFW, USFS, OSU, USFWS	not assessed	Stable isotope assessments plus mass-balance models	unfunded

FIGURE 1. Distribution of some regular habitat and environmental monitoring activities in the Walla Walla Subbasin.