9.0 RM&E PLAN

The Washington State Snake River Salmon Recovery Plan does not encompass any ESU in its entirety, and therefore cannot directly facilitate the recovery and ultimate delisting of any ESU. Instead, this plan aims to *support* recovery at the ESU level through improvements in performance at the population and MSA levels of aggregation. Hence, RM&E discussions in this document are limited to those that can detect change at the spatial levels of aggregation that are relevant to this plan, and to the adaptive management process associated with tributary habitat restoration and protection. These RM&E activities do ***not*** include:

1) Hatchery or fisheries mitigation programs that are managed at broader scales

2) Hydro-system operations

3) Marine or mainstem harvest

Current and planned activities included in this plan are limited to the monitoring and evaluation of the status and viability of relevant populations, action effectiveness, monitoring of tributary habitat restoration and protection programs. We have adopted a standardized procedure in evaluating the nature and extent of current RM&E activities (this section), and prescribing and planning future RM&E activities that would result in a comprehensive RM&E program to meet the adaptive management needs identified in this document. Current and proposed RM&E activities discussed in this chapter are those that address uncertainties associated with the management and conservation of the listed stocks. To denote those activities, the Regional Technical Team worked with managers to:

1) Identify relevant management objectives

2) Describe corresponding assumptions associated with the salmon recovery program

3) List the critical uncertainties associated with the manager's assumptions

3) Describe current, and prescribe future activities needed to address the critical uncertainties

4) Define the nature and level of RM&E effort needed statistically

9.1 CURRENT RM&E ACTIVITIES

A description of existing monitoring projects is shown in Table 9-1. The table includes information on project costs, lead agency, funding source, time frame, and monitoring type (i.e., habitat or biological).

A review of the RM&E program currently in place indicates that much of the data needed to document the effects the SRSRP would have on stream habitat conditions and salmon performance is being collected in many areas, at least at the subbasin scale. However, because the recovery goals established by the ICTRT requires that fish populations be tracked at the mSA and MSA scale, additional RM&E would be needed (see below). Additionally, few populations in southeast Washington are currently adequately monitored to provide estimates of adult escapement. Tucannon spring Chinook is one of the few exceptions where adequate escapement estimates are available every year. Current steelhead escapement abundance in southeast Washington is available for most years from redd surveys in index areas in portions of Asotin Creek and the Touchet and Tucannon Rivers. Other redd counts are periodically collected in other geographic areas to provide distribution and relative abundance information. However, currently there are no means to compile spawning escapements consistently that would allow appropriate comparisons from year to year to track population trends for entire populations. Filling this data need is a very high priority.

The co-managers will be meeting during the winter of 2007 to both agree upon study methodologies and coordinate RM&E activities in the recovery region.

Table 9-1. Existing RM&E 2004-2006

Project #	Project	Description	Lead Entity	Funding Source	Annual Cost	Location	Biological Parameters						
							Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
1	Walla Walla Basin (within WA) Salmonid Population and Habitat Assessment	Assess habitat conditions, fish distribution and relative abundance (adult and juvenile), and salmonid genetic characterization.	WDFW	BPA	$175,000	Walla Walla	●	●	●	●	●		
2	Tucannon Bull Trout Telemetry	Study the behavior of bull trout in the Tucannon and Snake rivers, and determine numbers and movements of bull trout from the Tucannon into the Snake River to evaluate the effects of the COE hydrosystem on this species	WDFW and USFWS	BPA	$150,000	Tucannon		●		●	●		
3	Asotin County Salmonid and Habitat Assessment	Project provides baseline information on fish and habitat conditions in small Snake and Grande Ronde tributaries, as well as George Creek system and upper Asotin for steelhead and bull trout	WDFW	BPA	$26,000	Asotin County	●	●	●	●	●		
4	Tucannon Bull Trout Genetics Sampling	Collaborative effort between WDFW and USFWS to characterize genetics of the Tucannon bull trout populations in various reaches of the upper Tucannon drainage	WDFW / USFWS	USFWS	$10,000	Tucannon					●		
5	Bull Trout monitoring in SE WA	Initial study to determine bull trout distribution and relative abundance in the upper Tucannon drainage and the Wenaha basin within WA. Data is being collected through electroshocking and spawning surveys	WDFW	USFWS	$6,700	Tucannon, Grande Ronde (Wenaha River)		●		●	●		
6	Resident Fish Monitoring	Baseline effort to monitor resident fish populations and plan in SE Washington.	WDFW	WDFW	$15,000	Recovery		●		●			

Table 9-1. Existing RM&E 2004-2006 (continued)

Project #	Project	Description	Lead Entity	Funding Source	Annual Cost	Location	Biological Parameters: Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
7	Anadromous Fish Monitoring	Baseline effort to monitor anadromous fish populations and plan in SE Washington.	WDFW	WDFW	$20,000	Recovery plan		●	●	●	●		
8	Anadromous Fish Planning	Funds are used for anadromous fish population planning.	WDFW	WDFW	$30,000	Snake River and tribs	●	●	●	●	●	●	●
9	Spring Chinook Creel Surveys	Conduct creel surveys to determine number of spring Chinook caught in sport fisheries.	WDFW	WDFW	$10,000	Snake River and tribs		●				●	●
10	Spring Chinook - Hatchery Supplementation and Mitigation Evaluation	Evaluate hatchery effects on natural spring Chinook populations; determine the relative reproductive success of natural vs. hatchery spring Chinook; estimate juvenile productivity (survival rates by life stage and smolt production estimates).	WDFW	USFWS	$234,000	Snake River and tribs		●	●	●	●	●	
11	Fall Chinook - Hatchery Supplementation/Mitigation /stock recovery evaluation	Determine the effects hatchery fall Chinook have on wild fall Chinook population genetics.	WDFW	USWFS	$234,000	Snake River and tribs						●	●
12	Steelhead - Evaluation of Harvest Mitigation and Supplementation Programs	Endemic broodstock development; determine hatchery steelhead behavior (juvenile residualism, adult straying), juvenile productivity (survival rates by life stage and smolt production estimates).	WDFW	USFWS	$234,000	Snake River and tribs		●	●	●	●	●	●
13	Steelhead Adult Escapement Monitoring	Monitoring of stock status, juvenile production estimate at smolt stage (productivity of unsupplemented natural population), developing a description of life history pathways for this species.	WDFW	BPA	$1,100,000	Asotin Creek		●	●	●	●		

Table 9-1. Existing RM&E 2004-2006 (continued)

Project #	Project	Description	Lead Entity	Funding Source	Annual Cost	Location	Biological Parameters						
							Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
14	Spring and Fall Chinook Adult Escapement Monitoring	Document adult escapement incidental to steelhead work in Asotin Creek. A secondary goal is to estimate smolt production if possible.	WDFW	BPA	$10,000	Asotin Creek		●	●	●			
15	Tucannon Captive Brood Project	Development and implementation of a captive broodstock program for one generation of Tucannon Spring Chinook to buoy the population through a bottleneck. A comparison of captive, supplementation and wild productivity, genetics and life stage performance will be documented.	WDFW	BPA	$126,000	Tucannon		●	●	●	●	●	
16	Snake River Fall Chinook Relative Reproductive Success	Utilize DNA samples from hatchery endemic Snake River fall Chinook and wild Snake fall Chinook to assess the applicability of a technique to assign parental origin to outmigrant fall Chinook smolts. The technique is being assessed on the Snake River, a system far too large to conduct a more traditional genetic parentage assignment study, to determine if the relative reproductive success of hatchery and wild Chinook can be accurately measured in a large river system.	WDFW	BPA	$138,000	Snake River and tribs					●	●	
17	Asotin Creek Road Abandonment Program and Culvert Replacement Program	See habitat actions table – Study to develop lists of roads and culverts that with removal will increase the quality/quantity of salmon habitat.	Nez Perce/ USFS	BPA/USFS		Asotin Creek	●						

Table 9-1. Existing RM&E 2004-2006 (continued)

Project #	Project	Description	Lead Entity	Funding Source	Annual Cost	Location	Biological Parameters: Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
18	Walla Walla River Basin Monitoring (NPPC 2000-039-00)	Natural production monitoring - Monitor adult and juvenile abundance, distribution, age and growth, outmigration and survival.	CTUIR	BPA	$670,000	Walla Walla		●	●	●	●		
19	Walla Walla Fish Passage Project (1996-011-00)	Evaluating fish passage conditions in Mill Creek and other locations in the basin.	CTUIR	BPA	$317,000	Walla Walla	●	●		●			
20	Monitor Natural Fish Production Walla Walla River		CTUIR	BPA	$300,000 to $500,000	Walla Walla		●	●	●	●	●	
21	Walla Walla Flow Enhancement Feasibility Evaluation	Determine the need and opportunities for increasing stream flow.	CTUIR USACE			Walla Walla	●						
22	Walla Walla IFIM Study	Conduct and IFIM evaluation of stream flow, and in the Walla Walla River basin.	Conservation District			Walla Walla	●						
23	Asotin Creek Water Quality Analysis	Determine water quality in Asotin Creek.	Conservation District			Asotin Creek	●						
24	Walla Walla Mainstem Bull Trout Evaluation	Monitor bull trout abundance and usage of mainstem habitat in the Walla Walla.	USFWS	USFWS		Walla Walla		●	●	●	●		
25	Walla Walla Bull Trout Abundance and Life History	Determine bull trout abundance/life history data in Oregon portion of Walla Walla.	Utah State University/ USFWS	USFWS		Walla Walla		●	●	●	●		
26	Upper Mill Creek Bull Trout Study	Determine abundance, distribution, spawning of bull trout in Upper Mill Creek.	ODFW/ USFS	BPA		Walla Walla (Mill Creek)		●	●	●	●		
27	Walla Walla Bull Trout Evaluation	Evaluating bull trout populations on USFS lands.	USFS			Walla Walla		●	●	●	●		

Table 9-1. Existing RM&E 2004-2006 (continued)

							Biological Parameters						
Project #	Project	Description	Lead Entity	Funding Source	Annual Cost	Location	Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
28	Video Monitoring of Adult Passage (Walla Walla River)	Conduct video dam counts of adult passage at Bennington Dam and Yellowhawk Diversion (Mill Creek).	USACE	USACE		Walla Walla (Mill Creek)		●		●			
29	Walla Walla Water Budget	Develop a water-budget for the Walla Walla River. Project is inventorying all water sources including springs, wells, and surface flows.	Walla Walla Watershed Council			Walla Walla	●						
30	Walla Walla TMDL Study	WDOE is conducting a TMDL evaluation of the Walla Walla River basin.	WDOE/OWR	WDOE		Walla Walla	●						
31	Grande Ronde Supplementation program M&E (NPPC 1998-007-03)	Develop, implement, and evaluate integrated conventional and captive brood hatchery projects to prevent extinction and stabilize populations of threatened spring Chinook salmon and summer steelhead populations in the Grande Ronde River.	In Oregon only CTUIR	BPA	$337,023	Grande Ronde		●	●	●	●	●	
32	Life Studies of Spring Chinook (NPPC 1992-026-04)	Investigate the abundance, migration patterns, survival, and life history strategies of spring Chinook salmon and summer steelhead from distinct populations and implement fish population and habitat monitoring in the Grande Ronde and Imnaha River basins.	In Oregon only ODFW	BPA	$949,504	Grande Ronde	●	●	●	●	●		
33	Snake River TMDL Study	WDOE is conducting a TMDL evaluation of the Walla Walla River basin.	WDOE	WDOE		Snake tributaries in SE WA							

Table 9-1. Existing RM&E 2004-2006 (continued)

Project #	Project	Description	Lead Entity	Funding Source	Annual Cost	Location	Biological Parameters: Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
34	Watershed Planning	Setting instream flows and allocation recommendations.	WDOE	WDOE		Walla Walla							
35	Watershed Planning	Setting instream flows and allocation recommendations.	WDOE	WDOE		Snake tributaries in SE WA							
36	Tucannon Cobble Embeddedness Assessment	Assess habitat conditions pertaining to percent fines and sediment using Wolmans' Pebble counts and embeddeness transects on Tucannon mainstem and its tributaries. Study will compare current conditions to those collected previously.	USFS and CCD	BPA	$12,000	Tucannon	●		●				
37	Tucannon Watershed Sediment and Temperature Monitoring	Project provides baseline information on fish and habitat conditions in the Tucannon River and its tributaries. Hobos to monitor temperature and ISCO sediment samplers for turbidity are placed for continuous assessment of project activity effects.	USFS	USFS	$8,000	Tucannon	●						
38	Asotin County Sediment and Temperature Monitoring	Project provides baseline information on fish and habitat conditions in the Asotin Creek and its tributaries. Hobos to monitor temperature and ISCO sediment samplers for turbidity are placed for continuous assessment of project affects.	USFS/ACCD	USFS/BPA	$12,000	Asotin Creek	●						

Table 9-1. Existing RM&E 2004-2006 (continued)

Project #	Project	Description	Lead Entity	Funding Source	Annual Cost	Location	Biological Parameters: Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
39	Tucannon/Asotin Watersheds Macro Invertebrate Study	Project provides baseline information on species and population diversity within the Tucannon Watershed. Study of species as an indicator of the healthy water conditions.	USFS	USFS	$10,000	Asotin/ Tucannon Rivers and Tribs	●	●	●		●		
40	Assess Salmonids in the Asotin Creek Watershed (2002-053-00)	This project implements the RM&E criteria specified in the Asotin Subbasin Plan by providing estimates of abundance, productivity, survival rates, and temporal and spatial distribution of ESA-listed species.	WDFW	BPA	$212,000	Asotin Creek	●	●	●	●	●	●	●

o Please note that these are current RME projects that are funded, some of these projects may be funded for a few months and some for a few years. Should we have an “expected funding duration” column or a note to clarify that the current funding is not static (some of it will likely disappear soon).

9.1.1 Coordination of Data Gathering and Research

Currently, the research and monitoring carried out by various entities, including the Tribes and state and federal governments, are not coordinated, resulting in inefficiencies, duplication of effort, missed opportunities, and a lack of standardization. These problems could be resolved by the creation and long-term funding of a "Watershed Monitoring Council" for the region, including WRIA 32 and WRIA 35. This would coordinate and standardize research and monitoring related to recovery plan implementation and adaptive management in the Snake River Recovery Region. Such a "one stop" venue for coordination would result in greater consistency among research and monitoring programs and would ensure greater accountability. During the first year of implementation, the RTT and Recovery Board will explore these options within the development of a Southeast Washington Comprehensive Monitoring and Evaluation Plan and the Intensively Monitored Watershed Program supported by the Federal Caucus.

9.1.2 Coordination of Quality Assurance and Quality Control

Under the guidance of the Watershed Monitoring Councils, the co-managers will develop a "Quality Assurance Program Plan (QAPP) for Environmental and Biological Monitoring". The QAPP will generally follow the QAPP requirements put forth by the U.S. Environmental Protection Agency, which sets the national standard for environmental monitoring quality control requirements. The QAPP will identify data quality objectives, training requirements, data management procedures, sampling designs, detailed sampling methods, sample handling, analytical methods, quality control requirements, equipment maintenance and control requirements, instrument calibration, assessment, response, and validation associated with each of the performance metrics described in this RM&E plan.

9.2 DATA GAPS

Data gaps important to the recovery plan can be divided into three major categories: 1) those dealing with critical uncertainties (status and trends), 2) gaps in knowledge about the linkages between specific actions and their impacts on habitat factors (project effectiveness), and 3) data dealing with the biological response of focal species to changes in habitat (program effectiveness). Some of the data gaps can be filled through monitoring and evaluation while others must be filled through research. The information needs prescribed by managers and referenced in Chapter 5 of this plan are associated with unfulfilled scientific data gaps needed to address hypotheses relevant to the adaptive management program discussed below.

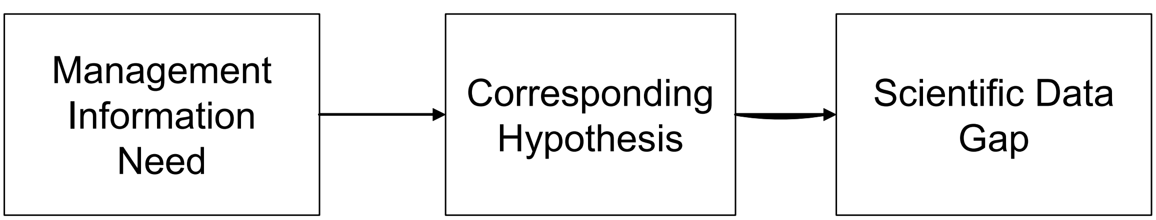

Figure 9-1. Conceptual Model for Discerning Relevant Data Gaps

The broad-scale management objective of the Snake River Salmon Recovery Plan for Southeast Washington is summarized in the vision; "a healthy ecosystem that fulfills the requirements of the key species and the people of the recovery region." In Chapter 5 the biological performance requirements needed to achieve that objective are specified for each of the target populations in terms of their viability, and in terms of the corresponding conditions that are needed to achieve viability in the population, assuming out of subbasin conditions do not degrade significantly during the management period. Each of these management objectives has associated information requirements and hypotheses that must be addressed by the scientific community to support adaptive management of salmon in the recovery region. Table 9-2 summarizes the corresponding objectives, assumptions and uncertainties within the recovery region.

Tables 5-1 through 5-9 identify future habitat conditions that must be satisfied to achieve viability. Each of the individual habitat metrics represents an objective of this plan, has the hypothesis that the habitat can be altered, and corresponding data gaps associated with the change in habitat through time. Therefore, the priority habitat-related RM&E activities are to assess and monitor habitat conditions in the priority geographic areas where performance metrics are expected or hypothesized to change, or imminent threats that affect salmonids in priority geographic areas are hypothesized to be reduced or eliminated.

A second inherent hypothesis of the habitat objectives is that salmon will respond to habitat changes locally and that these changes are statistically detectable. The complexities of fish-habitat interactions, Out of Subbasin Effects (OOSE), and multi-species relationships make it difficult to detect population responses to tributary habitat changes in the absence of an explicit experimental design. The scientific data gaps associated with effectiveness monitoring relate to the annual conditions of habitat and populations in treatment and reference watersheds, along with specific uncertainties associated with sampling methodologies needed to derive a statistically robust sample of these performance metrics. Some of these hypotheses and data gaps requiring explicit experimental designs will be dealt with regionally in the context of establishing a comprehensive RM&E plan, and an Intensively Monitored Watershed (IMWs) in the region – e.g.:

wdfw.wa.gov/fish/wild_salmon_monitor/imw.htm
www.ecy.wa.gov/programs/eap/imw/index.html
www.governor.wa.gov/gsro/science/pdf/IMW_Final_Rept_2006-1_w_cover.pdf

The general harvest objective identified in this plan is that "Harvest would not adversely affect abundance, productivity, distribution, and genetic diversity of any key species." The hypotheses associated with this objective are more elusive than those of the habitat objectives. In general, one must assume that harvest can be quantified, that sustainable harvest criteria can be established, and that adherence to these criteria would contribute to the achievement of VSP. Six specific harvest planning objectives identified in this plan are:

1. Harvest management in all areas would be based on the abundance of the weakest population components.
2. Harvest opportunities would be optimized by the use of selective fishing strategies and/or terminal fishery areas targeting abundant populations while minimizing impacts to weak populations.
3. Fishery management agencies would take timely actions to keep harvests within pre-determined limits.
4. Enforcement would be sufficient to reduce violations to insignificant levels.
5. Adequate funding and staffing are available to address the above assumptions.
6. Substantial population monitoring is funded and implemented to quantify impacts on the weakest stock impacted by each fishery.

These objectives carry with them information needs, hypotheses, and scientific data gaps regarding harvest, stock composition, target and non-target selectivity of specific practices, and the effectiveness of management and enforcement programs to nurture and/or hold harvest at or near specified limits.

Similarly, specific viability objectives for population performance are identified in Chapter 5 and were established by the Interior Columbia Technical Recovery Team (ICTRT). These criteria include abundance, productivity, diversity, and spatial structure metrics and carry with them information needs and the hypotheses that:

1. VSP criteria are adequate to ensure population persistence.
2. VSP criteria can be attained within the timeframe of this recovery plan.
3. Population performance can be quantified using standard techniques and practices.

These hypotheses carry with them data gaps associated with population performance, as well as those surrounding the error and power associated with prescribed methods and survey designs. In this section we identify the connections between management objectives, information needs, hypotheses, data gaps, and RM&E activities. In Section 9.1 we list the current RM&E efforts that are underway in the Washington Snake River Recovery Area. In Section 9.3 we discuss specific methods and levels of effort needed to achieve the relevant RM&E objectives based on a gap analysis between Section 9.1 and this section.

The management process is prescribed by this plan and the overarching federal documents which dictate the management process under the ESA. In terms of recovery and delisting, the agencies and authorities are charged to address the uncertainties associated with viability, and with the effectiveness of the management program in building habitat capacity and population productivity of tributary systems to support viability. Other data gaps associated with hatchery risks, hydrosystem operations, and out-of-subbasin harvest will be dealt with in the federal NOAA Salmon Recovery Plan which is ESU-wide and targeted to broader spatial scales.

Table 9-2. Management Objectives, Assumptions, and Critical Uncertainties for the Recovery Region

Management Domain	Management Objective	Focal Subbasins	Hypothesis	Data Gap	Current RM&E Effort	Required effort
Essential Fish Habitat	Restore riparian function	All	Riparian function is limiting	Condition of riparian function	Ongoing	Increase in-situ habitat assessments
	Improve flood-plain connectivity	Asotin Walla Walla Tucannon Lower Grande Ronde	Flood plain connectivity is limiting	Condition of flood plain	Ongoing	Expand remote sensing of flood-plain conditions
	Improve passage conditions	Asotin Walla Walla Tucannon	Passage conditions are limiting	Condition of fish passage	Ongoing	Site specific expansion of passage conditions
	Increase in-stream flow	Walla Walla Lower Snake Tribs	Flow is limiting	Flow conditions	Ongoing but at Risk	None
	Reduce fine-sediments	Walla Walla Lower Snake Tribs Joseph Creek	Fine-sediments are limiting	Sediment inputs	Ongoing but at Risk - Walla Walla Minimal – Lower Snake Tribs and Joseph Creek	Need sediment monitoring programs in Lower Snake Tribs and Joseph Creek
	Reduce stream temperatures	Walla Walla Lower Snake Tribs Joseph Creek	Stream temps are limiting	Temp profiles	Ongoing but at Risk – Walla Walla Minimal – Lower Snake Tribs and Joseph Creek	Need temp monitoring program for Lower Snake Tribs and Joseph Creek
	Increase large woody debris	All	Large woody debris is limiting	LWD distribution and abundance	Ongoing but at risk in Walla Walla Minimal in other tribs	Need habitat monitoring program in all subbasins other than Walla Walla
	Improve habitat diversity	All	Habitat Diversity is limiting	Diversity of available habitat	Ongoing but at risk in Walla Walla Minimal in other tribs	Need habitat monitoring program in all subbasins other than Walla Walla

Table 9-2. Management Objectives, Assumptions, and Critical Uncertainties for the Recovery Region (continued)

Management Domain	Management Objective	Focal Subbasins	Hypothesis	Data Gap	Current RM&E Effort	Required effort
	Increase habitat quantity	All	Tributary habitat quantity is limiting	Availability of EFH	Ongoing but at risk in Walla Walla Minimal in other tribs	Need habitat monitoring program in all subbasins other than Walla Walla
	Protect critical habitat in priority geographic areas	All	Tributary habitat is not being significantly degraded	Availability of EFH	Requires expansion	Broad remote-sensing based habitat monitoring program
Harvest	Manage harvest for weakest population components	All	Harvest impacts escapement	Quantity and distribution of harvest impacts	Stock specific	Improve assessment of poaching and harvest impacts for listed stocks
	Optimize harvest opportunities	Touchet, Walla Walla, Tucannon, Grande Ronde	Harvest of surplus biomass does not impact ESA listed stocks	Magnitude and distribution of harvest impacts	Minimal – limited WDFW creel	Requires robust creel program
	Fishery managers will take timely actions	All	Data is sufficient to result in adaptive management changes	Adaptive response to changing impacts	No formal program	Develop formal evaluation of management programs
	Enforcement will minimize poaching and violations	All	Poaching is detectable and enforceable	Magnitude and distribution of poaching	County officer surveys	Improve public awareness and outreach
	Monitoring will be funded and implemented	Touchet, Walla Walla, Tucannon, Grande Ronde	Non-selective fishing impacts ESA listed stocks	Incidental mortality of non-selective fishing is unknown	Minimal – limited WDFW creel.	Focused mortality assessment.
	Funding and staff will be available	Touchet, Walla Walla, Tucannon, Grande Ronde	Funding is limiting assessment actions.	Harvest impacts	Minimal – limited WDFW creel.	Enhanced monitoring.
Population Responses	Achieve adult abundance criteria	All	Abundance criteria are sufficient	Abundance of recruits by stock	Limited for all stocks	Achieve statistically viable assessment of abundance or escapement for all MSAs

Table 9-2. Management Objectives, Assumptions, and Critical Uncertainties for the Recovery Region (continued)

Management Domain	Management Objective	Focal Subbasins	Hypothesis	Data Gap	Current RM&E Effort	Required effort
	Achieve productivity criteria	All	Productivity criteria are sufficient	Productivity by brood year or age class	Limited for all stocks	Achieve statistically viable assessment of productivity for all stocks and age classes
	Maintain and improve life-history diversity	All	Life-history metrics relate to viability	Run timing and life-history information by stock	Sufficient by metric, but does not target all stocks	Achieve region-wide monitoring of life-history metrics for all stocks
	Maintain or improve spatial occupancy	All	Spatial distribution improves viability	Distribution of spawners on relative to intrinsic potential	Insufficient for all stocks	Achieve statistically defensible spatial coverage for all spawning-ground surveys
	Maintain or improve genetic diversity	All	Genetic diversity improves viability	Genetic diversity, Noeff, and genetic flow among MPGs	Collections near sufficient but require some improvement.	Expand collections slightly, significantly increase analysis

9.2.1 Conceptual Design for Monitoring and Evaluation

Methods for salmonid assessment and monitoring are ever evolving in the Pacific Northwest as new information, regulations, experiences, and communications are brought forth. Today, monitoring in the recovery region is facilitated by the Washington State Comprehensive Monitoring Plan, Pacific Northwest Aquatic Monitoring and Evaluation Partnership (PNAMP), Columbia System-wide Monitoring and Evaluation Partnership (CSMEP), and NMFS via the ICTRT and Northwest Fisheries Science Center. A large library of literature has been generated to guide fish population monitoring in northwest streams that cannot be reiterated or even well summarized here. Recently, NMFS Northwest Fisheries Science Center generated a suite of RM&E requirements for recovery plans to support adaptive management of listed stocks. In general, the NMFS guiding document requested that scientists:

1. Monitor environmental conditions
2. Monitor exploitation (harvest and other direct take), disease, and predation
3. Monitor population status and trends
4. Assess the effects of limiting factors on population change over time

In addition, the co-managers shall

5. Monitor the adequacy of regulatory mechanisms to support environmental and population recovery

This recovery plan is based on the proposition that a set of actions can change the environment to achieve the desired biological response for listed fish populations (Figure 9-2). For the Snake River Recovery Area subbasins, the proposition has been refined into a working hypothesis which relies upon the EDT model and assumptions about the effectiveness of hatchery and harvest programs. Chapter 5.0 set out objectives for environmental change and desired biological response for the fish populations of concern, while Chapter 6.0 described the SRSRB's strategies for achieving recovery.

Figure 9-2. Conceptual Model of Subbasin Restoration and Recovery of Listed Salmon Populations

The concept of the working hypothesis is that estimations can be made of environmental change resulting from implementation of a set of actions and that the environmental change, in turn, will result in positive biological changes for the listed populations. The positive changes, as discussed in Chapters 6.0 and 7.0, would occur in the abundance, productivity, biological diversity, and spatial structure (distribution) of the listed species. It is important that, as actions are implemented, the working hypothesis be continually evaluated to ensure its validity and to refine it as conditions change (Figure 9-3).

Success of subbasin level restoration depends to a large degree on external conditions in the Snake and Columbia Rivers, the estuary, and the ocean. While the number of returning adults is the ultimate indicator of program success, smolt production would be monitored to track the change in habitat quality in each subbasin and to estimate the relative contribution of tributary changes to population responses.

Monitoring and research are designed to monitor baseline biological and environmental conditions, and test implementation, evaluate effectiveness, and validate assumptions or models. Implementation monitoring determines if planned actions were implemented as intended and whether all implementation objectives are on schedule. Effectiveness monitoring will focus on whether the planned actions have changed the environment as predicted by the plan and whether those actions are correlated with specific biological responses. Biological monitoring will address the biological condition of listed fish populations over time, especially abundance, survival, behavior, genetics, and morphology of the listed populations in relation to the VSP parameters described in Chapter 7.0. Validation monitoring will determine whether the fundamental ecological assumptions underlying the recovery plan are true. Prominent among these assumptions are the impacts of specific environmental conditions on survival and abundance of listed fish species embodied in the EDT model.

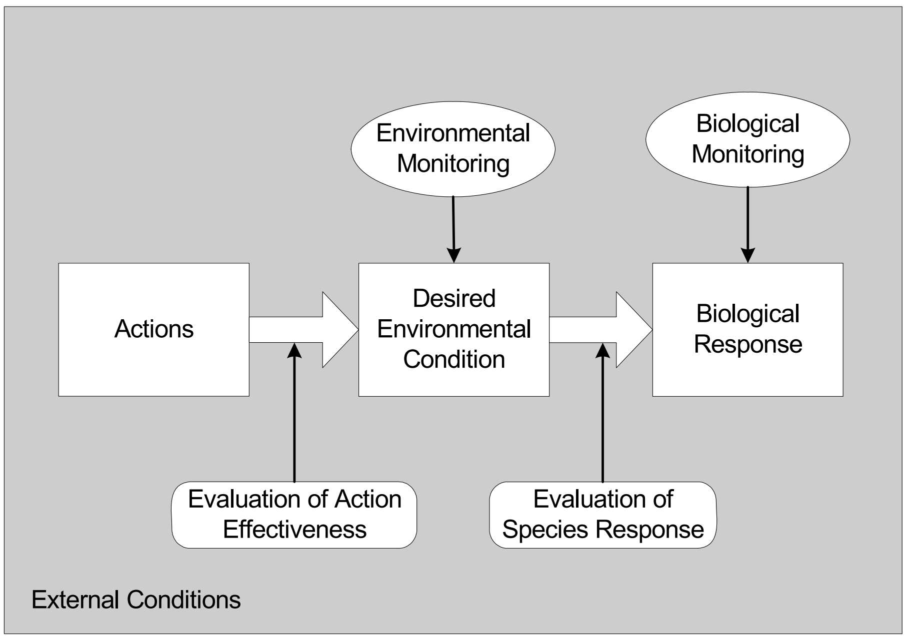

Figure 9-3 Monitoring and Evaluation of the Subbasin Restoration Hypothesis

Evaluation of assumptions and knowledge built into the EDT hypothesis will address the causal mechanisms linking actions to environmental change and biological response. Planners, under the working hypothesis, predict the anticipated effect of specific actions on the environment. They are reliant on a set of assumptions built into the EDT model linking environmental conditions to the biological response of listed fish populations. Evaluation is designed to test and refine the linkage between actions and fish population performance. The effectiveness of actions to improve environmental conditions will be addressed in the individual subbasins and will also synthesize knowledge gained from other subbasins and the general scientific literature.

The EDT species/habitat rating rules are the assumptions that provide the linkage between environmental conditions and species performance. These rules capture existing knowledge relating salmon productivity and capacity to environmental conditions. As scientific investigations continue in the Columbia Basin and elsewhere, this knowledge will improve and will be incorporated into the EDT model and the subbasin working hypothesis. In addition, the co-managers need to assess the validity of the EDT rules for southeast Washington populations to ensure that the assessment framework is accurate and well supported.

The EDT model was not used to forecast action effectiveness on bull trout populations because it is currently not configured for this species. Data required for the model do not extend far enough up watersheds to encompass most bull trout habitat. Although biological rules linking the environment to bull trout population performance are available, EDT has not been used to describe environments specific to bull trout. It is important that environmental impacts to bull trout be determined either through EDT analysis or through other means acceptable to the USFWS.

A final area of evaluation addresses external conditions comprising the context for fish population performance at the subbasin level. External factors will have a significant effect on the success of subbasin level actions in restoring listed fish populations. External factors include out-of-basin commercial harvest, sport and tribal harvest, conditions in the mainstem Snake and Columbia Rivers including hydroelectric operations, and conditions in the estuary and ocean including short and longer term cycles in ocean conditions.

In creating the recovery plan in Chapter 6.0, planners assumed fixed survival rates to account for external factors in their evaluation of restoration actions. Refinements to the estimates of external survival and to future changes in external conditions will be incorporated in future projections of the subbasin working hypotheses.

9.3 RESEARCH, MONITORING, AND EVALUATION OF IMPLEMENTATION PLAN

The research, monitoring, and evaluation (RM&E) program for the Snake River Salmon Recovery Plan is aimed at filling data gaps, analyzing the effectiveness of actions, modifying the plan when new information becomes available (adaptive management), and ensuring consistency with the statewide monitoring plan and federal guiding documents. The RM&E objectives and proposed tasks in this plan were taken from the gap assessment described above. We have asked what uncertainties can be addressed using the current design and which assumptions require more powerful information. An overview of the proposed RM&E approach is presented in Table 9-3. Table 9-4 lists the critical uncertainties identified in the Data Gaps analysis, and defines the RM&E Objectives and methods needed to address them. In addition the table highlights the proposed design and statistical power of the proposed level of effort associated with each methodology.

Table 9-3. Snake River Salmon Recovery Plan – Overview of RM&E

	General Description	Implementation Monitoring	Status and Trends		Effectiveness	Data Mgmt and Reporting	Organization Structure
			Biological and Fish	Habitat			
Snake River	The recovery plan is based on the proposition that a set of actions can change the environment to achieve the desired biological response (i.e., increased salmon production). Research and monitoring will be used to reduce critical uncertainties, fill in scientific data gaps and track resulting change to the environment and fish production from the implementation of the actions included in the plan.	Yearly Check Point At the end of each year provide a brief report detailing the actions implemented in each subbasin by MSA and mSA. In addition, for each action, information on cost, expected level of improvement in stream habitat conditions or fish response will be stated. All actions will be recorded in the EDT Scenario Builder so as to document progress toward established habitat objectives.	Subbasins defined as intensive- yearly Other (non-intensive) basins: 5-years (or rotating dependent on funding). Focused on determining VSP and ICTRT parameters of population productivity, diversity, abundance, spatial structure and number of hatchery fish present on spawning grounds (by MSA). Smolt monitoring proposed for all subbasins to track program success and separate improvements due to actions taken within the recovery region compared to outside. Research to better understand habitat relationships and fish performance would be undertaken/coordinated with other resource agencies and tribes. Research to evaluate hatchery supplementation program benefits and risks.	Habitat monitoring will be coordinated with the Comprehensive Statewide Monitoring Strategy (CMS). Baseline data to be collected on streams where information is lacking. Critical habitat uncertainties identified by local biologists and EDT modeling results will receive a higher priority than other environmental attributes. Habitat monitoring in MSAs will be prioritized over mSAs.	Biological- 1-5 years (consistent with TRT) Habitat- 1-30 years Expected change or increase in habitat quality and quantity from the implementation of each action will be clearly defined. Monitoring methodologies and time frames will be established based on action type, scale, location, cost and the environmental attribute(s) affected by the action. For example, riparian actions likely monitored over 15-30 years, flow actions every year.	Utilize pre-existing data infrastructure (EDT, StreamNet, APRE, PTAGIS, RMIS) to archive data and metadata. Simple yearly report and presentation to document progress and present draft conclusions from on-going monitoring to the public and decision-makers. More detailed reports every 5-years. Final report year 15.	SRSRB will provide policy direction, coordination and oversight throughout the implementation of the Monitoring, Research, and Evaluation Technical Working Group, will be convened and work with and report to the SRSRB.

Table 9-4. Critical Uncertainties And Corresponding Monitoring And Evaluation Activities Needed To Adaptively Manage The Recovery Process Outlined In This Plan.

Critical Uncertainty	RM&E Objective	Method	Design	Desired Statistical Power
Condition of riparian function	1: Assess and monitor riparian conditions in priority geographic areas	In-situ stream surveys	Census	0.80
Condition of flood plain	2: Assess and monitor flood plain conditions in priority geographic areas	Remote sensing plus in-situ surveys	Opportunistic	variable
Condition of in-stream habitat	3: Assess and monitor in-stream conditions in priority geographic areas	In-situ stream surveys	Census	0.80
Condition of passage barriers	4: Assess and monitor passage conditions in priority geographic areas	In-situ barrier assessments	Census	0.95
Condition of temperature profiles	5: Assess and monitor key water quality variables priority geographic areas	TMDL-focused	Stratified design to achieve EPA criteria by metric	0.80
Condition of sediment inputs	“”	“”	“”	“”
Diversity of available habitat	6: Estimate diversity of available habitat	In-situ stream surveys plus remote sensing	Census	0.80
Quantity of available habitat	7: Estimate the quantity of available habitat	In-situ stream surveys	Census	0.80
Quantity and distribution of harvest mortality	8: Estimate the quantity and distribution of harvest mortality by MSA	Creel and catch card	Probabilistic creel survey (Malvestuto design)	Variable by species and stock
Catch and release (hooking) mortality	9: Estimate the magnitude and distribution of hooking mortality	Radio-telemetry studies	Animal focal analysis	0.90
Abundance of spawners in MSA	10: Estimate the abundance of spawners in each MSA	Escapement estimates plus spawner surveys	Point estimates for escapement, test probabilistic design for summer steelhead, census surveys for bull trout, spring Chinook, and fall Chinook	0.80
Adult productivity of MSA by brood year or age class	11: Calculate the brood year or age-class productivity for each MSA or population	Run reconstruction	Model approach	0.80
Smolt productivity	12: Estimate smolt output for each stock	Smolt trapping	Expanded trap abundance estimates	0.80
Life-history and genetic diversity by MSA	13: Estimate the relative or comparative life-history diversity for each MSA.	Variable by life-history metric	Opportunistic by life-history metric	Variable by metric
Spatial Structure of MSA	14: Assess and monitor the spatial structure of spawning and rearing for each MSA.	Spawning ground surveys and summer electrofishing/ snorkeling surveys	Probabilistic design for summer steelhead, census for bull trout	0.80

9.3.1 Environmental Monitoring

Environmental monitoring will provide: 1) measurement of progress toward meeting the environmental objectives described in Chapter 6.0 and 2) information to refine the current diagnosis of habitat limitations. Planners in the affected subbasins have used the EDT model to formalize the working hypothesis linking actions, environmental condition, and fish performance. It must be emphasized that the expected improvement in the environment from the implementation of SRSRP actions is just a hypothesis that needs to be tested and confirmed. Although the actions selected are expected to improve stream habitat conditions over time, it is not possible to predict the absolute change or the time frame required for the change to occur.

EDT describes conditions in each subbasin at a stream reach scale in terms of environmental attributes related within the model to survival and capacity of salmonid life stages and, ultimately, to entire fish populations. The hypothesis is that change in one or more of these attributes as a result of restoration actions will affect fish performance in a positive manner. Change in EDT attributes over time will be tracked to refine the hypothesis, to incorporate unforeseen circumstances, and to measure progress.

The EDT analysis was used to prioritize environmental attributes in terms of potential impact of anthropogenic change on the biological performance of the listed populations (Table 9-5). While all attributes potentially affect fish performance to some degree, a limited set of attributes in each subbasin appear to have had a disproportionately large effect in determining current performance of salmonid populations (Chapter 6.0). Tables in Chapter 6.0 rank environmental attributes according to the effect anthropogenic changes in attributes have had on the performance of listed populations. A score of 1 (smallest effect) to 4 (largest effect) was assigned to each attribute. Attributes receiving a score of 3 or 4 are designated “key” attributes. Key attributes are proposed as primary targets for monitoring to track progress toward restoration of the environment within each subbasin with respect to the listed fish populations (Table 9-5).

Critical uncertainties are a subset of the key attributes (Table 9-5). The EDT analysis relies upon information currently available to planners, regardless of its completeness. Some information consists of reliable, empirical measurements while other information is more qualitative or based on expert opinion. Attributes identified as critical uncertainties will receive special investigation in the short-term to refine the EDT diagnosis. They will also be part of the long-term environmental monitoring effort. Once these data are collected and analyzed, they will be used to review habitat actions proposed in Chapter 7.0.

Table 8-6 also highlights the fact that environmental information was almost totally lacking for some streams in the recovery area. These streams include three tributaries considered satellite populations of the Tucannon River (Penawawa, Alkali Flat, and Meadow Creeks) and three tributaries considered satellite populations of Asotin Creek (Steptoe, Wawawai, Couse, and Alpowa Creeks). EDT diagnosis of habitat limiting factors was not possible in these streams due to the lack of data. Therefore, before proceeding with actions in these tributaries, habitat data will be collected to determine the critical limiting factors in each; recovery actions will be assigned accordingly.

In many cases, the same attributes should be monitored in each subbasin. Changes in woody debris and riparian functions were key attributes limiting performance of listed fish populations in all streams analyzed. The increase in anthropogenic confinement (diking, roads, and other actions confining the stream channel) was a key attribute limiting performance in all assessed streams except Asotin Creek. Attributes associated with sedimentation, such as embeddedness, fine sediments in riffles, and turbidity, were limiting in most streams.

Table 9-5. Environmental Monitoring Indices for Snake River Recovery Area

Environmental Attribute	Walla Walla	Tucannon	Asotin	Almota	Deadman	Other Lower Snake Tributaries	Lower Grande Ronde and Wenaha
Alkalinity						*	
Bed Scour	P	P	O		P	*	P
Benthic Production						*	
Channel Length						*	
Maximum Channel Width						*	
Minimum Channel Width						*	
Confinement – anthropogenic	O	O		O	O	*	
Confinement – natural						*	
Dissolved Oxygen						*	
Embeddedness	P	O	O	O	O	*	P
Fines			O	O		*	
Fish Community Richness						*	
Fish Pathogens		●				*	
Exotic Fish Species						*	
Flow – High						*	
Flow – Low				O		*	
Flow – Diel Fluctuations						*	
Flow – Flashiness						*	
Gradient	P	P	P	P	P	*	
Pools (Quantity and Quality)	P	O	P	P	P	*	P
Off-channel Habitat						*	
Harassment		O				*	
Outplants	P	●	P	P	P	*	P
Icing						*	P
Metals – Water Column						*	
Metals – Soils/Sediment						*	
Nutrients (eutrophication)						*	
Obstructions	O					*	P
Predation Risk						*	
Riparian Function	O	O	O	O	O	*	
Salmon Carcasses		O				*	
Temperature – Maximum	O	●	P	P	O	*	P

Continued

Table 9-5. Environmental Monitoring Indices for Snake River Recovery Area (continued)

Environmental Attribute	Walla Walla	Tucannon	Asotin	Almota	Deadman	Other Lower Snake Tributaries	Lower Grande Ronde and Wenaha
Temperature – Minimum						*	
Turbidity	○		○		○	*	
Withdrawals (Diversions)	P	P	P	P	P	*	P
Woody Debris	○	○	○	○	○	*	

Note: Key attributes were identified through EDT analysis. Critical uncertainties are key attributes that also have a high level of uncertainty regarding current condition.

● = Critical uncertainties.

○ = Key attribute.

* = No data available.

P= Based on professional opinion of RTT.

In addition to the environmental attributes identified through EDT modeling, the RTT also concluded that enough uncertainty existed in the baseline habitat data used to run EDT that more information was needed on certain key attributes. These attributes are identified with a “P” in Table 9-5 and include gradient, withdrawals, maximum stream temperature, icing (Grande Ronde), bed scour, and pools.

Although not included in Table 8-5, more information is needed on pesticides and other toxicants that may be present in the streams. This type of data is being collected as part of the Walla Walla TMDL study and should be expanded to other subbasins. As results become available they will be reviewed to determine if new actions should be developed to address identified problems.

9.3.1.1 Environmental Monitoring Protocols

Environmental monitoring to track the progress of the SRSRP and address critical uncertainties will be coordinated with on-going monitoring by state and tribal entities wherever possible. In particular, monitoring will be coordinated with the comprehensive statewide monitoring strategy (CMS) developed by the Washington Salmon Recovery Board (Monitoring Oversight Committee 2002). The CMS will be especially important in the identification of deficiencies in current and proposed monitoring programs. The documentation presents a detailed draft plan for monitoring associated with subbasin plan implementation in the Walla Walla River, including an outline for activities in all recovery region subbasins. It is expected that the monitoring program will be implemented and supervised by technical advisory committees in the recovery region. The exact process for establishing this committee will be developed once funding for a technical team administrator and monitoring programs has been determined.

In the initial years of the recovery plan implementation, emphasis would be placed on collecting baseline data on stream habitat conditions in MSAs and mSAs where little or no data are currently available for listed species. This data collection would start in year one of the plan and continue on a rotating basis dependent on available funding.

All salmonid reaches will be assessed in the recovery region; however, the order in which reaches are surveyed will be based on priority geographic area designations and a randomization routine. The EMAP site selection and rotating panel design developed by the EPA will be employed for some of the habitat inventory or the monitoring of aquatic macroinvertebrates. Use of this probabilistic sampling approach would be used so results can be statistically analyzed and rolled up at various large spatial scales such as Subbasin, Water Resource Inventory Area (WRIA), ESU, and state levels, as recommended by larger regional monitoring efforts. The draft Habitat and Water Quality Status and Trends Statewide Monitoring Framework for Washington (WDOE 2006) has recommended that 17 EMAP sites would need to be sampled each year in each WRIA over 5 years to achieve an 80% confidence level, with the potential for stratification or samples into other categories (e.g., land use). We will incorporate additional guidance that is expected soon through the Washington State, Oregon, PNAMP, or other regional processes so we will be able to collect data that are consistent and compatible with their needs. Sampling for a period of 5 years would be required before general characterization is available for stream habitat conditions. An alternative is to sample at a much higher rate using the EMAP probabilistic site selection process, or to conduct systematic habitat inventory over large stream reaches using methods similar to Hankin and Reeves or the ODFW inventory method. We plan to pursue the systematic habitat inventory approach similar to Hankin and Reeves to cover large reaches in priority geographic areas first to provide detailed information quickly that is useful at smaller spatial scales such as reach, drainage, or even the watershed. We have repeatedly found that a partial survey of stream habitat conditions can result in not detecting critical obstructions, diversions, or other habitat restoration opportunities. The Columbia Plateau and Blue Mountains stream habitat is rarer than coastal habitat where probabilistic designs have been used to survey habitat conditions. Virtually all the habitat can be visited in a reasonable amount of time, and an understanding of the conditions of any particular habitat unit critical to population recovery/restoration can be reached. Therefore, we will census instream habitat conditions using an augmented Hankin and Reeves approach. Statistical inference will be used to relate instream habitat, groundwater, surfacewater, and population performance information based on an analytical framework such as EDT or SHIRAz modeling approaches.

By using both the probalistic sampling needed at the larger scales with the Hankin and Reeves intensive reach inventory procedure we will be able to evaluate habitat conditions and changes useful at both the local and regional scales. Sampling will occur in the priority geographic areas identified during Subbasin Planning and earlier in the SRSRP. Sampling will occur primarily during the low flow period. The habitat metrics will be similar to those used by ODFW (Moore et al. 2002).

EMAP sampling routines will be used to determine the amount and locations in each reach that is surveyed annually for habitat inventory information. Priority inventory areas will consist of Priority Protection or Restoration reaches and MSAs or mSAs. These areas will be divided into contiguous quadrants based on linear habitat characteristics. In general we will use a modified Hankin and Reeves habitat inventory approach similar to the ODFW habitat survey protocols (Moore et al. 2002) that is consistent with ODFW, Washington State (Crawford et al. 2002, Crawford 2004), and other regional monitoring protocols and standards (e.g., PNAMP, CSMEP). Measured habitat attributes will emphasize those necessary for verifying EDT model inputs and estimating fish population changes with EDT modeling. Supplemental habitat inventory efforts could be implemented in areas that managers believe may have been misclassified and possibly could be elevated to priority areas. An additional metric of percent-effective-shade and other riparian parameters will be collected during the habitat EMAP sampling routines in order to quantify current conditions relative to potential restoration. Protocols were developed using a variety of tools and follow guidelines of the current regional and local protocols. The quantitative goal of the habitat monitoring program is to estimate the total abundance, distribution, and condition of essential fish habitat throughout the subbasin for each species every 10 years.

Water quality, in particular, stream temperature, was identified as a limiting factor during the EDT modeling process. The Region’s tributaries have been monitored for many years by natural resource agencies, Tribes, and local groups. The U.S. Forest Service manages much of the higher elevation portions of the watersheds where the greatest volume of stream water originates as groundwater or precipitation. USFS monitoring supports strategies for land management and drinking source water protection. The Oregon Department of Environmental Quality and the Washington Department of Ecology are responsible for subbasin-wide monitoring to evaluate whether water quality is sufficient to ensure that beneficial uses of public waters are fully supported. State and federal fish and wildlife departments monitor stream habitat in the Basin. The Natural Resource Department of the Confederated Tribes of the Umatilla Indian Reservation is monitoring habitat and water quality in the subbasin as well. The Walla Walla Basin Watershed Council monitors water quality and flow and is evaluating groundwater and stream interaction within portions of the Walla Walla Subbasin. The Columbia County, Garfield County and Asotin Conservation Districts are monitoring in some areas of Snake River tributaries. Concerns have been identified for elevated temperature, fecal mammalian and/or avian bacteria, chlorinated pesticides, polychlorinated biphenyl compounds and pH. Tribes, WWBWC, WDFW, and WDOE are conducting on-going temperature monitoring which is supported by ODEQ. On-going monitoring for the other constituents is still in the planning phase and will likely be carried out as a collaborative inter-organizational effort. In general, these monitoring activities are well coordinated.

The co-managers and collaborators will collect temperature and specific conductivity data (for source water information). Temperature and water quality conditions will be monitored at designated locations including EMAP locations to complement habitat monitoring in the other work elements of this proposal. Site locations could be based on reach specific questions, BMP based restoration projects or sites necessary for the USFWS/Irrigation District agreement monitoring in the Walla Walla River or the long term monitoring sites determined by the TMDL development process. Data from this network will also be useful for surface groundwater model calibration (e.g., conductivity helps determined ground water movement through the spring and shallow aquifer system).

The Walla Walla Basin Watershed Council (under guidance from ODEQ) created a Water Quality Monitoring Plan for the anticipated water quality and quantity monitoring work in the Walla Walla Basin. This plan includes a detailed description of the Council's plan for monitoring protocols including: a description of ODEQ approved methods, materials, calibration standards and chemicals, sampling frequency, site selection criteria, as well as an in-depth Quality Assurance/Quality Control plan. All water quality protocols are outlined according to the Water Quality Monitoring and Technical Guidebook (OWEB, 1999). This plan will be used as a template for the standardized methods in the recovery region.

9.3.2 Biological Monitoring

Population monitoring will provide information on the abundance, productivity, biological diversity, and spatial structure of each MPG in the recovery region. Scientifically defensible estimates of abundance, productivity and distribution (spatial structure) will be developed, as these are quantitative performance metrics that directly impact the delisting process. Life history and genetic information is collected opportunistically as part of numerous survey efforts including survival monitoring (i.e., PIT-tag derived estimates of run timing), carcass surveys (i.e., scale collections and run reconstruction), and virtually every opportunity where fish are being directly handled or remotely interrogated.

Biological monitoring will monitor baseline conditions and track progress toward meeting the recovery (delisting) goals for listed populations presented in Chapter 5. Monitoring would be focused on the VSP attributes are based on the four VSP parameters (population abundance, productivity, spatial structure, and biological diversity) (McElhany et al. 2000). The ICTRT is in the process of developing specific population standards that relate to the VSP parameters. A list of measurable attributes and their relation to the VSP parameters is presented in Table 9-6. The attributes are based on the latest guidance from the ICTRT. The ICTRT is continuing to review fish recovery needs and to identify specific standards for tracking recovery of listed populations.

Table 9-6. Measurable Attributes Related to VSP Parameters Likely to be Included in Biological Population Monitoring

Metrics	Abundance	Productivity	Spatial Structure	Biological Diversity
Adult Returns	●	●		
Harvest	●			
Origin (hatchery vs. natural)	●	●		●
Juvenile Outmigrants		●		
Age at Outmigration				●
Adult Age Structure		●		●
Monitoring of Major and Minor Spawning Aggregations			●	
Morphology				●
Juvenile Survival		●		
Adult Survival		●		
Age at Return		●		●
Outmigration Timing				●
Adult Return Timing				●
Fecundity		●		●

The SRSRP prioritization approach requires that most fish-bearing streams in the recovery area be monitored, although certain streams should be monitored much more intensively than others. Intensive monitoring is defined by the RTT as annual, long-term monitoring of:

1. Smolt production including both estimates of abundance and smolts per adult, which the SRSRB believe are critical for determining the effectiveness of proposed recovery area actions and tracking plan progress.

2. Adult returns by type (hatchery/wild), juvenile and adult age composition, distribution of spawners and juveniles, relative abundance by species and age-class, genetic characterization, smolt-to-adult survival rates, and adult recruitment rates. This information will be used to determine if NMFS recovery goals for each population are being achieved.

Biological monitoring would also occur to resolve environmental critical uncertainties and to fill data gaps. The portions of the recovery area that would receive intensive monitoring include the Walla Walla River, Touchet River, Tucannon River, Asotin Creek, and possibly Mill Creek. The scope of the reaches monitored in these areas should extend far enough up into the watershed to include bull trout spawning areas. The data shown in Table 8-3 would be collected yearly in the intensively monitored basins.

All other areas would be monitored on a non-intensive basis. Such areas would be monitored 2 to 3 years in succession, on a 5-year rotation. The objectives of non-intensive monitoring include spawner abundance and distribution, relative juvenile abundance and distribution, collection of genetic samples, and periodic habitat monitoring similar to that for intensively monitored areas.

In the initial years of the recovery plan implementation, emphasis would be placed on collecting baseline data on fish distribution and abundance in major and minor spawning areas where little or no data are currently available for listed species. For example, baseline data are lacking for Asotin Creek bull trout, all listed species in the Wenaha River, and steelhead abundance in small mainstem Snake River tributaries. Steelhead abundance in the smaller Lower Snake River tributaries and Grande Ronde would also be collected in year one of the plan to supplement on-going efforts.

9.3.3 Biological Monitoring Protocols

Detailed methods describing the collection of each performance metric can be found online[30]. Field techniques are modified regularly to accommodate changes in regional standards, however the general methods for quantifying abundance, productivity, diversity, and spatial structure will be held constant throughout the recovery period. Here we generally discuss the biological monitoring protocols that will be implemented in the recovery region to quantify the performance metrics referenced in this section and in Chapter 5 of this plan.

9.3.3.1 Adult Escapement

Adult enumeration facilities throughout the recovery area have different physical structures and criteria for operations, based in part on their location. State and tribal staff will work throughout the region to conduct continuous video enumeration or operation of traps for determining escapement. Staff will collect fish numbers and species (including number of steelhead kelts), direction of bull trout movement, and age class (adult and jacks) for spring Chinook. At weirs, staff will collect similar information for all focal species that are handled. In addition the co-managers will mark (opercle punch or PIT-tag) specimens to estimate weir efficiency, and will take genetic samples when practical.

Accurate enumeration of adult salmonid escapement in the main production areas of the Touchet River, and of the smolt production that results from their spawning are two critical pieces of information (Walla Walla Subbasin Plan, Appendix AD3, pages AD3-3, 3-4, 3-9) needed to evaluate whether in-basin factors are limiting summer steelhead (or other salmonid) populations.

Poor historical enumeration of adult summer steelhead and other salmonid species escaping into the upper Touchet River is currently being addressed. A proposal (funding provided by LSRCP, SRFB, WDOE, WDFW, and FRIMA) to modify an existing water intake structure and temporary adult trap that supplies water for a hatchery steelhead acclimation pond operated by Washington as part of the LSRCP will potentially be addressed in 2007. This proposed new fish ladder/trap will allow managers to collect a more complete and accurate census of summer steelhead and other salmonids escaping into the Touchet River above Dayton, where the majority of existing salmonid habitat remains. Once complete (estimated fall 2007), accurate adult recruit:spawner ratios can be calculated, allowing managers to determine whether the Touchet River summer steelhead population is at, above, or below replacement level; a critical value in the ICTRT's (2005) VSP population criteria. The WDFW fish management staff operated a temporary adult trap (provided by LSRCP) on Coppei Creek during the spring of 2005. WDFW (fish management and LSRCP hatchery evaluations) wish to continue this operation in the future to determine hatchery influence on this small tributary of the Touchet River (within 10 miles of the Dayton summer steelhead Acclimation Pond). Coppei Creek is a very flashy system, and the original trap/weir that was designed will need modifications to operate successfully in this stream. This trap is to ensure that the hatchery mitigation program is primarily being isolated in the mainstem of the Touchet River, and not spilling over into the small tributary and endangering the natural summer steelhead populations within those.

9.3.3.2 Passage Assessment

Understanding delay at passage impediments, or at the recently constructed and modified fish passage facilities, is a necessary and mandated component for determining the success of the recovery program, and for evaluating the effects of these facility operations on ESA listed fish. Considerable effort and

---

[30] http://www.pnamp.org/web/workgroups/meetings.cfm?meeting=all&strWGShort=FPM

resources are put towards flow and passage restoration; however, the direct benefits to fish have not yet been fully been quantified. Baseline effectiveness monitoring is needed to understand the added benefits to fish that passage restoration programs would bring to the recovery region.

We will use radio telemetry to monitor passage, holding, and spawning in selected areas. We will assess the spatial distribution and temporal patterns in adult abundance, delay patterns and fish ladder use, and spawning/holding/pre-spawn performance. Radio tags will be implanted gastrically in adult fish collected from the lower Walla Walla River and on other tributaries where significant passage modifications occur. Tagged fish would be monitored by aerial and ground mobile tracking and by maintaining a set of fixed monitoring stations such as those already in place in the Walla Walla Subbasin. Fish collection and tagging effort will be stratified across the duration of the adult return to reflect the temporal distribution of the run based on previous returns. Chinook and steelhead will be tagged from February to June and September to January, respectively. In addition, hatchery and wild fish would be counted when captured at the various traps in lower Asotin Creek and the Tucannon, Walla Walla and Touchet Rivers, as well as in Mill and Coppei Creeks. And finally, visual counts of adults would be obtained by observers while walking, boating, or snorkeling. Ideally, roving radio telemetry and visual surveys should cover all summer holding and spawning areas, but alternatively, a stratified random sampling design could be used.

Fish will be collected for tagging in the lower Walla Walla River by using floating fyke traps (Merwin Trap), variable mesh tangle nets and angling. The Merwin Trap is a relatively large, passive capture technique designed to be highly mobile and easily assembled (Mallette et al. 1993). Use of the trap will enhance and standardize capture and handling; and should reduce possible fish injury and harm. However, if the trap catch cannot meet project tagging goals, then additional fish will be captured by setting tangle nets or angling (Nelson et al. 2005).

All the fish are collected and taken to a sampling station, recorded by species, examined for injury and fin marks, coded-wire tags, Passive Integrated Transponder Tags (PIT tags) or other type of tags, and counted. Fish are measured to the nearest millimeter fork length, and externally sexed. Healthy steelhead and spring Chinook salmon that are esophageally implanted with radio transmitters may be held overnight to assess tag retention prior to release.

On average, tagged fish will be geo-located (e.g., GPS: UTM coordinates) once per week. Fish location is estimated by strongest record signal strength of the observation and mapped using Topographical Map Software for Washington and Oregon (TOPO!). Estimates of tag loss due to study effect, harvest, natural and unknown causes are important components of study planning and results (Ramstad and Woody 2003). Snorkel divers will regularly validate tag retention, observe fish behavior, confirm fish disposition (e.g., mortality, tag loss) and recover lost transmitters.

9.3.3.3 Spawner Surveys

Summer steelhead redds are highly correlated with adult escapement. For example, in the Umatilla Subbasin where escapement monitoring is 100% efficient, redd density and abundance at index areas is highly correlated with escapement to the fish ladder at Three Mile Falls Dam ($R_{sq}=0.86$, $p<0.01$). Thus, in the Recovery Region where steelhead and Chinook escapement cannot be fully monitored due to the placement and efficiency of the ladders and weirs, we will use spawning density and abundance as a proxy for escapement, to validate/calibrate weir and ladder estimates, and to quantify adult distribution.

We will implement and test spatially balanced randomized rolling panel surveys of summer steelhead spawning using visual multiple-pass sampling. Additional index spawning surveys will be continued for the short term as the Environmental Protection Agency (EPA) Environmental Monitoring and Assessment

Protocol (EMAP) sampling is phased in. This will help ensure that data can be used with existing databases and past monitoring efforts.

To determine the sampling effort required in the recovery region, we used Monte-Carlo sub-sampling routines to estimate the survey effort needed to optimize power and confidence using different survey reach lengths. The modeling was based on 15 years of 3-pass redd surveys at seven index tributaries in the Umatilla Subbasin (Schwartz et al. 2005a). Our analysis supports previous recommendations by EPA, ODFW, Washington State and NOAA, and suggests that using samples of 1 km reaches will allow us to estimate the mean redds per mile with 80% power and 90% confidence by surveying just 10% of the available spawning habitat in the region (Figure 9-4). This sample size should be more than sufficient to describe the distribution of the spawning population for the entire region.

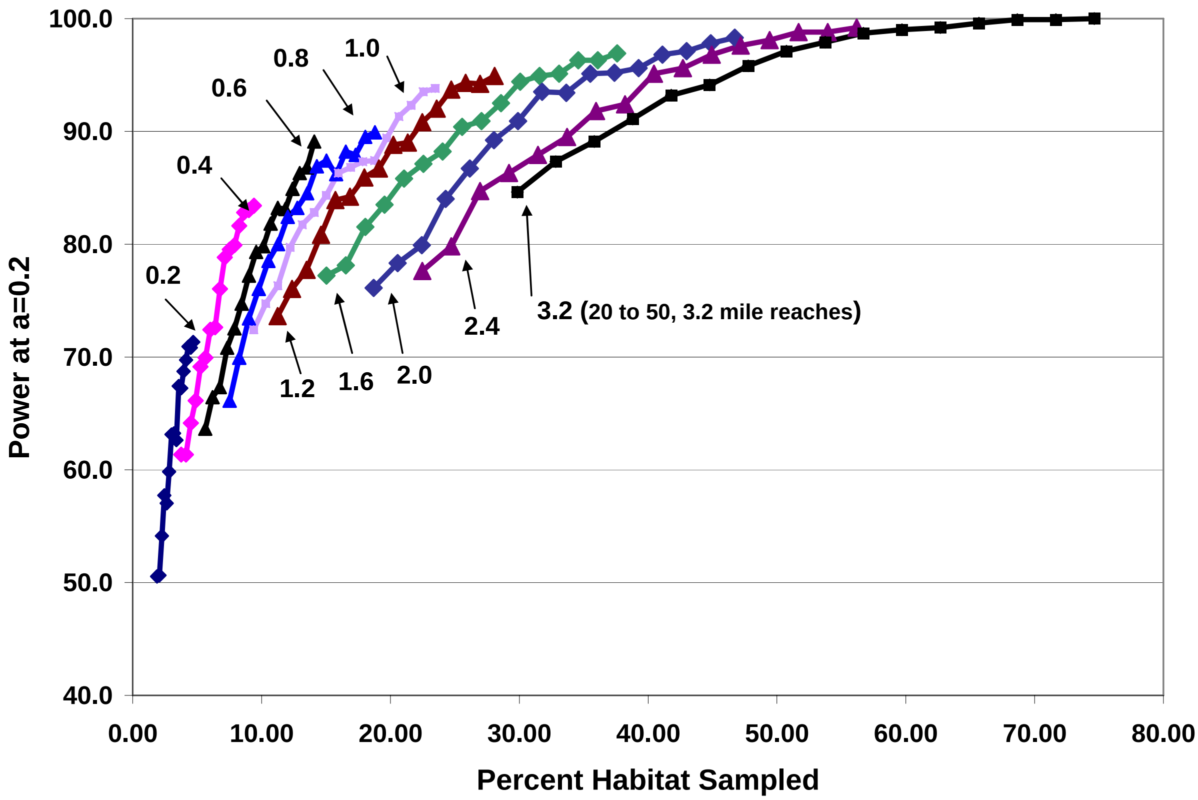

Figure 9-4. Statistical Power vs. the Percent of Habitat Sampled for Different Summer Steelhead Spawner Survey Reaches, Based on Markov Re-sampling of a 15 Year Data Set in the Umatilla Subbasin.

We will select steelhead EMAP sites randomly and assign them to a rolling panel allocation of index, 3 year, or one time sampling (Stevens and Olsen 2003). Randomly selected sites will be pulled from the 4,467-point dataset produced by the Oregon Corvallis EMAP program. These points have spatial balance, full coverage of the wetted stream habitat, and will be used for all probabilistic fish surveys. Sites lacking surface flows, or those where landowner permission cannot be obtained will be replaced with samples immediately upstream or downstream. Some details in the survey methodologies between cooperators are currently different, but will be standardized prior to the first field season. Each observed redd will be flagged by marking tape on adjacent vegetation to avoid re-sampling. Surveyor effort and timing will be allocated throughout the sampling universe within season based on flow conditions and redd visibility. The location and condition of each redd, and any fish or carcasses observed, will be recorded within short geo-referenced reaches, or individually using a GeoXT-Pathfinder Pro sub-meter GPS system, or other available GPS unit, provided a geolocation can be determined. Otherwise, information will be recorded in datasheets, and a geolocation will be estimated in the office using mapping software. This technique allows for high-resolution analysis of spatial structure and geostatistical computations.

Bull trout spawning habitat is extremely limited in the recovery region, in great part due to temperature limitations. It is essential to quantify expansion and contraction in bull trout production to understand the effectiveness of the recovery and restoration efforts. Numerous federal, state, and tribal scientific programs all play a role in monitoring bull trout. This collaboration will support collaborative monitoring of bull trout abundance and spatial structure by coordinating spawner surveys.

Bull trout redd data provides an important index of abundance, and is a useful indicator of spatial structure for the spawning fraction. A complete census of these areas is practical, powerful, and informative. In addition, recent attempts to integrate probabilistic surveys of bull trout have not been shown to improve cost-performance over traditional census surveys. Bull trout redd abundance and density has varied inconsistently across the region over the past several years Mitigation programs are currently being implemented throughout the basin, and it is essential that these redd surveys be continued to support population status monitoring and conservation planning. Redd enumeration consists of three or more pass visual surveys conducted on foot at approximate intervals of every other week. Data will be recorded on data sheets and redd locations may be georeferenced with GPS, or at least documented and summed for relatively short stream reaches of 1-4 miles.

In addition, the USGS, USFS, USFWS, CTUIR, ODFW, and WDFW have supported radio telemetry, PIT, and floy tagging efforts in the Walla Walla Subbasin. The Federal Caucus has used this information to conduct mark-recapture estimates of BT abundance, demographics, and movement. This collaboration will compile and report all recaptures of PIT, or radio-transmitter tags from snorkeling, electrofishing, or other visual assessments to the Federal Caucus annually. We will participate in collaborative analysis of population performance, and will assist with collaborative reporting as described below.

Chinook and coho spawning habitat is limiting in extent and distribution, but is expected to increase in size at an unpredictable rate due to management intervention. We will conduct a complete census of all known spawning areas for these taxa, but will begin to expand our survey efforts to include a probabilistic survey of expanded spawning using EMAP protocols. The sampling universe for expanded EMAP surveys will be all known, or presumed historical spawning areas (Swindell 1941). We will census current spawning habitat using 3-pass visual surveys, and may sample an additional 10 sites annually to determine distribution and relative abundance in suitable but currently unoccupied regions for each stock.

Chinook redds and carcasses will be enumerated as an index of spawner abundance and spatial structure. The location of each redd and carcass will be georeferenced individually or within short reaches, when reception is available. The conditions of each redd and any observed spawner activity will be noted. Each observed redd will be flagged by marking tape on adjacent vegetation to avoid re-sampling. Carcasses will be measured (e.g., fork length and MEHP) and a scale sample will be collected for age, growth and origin analysis. Each carcass will be cut open to determine the spawning success of females. All external marks and tags will be noted. The snouts of clipped fish will be removed for CWT analysis. Tails will be removed from sampled fish to ensure they are not resampled later.

Fall Chinook spawning surveys will be conducted similar to spring Chinook salmon surveys, except that more effort may be allocated to intercepting carcasses than to enumerating redds. Water quality conditions during the fall Chinook and coho salmon spawning season are not conducive to reliable redd enumeration, and thus the site fidelity of salmon carcasses will be used in combination with the density and distribution of redds enumerated to develop a carcass intercept model. In general, the fate of salmon carcasses is representative of the distribution of the spawning population (Cederholm et al. 1989). A boat or other means may be used to survey the mainstem Walla Walla River, conducting multiple passes annually. The condition, geolocation and spawning state of each carcass and redd will be recorded as above.

9.3.3.4 Outmigrant Assessment

Outmigration and survival (O&S) is a key performance metric used in decision-making analysis. Smolt abundance, migration timing, and in-basin survival are all collected through O&S monitoring activities. Smolt production and smolt-to-adult survival, by stock, are critical scientific data gaps that should be obtained to establish baseline stock status and performance.

Smolts/spawner is a generally accepted descriptive metric of population health (NOAA Fisheries 2003). Estimates of smolt production through deployment of a smolt trap is an accepted method to estimate smolt production from Columbia Basin rivers, and has been used recently in the Walla Walla by the CTUIR and widely used by WDFW around Washington. Smolt yield is important for long-term monitoring of restoration actions, and provides the foundation for relationships used to estimate in-basin capacity and productivity measures. An understanding of migration success and survival is also necessary to identify in and out-of-basin bottlenecks and to estimate loss by life stage for hatchery- and naturally-reared salmonids. Survival is estimated at both the subbasin and watershed scales, and is discussed below. We may estimate outmigrant abundance at the subbasin scale using headwater PIT-tagging and rotary screw traps. We will evaluate the benefits and risks of estimating outmigration abundance at the subbasin scale by using headwater PIT tagging and rotary screw traps and may implement this strategy pending the outcome of our evaluation

Downstream migrant salmonids are trapped, PIT tagged, and tracked as they migrate to the Pacific Ocean from the headwaters to the Snake or Columbia rivers. Rotary screw traps, irrigation canal bypass facilities, beach seining and electroshocking are utilized to capture rearing and emigrating juvenile salmonids. PIT tag detections are analyzed from tagged juvenile salmonids detected at in-basin antenna arrays and traps, and interrogation systems located at mainstem Snake and Columbia River dams.

Rotary screw traps are currently being used in the lower Walla Walla and Tucannon rivers, in Asotin Creek (above George Creek) and the lower Grande Ronde. We are planning to modify the operation of the trap in the lower Grande Ronde and we are proposing to operate a trap in the Touchet River. We intend to place the Touchet River screw trap near the Dayton Weir, in series with the trap at the mouth, to estimate production from the Touchet drainage.

Walla Walla summer steelhead, as with most steelhead populations, exhibit a complex life history pattern. For example, smolts are believed to migrate from the Touchet River at ages 1-4 (Age 1: 5.5%, Age 2: 78.4%, Age 3: 15.6%, and Age 4:0.5%) based on a limited number of adult scale samples (<150/year) collected at the Dayton adult trap (Bumgarner et al. 2004). Based on those same scales, adults return predominantly after 1 to 2 years in the ocean. Describing the relative contribution of these variants, in a more robust manner than from limited adult scale samples, is essential to understanding the productivity and survival of summer steelhead in the Walla Walla Basin. Previous work by this collaboration included supporting a mid-tributary trap in the Walla Walla and Mill Creek drainages to assess mid-stream mortality, and ultimately aid in the estimate of outmigrant abundance. This detailed smolt information has been used to assign production to particular broods or stocks, and to develop watershed-specific estimates of production. Redeployment of the Mill Creek Trap to the Touchet River is the next logical step in describing these attributes for the Touchet River SSH population.

Regardless of trap type or location, in most cases, captured fish are held in a 0.23 m^3 or 0.76 m^3 6.4mm small mesh knotless nylon seine holding pens or aerated 19L buckets prior to or during sampling. All salmonids captured are anesthetized in an aerated bath containing 40 mg/l of tricaine methanesulfonate (MS-222) prior to sampling. Fish are enumerated by species, race and rearing type. Rearing type is categorized as “natural” or “hatchery” based on the presence/absence of a fin clip, mark, tag, and the appearance of wear on the dorsal and ventral fins. Scales are collected from a subsample of natural summer steelhead for age analysis. Developmental (smoltification) stage for all species is assessed by visible brightness and the presence or absence of parr marks. Fork length (FL) is measured to the nearest millimeter (mm) and single character descriptor codes are used to describe descaling, injuries, parasites, and disease for all natural juvenile salmonids and a sub-sample of 60 hatchery salmonids per day.

All smolts captured during fish sampling are manually interrogated for PIT tags. Fit, healthy, and uninjured Chinook salmon greater then 70mm and summer steelhead-rainbow trout greater than 100mm with smolt or partial smolt characteristics will be PIT-tagged. A PIT tag is injected by hand into the body cavity of a fish by access of the underbody, posterior of the pectoral fin with a modified hypodermic syringe (Prentice et al. 1986, Prentice et al. 1990). Syringes are disinfected for 10 minutes in 80% isopropyl alcohol and allowed to dry for 10 minutes between each use. Fish are processed using a Biomark data collection station or portable tagging station that consists of a computer, PIT tag reader, measuring board, and electronic balance to record the tag code, fork length (±1 mm), and weight (± 0.1 g) of sampled fish. Data is recorded directly into the PIT Tag 3 program using the computer and on field data forms and transcribed to a relational database. PIT-tagged fish are held until full recovery and then released. The CTUIR, WDFW or ODFW PIT tag coordinator will review and submit the appropriate tag files to PTAGIS according to established procedures.

To calibrate the collection efficiency of the trap and estimate outmigrant abundance and survival, groups of fish by species are collected, PIT-tagged or fin clipped and released upstream of the trap for recapture. Tests are conducted minimally 2 times a week for each species while sufficient numbers of fish are being captured. Tagged fish are typically held for 24 hours prior to release, to assess latent mortality (tagging effect), tag loss and determine the probability of survival of individual release groups.

9.3.3.5 Summer Juvenile Surveys

Juvenile and rearing salmonids are highly responsive to local habitat conditions within brood years, with additional variability at sites through time. Quality fish habitat tends to attract rearing juveniles from throughout a watershed, and will usually maintain high salmonid densities from year to year (Roper et al. 2003). This makes reach-scale changes in productivity extremely difficult to detect in the absence of relatively large (>20%) changes in rearing densities. Assessing status and detecting changes in juvenile and resident salmonids and their habitat is critical for quantifying the abundance and distribution of a population, and for understanding the local response of populations to restoration actions. It is also central to computing productivity and diversity in general.

We will conduct EMAP surveys of juvenile and resident salmonids using standardized protocols consistent with all regional RM&E standards to assess status and trends, and conduct project and program effectiveness evaluations. This section includes methods for electrofishing, and snorkeling collectively termed “summer EMAP surveys.” The sampling universe for summer EMAP surveys will be all wetted reaches in the recovery region based on the USGS quad. The samples will be selected from the random points generated by the Corvallis EMAP project, or elsewhere. We will use these spatially balanced points to allocate sampling effort evenly across the recovery region. In addition, sampling intensity will be increased as needed in geographic areas that are receiving supplementation, flow, or habitat treatments.

For quantitative electrofishing surveys in wade-able reaches, a Smith-Root backpack electrofishing unit will be used to collect fish for abundance and density estimates. Low voltage pulsed direct current generated by the electrofisher will be used to stun and collect fish (range: 200-500 volts, 40-60 Hertz, .5-4µs). Electrofisher settings will be set to the minimum effective electrical field to reduce injury to fish. If no minimal effective setting can be achieved electrofishing efforts will be aborted. Block nets will be set in the stream channel to prevent fish from entering or escaping the sample site. Survey methodologies between cooperators are currently slightly different, but will be standardized prior to the first field season. Sample sites will receive up to three passes with comparable effort until a 60% reduction in salmonid catch is achieved between successive passes. Salmonids will be collected by dip netters, identified (genus and species), measured (fork length in mm), weighted (g), checked for marks or injury, and counted.

Fish densities will be estimated based on the number of each species observed and the total area surveyed. To account for the impacts of environmental variability through time we will electrofish sites with unequal frequency. Two-thirds of the sites will be newly selected annually based on a rolling-panel design, while one-third will consist of index areas that will be sampled each year. The index sites will be used to assess covariance among sites, and used in combination to the 1-, 3- and 10-year samples to assess changes in abundance and distribution across space and time.

For non-wadeable pools, we will snorkel using single-pass visual surveys. Surveyors will use slate and pencil or high-resolution video depending on conditions. Surveyors will move from downstream to upstream margins of the pool, being careful to minimize their disturbance of the water column and the fish. Counts of individual specimens will be made for all salmonids and relative abundance estimates made for other aquatic species. Indices of detectability may be developed and correlated to water clarity.

In addition, the collaborators will utilize electrofishing equipment and personnel for fish salvages or fine-scale assessments as needed. The federal, tribal, state, county, and city governments co-sponsor an extensive mitigation and restoration program in the region. These efforts often require small-scale salvages or presence/absence surveys in association with emergency response, small-scale construction/mitigation activities, responsive short-term planning, or regular maintenance of irrigation facilities, ladders and dams, and screens. This collaboration will provide a reasonable level of support to the co-management community at large, and will request matching support from responsible parties when appropriate.

9.3.3.6 Genetics Monitoring

As a group, we may collect and archive up to 300 samples of each salmonid population annually to serve in the long-term monitoring and assessment of genetic characteristics, but sampling efforts will be planned in advance and focused to address specific questions whenever possible. Samples will be taken from adult traps, hatchery or natural broodstocks, carcasses (when deemed in a condition where good genetic material can be obtained), and specimens collected during electrofishing surveys. Non-lethal fin clips will be taken to avoid harm, except for mortalities where a sub-dermal sample will be taken. Samples will be labeled and stored in 100% molecular grade denatured ethanol, and archived by WDFW, ODFW, or NOAA and or Hagerman Genetics Laboratory. Previous samples collected by the agencies should be evaluated and combined or utilized where possible to reduce redundancy in future data collections and to help plan analyzes.

9.3.3.7 Harvest Monitoring

Non-tribal fisheries will be monitored by ODFW and WDFW using a combination of stratified roving creel surveys and catch-record card data from anglers that turn in their salmon and steelhead harvest cards. Geographically and temporally stratified variance in the tribal and non-tribal catch and harvest estimators will be based on the variances of the fishing effort and catch and harvest rates. Effort, catch and harvest will be estimated for Chinook (ceremonial) and steelhead (recreational), whenever possible. Limited trout or non-salmonid creel surveys will be conducted periodically to determine the potential impacts of these fisheries on Chinook or listed salmonids. Methods for randomized creel surveys follow Malvestuto (1996). Methods for probabilistic sampling of tribal harvest will be finalized as part of planning and coordination prior to the engagement of more significant tribal harvest efforts.

9.3.4 Analysis and Model Evaluation

9.3.4.1 Productivity

Smolt Components

Salmonids will be PIT-tagged at hatcheries and at trapping locations and potentially in the headwaters. The number and allocation of PIT tags deployed to any cohort and species in any watershed is managed using the PTAGIS system. Recaptures of PIT tags are used at traps or from in-basin fisheries or spawning surveys for abundance and survival estimations, and Snake or Columbia River mainstems for hydrosystem and whole-life-cycle performance evaluations. Out-of basin survival will be estimated using the CRiSP (www.cbr.washington.edu) and SURPH models.

Survival estimates for hatchery and natural salmonids are conducted to assess in-basin and out-of-basin loss by species and life-stage. Survival estimates are also generated to support hatchery production monitoring and evaluation of optimal release and rearing strategies. A mark-recapture methodology utilizing PIT tags and subsequent detections at in-basin PIT tag detection antennae arrays, the mainstem rotary screw traps, and interrogation facilities at Snake or Columbia River dams is used to calculate survival. In-basin survival of hatchery salmonids is currently estimated using the Migrant Abundance Method (Dauble et al. 1993), whereby:

Equation 1 $S = A/R$

Equation 2 $A = TD/TE$

S = survival, A = abundance (estimated total number of outmigrants passing RM 3.7), R = the number of tagged fish released at upriver sites (R), TD = number of tagged migrants recaptured in tributary traps, and TE = estimated trap efficiency.

Since detections are date specific, efficiency estimates used encompass corresponding tag dates. If efficiency estimates do not correspond to the dates tags are detected, trap efficiency data is arbitrarily pooled using the closest daily estimates before and after the detection date. Confidence intervals (95 percent) for survival estimates are based on derived population confidence intervals. The binomial test is used to test for significant differences in detection between comparable hatchery release strategies (acclimated vs. direct released fish, different release locations).

Testing for significant differences in survival rates will be conducted annually, and in detail over aggregated 5-year periods. However, it must be noted that calculated survivals may not have sufficient accuracy or precision to determine whether actual differences exist except in aggregated data sets. The SURPH model and other likelihood estimators will be used to estimate in-stream survival based on release sizes, trap efficiencies, and the number of recaptures. Smolt survival estimates generated by SURPH include a point estimate and associated variance. ANOVA testing with transformed data and trend analysis will be used to characterize trends over time.

Finally, smolt emigrant abundance is defined as the number of smolts leaving each watershed. It is calculated for both hatchery and natural emigrants and is a key component required to address critical uncertainties surrounding in-basin productivity and natural production capacity. Smolt abundance is derived based on the number of fish collected at the lower trap site and the estimated trap efficiency. Smolt abundance of fish sampled at the screw trap is estimated as:

Equation 3

$$A = (C/TR)/TE$$

whereby, A = total number estimated outmigrants, C = the number of fish captured, TR = trap retention efficiency and TE = estimated trap efficiency. Sampling rate and time were not adjusted due to 24 hour a day trap operation.

Emigrant abundance is calculated on a biweekly or monthly basis and then summed to derive a total number of natural outmigrants for the season. If no fish are available for a particular month, environmental parameters (flow and turbidity) may be used to estimate efficiency, or at a minimum efficiency estimates from the month before or month after are used. The Bootstrap method (Efron and Tibshirani 1986, Thedinga et al. 1994), with 1,000 iterations, is used to derive a variance and 95% CI for abundance estimates. We currently use the DARR model (Bjorkstedt 2005) for estimating abundance, and attribute the contribution of each watershed to the smolt output based on the fraction of PIT tag recaptures from each system. The current sampling design is reasonably sufficient for most outmigrant abundance metrics, but will require additional support due to the addition of a Touchet trap.

Growth Components

Growth information is a strong indicator of within cohort productivity across space and time. Growth patterns can explain the life history of anadromous fish, displaying age at migration, timing of migration timing, and can help assess certain management implications (Mathews and Ishida 1989, Soderberg 1992, Bernard and Myers 1996, Tattam et al. 2003). Circuli spacing and the growth function are reliable indicators of fish health, population production and habitat quality (Nitschke and Kelly 2003, Gledhill 2005).

Scales are usually the structure of choice for ageing of fish, due to their ease of collection and non-lethal sampling nature. The life history of steelhead and bull trout varies throughout the extent of its range. The fresh water life history of the anadromous steelhead can reach 7 years prior to smoltification and can spend up to 3 years in saltwater before returning to spawn in the natal stream (Mosher 1969, Busby 1996). Southeast Washington and Mid-Columbia salmonids seem well suited to scale analysis, and the information has been put to good use (Bumgarner 2003, Schwartz et al. 2005a). In addition, age analysis allows for run reconstruction, and is the foundation for estimating productivity. Age and growth monitoring, and its application to stock assessment and run reconstruction, will follow the methods and standards outlined in Gallucci et al. (1996). Hard structures (scales, otoliths, fin rays, and opercula) will be collected from juvenile and adult fishes during a variety of sampling activities. However, this will be carefully planned and sampling will be targeted as necessary. These structures can be used to assess age as they all grow in tandem with the fish. Hard structures will be analyzed to detect growth rings and other growth patterns including accelerated development of the nuclei (indicating hatchery-reared origin) and marine/freshwater transitional depositions (indicating years at sea and years in-river).

Adult scales will be mounted on gum cards and pressed in cellulose acetate. Hard structures will be sanded flat and mounted in CrystalBond© medium and sanded or section using a diamond saw. Adult scales will be examined under a stereo microscope at a magnification of 42x and/or 72x, or a microfiche reader of 36x or 42x. Age designation will utilize the European method – e.g., a spring Chinook returning in 2002 at age 1.2 was spawned in 1998, emerged from the gravel in January-March of 1999, migrated to the ocean in the spring of 2000, returned to freshwater in the spring of 2002 and spawned in the late summer of 2002 at age 4. Juvenile scales, otoliths, rays, and vertebrae will be examined under a compound scope at 100X or greater magnification. Daily, lunar, seasonal, and annual patterns will be discerned. Growth curves will be developed using von Bertalanffy equations (von Bertalanffy 1934).

Equation 4

$$dl/dt = K(L_{inf} - l)$$

whereby, L = length of fish in cm; L_{inf} = the asymptotic length of fish in cm; K = the rate at which length tends toward the asymptote; t =time (age of fish)

Age and growth analysis will be used to estimate rates of biomass accumulation at the geographic area level of aggregation, and to reconstruct run performance. Cohort performance metrics will be used to estimate productivity within and across cohorts, space, and time based on the general analytical techniques described below.

Measuring the dimensions of annuli is used to determine the size of the individual fish at earlier ages. This process is called back calculating and assumes that there is a correlation between size of the hard structure and length of the fish. Ward et al. (1989) used back calculations to determine smolt-to-adult survival and was positively correlated to smolt size. We will follow the common practice and good science to cross validate all age readings and back calculations by other fisheries biologists to ensure proper ageing precision.

Run Reconstruction

Representative samples of multiple age and abundance samples can be used to determine year class abundance and assess cohort strength. This process, often termed “run re-construction,” is the foundation for developing productivity performance indicators. Life-stage specific estimates of productivity provide common units for comparing population performance across geographic and temporal scales.

We will integrate subbasin information using a relational database. Age, abundance, and distribution information will be used to assign fractions to cohorts, and reconstruct brood years. Brood year by life-stage information will be used to calculate the standard life-history performance metrics such as adult-to-adult, smolt-to-adult, and smolt-to-smolt productivity.

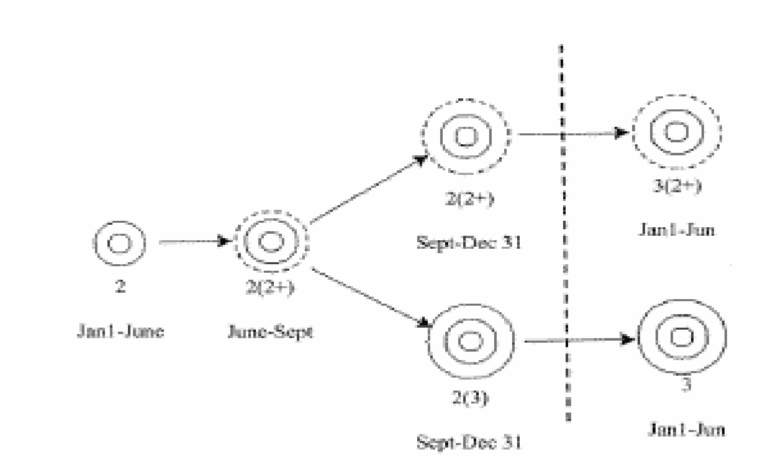

Figure 9-5. Information and Analytical Flow Associated with Run Reconstruction

9.3.4.2 Analysis of Distribution

We will use associative analysis to assess the distribution, correlation, and covariance among abundance and distribution performance metrics. Traditional inferential statistics including ANOVAs, t-tests, regression, and principle components analysis all utilize the associative paradigm. The general equations for associative analysis of any variable X are the probability functions:

Equation 5

$$\mu = \sum x \bullet P(x)$$

Equation 6

$$\sigma^2 = \sum [(x-\mu)^2 \bullet P(x)]$$

Equation 7

$$\sigma = \sqrt{[\sum x^2 \bullet P(x)] - \mu^2}$$

where P is the probability of encountering any given value of x, μ is the mean of that probability function, σ is the variance, and σ^2 is its standard deviation. Similar frequentist statistics will be applied in multivariate regression of abundance and distribution information.

In addition, juvenile population and community estimates will be expanded from the site and reach scale to the tributary, watershed, and subbasin levels of aggregation using geostatistical stock assessment based on habitat data (Petitgas 2001), and fish-habitat relationships (Watson and Hillman 1997, Torgersen et al. 1999, Brown et al. 2000, Turgeon and Rodriguez 2005). Geostatistical analysis is used to assess the spatial variability of a variable or variables, and then to utilize that variability and co-variability as an estimator or predictor of another covariate such as population density (Petitgas 2001). Geostatistical analysis recognizes the potential spatial co-variation of metrics that can be associative, confounding, or predictive. Changes across space can result from the spatial distribution of variables such as the extent of clustering, or it can result from underlying co-variation with habitat characteristics or inter-specific relationships. In a stream-network spatial variability can also result from contingency and dependency on up-stream or down-stream factors. Geostatistical analysis relies on the estimation of spatial means, called the zone mean, rather than the process mean used in inferential statistics. The mean (Z) is derived from:

Equation 8

$$Z_v = \frac{1}{V}\int_V z(x)dx$$

for any variable x, and its covariate v. The calculation of the estimate and estimator variance is exponentially more complex, and depends on the realization of an expectation function, covariogram, and variogram. The use of these spatial means to develop geostatistical or geospatial estimates of random or deterministic functions is perhaps not more complex, but more complicated because the precise method (or kriging formula) depends on the realized variogram and covariogram functions. The reader is referred elsewhere for discussions regarding the kriging decision tree (Demyanov et al. 2001, Lloyd and Atkinson 2001) and the application of kriged results (Rendu 1980, Warren 1998, Barbaras et al. 2001).

9.3.4.3 Run Timing and Time Series Analysis

In the short term, predictions of run timing are powerful tools for managing fisheries and flow regimes. The Columbia Basin is a tightly managed system, and the harvest and water management regimes are expensive endeavors that are continually scrutinized. For some stocks in some years success can depend on a handful of naturally produced fish escaping to the spawning grounds. On longer time scales we are interested in the probability that trends in performance will persist. The current models for run prediction are based solely on the number of returns in years previous to the run, while more sophisticated and powerful methods could be adopted (**www.cbr.washington.edu**). In addition to the use of simple multivariate regression for predicting and explaining performance, we will employ multivariate time series analysis (Ives et al. 2003).

Annual variability at index sites, and of aggregated randomly selected sites, will be analyzed using time-series analysis. The trend analysis paradigm shares some features with associative analysis with one critical difference. Trend analysis recognizes the linear nature of time series; that no point in time can ever being experienced again, and that no co-occurrences in time can be fully independent of each other. Changes over time can result from the interactions of associated variables, but can also stem from serial dependency, seasonality, and temporal stochasticity. There are two major foci of time series analysis; to identify the correlates in time of a variable represented by a series of observations, and to predict the future values of that variable. Trend analysis is generally conducted as an autocorrelative function; the serial correlation coefficients and standard errors of temporal lags in covariates for variable x:

Equation 9

$$x_t = \xi + \phi_1 * x_{(t-1)} + \phi_2 * x_{(t-2)} + \phi_3 * x_{(t-3)} + \ldots + \varepsilon$$

where: ξ is a constant (intercept), and ϕ_1, ϕ_2, ϕ_3 are the autoregressive model parameters

Juvenile population and community information will be analyzed using trend analysis for all index sites, and for the aggregation of all index and randomly selected sites to the watershed and subbasin scale. Through time the stability, resilience, and resistance of populations will be quantified.

Immigration and emigration timing are key performance measures of life history diversity (Waples et al. 2001), as are disease resistance and condition at age. Information on life history diversity will be collected during outmigrant and adult abundance enumeration. Emigration timing is a key performance measure used to assess life history diversity. To monitor emigration timing in the mainstem rivers or at other smolt trapping locations, weekly abundance estimates will be derived and expressed as a percentage of the total run over time. Weekly frequency distributions will be compared using the Kolmogorov-Smirnov test. PIT tag detection data will also be used to compare smolt migration characteristics between hatchery and natural smolts. Age at emigration is characterized as the annual proportion of smolts in a particular age class migrating past the rotary fish trap. Percent age composition analysis from a 5-year mean of adult returns is applied to annual smolt abundance estimates to derive the total estimated number of emigrants by freshwater age class for a particular year.

Size at emigration is quantified annually from fish captured in traps for each species of salmonid. Length data is used to create monthly length-frequency distributions and summary statistics; including sample size, mean fork length, and minimum and maximum fork lengths. A one-way analysis of variance (ANOVA) is used to make interannual comparisons of mean fork length for each species of natural emigrants ($\alpha = 0.05$). When significant differences are found, further analysis will be performed using the Scheffé method for multiple comparisons among means ($\alpha = 0.05$). All PIT tagged fish encountered in hand samples are measured to assess growth from tag date to recapture date. The growth in length (mm/d) for individual tagged fish is calculated as length at recapture minus length at tagging divided by the number of days between tagging and recapture.

Some sampling methods (i.e., descaling, fish health) between cooperators at the smolt traps are currently different, but will be standardized prior to the first field season. The following provides an example of characteristics that will be documented, with exact protocols cooperatively agreed upon later. Condition of individual fish is categorized into one of three categories: good, partially descaled, and descaled. Condition is considered "good" if cumulative scale loss on either side of the fish was less than 3%. Fish are considered "partially descaled" if cumulative scale loss was greater than 3% but less than 20%. Fish with scale loss greater than 20% are considered "descaled." Juvenile fish health is monitored during emigration by using single character descriptor codes to describe body injuries, external parasites, bird marks, obvious fungal infections of the body surface, and signs of potential disease. The Spearman rank correlation test is used to analyze the possible association of descaling and fish health variables and three independent variables. The independent variables are river discharge, secchi depth, and water temperature. This analysis ranks the variants and calculates a coefficient of rank correlation. A nonparametric test is used because scale loss data is not typically normally distributed.

Fish mortalities are noted by species and identified as being from an unknown source or a direct result of sampling/trapping activities. Annual mortality rates are calculated for unknown, sampling, and combined mortalities. Natural fish that die from an unknown cause and some diseased and dead hatchery fish are forwarded to a Fish Pathology Lab. Sample, diagnostic and statistical analyses conform if possible to the Integrated Hatchery Operations Team (IHOT) and the Pacific Northwest Fish Health Protection Committee guidelines. Analysis of samples follows standard protocols defined in the latest edition of the American Fisheries Society's Fish Health Blue Book (Procedures for the Detection and Identification of Certain Fish Pathogens).

To account for the impacts of environmental variability, smolt-per-adult metrics will be regressed against environmental variables including river discharge, flow augmentation, water temperature and water clarity. These are monitored annually and analyzed using associative and time-series analysis to characterize conditions in the Walla Walla River and to assess their effects on emigration timing and fish passage. The net results of this assessment are smolt-per-adult metrics of tributary performance that are likely highly indicative of habitat success, and highly independent from out-of-subbasin processes.

Environmental variables including river discharge, flow augmentation, water temperature and water clarity are monitored annually and analyzed using associative and time-series analysis to characterize conditions in the river or subbasin and to assess their effects on emigration timing and fish passage. Daily river discharge and water temperature data is available from stream flow gauging stations near the trap sites. Water clarity will be measured using a secchi disk.

The relationship between river discharge, temperature, and water clarity and the daily proportion of emigrants passing a trap site will be tested using the Spearman rank correlation test. The variable reflecting the river discharge or water temperature during the passage period is the average of the mean of the day before and the day of passage. The time period used for the analysis is between the day when the first and last emigrant was observed. Any missing discharge or temperature records are estimated by taking the average of the mean daily discharge or temperature 3 days prior and 3 days after the missing record. Linear regression is used to evaluate the possible relationship of environmental variables and smolt emigration timing by comparing the day of year of median emigration with average daily water temperature and river discharge from November 1 to July 1.

Migration parameters will be monitored using PIT tags and subsequent detections at the lower river screw traps. Parameters analyzed include emigration timing, duration, and travel speed and will be monitored to evaluate the migration success of hatchery-reared species compared with that of naturally reared counterparts. Smolt emigration timing will be expressed as the proportion of juvenile salmonids moving past the rotary screw trap during a particular period. Peak smolt movement will be defined as the date when the maximum number of tagged emigrants passed through the trap. Median emigration will be the date when 50 percent of the tag detections are observed. Diel movement will be determined by the percentage of fish detected within hourly blocks of time, and migration duration will be considered the period between the first and last date of tag detections.

Travel speed will be calculated for each tagged fish detected at screw traps and at mainstem dams. The median travel speed will be calculated for all naturally reared fish and comparable release groups of hatchery-reared fish. Median rather than mean travel speeds will be computed because detection distributions are usually skewed. Negative travel speed estimates from volitional movement of hatchery-reared fish will be omitted from the analysis, along with tagged fish interrogated during trapping operations, because of the inability to assign an accurate date and time stamp of detection.

A fish passage index will be used to analyze the migration parameters of juvenile salmonids in years where insufficient numbers of hatchery- or naturally-reared fish are tagged. The fish passage index is the number of fish captured during a designated block of time expanded by the sampling rate. Designated blocks of time range from a few minutes to several hours and sample rates are between 1 and 100 percent. Past experience has resulted in similar migration parameters between the PIT tag analysis and fish passage index methods.

Migration parameters are monitored using PIT tags and subsequent detections at Snake and Columbia River dams. Migration parameters will be summarized by the 10, 50, and 90 percent detection dates at three downstream dams. PIT tag detections at the rotary screw traps will be expanded by examining downstream detections at the two closest downstream dams (e.g., use McNary and John Day dams to evaluate survival from the Walla Walla River) to generate day-by-day estimates of the proportion of PIT tagged fish detected vs. those not detected as they passed the rotary screw trap using the equation:

Equation 10

$$f_e = N_{JD\text{-}MCN} / N_{TJD}$$

Where f_e is the expansion factor, $N_{JD\text{-}MCN}$ is the number of PIT tagged fish detected at second dam downstream (e.g., John Day Dam) previously detected at the first downstream dam (e.g.NcNary Dam), and N_{TJD} is the total number of specific tributary (e.g., Walla Walla) PIT tagged fish detected at the second downstream dam (e.g., John Day Dam).

Alternatively, if the sample size of PIT tagged fish passing John Day Dam is too small, we will use weekly trap efficiency estimates to estimate the number of PIT tagged fish passing the trap. A similar approach using Bonneville Dam detections will be used to expand PIT tags observed at John Day Dam. While this approach may be the only method available to assess fish migration it should be acknowledged that the data will be biased by the impacts of the hydrosystem on fish survival.

The number of smolts passing Bonneville Dam daily will be estimated by expanding daily numbers of PIT tag detections according to the proportion of water passing through the powerhouse. Separate estimates will be made for each powerhouse and then summed to generate day-by-day totals. No adjustments will be made for fish guidance efficiency, horizontal, vertical, or temporal fish distribution.

Equation 11

$$f_{P1} = (P1 + P2 + S) / P1$$

Equation 12

$$f_{P2}= (P1 + P2 + S) / P1$$

Where f_{P1} and f_{P2} are the expansion factors for powerhouse 1 and 2, respectively, P1 and P2 are the flows through powerhouse 1 and 2, respectively, and S is the flow being spilled over the dam. A Kruskal-Wallis test on the dates of detection, expressed as day of the year, will be performed to test for differences in the emigration timing of hatchery and natural summer steelhead smolts ($\alpha = 0.05$). The Kruskal-Wallis test ranks observations from lowest to highest and tests the null hypothesis that the medians of the two samples are equal.

Travel speed to the mouth of the subbasins will be expressed in miles per day and calculated for each tagged fish detected at mainstem rotary screw traps using the following equation:

Equation 13

$$TS = (RM-3.7)/(D-R)$$

Where TS = travel speed, RM = river mile of release or tagging, D = date and time of detection at the rotary screw trap, and R = date and time of forced release or tagging. Travel speed of individual fish will be loge transformed to meet the assumption of normality. Within-year comparisons of hatchery release groups will be conducted using ANOVA (α. = 0.05). The Scheffé test will be used to make pairwise comparisons when significant differences are found (α. = 0.05). Negative travel speed estimates from volitional movement of hatchery fish are omitted from the analysis, along with tagged fish interrogated during trapping operations, because of the inability to assign an accurate date and time stamp of detection.

9.3.4.4 Genetic Characteristics

Development of new techniques and methods of data analysis has greatly expanded the role of genetics in fish research and management (Hallerman 2003). In particular, the role of genetics in conservation and recovery of rare species has been increasingly significant. The role of cultured fishes in recovery of depleted populations is heavily influenced by genetic concerns. Similarly, recovery efforts for ESA-listed anadromous salmonids in the Pacific Northwest are driven to a large extent by genetics issues (McElhany et al. 2000, TRT 2004, 2005).

Applications using nuclear DNA (nDNA) are currently receiving the most widespread use, due to the great variability observed. Recent published nDNA research can be broadly grouped into demographic and population structure, mechanisms of change, intervention evaluation, and planning. Sampling on various geographic and temporal scales can define population structure (Spruell et al. 1994, Spruell et al. 1999, Spruell et al. 2001, Spruell et al. 2003) and effective population size (Rieman and Allendorf 2001, Heath et al. 2002, Waples 2002, Ardren and Kapuscinski 2003, Ford et al. 2004) and reproductive isolation or connectivity, or hybridization. Life history attributes may be heritable to various degrees, including size, age, and fecundity (Reisenbichler et al. 1992, Nielsen et al. 1997, Savvaitova et al. 2000, Waples et al. 2001) run and spawn timing (Millenbach 1973, Okazaki 1986, Guthrie et al. 2000, Kinnison et al. 2001), juvenile development (Beacham et al. 1999, 2000) and resistance to pathogens (Arkoosh and Collier 2002, Arkoosh et al. 2004).

Mechanisms of population change can be explored using genetics as well. These include mutation accumulation (Drobner et al. 1998, Oleinik 2000, Wang et al. 2001), “bottlenecks” (Nielsen et al. 1997, Spruell et al. 1999, Taylor et al. 2001), inbreeding and outbreeding depression (Neraas and Spruell 2001, Wang et al. 2001, Utter 2004), and genetic compensation (Ardren and Kapuscinski 2003). Ultimately, various types of genetics research can help inform decision-makers. Unfortunately it is difficult to predict apriori which questions will require genetic time series, and it is not possible to go back in time and collect the samples. Fortunately the collection and archiving of genetic information is extremely inexpensive, and the bulk of the expense rests in the analysis and evaluation. While precise future needs for genetic samples are not known at this time, there is a need to collect and archive samples, which can be done inexpensively for research in the future.

We will evaluate current genetic collections, or samples needed, and prioritize analyses and further collections of samples. Collections and analyses will concentrate on characterization of identification and relatedness of populations and their stability or change over time.

9.3.4.5 Evaluation of action effectiveness.

The recovery plan describes specific strategies and projects to restore habitat for listed fish populations in the affected subbasins. Planners have estimated the effectiveness of these actions to change specific environmental attributes (Table 8-2) based on published information and professional experience. The expected environmental changes have been entered into EDT to estimate their collective benefit to listed fish populations. As with all information underlying the EDT working hypothesis, the actual effect of actions on the environment must be evaluated for specific portions of specific watersheds. As knowledge of the effectiveness of prescribed actions on specific habitat problems increases, the working hypothesis will be revised to accommodate the changed database.

To the maximum extent possible, effectiveness monitoring will be coordinated with on-going monitoring using established protocols. Appropriate protocols include those developed by the Washington Salmon Recovery Board for use across the state (Crawford 2004a, b, c and d). Reeves et al. (2004) provide guidance for effectiveness monitoring relative to the Federal Northwest Forest Plan.

Also, the intensity and frequency of effectiveness monitoring would be based on the attribute being tested. For example, monitoring of slow maturing actions such as riparian restoration would likely occur at 5-year intervals over a 30-year time frame. In contrast, the effectiveness of a new fish screen would be examined for 1-2 years, after which time the monitoring would likely end.

9.3.4.6 Evaluation of species-habitat relationships.

The working hypothesis used to select habitat actions for this plan is based primarily on a set of species-specific relationships between environmental attributes and species productivity and capacity. These relationships reflect the prevailing scientific knowledge available today. However, as this knowledge improves through scientific research and as EDT is refined over time, the working hypothesis will be refined to provide adaptive corrections to recovery strategies. Because these relationships are needed region-wide, the plan calls for working collaboratively with other groups to more effectively utilize limited resources.

9.3.4.7 Evaluation of external factors.

Because salmon are anadromous and spend the majority of their lives outside the recovery region, the success of efforts to rebuild fish populations through the recovery plan will depend, to a large degree, on human actions and natural factors outside the recovery region. Factors outside the recovery region (Chapter 4.0) include the FCRPS; water quality and conditions throughout the Columbia River, the estuary, and the Northeast Pacific Ocean; as well as commercial, sport, and tribal fisheries in the ocean and Columbia River.

In constructing the EDT working hypothesis for the affected subbasins, planners have incorporated a simple set of assumptions to account for the "out-of-subbasin effects." Those assumptions may need to be revised as monitoring and scientific investigation refines knowledge of conditions outside the recovery region. Conditions through the Columbia River hydroelectric system are monitored through a variety of state and federal monitoring programs; the Fish Passage Center (www.fpc.org) and the University of Washington DART system (http://www.cbr.washington.edu/dart/dart.html) collect and provide access to much of the information and will be consulted to determine if adjustments in EDT assumptions are needed. Fishery management agencies including the Pacific Fishery Management Council, Washington and Oregon state fish and wildlife agencies, and the Columbia River Intertribal Fish Commission all collect and summarize harvest information that will be used to update harvest assumptions as necessary.

Conditions and environmental cycles in the ocean and regional climate are the subjects of on-going and active areas of research. The scientific literature will be consulted regarding the latest understandings of ocean survival conditions and regional climates.

9.3.5 New RM&E Projects

A list of the new RM&E projects required for addressing the environmental, biological, and model uncertainties identified in the previous section is shown in Table 9-7. It should be noted that the costs associated with the new RM&E projects are only estimates, which were developed based on past experience; these costs will be updated after study plans are developed for each project. In addition, a remote sensing effort (using aerial photographs), with a rotating spatial panel, should be used to monitor habitat loss or gains to ensure a net increase in good quality habitat occurs over time. Otherwise, increasing development, channel modifications, roads, etc., could negate any accrued habitat improvements to benefit salmonids.

A major uncertainty in the SRSRP is the level of regional commitment to funding the RM&E program. Currently, it is estimated that RM&E costs associated with monitoring habitat and fish communities in the recovery area as part of the SRSRP and other processes may be as high as $6 million per year ($90 million over 15 years). Current monitoring is inadequate to evaluate habitat conditions, stock status or trends, or the effectiveness of habitat actions. With limited funding, certain monitoring and evaluation activities should be prioritized. The first priority should be to adequately estimate adult escapement within each MSA and population and adequately estimating smolt production from several of the major stream systems. These priorities will fulfill much of the abundance and productivity aspects of VSP. Another high priority is habitat condition assessment and monitoring. These priorities will accomplish primary aspects of status and trend monitoring and they allow direct assessment of the freshwater tributary fish production and assessment of the effectiveness of tributary habitat restoration and protection actions. Monitoring of other portions of the VSP criteria (spatial distribution and diversity) may have to be kept very limited without additional funding. Because resources are limited, the plan proposes that the co-managers meet with NMFS and USFWS to better define the level (scale, frequency, location) of monitoring required to determine when recovery goals are achieved. A major discussion topic of these conversations would be the need to track fish performance at the mSA and MSA scales. Conducting monitoring activities at this scale increases RM&E costs significantly as multiple adult and juvenile monitoring facilities are required to determine production as this smaller scale. The results of these conversations would be used to better define monitoring tasks and allow for the prioritization of expenditures.

9.3.6 Data Documentation and Reporting

All data collected will be entered into the appropriate databases each year. New habitat data would be entered into the EDT model, biological data into StreamNet, and tagging data into either RMIS (Regional Mark Information System) or PTAGIS (PIT Tag Information System). This approach allows for both archiving of the data, and performing the modeling needed to track plan effectiveness as well as select and prioritize new actions over time.

At the end of each year, a public meeting will be held to describe RM&E activities, present results and provide an overview of activities proposed for the next year and a rationale for why they are being taken.

Summary reports of all RM&E activities will be developed at 5-year intervals. The report will include analyses of fish abundance (adult and juveniles), productivity, distribution (hatchery and natural origin), harvest levels (ocean, mainstem, and tributaries), overall survival and updated EDT runs showing assumed habitat progress to date both within and outside of the recovery area.

The 5-year report developed at the end of year 15 would be considered the final report. This report would summarize all activities completed during the previous 15 years. In addition to summarizing all actions and analyses, the report will also provide recommendations as to what actions, if any, should be taken over the next 5 to 15 years to achieve recovery and restoration goals.

Table 9-7. Proposed New RM&E

Project #	Project	Description	Lead Entity	Funding Source	Cost	# of Years	Location	Biological Parameters: Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
1	Touchet River Smolt Trapping	Estimate smolt production (all species) from the Touchet River. Trap would be located near Waitsburg	WDFW		$150,000	15	Walla Walla (Touchet River)		●	●	●	●		
2	Touchet River Adult Counts	Improve adult counting operations at Touchet Dam	WDFW		$10,000	15	Walla Walla (Touchet River)		●	●	●	●	●	
3	Coppei Creek Adult Counts	Enumerate adult fish entering the creek (all species)	WDFW		$20,000	15	Walla Walla (Coppei Creek)		●	●	●	●	●	
4	Adult Counts Nursery Bridge	Video count adults at both fish ladders (all species)	ODFW/CTUIR		$30,000	15	Walla Walla		●	●	●	●	●	
5	Conduct Spawning Surveys in the Recovery Area	Spawning surveys would be conducted in all MSAs and mSAs on a yearly basis	WDFW/ODFW/ CTUIR		$150,000	15	Walla Walla		●	●	●	●	●	
6	Tuccannon River Adult Counts	Develop new method and facility for counting adult migrants in the lower Tucannon River.	WDFW		$75,000	15	Tucannon		●	●	●	●	●	
7	PIT Tag Monitoring	Maintain and fund PIT Tag systems designed to monitor juvenile and adult production in the Asotin Creek, Tucannon River and Walla Walla River.	WDFW/CTUIR		$50,000	15	Asotin Creek, Tucannon River, Walla Walla River		●	●	●	●		
8	George Creek Juvenile and Adult Enumeration	Monitor adult and juvenile production in George Creek (Asotin Creek)	WDFW		$50,000	15	Asotin Creek (George Creek)		●	●	●	●	●	

Table 9-7 Proposed New RM&E (continued)

								Biological Parameters						
Project #	Project	Description	Lead Entity	Funding Source	Cost	# of Years	Location	Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
9	Hatchery Fish Marking	Expanded or maintaining current marking/tagging of hatchery fish released in the recovery area	WDFW/ CTUIR/NPT		$250,000	15	Recovery Area						●	
10	Genetic Evaluation of Fish Populations	Collect genetic data/samples on key fish populations throughout the recovery area	WDFW		$25,000	5	Snake River and Tribs				●	●	●	
11	Baseline Habitat Data Collection	Conduct baseline habitat surveys in all tributaries where this data does not currently exist. Additionally, collect information on key environmental attributes listed in Table 8-2 (SRSRP)	WDFW/CTUIR		$200,000	10	Recovery Area	●						
12	Conduct Baseline Population Sampling Throughout Recovery Area	Presence/absence and estimates of abundance would be collected in all streams throughout the recovery area	WDFW/ODFW/ CTUIR		$50,000	3	Recovery Area		●	●	●	●	●	
13	Bull Trout Fish Distribution and Abundance Surveys	Presence/absence and estimates of abundance would be collected in all bull trout streams throughout the recovery area	WDFW/ODFW		$75,000	15	Wenaha, Tucannon, Mill Creek		●	●	●	●		
14	Evaluation of External Factors	Quantify to the extent possible the impacts factors outside of the subbasins or recovery area are having on recovery goals (harvest, hydro, estuary, predation etc.)	NPPC/NOAA	NPPC	$50,000	15	Columbia Basin	●	●	●	●	●	●	●
15	Evaluation of Action Effectiveness	Conduct studies to ensure that implemented actions are changing the environment as expected	WDFW/CTUIR		$75,000	15	Recovery Area	●	●	●	●	●		

Table 9-7 Proposed New RM&E (continued)

Project #	Project	Description	Lead Entity	Funding Source	Cost	# of Years	Location	Biological Parameters: Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
16	Evaluation of Species Habitat relationships	Implement research to better define linkages between habitat attributes and fish performance	WDFW/CTUIR	?	$100,000	15	Columbia Basin	●	●	●				
17	Adult Monitoring at Bennington Dam	Monitor adult passage	WDFW/ USACE/CTUIR		$50,000	15	Walla Walla		●	●	●	●		●
18	Monitor Stream Fisheries	Monitor fish harvest (creel surveys for salmonid fisheries) throughout recovery area	WDFW		$100,000	15	Recovery Area							●
19	Substrate Assessment Tucannon River and Tributaries	Assess habitat conditions pertaining to percent fines and sediment using Wolmans' Pebble counts and embeddeness transects on Tucannon mainstem and its tributaries. Study will compare current conditions to those collected previously.	CCD/USFS	BPA/USFS	$8,000 annually	3-5	Tucannon River	●		●				
20	Suspended Sediment Tucannon River	Seven additional ISCO sediment samplers for turbidity would be placed for continuous assessment of project activity effects. Samplers were previously in place at the selected sites. Study will compare results of previously collected data for trends.	CCD/USFS	BPA/USFS	$20,000 annually	?	Tucannon River	●		●				

Table 9-7 Proposed New RM&E (continued)

Project #	Project	Description	Lead Entity	Funding Source	Cost	# of Years	Location	Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
								Biological Parameters						
21	Hooking Mortality Study on Salmonids in Snake River Hooking Mortality Study on Salmonids in Snake River	Assess adverse impacts of hooking mortality from incidental catch on listed salmon and steelhead within the recovery area	WDFW		40,000	5	Snake River/ Grande Ronde							
22	Reproductive Success of Spring Chinook and Summer Steelhead in Tucannon River	Genetic study in upper Tucannon River to determine reproductive success of hatchery fish.	WDFW		150,000	3	Tucannon		●	●	●	●	●	
23	Fall Chinook Production in the Lower Tucannon River	Implement research and monitoring to describe factors limiting fall Chinook production in the lower Tucannon River	WDFW		80,000	3	Tucannon	●	●	●	●		●	
24	Monitor Natural Coho Production in the Lower Tucannon River	Increase monitoring efforts for Coho salmon in the lower Tucannon River	WDFW		10,000	10	Tucannon		●	●	●	●		
25	Predation of Fall Chinook in the Tucannon River by Summer Steelhead and Other Predatory Species	Implement a study to document the amount of predation on fall Chinook in the Tucannon River by hatchery summer steelhead or other predatory species.	WDFW		25,000	3	Tucannon		●	●	●	●	●	

Table 9-7 Proposed New RM&E (continued)

Project #	Project	Description	Lead Entity	Funding Source	Cost	# of Years	Location	Biological Parameters: Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
26	Remote Adult Counting Stations in Small Tributaries	Deploy 2-3 remote adult summer steelhead counting weirs using Resistivity Counters	WDFW		$100,000	15	Asotin Creek Tucannon Touchet		●	●	●	●		
27	Fall Chinook Run Reconstruction	Funding for biologist to compile and finalize data for accurate run reconstruction at Lower Granite Dam for Snake Rive fall Chinook	WDFW Nez Perce	Pacific Salmon Treaty	$35,000	annually	Snake River		●	●	●	●		●
28	Wildlife Area Management Plans	Update the previous Wildlife Area Management Plans (Chief Joseph, Wooten, Asotin Ck Wildlife Areas	WDFW		$15,000	1	Asotin Ck/ Tucannon R. /Grande Ronde R.	●						
29	Asotin Creek Wildlife Area	Assess existing habitat conditions and public utilization of the Asotin Creek Wildlife Area implement projects to enhance fish and wildlife habitat.	WDFW		$50,000	1	Asotin Creek Wildlife Area Asotin Creek-George Creek-Pintler Creek	●						
30	Chief Joseph Wildlife Area Habitat Projects	Assess existing habitat conditions and public utilization of the Chief Joseph Wildlife Area implement projects to enhance fish habitat and improve instream and riparian habitat.	WDFW		$50,000	1	Chief Joseph Wildlife Area/ Joseph Creek-Grand Ronde	●						
31	Tucannon	Assessment	HDR		$50,000	1	Tucannon	●						
32	Mill Creek Assessment	Fish Passage Barrier Assessment	WDFW/Mill Creek Work Group		$115,000	1	Walla Walla	●						

Table 9-7 Proposed New RM&E (continued)

Project #	Project	Description	Lead Entity	Funding Source	Cost	# of Years	Location	Biological Parameters: Habitat	Abundance	Productivity	Spatial Structure	Diversity	Hatchery Effects	Harvest Effects
33	Old Lowden, Bergevin Williams, and Byerley Irrigation Consolidation	Explore feasibility of consolidating the diversions and upgrade screens	WWCCD/ WDFW/Ditch Board		$100,000	1	Walla Walla River	●						
34	All priority geographic Areas	Use Remote Sensing to assess and monitor quantity and quality of habitat and effects to ensure net gains in habitat conditions	WDFW	SRFB, BPA, etc.	75,000	15	All	●						
35	All priority geographic Areas	Assess barriers or imminent threats	WDFW	SRFB, BPA, etc.	$100,000	5	All		●		●			
36	Touchet-Lowden Area Assurances Strategy	Assemble background data for an "Assurances" agreement between irrigators in the Touchet Lowden area and the USFWS and NMFS.	WWCCD/ NRCS		$200,000	1	Walla Walla Watershed in heavily irrigated Touchet Lowden Area	●						

9.3.7 Adaptive Management

Adaptive management has been defined in Washington State law as "reliance on scientific methods to test the results of actions taken so that the management and related policy can be changed promptly and appropriately" (RCW 79.09.020). It is described as a cycle occurring in four stages: identification of information needs, information acquisition and assessment (monitoring), evaluation and decision-making, and continued or revised implementation of management actions. The essence of adaptive management is captured in the sequence "monitor," "evaluate," and "respond."

The Walla Walla Watershed Plan states that a true adaptive management program for a salmon recovery plan is an intensive exercise involving the development of biotic and abiotic systems models and their interaction. At present, the EDT model is used to link environmental conditions to fish population performance. The watershed planning process is expected to develop an adaptive management plan in Phase 4 (Implementation). An adaptive management program has not yet been developed for the Snake River Salmon Recovery Plan. However, basic elements of an adaptive management plan and some issues and problems (including funding and oversight) can be identified now.

Performance standards should be established for each management action whenever possible. At the level of environmental effectiveness monitoring, these standards consist of the reach-specific conditions proposed as objectives in the recovery plan. The biological performance standards cannot so easily be tied to specific management actions, although the net effect of all actions has been expressed in terms of equilibrium abundance, productivity, carrying capacity, and life history diversity. These parameters can be considered biological performance standards for an entire recovery plan.

For each performance standard, a threshold level that triggers management changes must be identified. The trigger must be measurable over a period short enough to allow for timely management changes or, at a minimum, soon enough to serve as an early warning of ineffective or unforeseen adverse impacts. When a performance metric reaches the triggering threshold, a management response is required. Three general management responses are possible: 1) predefined mandatory responses; 2) mandatory, but circumstance-specific responses; and 3) responses made as a result of newly discovered opportunities. During the first few years of recovery plan implementation, it is expected that most of the management response triggers will be of types 2 and 3 due to the large uncertainties associated with implementation of a new program.

Before a complete adaptive management plan for the Snake River Recovery Plan can be put into effect, the following issues must be resolved.

- A coordinating and oversight entity must be created and funded. The Comprehensive Statewide Monitoring Strategy (Crawford et al. 2002) refers to this monitoring oversight entity as a "Watershed Monitoring Council." This entity would lead the adaptive management effort, directing monitoring work and analyzing and summarizing data. The Watershed Monitoring Council would also interact directly with stakeholders, sharing new insights, and identifying and promoting revised management actions.
- Standardized monitoring protocols must be developed to facilitate comparison of information across geographical and temporal scales.
- Threshold values for performance standards must be developed for each environmental objective included in the recovery plan. Currently, the lack of accurate and effective response triggers is a significant limitation on the recovery plan. In the opinion of the SRSRB, natural resource specialists (stream temperature modelers, experts in sediment routing, hydrologists, etc.) should be retained in the near future to identify basin-specific response triggers, an appropriate monitoring frequency for such triggers, and management responses most likely to be needed in the event of failure to make adequate progress toward the objective.

- Priority habitat and fish status and trends and effectiveness monitoring must be funded and implemented as identified in the recovery plan, the subbasin plans, limiting factors reports, and the draft Bull Trout Recovery Plan.