IMPLEMENTATION GUIDANCE FOR THE WRIA 9 SALMON HABITAT PLAN

Prepared for

WRIA 9 Steering Committee

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Terminology used in describing different types of monitoring activities and in describing the steps of adaptive management has evolved over the years, and terms are often used in various ways by different groups and authors. This has led to substantial, but potentially avoidable, confusion. In an effort to clarify meaning for the purposes of this report, the following definitions are provided to assist the reader:

Adaptive Management is an implementation strategy that involves learning and modifying actions as new knowledge is gained. In the face of uncertainty regarding project outcomes, projects are implemented in an experimental framework such that incoming results are used to inform future decisions.

Effectiveness Monitoring targets the collection of information to determine whether the project or action resulted in the achievement of desired performance objectives. (e.g., Did the management actions result in improved habitat conditions? Did the improved habitat conditions result in enhanced salmon use of the habitat, growth, or survival?) For the purposes of this document, effectiveness monitoring is broken down into two categories, described below.

Physical and Sustainability Monitoring is the collection of empirical information used to determine whether the desired physical changes in habitat have occurred and whether observed changes are permanent or are lasting as long as expected.

Biological and Ecological Monitoring is the collection of empirical information used to determine, concomitant with the physical changes, whether the desired biological and ecological changes have occurred (e.g., enhanced salmon prey supply or availability, increased salmon abundance at habitat, longer residence, etc.)

HORs (hatchery origin recruits) are juvenile or adult salmon that are known to be progeny of parents spawned in the hatchery environment. (Note: beginning with the Chinook salmon returning to the Green/Duwamish River in 2003, all HORs were visually distinguishable based on the absence of an adipose fin.)

Implementation Monitoring targets the collection of information to determine whether management actions such as projects, programs, or guidance were implemented as planned and designed. (e.g., was the project implemented/constructed as proposed?)

NORs (natural origin recruits) are juvenile or adult salmon that are known to be progeny of naturally spawning parents; parents of NORs can be of either hatchery or natural origin.

VSP or Viable Salmonid Population Monitoring refers to the collection of information to assess population status relative to the four VSP parameters as identified by National Marine Fisheries Service (NMFS) (McElhany et al. 2000): abundance, life cycle productivity or cohort replacement rate, genetic and life history diversity, and spatial structure and distribution.

1 INTRODUCTION

This *Implementation Guidance for the WRIA 9 Salmon Habitat Plan*, herein referred to as the Implementation Guidance, is a general guide to monitoring and evaluating progress toward restoring ecosystem health in the Green/Duwamish Watershed and adjacent Puget Sound shorelines, and in particular tracking progress toward rebuilding the once abundant population of Chinook salmon. The Implementation Guidance describes a proposed approach to monitoring program effectiveness and how the results of this monitoring will be used to inform (i.e., adaptively manage) future WRIA 9 Salmon Habitat Plan, herein referred to as the Habitat Plan (WRIA 9 Watershed Forum 2005) implementation. It is not a detailed monitoring plan for habitat projects that have been proposed, nor is it a template for a comprehensive adaptive management plan. These aspects were not addressed in this document because more certainty and clarity of funding and community commitments to addressing "unsuccessful" action elements is necessary to appropriately and realistically scale the plan.

In terms of adaptive management, this Implementation Guidance embraces a "passive" approach, taking advantage of knowledge gained through conventional project implementation to modify current projects and improve future ones. Moreover, in developing this guidance, every effort was made to acknowledge the likely limitations of funding and staffing, and the need for a pragmatic and practical approach to implementation. In many respects this document is a framework and starting point, with many of the detailed aspects of implementation yet to be worked out. Examples of subjects that need additional attention include data management, identification of project specific monitoring metrics, and identification of thresholds where either changes should be made or formal evaluation should occur. These "next steps," along with a timeline for resolving them, are highlighted at the end of this document.

In considering the monitoring component of the implementation plan, it is important to recognize that the Green/Duwamish River Chinook salmon population is one out of the 22 independent populations of Chinook that comprise the Puget Sound Evolutionarily Significant Unit listed as threatened under the Endangered Species Act. Because Chinook salmon are listed on a Puget Sound-wide basis, we anticipate that progress toward recovery will need to be monitored on a Sound-wide basis and ultimately delisting will necessarily occur on this same scale. This effectively establishes a context and expectation that there eventually will be an

ESU-scale monitoring program and that technical guidance will be forthcoming. Hence is it important to acknowledge that what is initially put in place in WRIA 9 should be, to the extent practicable, consistent with and feed into this larger program.

The Implementation Guidance is intended to guide local actions over the next 10 years from 2006 to 2015, which is the same period covered by the Habitat Plan. Although ten years can be viewed as a relatively long time period from an operational perspective, it represents only two sequential Chinook salmon life cycles. Thus, because of this relatively short-term biological focus, it is expected that detectable changes in salmon population parameters (i.e. abundance, productivity, spatial structure, and diversity) under the term of this plan are unlikely to be observed. Hence, it is recommended that the WRIA 9 monitoring program focuses, at least initially, on near-term changes in project effectiveness. As a result this Implementation Guidance emphasizes physical monitoring during the initial period of project implementation. It is anticipated that the information on near-term project effectiveness monitoring will yield important information on the outcomes of specific habitat restoration projects, providing timely and important feedback for fine-tuning similar projects that may still be at the design and engineering stage. The cost and responsibility for project effectiveness monitoring will reside primarily with project proponents.

Watershed-wide habitat monitoring is the other important monitoring component that will be addressed directly by WRIA 9. Watershed-wide monitoring includes the following:

1. Implementation of the habitat plan-are we implementing priority projects at the pace and locations needed to meet the 10-year implementation targets reflected in Table 8?

2. Implementation of local programmatic and regulatory actions-are WRIA 9 local jurisdictions implementing the watershed-wide and subwatershed programs relevant to them within the ten year plan timeframe?

3. Tracking environmental indicators (also known as status and trends monitoring)-are key environmental indicators (e.g. water temperature, miles of shoreline armoring, distribution of spawning gravel and large woody debris) improving?

Although the National Marine Fisheries Service (NMFS) will be focusing primarily on population-level (Viable Salmonid Population or VSP) monitoring, this Implementation Plan recognizes that such a substantial data collection effort is beyond the resources and ability of WRIA 9. Fortunately, however, most of these data are already being collected (to some degree) by Washington Department of Fish and Wildlife (WDFW) and the Muckleshoot Indian Tribe.

This Implementation Guidance focuses exclusively on habitat, and will not deal directly with any potential actions involving hatchery and harvest management for which the fishery co-managers have regulatory authority. However, the monitoring activities contemplated by this plan are expected to generate valuable information for integrating these activities (integrating habitat, hatchery, and harvest management is often referred to as H-integration) that may identify opportunities for harvest and hatchery changes.

This Implementation Guidance was developed at the direction of the WRIA 9 Steering Committee and is based on the discussions and inputs of an *ad hoc* WRIA 9 Monitoring and Adaptive Management (MAM) Working Group that met seven times over a 3-month period, from May to July 2006. The plan was drafted by WRIA 9 staff and Anchor Environmental, L.L.C., and subsequently provided to the MAM Working Group for review. Participants in one or more of the working group meetings included the following individuals and organizations, listed alphabetically by affiliation:

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Aaron Nix (City of Auburn)
The Honorable Joan McGilton (City of Burien)
Jennifer Knauer and John Koon (King County)
Paul Hage (Muckleshoot Indian Tribe)
Greg Ruggerone (National Resources Consultants, Inc.)
Ann Kenny (Port of Seattle)
Chris Sergeant (Puget Sound Shared Strategy)
Julie Hall (Seattle Public Utilities)
Dennis Clark, Doug Osterman, and Gordon Thomson (WRIA 9 Team)
Kirk Lakey (Washington Department of Fish and Wildlife [WDFW])

1.1 Background

The WRIA 9 watershed encompasses the Green/ Duwamish River and tributaries from Stampede Pass in the Cascade Mountains to Elliott Bay in Seattle, and nearshore areas of Puget Sound from Magnolia in Seattle to the King/Pierce County line, including Vashon and Maury Islands. Major tributaries within the watershed include Newaukum Creek and Soos Creek. The focus of the WRIA 9 Habitat Plan is restoration of the aquatic ecosystem with a focus on the needs of Chinook salmon. Adopted unanimously by all 15 municipalities within the watershed plus King County and the City of Tacoma, the Habitat Plan establishes a priority list of conservation, restoration, rehabilitation, and substitution projects, and programs that are expected to support recovery of wild Chinook salmon in the watershed for the next 10 years.

Project priorities for the Green/Duwamish and Central Puget Sound Watershed (WRIA 9) were identified based on technical merit and policy considerations and guided by Habitat Plan policy MS-1. These projects are listed in Table 8-2 in the Habitat Plan and Appendix D – Three-Year Watershed Implementation Priorities: WRIA 9 Habitat Work Schedule (WRIA 9 Watershed Forum 2005). In short, the Habitat Plan is designed to increase spawning and rearing habitat in the freshwater areas of the watershed and rearing habitat in the estuary and marine nearshore. Specifically, the Habitat Plan states that:

> The focus of management action implementation efforts in this Habitat Plan will be on the following distinct habitats that are limiting viable salmonid populations in WRIA 9:
>
> - Duwamish Estuary transition zone habitat;
> - Middle Green River, Lower Green River, Duwamish Estuary, Marine Nearshore rearing habitat; and
> - Middle Green and upper Lower Green River spawning habitat.
>
> Because of the importance of the transition zone and the negative effect on habitat recovery efforts upstream if a severe transition zone habitat limitation does exist, 40% of funding for management action recovery efforts will be focused on the transition zone. The remaining 60% of funding for management action recovery efforts will be split 30% for the rearing habitats and 30% for the spawning habitats as described above. This allocation of funding would apply over the first 10-year period of the Habitat Plan (i.e. annual funding allocations could vary from this distribution) and would be subject to change as part of adaptive management.

1.2 Document Structure

This Implementation Guidance describes the process to be used for implementing the Habitat Plan, which includes a strong emphasis on monitoring and evaluating actions and using the results of monitoring to inform ongoing and future actions.

This plan is organized into sections that focus on:

- Adaptive management,
- Monitoring,
- Data management, and
- Integration.

The section on adaptive management focuses on the process of plan implementation, including:

- Proposed committee structure,
- Decision making process,
- Reporting requirements, and
- Public involvement.

The monitoring section is divided into three subsections that focus on:

- Project specific monitoring,
- Watershed-wide monitoring, and
- Salmon population-level monitoring.

The data management section proposes a mechanism for archiving and distributing the results of the range of monitoring programs and activities.

The section on "H" integration describes expectations on how changes in salmon habitat in WRIA 9 could influence hatchery and harvest management in the Green/Duwamish River.

Lastly, the section on "Next Steps" includes both a listing of issues that will require further consideration, and a proposed process and timeline for resolving them.

The WRIA 9 Habitat Plan reflects the best available information at the time of completion and adoption in August 2005. However, there is much more to be learned through plan implementation efforts. Therefore, the Habitat Plan and this Implementation Guidance are intended to be "living documents" that are expected to evolve as information is obtained about the experiences of implementing projects and programs, how best to monitor and evaluate project and program effectiveness, and how to consider the interactions of harvest and hatchery operations and the impacts of these on Chinook salmon recovery efforts. It is also likely that there will be "lessons learned" from projects elsewhere in Puget Sound and the Pacific Northwest that can be used to inform future steps in implementing the recommendations of the Habitat Plan.

2 ADAPTIVE MANAGEMENT

This section of the plan describes how WRIA 9 intends to use an adaptive approach to implement its Habitat Plan, including:

- Proposed committee structure,
- Decision making process,
- Reporting requirements, and
- Public involvement.

Specific outcome-based actions are described more fully in Section 3, which covers project-specific, watershed-wide, and population-level monitoring.

2.1 Adaptive Management in WRIA 9

Adaptive management can be either active or passive. In the case of active adaptive management, a particular class or type of project such as, for example, levee setbacks might be designed and constructed in several different ways with a goal of determining which would be the most effective design for informing decisions about the design and construction of future projects or the modification of existing projects Such an approach requires detailed experimental designs, comprehensive collection of post-construction data, and rigorous statistical analyses to determine the degree to which project objectives were achieved. In contrast, passive adaptive management is less structured around rigorous experiments *per se*, but instead uses information gained through traditional project implementation to guide similar types of projects in the future or modify existing projects that are not meeting expectations. It is this latter approach that is described herein. Implementation and evaluation of the WRIA 9 Salmon Habitat Plan will rely on an Implementation Technical Committee (ITC) consisting of technical and policy members to deliberate a broad range of implementation issues and make recommendations to the WRIA 9 Steering Committee (see figure 1).

2.2 Committee Structure

A key to the success of implementing the Habitat Plan will be a thoughtfully designed management structure. The following principles should form the basis for that management structure:

- Maximize the collaborative process and public participation,
- Provide parity between the needs of managers for information to support decision making and the time required to complete rigorous monitoring activities,
- Have measurable goals and objectives for monitoring and data analysis, and
- Take into account the uncertainty of project outcomes.
- The public will have access to the information generated by the projects and will be able to participate in the decision making process. This process is intended to be transparent and understandable in order to both serve the public's interest and provide the opportunity for productive input into management decisions.

Three committees have been identified that will be essential to making management decisions for action implementation, monitoring, and evaluation. Two of the committees, the WRIA 9 Watershed Forum and the WRIA 9 Steering Committee, are established and have led the salmon recovery planning efforts in the watershed. A third committee, the Implementation Technical Committee (ITC), will need to be formed.

2.2.1 WRIA 9 Watershed Forum of Local Governments

The WRIA 9 Watershed Forum of Local Governments is composed of elected officials representing 16 local governments within WRIA 9 and the City of Tacoma. The WRIA 9 Watershed Forum will make adaptive management decisions regarding:

- Amendments to the WRIA 9 Habitat Plan,
- The framework for adaptive management policy, goals, and direction,
- Multiple-year budgets and annual operation plans,
- Final review and approval of major science and management activities,
- Establishment of priorities for program implementation,
- Adoption of a set of thresholds that will trigger the evaluation and decision-making process, and
- Solicitation and coordination of input from all interested parties.

2.2.2 WRIA 9 Steering Committee

The WRIA 9 Steering Committee is appointed by the Forum and is composed of stakeholders representing a broad range of federal, state, local government, businesses, environmental organizations, and citizens. The WRIA 9 Steering Committee is responsible for making recommendations to the Forum, including:

- Recommending amendments to the Habitat Plan,
- Recommending amendments to this Implementation Guidance, and
- Addressing actions needed in response to monitoring results.

2.2.3 WRIA 9 Implementation Technical Committee

The primary responsibilities of the ITC will be to oversee the collection and interpretation of physical and biological data for salmon habitat restoration projects completed in WRIA 9 and to provide recommendations to the WRIA 9 Watershed Forum and WRIA 9 Steering Committee regarding improvements to the existing projects and/or modifications to incorporate into future projects. The oversight role is envisioned to be distanced from the actual data collection and will not entail shepherding the completion of monitoring efforts. The goal of the ITC will be to reach consensus in recommendations and decisions. When this is not possible, provisions for the expression of minority opinions will be made so that decision makers and the public are informed of the diversity of views.

The ITC will be comprised primarily of staff scientists from the ILA participants with some policy expert participation. Members of the Technical Committee that was convened during the preparation of the Habitat Plan would be ideal participants in the ITC due to the institutional knowledge that the members provide. The ITC will be appointed by the WRIA 9 Watershed Forum per section 6 of the 2007 WRIA 9 Interlocal Agreement.

The ITC will have an active role in ensuring adequate monitoring plans are developed and that the results are incorporated into future decisions. Specifically, the following responsibilities are envisioned for the ITC:

1. Assembly and distribution of relevant technical information and recommendations to the WRIA 9 Watershed Forum and WRIA 9 Steering Committee
2. Drafting monitoring and research objectives, protocols, and plans, particularly for biological monitoring
3. Coordination with Shared Strategy and other watershed monitoring efforts to advance efforts to monitor VSP and environmental indicators, as well as to gain information from project monitoring in other watersheds
4. Overseeing data management and analysis
5. Reviewing monitoring and research reports
6. Developing and review budgets and requests for proposals (RFPs) for monitoring work
7. Evaluating the effects of management actions
8. Recommending changes if certain thresholds are (or are not) reached
9. Recommending changes to the Implementation Guidance and the Habitat Plan.

A substantial time commitment of an ILA staff member or other ITC member will be necessary in addition to any meeting time required of the entire ITC to successfully meet these 12 responsibilities. This person will lead the background efforts needed to help the ITC develop recommendations This person would also coordinate and direct the ITC's internal work, as well as to stay informed of efforts in other watershed's that may provide useful information for salmon recovery efforts in WRIA 9.

The ITC will meet every three months during the initial stages of implementation of the Habitat Plan. Thereafter, meeting frequency is expected to be reduced, possibly to one time per year.

The five initial tasks of the ITC will be:

1. Assessing data management needs and developing a Data Management Plan
2. Adapting King County's Capital Improvement Project database to include appropriate parameters to track all monitoring types described in this Implementation Guidance

3. Reviewing and recommending criteria and thresholds that would indicate the point at which either changes should be made or formal evaluation should occur, as appropriate (trigger points)
4. Identifying available sources of baseline information on the environmental indicators (described in Section 3.2.3)
5. Identifying the Corps' monitoring commitments for projects conducted as part of the Ecosystem Restoration Project and determining how this monitoring compares to the monitoring needs identified in this Implementation Guidance and any subsequent iteration.

The ITC formation, including staff commitments to the committee, will be a "next step" that will need to be completed (see Section 6).

2.3 Decision Process/Decision Rules

The WRIA 9 Implementation Guidance decision process includes the sequential steps that typify many adaptive management plans such as: 1) Assessment, 2) Design, 3) Implementation, 4) Monitoring, 5) Evaluation, and 6) Adjustment (see Figure 1). For example, this Implementation Guidance establishes thresholds that are used to pre-define what would constitute unusual and undesirable outcomes. These thresholds are intended to be reviewed during the period prior to implementation and periodically thereafter as information is gathered, to ensure that thresholds are set appropriately. In some cases, statistical testing may be used to determine whether thresholds have been exceeded. If statistical testing is not feasible, the ITC will be asked to provide independent assessments of these data, evaluate whether a threshold has been exceeded, and determine the causes. The ITC would be expected to consult with any of the researchers involved. The ITC will provide its findings to the Steering Committee, along with any actions that it recommends. If response actions are needed, monitoring will continue to determine whether the response action has been successful in reducing the effect so that it drops below the threshold level. If the response action is unsuccessful, further analysis would lead to consideration of alternatives. Thus, the adaptive management process is a cycle involving monitoring, evaluation, adjustments to operations when necessary, and continued monitoring and evaluation (see Figure 2).

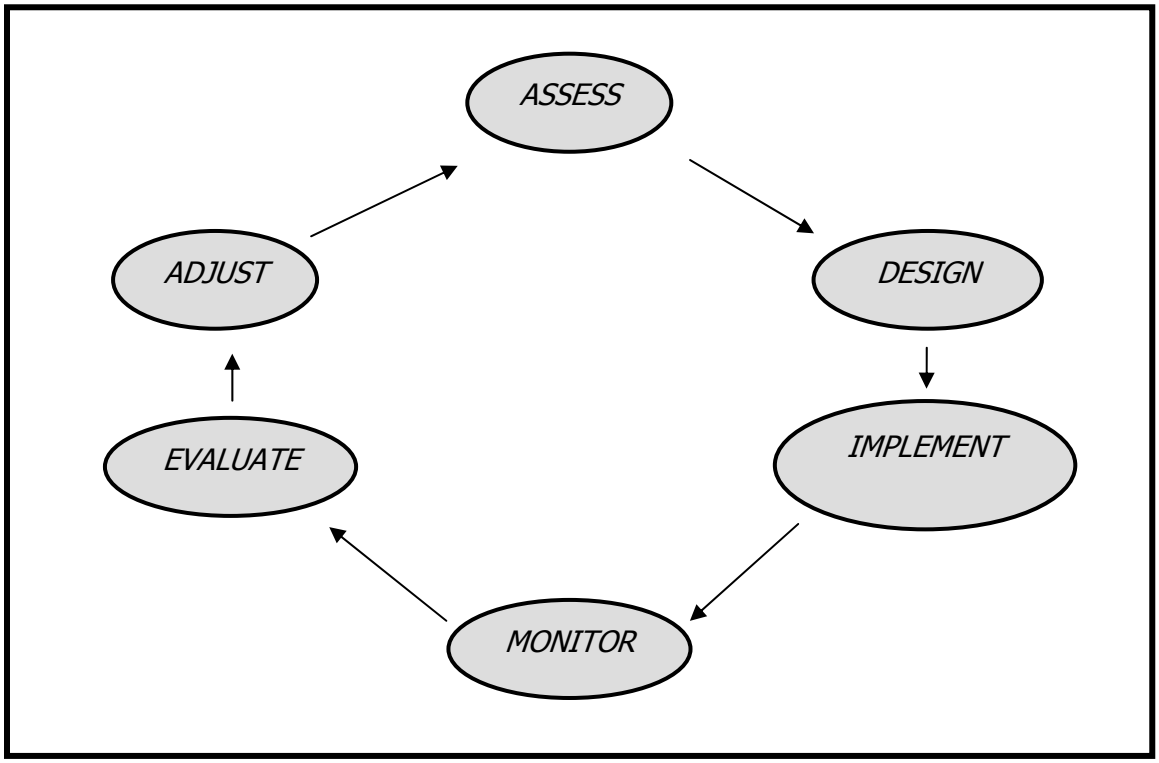

Figure 2 Six Steps of Adaptive Management

2.4 Reports and Reporting Requirements

The development of a system to ensure that the appropriate information is collected, reviewed, reported, and stored is crucial to enabling the objective evaluation of Habitat Plan implementation. The data management system will include procedures for the acquisition, transfer, quality assurance/quality control (QA/QC), archive, and access to data. WRIA 9 currently uses a King County Capital Improvement Project (CIP) database to track individual projects. The project database is available online and can be browsed as a guest at http://dnr.metrokc.gov/Wrias/9/projectportfolio.htm. As described in Section 2.2.3, this database will need to be modified by the ITC to include the appropriate information for project monitoring and evaluation. An ILA staff member or an ITC member would need to manage the data. Developing a Data Management Plan is one of the initial tasks identified for the ITC.

2.5 Updating the WRIA 9 Habitat Plan

An important component of adaptive management is the periodic review and analysis of the Habitat Plan conservation hypotheses, management strategies, policies, and actions (projects and programs). Reviews are used to assess progress in implementing the Habitat Plan and to provide a measure for achieving results. In addition to evaluating progress over the short term, implementation evaluations are used to identify areas where adjustments or amendments are needed to support long-term watershed management success.

Management actions recommended in the Habitat Plan will need to be refined or modified due to changing circumstances. Modifications may be necessary due to changing conditions such as results of monitoring programs or an analysis of experimental management tools; the adoption of rules or ordinances implementing specific plan provisions; or even programs or projects conducted outside of the habitat planning framework may affect the Habitat Plan policies, recommendations, or actions. Management actions also will change as opportunities arise in terms of availability of properties for conservation, restoration, rehabilitation, and substitution. In addition, two reports on the marine nearshore that were completed following the August 2005 publication of the WRIA 9 Habitat Plan have identified further opportunities to protect and restore the marine nearshore; high priority opportunities should be included in the Habitat Plan at some point in the future.

2.6 Recommended Plan Review Process

It is recommended that the Habitat Plan, including the Three-Year Watershed Implementation Priorities: WRIA 9 Habitat Work Schedule, be reviewed and evaluated annually by the Steering Committee and implementing agencies, with a comprehensive review and update of the Habitat Plan every five years. Annual review would by completed by no later than September of each year and the five-year comprehensive reviews would occur in 2010, 2015, and 2020.

During these reviews, the Steering Committee should consider the following assessment questions:

- Have the coordination and resource management actions listed in the Habitat Plan been implemented?

- Are the desired results being achieved?
- Is the overall intent of the Habitat Plan being met?
- Are there new information gaps or changing conditions that require review?
- Are there new issues that were not considered during the planning phase that need to be addressed?
- Are there new actions that should be included in the Habitat Plan?

The conclusions and findings of Habitat Plan review should be reported to the Forum of Local Governments and to the legislative authorities of counties and cities in the WRIA planning area, as well as to other agencies and organizations participating in plan implementation. Implementing agencies would be expected to consider this information as their work plans are developed and finalized for the upcoming year.

For the five-year review, depending on the answers to the above questions, the Steering Committee could recommend to the Forum and implementing governments that the Habitat Plan be formally re-opened and updated. It is envisioned that the Steering Committee would lead this review and plan update, with support from the ITC. A specific work plan and schedule for updating the plan would be developed prior to the initiation of the update process.

2.7 Public Involvement During Plan Implementation

As the Habitat Plan is implemented, continued stakeholder and public support are necessary to advocate for effective execution of recommended policies and actions. Continuous participation and support from individuals, the public, and organizations with diverse perspectives and interests helps bolster the Habitat Plan and implementation of actions. The key mechanism for this on-going public involvement will be the Steering Committee itself, which since 1998 has served as a means for the diverse interests in the watershed to learn about and address the problems of aquatic habitat in the Green/Duwamish and Central Puget Sound Watershed. Watershed Coordination Services (WCS) staff would continue to organize public involvement efforts determined to be important to successful implementation of a project or program and seek guidance from the Steering Committee in these efforts.

Communication efforts should continue to target stakeholders with implementation responsibilities and others whose use of aquatic resources may be impacted, but also include a broad range of citizen groups with vested interests in the planning area and process. Information conveyed to the public may include:

- Management strategy needs and priorities,
- Status of plan implementation and associated performance measures,
- Successful management actions and projects,
- Innovative water management best management practices (BMPs), and
- A summary of ongoing monitoring programs.

3 MONITORING

This section of the plan describes the three primary types of monitoring (Project specific, Watershed-wide, and Population-level) necessary for the implementation of the WRIA 9 Habitat Plan. That monitoring is a necessity for plan implementation is evident in the benefits derived which include:

- Providing certainty that money is spent effectively on priority actions;
- Showing that the actions are achieving the desired objectives; and
- Assessing progress towards WRIA goals for habitat and populations.

The WRIA 9 Habitat Plan monitoring recommendations (Table 9-1) are included in Appendix E of this plan.

3.1 Project-Specific Monitoring

Project-specific monitoring can be summarized as the collection of empirical information before, during, and after a project is implemented with the purpose of determining whether project objectives were achieved. The following questions highlight the type of information needed to make that determination:

- Was the project constructed as designed?
- Did the expected physical changes in habitat occur?
- Did the changes persist over time?
- Did the expected biological responses to the physical changes occur?

Although each project presents unique monitoring challenges and requirements, the general sampling and analytical approaches are similar among projects. Hence, for each of the monitoring categories, there is a summary of the types of data or information that could be collected, followed by a summary of a general approach to evaluating and using the information to inform future decisions. The latter is, of course, the foundation of adaptive management (see Section 2). Also, for convenience, currently contemplated WRIA 9 projects are classified into one or more of the following project elements:

- Removal or setback of levees or revetments and floodplain connection,
- Reconnection or creation of side channels,
- Placement of log jams/large woody debris (LWD),
- Supplementation or reconnection of sediment supply,
- Reestablishment of riparian vegetation,

- Control of non-native invasive vegetation,
- Creation of shallow water or marsh habitat,
- Creation of salt marshes and mudflats, and
- Construction of soft shoreline armoring.

Many of the projects in the Habitat Plan actually include multiple project elements. For this reason, the following discussion of the physical effectiveness and biological monitoring would need to include monitoring components for multiple project types. For example, monitoring of a levee setback project that uses LWD to create a side channel would need to include the monitoring components described for levee setbacks, LWD placement, and side channel creation.

Project proponents will be responsible for monitoring. This includes preparing a monitoring design, conducting the monitoring, and evaluating the monitoring results to the monitoring framework described in this Implementation Guidance or a future iteration of monitoring effectiveness criteria. An ILA staff member or an ITC member will be available to assist project proponents develop the monitoring design, and possibly assist in the identification of funding sources for monitoring.

3.1.1 Implementation Monitoring

The purpose of project-specific implementation monitoring is to determine whether a project was constructed as designed, including any modifications approved during construction. Within 90 days of project completion, project sponsors will be expected to provide the WRIA 9 ITC with an As-Built Implementation Report or Checklist that includes the information described in Table 1. As shown in Table 2, it is anticipated that this information will be a source of valuable feedback for understanding pitfalls and special design/construction considerations for future projects of a similar nature, and will support the tracking of overall implementation of the Habitat Plan.

3.1.2 Project Effectiveness Monitoring

Project effectiveness monitoring is used to determine whether an individual project has achieved its intended physical and biological objectives. In the two sections that follow, these two aspects of monitoring are discussed and examples provided of typical

monitoring parameters and criteria for each of the nine categories of project types (see Section 3.1). A more detailed example of monitoring plans for two specific types of projects (levee setback projects and shallow water habitat creation projects), are provided in Appendices B and C, respectively.

There are several potential objectives that may be relevant to each of the project elements identified above. Table 3 presents several potential objectives of each of the project elements. These potential objectives reflect the Habitat Management Strategies identified in the Implementation Chapter of the Habitat Plan. The set of objectives that applies to a given project will be project-specific and will dictate the appropriate project effectiveness monitoring that needs to be conducted. The objectives of a project may require refinement of the monitoring descriptions described in the following sections.

Before moving to the more specific information and examples below, it is important to consider and select an analytical strategy for monitoring, including an analytical approach and the methods to be used. The choice of analytical approach and estimating the statistical power to detect changes or differences is of utmost importance in developing a sound and useful monitoring program. An analytical plan developed *before* sampling or monitoring begins is vital to minimizing potential for an ambiguous outcome.

There are a number of approaches to monitoring the effectiveness of habitat restoration projects, each with its own strengths and limitations[1]. In general, these approaches can be divided into two broad categories: "before and after" designs and "post-treatment" designs. Either of these two approaches can be further subdivided based on whether they are spatially replicated and involve single or multiple sites.

As the name implies, a "before and after" study design requires the collection of data both before and after treatment (project construction), and is thus considered replicated in time rather than space. Of the before and after designs available, the most commonly

[1] Roni (2005) provides a comprehensive review and the Washington Salmon Recovery Funding Board website (www.iac.wa.gov/srfb/docs.htm#monitoring) describes monitoring approaches for a variety of habitat restoration projects.

employed is the Before-After-Control-Index (BACI) design, in which a control or reference site is evaluated over the same time period as the treatment site. By including a reference site(s), it is possible to differentiate treatment effects from natural variability.

"Post-treatment" designs typically are used in cases when collecting data prior to implementation of a restoration project is not possible (e.g., habitat creation projects). In these situations, the approach to monitoring involves using untreated reference site(s) known to be similar to the treatment site (but absent the restoration project) as comparisons. Hence, replication is achieved in space rather than time (unlike in BACI designs). There are two generally recognized types of post-treatment designs: intensive post-treatment (IPT), in which data are collected at one or a few paired treatment and reference sites over multiple years (typically three or more years); and extensive post-treatment (EPT) in which data are collected from multiple paired treatment and reference sites over a shorter time frame (one or two years). In many respects, an IPT design could be considered to be a BACI design that lacks pre-project information.

As noted above, selecting a general monitoring design and an analytical approach are only the first steps in the process of developing a monitoring plan. Equally important is choosing appropriate statistical methods and tests to analyze these data. Among the more important statistical considerations is determining the required sample sizes and statistical power. Statistical power should be based on the probability that results that indicate a difference between reference and control that may or may not be truly different.

Notwithstanding the above overview of general monitoring approaches and the importance of analytical choices, it must be recognized that statistically rigorous monitoring represents a large financial investment that may not always be feasible or realistic. Natural cycles and background "physical and biological noise" can be, by themselves, formidable sources of natural variation that often makes the detection of change difficult even with large sample sizes, extremely long-term monitoring, and massive replication. As a result, many monitoring plans incorporate a "biological effect" threshold or target. An example of a biological target might be a "five- or 10-year

increasing trend in the abundance of Chinook salmon juveniles using a restored habitat" or "an increase of X numbers of spawning fish averaged over 10 years."

The MAM Working Group discussed the options of setting targets or evaluating results statistically. The Working Group endorsed developing representative biological effect thresholds or targets for evaluating the outcomes of selected projects. The endorsement is not a recommendation to abandon the use of statistical approaches, but rather an acknowledgement that detecting changes (and hopefully improvements) resulting from the actions contemplated by the Habitat Plan could be difficult when using a strictly statistical approach. If carefully and thoughtfully developed, biological effects thresholds can be an important component of the WRIA 9 monitoring and adaptive management strategy.

Project effectiveness monitoring can be broken down into "physical effectiveness monitoring" and "ecological and biological monitoring," described as follows:

3.1.2.1 Physical Effectiveness

Whether a project achieves the desired physical changes to the habitat and whether the changes persist as expected (i.e., is sustainable) is the focus of physical effectiveness and sustainability monitoring. The kinds of questions addressed might include the following:

- Does the created or restored habitat provide the desirable depth and velocity conditions?
- Did sediment or gravel accrete as expected?
- Did the transplanted vegetation survive?
- Is the habitat accessible during all intended flow/tidal conditions?
- Does sediment accumulate on the beach?

Table 4 provides general guidelines for conducting physical effectiveness and sustainability monitoring for projects recommended in the Habitat Plan. This table includes general guidelines regarding frequency and duration of monitoring, potential effectiveness criteria, types of parameters to monitor, and performance standards. As noted above, specific sampling requirements (sample sizes,

replication, duration of sampling, etc.) are best developed as part of an analytical plan that ideally would be developed on a case-by-case basis.

Table 5 summarizes the adaptive management process envisioned for using the information derived from physical effectiveness and sustainability monitoring to inform the design and implementation of future projects of a similar nature. If the desired outcome is not achieved (i.e. "incomplete"), the general approach is for the ITC to conduct a detailed evaluation of the data, explore potential reasons for the incomplete outcome, and prepare a list of recommended changes deemed necessary to achieve the desired outcome in future projects. These recommendations would be vetted with the Steering Committee, and, in their final form, submitted to the Forum of Local Governments for adoption.

3.1.2.2 Biological and Ecological Effectiveness

Results of biological and ecological monitoring are in many respects the ultimate measure of success or failure at the individual project level. Key questions addressed include the following:

- Are a greater number of salmonids using the habitat?
- Are they using the habitat for longer periods?
- Are other fish species using the habitat?
- Are fish using it only under certain conditions?
- Are the salmon using it of hatchery or natural origin?
- Did the physical changes and/or vegetation increase the abundance of diet items (e.g., benthic invertebrates, insects)?

Table 6 provides general guidelines for conducting biological and ecological effectiveness monitoring for the nine classes of projects recommended in the Habitat Plan. Four primary components of biological monitoring are identified:

- Juvenile fish monitoring,
- Adult fish monitoring,
- Prey resource monitoring, and
- Riparian vegetation monitoring.

The biological monitoring for most types of projects and in most portions of the watershed would include more than one of the biological monitoring components. The sampling design for each project will depend upon project-specific objectives and conditions. However, it is expected that a fairly intensive monitoring effort throughout the month(s) of expected use and over multiple years (including pre-construction) will be necessary to gain sufficient information to answer the key questions stated above.

Table 7 summarizes the adaptive management process envisioned for using the information derived from biological effectiveness monitoring to inform the design and implementation of future projects of a similar nature. As with the physical effectiveness monitoring, if the desired outcome is not achieved (i.e. "incomplete"), the general approach is for the ITC to conduct a detailed evaluation of the data, explore potential reasons for the incomplete outcome, and prepare a list of recommended changes deemed necessary to achieve the desired outcome in future projects. These recommendations would be vetted with the Steering Committee, and, in their final form, submitted to the Forum of Local Governments for adoption.

3.2 Watershed-Wide Monitoring

Watershed-wide monitoring consists of tracking three distinct activities/indicators:

- Implementation of the overall Habitat Plan to determine whether it is proceeding as planned,
- Implementation of local programmatic and regulatory actions in an effort to determine their cumulative effect, and
- Tracking indicators of environmental health, with an emphasis on those habitat characteristics or features that are limiting to salmon recovery. This is also sometimes referred to as Status and Trends monitoring.

Each of these types of monitoring is described below.

3.2.1 Implementation of the Habitat Plan

The Habitat Plan sets forth a strategy for watershed-wide project implementation in policy MS-1 (see Section 1). Policy MS-1 establishes that in the first 10 years of implementation, 40 percent of funding for management actions will go the projects

within the Duwamish Estuary transition zone, 30 percent will go to spawning habitat projects in the Lower and Middle Green River, and 30 percent will go to rearing habitat projects in the Lower and Middle Green River, Duwamish Estuary, and Marine Nearshore. The Upper Green River Subwatershed is not included in watershed-wide project monitoring for the first 10 years of plan implementation. This is because actions taken in the Upper Green River subwatershed will be monitored as part of the Tacoma Water Habitat Conservation Plan and the Howard Hanson Dam Additional Water Storage Project.

Monitoring the implementation of the Habitat Plan involves periodically assessing whether the projects identified in the plan are being implemented at a rate and in appropriate locations to meet 10-year implementation targets. In order to address these questions, cumulative outcome benchmarks have been set forth to adaptively manage Habitat Plan implementation (Table 8). The benchmarks will be evaluated by the review of annual and/or biennial status updates of all project implementation efforts, to include information about observed obstacles to implementation and discussion on whether implementation in the 10-year time frame is feasible. The benchmarks are established for three[2]-, five-, eight-, and 10-year time periods (i.e. 2008, 2010, 2013, and 2015, respectively) and will be used to determine whether various habitat types for each subwatershed are being actively and sufficiently developed. Implementation efforts for projects will be categorized as:

- Securing funding,
- Developing designs,
- Applying for permits,
- Purchasing property/easements,
- Construction, or
- Post-construction monitoring.

The benchmarks listed in Table 8 are based on what the MAM Working Group believes is achievable if watershed partners maintain a commitment to regional cooperation and if funding can be obtained from state and federal sources.

[2] The three-year benchmarks are consistent with the Habitat Plan Three Year Work Schedule, which was approved by the WRIA 9 Steering Committee in June 2006.

The ITC will prepare recommendations for the Steering Committee regarding habitat projects that should be initiated or accelerated to ensure that the implementation timeline is on schedule. The WRIA 9 Steering Committee will then consider the ITC recommendations, refine these recommendations as appropriate, and provide final recommendations to the Forum of Local Governments. Recommendations will include specific changes needed to meet 10-year implementation targets. The Forum of Local Governments will consider the Steering Committee recommendations and make commitments of staff or other resources to take action to remedy observed obstacles to implementation.

3.2.2 Implementation of Local Programmatic and Regulatory Actions

The WRIA 9 Habitat Plan recommends 30 watershed-wide and subwatershed programmatic and regulatory actions. WRIA 9 staff is working with local WRIA 9 jurisdictions to identify the programs that are appropriate for implementation based on local jurisdiction circumstances. This step is necessary because some programs are relevant to all jurisdictions, whereas others are most relevant to specific jurisdictions or groups of jurisdictions. Moreover, some programs are best implemented by jurisdictions working independently to meet local conditions, while other programs could benefit from common approaches or cooperation between jurisdictions. Monitoring the implementation of Habitat Plan programs depends on determining which Habitat Plan projects and regulatory actions have been implemented and by which jurisdictions.

Annual status reports on Habitat Plan programs and regulatory action implementation by WRIA 9 jurisdictions will be prepared. These reports may follow the model used to track implementation of the Near-Term Action Agenda (WRIA 9 Steering Committee 2002); progress reports were prepared for 2002, 2003, and 2004-2005. Preparing status reports annually will:

- Provide an annual indication of the progress being made,
- Identify opportunities for coordination between WRIA partners,
- Record accomplishments that can be publicized, and

- Underscore to jurisdiction elected officials and staff the importance of steady progress toward implementation of the programmatic and regulatory recommendations.

In order to provide an opportunity for systematic review and management changes to programmatic and regulatory actions, cumulative outcome benchmarks have been set forth in Table 9. The benchmarks are established for three-, five-, eight-, and 10- year time periods. The annual status reports will provide the information needed to determine whether the benchmarks are attained. (The annual status reports for non-benchmark years are not expected to result in adaptive management changes.) Using the raw data from the annual progress reports, the ITC will prepare a review and status report for the Steering Committee for each of the four benchmark periods (three-, five-, eight-, and 10-year). The WRIA 9 Steering Committee will review the status reports and determine which programmatic and regulatory actions, if any, should be modified or emphasized in the subsequent benchmark period. Note that although information gathered in non-benchmark years will not necessarily be used for management purposes, it will be used for public information/education purposes and to help Watershed Coordination Services staff develop internal annual work plans.

3.2.3 Tracking of Environmental Indicators

The tracking of a limited number of key environmental features and habitat characteristics, particularly those that have been identified as limiting to salmon or factors for decline, is an excellent way to gauge progress toward reestablishing watershed ecosystem health. Further supporting this need to address limiting factors is the expectation that NMFS (the agency with jurisdiction over Endangered Species Act issues for Puget Sound Chinook) will explicitly consider the degree to which watersheds have addressed these habitat limiting conditions in a potential future delisting process.

Regional monitoring efforts, as well as WRIA-initiated monitoring, will both contribute data to track environmental indicators. The Washington Department of Ecology's Status and Trend Monitoring is an existing monitoring program that can provide useful environmental indicator data. Other potential regional monitoring efforts that may provide data include monitoring by Shared Strategy and shoreline monitoring by the Washington Department of Natural Resources. It is likely that most of the environmental indicator monitoring would need to be conducted locally by WRIA ILA participants. There is a substantial amount of baseline data that is available, but an inventory of the information available and the comparability of the various techniques is recommended to be an initial responsibility of the ITC.

After considering the merits and practicality of a long list of potential habitat features and parameters, the MAM Work Group settled on the seven indicators listed in Table 10. These include:

- Width and composition of riparian vegetation,
- Distributions of spawning gravel,
- Distribution of large woody debris (LWD),
- Miles of shoreline armoring,
- Number of impediments to fish passage,
- Water temperature, and
- Water quality (other than temperature).

In addition to the value of these parameters as general indicators of watershed health, each of these parameters relate to a habitat feature or characteristic that is considered limiting to recovery of salmon in the Green/Duwamish Watershed (WRIA 9 Steering

Committee 2002). Each of the seven indicator parameters is described below in more detail. Table 11 outlines the recommended approach to adaptively managing the results of watershed-wide indicators monitoring.

3.2.3.1 Width and Composition of Riparian Vegetation

Loss of riparian vegetation has been identified as a major habitat limiting factor in WRIA 9 (WRIA 9 Steering Committee 2002). The loss affects several physical and biological characteristics of the Green/Duwamish River, including and contributing to increased water temperature (due to reduced shading), reduced recruitment of wood, increased sediment runoff, shoreline habitat simplification, and reduced food supply for salmonids. Monitoring the width and composition of riparian vegetation is a straightforward way to monitoring progress toward restoring riparian health. Progress can be monitored by remote collection and interpretation of aerial photos and changes should be reported at five-year intervals. Five-year reporting intervals were selected to track changes in riparian conditions so as to provide sufficient time for any new plantings to become established.

The interpretation of aerial photos will require some ground-truthing to ensure the quality and accuracy of interpretation. The basic elements of the aerial interpretation (e.g., width of corridor to analyze, vegetation type categories, estimating overhanging vegetation, and tributaries to include) will need to be developed during the first monitoring event.

3.2.3.2 Distribution of Spawning Gravel

The distribution of instream gravel suitable for Chinook salmon spawning in the Middle and Lower Green River limits both the numbers and distribution of spawning Chinook salmon. Moreover, altered sediment transport has been identified as a limiting factor throughout the Green/Duwamish Watershed (WRIA 9 Steering Committee 2002). Changes in the distribution and quality of spawning gravels can be monitored during routine, multi-purpose low water surveys. Expanding the distribution of spawning Chinook salmon in WRIA 9 can contribute to increasing both their spatial structure and abundance, two of the four viable salmonid population parameters that are critical to recovery and delisting.

3.2.3.3 Distribution of Large Woody Debris

The distribution of large woody debris (LWD), whether naturally recruited or placed in the form of an engineered log jam or other cabled logs, is an important component of habitat complexity and diversity. It has long been recognized that LWD controls many of the physical forces that determine the distributions of pools and riffles that are needed for healthy salmon populations (Bisson et al. 1987). The severely limited recruitment of natural wood that has resulted from construction of Howard Hanson Dam in the Upper Green River, coupled with the major loss of native trees in the riparian corridor throughout the entire watershed, has been recognized as a habitat limiting factor in this area (WRIA 9 Steering Committee 2002). Changes in the distribution and types of LWD can be monitored during the same multi-purpose low water surveys in which the distributions of spawning gravels are documented. The population level changes associated with increased complexity and quality of rearing habitat include increased fish life cycle productivity and, over time, increased fish abundance.

3.2.3.4 Miles of Shoreline Armoring

Shoreline armoring in both fresh and saltwater have long been recognized as disrupting natural sediment transport processes, cutting off access to side channel and wetlands, limiting sediment drift cell function, and constraining natural channel migration (Williams and Thom 2001; Bolton and Shellberg 2001). These ecological impacts have documented as especially damaging in the Green/Duwamish Watershed (WRIA 9 Steering Committee 2002). Tracking progress toward reducing the impacts from shoreline armoring by periodically monitoring total miles of shoreline armoring can provide an important indicator of ecosystem health. Progress can be monitored by remote collection and interpretation of aerial photos and changes should be reported at five-year intervals. The five-year interval was selected as a reasonable time interval to document changes. Reestablishing more normative habitat forming processes will be a key element to creating sustainable habitat features that benefit salmon. Baseline information on shoreline armoring along the marine nearshore of WRIA 9 is available in the Prioritization of Marine Shorelines in WRIA 9 report (Anchor 2006).

3.2.3.5 Number of Impediments to Fish Passage

Fish passage can be impacted by a variety of instream physical barriers or obstructions, including dams, perched culverts, and irrigation diversions. Although the new fish passage facilities at Howard Hanson Dam and the Tacoma Headworks will contribute to reducing the impact of these two major barriers on the Green River, other passage barriers also exist in the WRIA 9 watershed. Improving or opening access to the habitats blocked by these barriers is an important means of enhancing the spatial distribution of salmon and increasing their overall abundance. Reducing the numbers of barriers in the Green/Duwamish Watershed will be an important step in reestablishing the ecological health of tributary streams.

3.2.3.6 Water Temperature

Monitoring water temperature is virtually always included among environmental indicators of watershed health and would be a logical parameter to monitor in WRIA 9 as well. As an environmental indicator, water temperature is affected by a number of factors and conditions, including flows and riparian shade or cover. Water temperature also represents an integration of several additional indicators of ecological health. The Green River is currently listed as a Category 5 water body (polluted) on Washington Department of Ecology's (Ecology) 303(d) list for temperature. Ecology currently monitors water temperature at six stations in WRIA 9, including the major tributaries (Green River at Tukwila, Green River at Kanaskat, Des Moines Creek at creek mouth, Miller Creek at creek mouth, Longfellow Creek above 24-25th Street junction, Fauntleroy Creek at creek mouth). In addition, King County's Water Quality Monitoring program operates several water temperature monitoring stations in the Green and Duwamish River (Middle Green River – two stations; Lower Green River – two stations; Duwamish Estuary – three stations in lower river). Hence, periodically compiling and reporting trends in water temperature should be a relatively straightforward undertaking.

3.2.3.7 Other Water Quality Conditions

Other water quality conditions monitored in the Green/Duwamish basin by Ecology and King County are varied and include such parameters as conductivity, fecal

coliform, ammonia, metals, phosphorus, dissolved oxygen, pH, hardness, suspended solids, nitrogen, and turbidity. Summarizing these data for multiple years should also be a straightforward task that can provide useful insights on environmental trends in the watershed.

3.3 Population-Level Monitoring

Puget Sound Chinook salmon were listed as threatened under the Endangered Species Act by the National Marine Fisheries Service (NMFS) in 1999 based on a scientific review and judgment that they "were likely to become endangered in the foreseeable future." Although that is the strict legal definition of "threatened," the decision to list is ultimately a judgment supported by the population biology and the identification of limiting factors. From a population biology perspective, NMFS relies heavily on a concept termed Viable Salmonid Population (VSP). According to NMFS (McElhany et al. 2000), a viable salmonid population is an "independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year time frame."

McElhany et al. (2000) identified four key population characteristic or parameters for evaluating population viability status:

- Abundance,
- Population growth rate or entire life cycle productivity,
- Population spatial structure, and
- Diversity.

The following sections presents a brief introduction to each of the VSP parameters and the types of data required to either estimate the parameter or document changes. It is anticipated that these data will be required by NMFS on a Puget Sound-wide basis to make a determination regarding any change in status, including delisting, of the Puget Sound Chinook Evolutionarily Significant Unit (ESU). The effort required to collect these kinds of data is substantial, and the MAM Working Group considers that it is well beyond any expectation that it could be accomplished solely by WRIA 9. Fortunately, however, most of these data are already being collected (to some degree) by WDFW and the Muckleshoot Indian Tribe and it is expected that these groups will continue to do so. WRIA 9 should

track the data and findings using the approach summarized in Table 12. WRIA 9 should also track the funding and certainty of this monitoring in the watershed and pursue funding to continue the monitoring independently if one of the investigating entities is no longer able to fund the monitoring.

No discussion of VSP would be complete without emphasizing that any change in risk associated with these population parameters is affected by a myriad of factors, and consequently is a long-term proposition. Many of these factors (e.g., ocean conditions and marine survival rates) are largely outside of human control. Moreover, changes expected from the types of actions contemplated in the Habitat Plan are most likely to occur on a generational scale, and the likelihood is low that there would be detectable changes in the roughly two Chinook salmon generations covered by the time period of this plan. Also, there is huge uncertainty associated with estimates of productivity due to the massive hatchery program in the Green/Duwamish Watershed. Although some of this uncertainty will be reduced by the mass marking of hatchery fish that will allow hatchery fish identification on the spawning grounds, there is still substantial uncertainty over their reproductive success and contribution to future generations (Berejikian and Ford 2004)

3.3.1 Abundance

Population size is perhaps the most straightforward to measure of the Viable Salmonid Population parameters and is an important consideration in estimating extinction risk. All other factors being equal, a population at low abundance is intrinsically at greater risk of extinction than is a larger one. The primary drivers of this increased risk are the many processes that regulate population dynamics—particularly those that operate differently on small populations. Examples include environmental variation and catastrophes, demographic stochasticity (intrinsic random variability in population size), selected genetic processes (e.g., inbreeding depression), and deterministic density effects. Although the negative interaction between abundance and productivity may protect some small populations, there is obviously a point below which a population is unlikely to persist.

Estimates of total abundance (i.e. the numbers of returning fish, known as escapement) can be made based on carcass counts on the spawning grounds (using an approach

termed "area under the curve") and numbers of fish harvested by cohort. During these spawning ground surveys, it is important to collect information on sex and age structure for use estimating production by cohort or year-class. Because of the current practice of releasing high numbers of hatchery fish from Soos Creek Hatchery, allowing large numbers of fish to spawn naturally, it is also important to document the proportion of wild-spawning fish that are of hatchery vs. natural origin (i.e. HORs and NORs must be tracked separately). With the onset of mass marking several years ago, this can done by tracking the numbers of adipose fin-present v. adipose fin-absent fish.

3.3.2 Life Cycle Productivity

Population growth rate (λ) or productivity over the entire life cycle is a key measure of population performance in a species' habitat. In simple terms, it describes the degree to which a population is replacing itself. A $\lambda = 1.0$ means that a population is exactly replacing itself (one spawner produces one spawner in the next generation); whereas a $\lambda = 0.9$ means that the population is declining at a rate of 10 percent annually—a trend that is obviously not sustainable in the long term. Conversely, a $\lambda = 1.1$ indicates a population is increasing 10 percent, a circumstance that likewise cannot continue *ad infinitum* since all habitats have an upper limit or carrying capacity. If one were forced to choose a single parameter to measure the status of a population, it would logically be productivity.

Data needed to estimate life cycle productivity includes a time series (ideally of 20 years or more) of abundance of returning fish (including those harvested) sorted by cohort or year class. This basic census information allows run reconstruction and estimation of the numbers returning adults in sequential generations (i.e. the number of adults produced by the previous generation.) When thinking about productivity, it is important to recognize that for a population to maintain its current size, from the 4,000 eggs produced by female Chinook salmon, only two need to survive and spawn: one male and one female. Any less, over some period of time, indicates the population is declining; any more over a similar period of time, indicates the population is growing. As was the case noted above, it is critically important to distinguish HORs from NORs so as to properly attribute the source of the production. Adding more complexity to the procedure for making estimates of productivity is the uncertainty over the reproductive

success of HORs when spawning naturally. There have been studies suggesting that the reproductive success of HORs spawning naturally is markedly reduced compared to that of NORs spawning naturally (Berejikian and Ford 2004). As a result, and depending on assumptions about reproductive success, markedly different productivity estimates will be derived. As a way to bracket this uncertainty, NMFS often estimates productivity using a range of assumptions regarding reproductive success and, therefore, a range of productivity estimates.

Although overall life cycle productivity is the population parameter that NMFS considers under its VSP policy, much information can also be gained by distinguishing productivity between the freshwater life phase and the marine phase. Indeed, it is freshwater productivity that would be most affected by habitat activities such as those contemplated in the Habitat Plan. Estimation of freshwater productivity requires relating the numbers of spawning adults to the numbers of smolts that are produced and migrate to the marine environment. Estimating the numbers of outmigrating smolts typically requires the operation of smolt traps in the lower reaches of a river and the ability to distinguish between hatchery and natural origin smolts. At the present time WDFW is operating such a trap in the Middle Green River.

3.3.3 Diversity

Biological diversity within and among populations of salmon is generally considered important for three reasons:

- Diversity of life histories patterns is associated with a use of a wider array of habitats,
- Diversity protects a species against short-term spatial and temporal changes in the environment, and
- Genetic diversity is the so-called raw material for adapting to long-term environmental change.

The latter two reasons are often described as nature's way of hedging its bets—a mechanism for dealing with the inevitable fluctuations in environmental conditions—in the long and short term. With respect to diversity, more is better to minimize the risk of extinction.

The current understanding of population structure and life history diversity in the Green/Duwamish Watershed is limited to the division of outmigrants into life history trajectories based on rearing location and emigration timing (see Figure 4-2 in the Habitat Plan). Hence, estimating life history diversity is probably best approached in the Green/Duwamish by estimating the abundance or relative proportions of the different life history trajectories (LHTs). This could be accomplished in at least two different ways:

- Operation of smolt traps in the Green River that could be used to estimate the proportion of the different LHTs and/or
- Analyzing scales from returning adults to determine early life history.

Another characteristic of fish that contributes to life history diversity is spawning distribution. As new spawning habitat is created or restored, this also represents an expansion of life history diversity. This means that spawning ground surveys will have to be expanded to include areas where projects may result in new spawning habitat.

Ultimately, in WRIA 9, the largest contribution to expanding life history diversity and geographic distribution (see below) will be the re-establishment of Chinook salmon in the Upper Green River. If the decision is made to use a spring-type Chinook (e.g., White River spring Chinook), it will represent a major improvement in Chinook diversity for the Puget Sound ESU. Currently, there are only two populations of spring-type Chinook salmon in Puget Sound: one in the Nooksack River and one in the White River.

3.3.4 Spatial Structure

Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as a metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is to consider that in the presence of such a distribution, a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations.

Spatial structure and distribution is a very straightforward VSP parameter to estimate. It could either be based on spawning ground surveys or juvenile rearing surveys to estimate the geographical extent of habitat usage. Detailed adult spawner surveys have been carried out by Washington State Department of Fish and Wildlife (WDFW) in the Green River mainstem in river miles 25.4-61 since 1999. Newaukum Creek surveys are carried out in river miles 0-3.8. Additional surveys are needed in Soos Creek to quantify spawning of this sub-population. The U.S. Army Corp of Engineers is also doing redd mapping surveys in river miles 56.5-61 from 2003-2008 (different from WDFW surveys in that individual Chinook redds are mapped).

Juvenile salmonid studies occurred in 2002, 2003, and 2005 to examine migration, growth and habitat use in the Lower Green and Duwamish (2003 and 2005 efforts were $100-200,000). This could continue every 2-3 years to characterize juvenile survival, migration and timing, and variability for different conditions.

4 DATA MANAGEMENT

Data management can be defined as the organization and control of information to ensure proper security, integrity, and availability. Data management is a significant component of comprehensive monitoring and requires a steadfast commitment of resources and a highly organized filing system. Thoughtful data management facilitates data analysis and interpretation and therefore feeds directly into the adaptive management framework.

Databases can exist as a single "data warehouse" or in a distributed network of connected data repositories. Databases can be classified as "primary" if they are the first and original repository for data, or "secondary" if they function as a data portal with links to the primary data. As encompassed in the broad definition above, a comprehensive database design includes myriad elements, including database architecture, access and security, data format, data sharing agreements, QA/QC, metadata storage, and data achieving. A detailed treatment of all of these topics is beyond the scope of this document, but necessary in the long term for implementing this plan.

The MAM Working Group considered a variety of possible approaches to managing WRIA 9 data, with the overarching goal of making sure it was accessible both within WRIA 9 for adaptively managing the habitat program and outside WRIA 9 for use consideration in any review of the status of the Puget Sound Chinook salmon ESU. In reviewing options and considering these goals, the MAM Work Group recognized the diverse nature of these data sources, including the reality that different types of data would need to be handled in different ways. The MAM Work Group also acknowledged that much of the relevant data WRIA 9 needs may be initially gathered and organized by other partners, some of which are active in WRIA 9 habitat recovery and others that are not.

Based on these considerations, the MAM Working Group recommends that all Habitat Plan monitoring data be maintained within the WRIA 9 community. This ensures ready access and a solid foundation for adaptive management. In the case of data from project-specific monitoring and from watershed-wide monitoring, the WRIA 9 database would function as the primary repository. In the case of population monitoring data (i.e. the VSP parameters), the primary data would be maintained by the entities collecting those data (i.e. WDFW and the Muckleshoot

Indian Tribe). These latter data would need to be readily accessible by NMFS, if not already accessible directly from WDFW and Muckleshoot Indian Tribe.

Rather than create a new stand-alone database, a preliminary evaluation of options suggests using the existing King County Capital Improvement Project database as the primary repository for WRIA 9 project-specific and watershed-wide monitoring data. This recommendation is based both on a discussion among WRIA 9 staff and King County staff concluding that the database architecture is flexible enough to accommodate all types of anticipated monitoring data and the obvious cost efficiency of using an existing database. More specific aspects of data management are expected to be determined in ongoing discussions among WRIA 9 and King County staff.

5 INTEGRATION

For the purposes of developing recovery and conservation plans, Puget Sound Shared Strategy defines *integration* as: "the development and assembly of a set of inter-related management actions and activities, logical and coherent in outcome, timing and sequence that are predicted to achieve population (or ESU) viability." Integrated actions are those that:

- Are consistent with the causal hypotheses, conservation strategies, and population goals,
- Are inter-related through their effects on Viable Salmonid Population (VSP) attributes,
- Produce no lasting (permanent) pathological or contrary effects in the population parameters,
- Achieve the necessary VSP outcomes before irreversible harm is done to the population, and
- Include activities in habitat, harvest, and hatchery management areas.

This section describes expectations regarding the integration of hatchery, harvest, and habitat actions both at the WRIA 9 watershed level and Puget Sound-wide level.

5.1 Integrating Habitat Restoration with Harvest and Hatchery Operations in WRIA 9

Because of jurisdictional boundaries, the integration of hatchery and harvest operations with habitat restoration activities contemplated by the Habitat Plan will be a formidable challenge. Each is operated or regulated by different entities, often with different overarching objectives. As currently operated, hatchery production is co-managed by WDFW and the regional Native American tribes (in the case of WRIA 9, the Muckleshoot Tribe). Harvest also is managed by WDFW and the regional tribes, but in the case of harvest, NMFS is also directly involved both from the requirement to manage salmon harvest on a coast-wide basis under the Pacific Fishery Management Council and from the perspective of permitting hatchery programs and harvest plans under Section 7 of the Endangered Species Act. Hatchery programs and harvest management both have a number of very significant external drivers, including specific allocations under tribal and international treaties and agreements such as U.S. v. Washington (i.e. the Boldt Decision), and the U.S./Canada Pacific Salmon Treaty. In contrast to the above, habitat restoration is largely shaped by the WRIA 9 Forum of Local Governments and private land owners. At a minimum, integrating habitat, hatchery, and harvest decisions will require the cooperation

and coordination of efforts by the WRIA 9 Forum of Local Governments, WDFW, and the Muckleshoot Indian Tribe.

Notwithstanding these complexities, the vision for the Habitat Plan is to restore a sustainable population of naturally spawning Chinook salmon in Green/Duwamish Watershed. To achieve this goal, changes in hatchery production and harvest management may be required. Over the next 10 years, the WDFW is expected to run integrated hatcheries[3] in the Green River in a manner that minimizes competition between hatchery and natural origin fish, and maximizes the number of natural origin recruits brought into the brood stock. (See the *Puget Sound and Coastal Washington Hatchery Reform Project: May 2005 Update* for the rationale for operating integrated type hatchery programs with high proportions of naturally returning fish as part of broodstock.) It is expected that WDFW will use the All-H Analyzer tool (AHA) (developed by the Puget Sound Hatchery Scientific Review Group) to monitor proportions of NORs in the hatchery broodstock and proportions of HORs allowed to spawn naturally, and to achieve a "proportion natural influence" (PNI) of 0.5 to 0.7[4]. Translated into lay terms, this means that WDFW will manage the Green River population of Chinook salmon to increase and enhance the influence of natural selection on the population and the natural environment will drive selection, not the hatchery environment.

Also with respect to harvest, salmonid harvest will continue to be managed through the North of Falcon process under the Pacific Fishery Management Council. Chinook harvests will be consistent with the Chinook Harvest Regional Management Plan (RMP) submitted by the co-managers and approved by NMFS (term expires April 30, 2010). Non-Native American non-salmon harvest in Puget Sound will be managed by WDFW.

During the 10 year period of this plan, there is an expectation that as the local jurisdictions make progress implementing the Habitat Plan, the watershed will be adding capacity to

[3] Integrated hatchery programs are those that routinely incorporate returning adults of both natural- and hatchery-origin (NORs and HORs).

[4] PNI or proportion natural influence is the metric used in the AHA tool to estimate the influence of the natural environment (versus that of the hatchery) on the evolution of a population. Literally, it is [1-(the proportion of NORs in a broodstock)]/[(the proportion of NORs in a broodstock) + (the proportion of HORs spawning naturally)]. A PNI > 0.5 means the influence of the natural environment is greater than that of the hatchery environment.

support increasing of numbers naturally spawning and rearing Chinook salmon, and that changes in the artificial production of fish in the hatchery programs will be possible and perhaps even necessary. These latter changes will have to involve all of the principal stakeholders in the process, including the WRIA 9 Forum of Local Governments, WDFW, and the regional tribes.

In implementing the Habitat Plan and monitoring its effects, it will be important to collect fish data to distinguish HORs from NORs, particularly in terms of the Habitat Plan VSP goals. In the Green River, the number of NORs is small and could become smaller with increasing hatchery influence. From 1993 to 2002, the mean NOR spawner escapement was calculated (by the Technical Recovery Team) at 1,737. The population is considered to be very near the "critical population threshold" and should be increased to the upper values suggested in the VSP guidelines—1,000 to 4,200 per year. If the target of 1,000 as an effective population size for NORs is used, then the rate of growth to achieve this target in the next 15 years is at a minimum 1.05. Diversity and spatial structure within the WRIA 9 watershed have also been reduced with the loss of habitat throughout the Green/Duwamish River, including the estuary and the marine nearshore. The overall goal of the Habitat Plan therefore is to increase habitat in key rearing and spawning areas of the Middle and Lower Green River, Duwamish transition zone, and marine nearshore.

Based on the results of the population analyses, the Habitat Plan included three conservation hypotheses that were developed to address non-habitat conditions and are relevant to the integration of habitat, hatchery, and harvest practices. Two hypotheses are rated as Tier 1 (high priority) and one hypothesis is rated a Tier 3 (lower priority). These hypotheses are described below.

> **Non-habitat–1 (Tier 1)**: Employing live capture techniques to harvest hatchery salmon (marked) and release natural salmon will reduce mortality of naturally-produced salmon while providing the opportunity to harvest a greater percentage of hatchery fish and thereby reducing straying of hatchery fish to the spawning grounds. (Note:

Ranking of this hypothesis was based on the presumption of a segregated broodstock[5]. However, Chinook in the Green/Duwamish are currently managed as an integrated broodstock.)

Non-habitat–2 (Tier 1): Modifying hatchery practices (e.g., more natural rearing conditions, smaller releases, release timing and location, genetic management, etc.) and improving the attractiveness of hatcheries to returning HOR adults will lead to reduced interactions between HOR and NOR Chinook salmon and enhance production of NOR Chinook.

Non-habitat–3 (Tier 3): Reducing harvest of non-salmonid commercially and recreationally important species (e.g., Dungeness crab, and forage fish) will lead to greater prey availability for juvenile and adult salmonids.

With regard to the implementation of these non-habitat conservation hypotheses, the MAM Working Group makes the following recommendations for the integration of habitat, harvest, and hatchery management within WRIA 9:

- Non-habitat conservation hypothesis-1 (Tier 1) is based on the presumption of a segregated stock based on the Shared Strategy and the Puget Sound Technical Recovery Team's guidance that an integrated management approach with high straying of hatchery origin salmon on the spawning grounds would likely keep the stocks in the "high risk" category. However, WRIA 9 should acknowledge and accept the scientifically-based decision of the co-managers and the Hatchery Scientific Review Group to run integrated type hatchery programs in WRIA 9.
- WRIA 9 should consult regularly with the co-managers to get specific details on how hatchery operations will be modified in the Green River and discuss what the implications are for the actions and goals of the Plan.
- WRIA 9 should evaluate implications of harvest management changes on the plan as part of ongoing plan implementation.

[5] A segregated broodstock is one composed of HORs only. It is managed separate or segregated from any natural population in the area. This contrasts with an integrated broodstock which routinely incorporates both NORs and HORs.

5.2 Puget Sound-Wide Integration

Green/Duwamish River Chinook salmon are one of 22 independent Chinook populations in Puget Sound. NOAA Fisheries delisting decisions will therefore focus on recovery of multiple populations in addition to this stock. The NOAA Fisheries framework for Puget Sound-wide monitoring will determine what monitoring data are needed. Green/Duwamish Viable Salmonid Population monitoring data would be provided to NOAA Fisheries by WDFW. It is expected that a minimum of two to three generations (10 to 15 years) of Chinook monitoring data will be required before trends in productivity can begin to be discerned.

6 NEXT STEPS

This Implementation Guidance has identified several activities that will require additional refinement and agreement among participating communities in the ILA. A fundamental issue to discuss and address is the staffing and funding commitments that the communities can make to the implementation of this plan. These commitments include such definable issues as technical staff time that will be dedicated to participation in the ITC. A less clear issue that can be clarified by understanding the contributions possible by the participating ILA communities, is the degree to which the WRIA 9 ILA participants will be able to "fill in" funding gaps for project monitoring that will inevitably be encountered as projects are constructed. These gaps could be incomplete or absent monitoring to provide the physical and biological effectiveness information needed to understand the project's success.

Assembling the ITC as described in Section 2.2.3 is a top priority given the committee's responsibilities in refining the monitoring needs and interpreting monitoring results. Five initial tasks are envisioned for the ITC:

1. Assessing data management needs and developing a Data Management Plan
2. Adapting King County's Capital Improvement Project database to include appropriate parameters to track all monitoring types described in this Implementation Guidance
3. Reviewing and recommending criteria and thresholds that would indicate the point at which either changes should be made or formal evaluation should occur, as appropriate (trigger points)

4. Identifying available sources of baseline information on the environmental indicators
5. Identifying the Corps' monitoring commitments for projects conducted as part of the Ecosystem Restoration Project and determining how this monitoring compares to the monitoring needs identified in this Implementation Guidance and any subsequent iteration.

7 SUMMARY

This Implementation Guidance describes an adaptive approach to implementing the WRIA 9 Habitat Plan.

The majority of this plan focuses on the types of monitoring that are needed to effectively manage implementation of the Habitat Plan during the first 10 years. The different types of monitoring include:

- Project-specific implementation and effectiveness monitoring,
- Watershed-wide monitoring, and
- Population level monitoring.

Within these categories, guidelines are provided on the types of observations or measurements that are needed and the types of analyses that could be used to identify successful or incomplete outcomes.

This plan also establishes an Adaptive Management Technical Committee to review results of a comprehensive monitoring and evaluation program, and directs the ITC to regularly report on and prepare recommendations for program changes. The Steering Committee and Forum of Local Governments remain the decision making bodies.

As with any new program, there is every expectation that implementation will be a learning process, and that an adaptive approach will be a key to long-term success. Although the plan includes monitoring at the project-specific, watershed-wide, and population levels, it is the project-specific monitoring that is considered critical in the first 10 years of this program.

The responsibility to respond to any shortcomings in attaining the implementation benchmarks or in individual project design effectiveness lies with the organizations forming the interlocal WRIA 9 committees. The ability to adaptively manage the recovery efforts in order to achieve the vision of a sustainable naturally spawning Chinook population will require a steadfast commitment of the local communities and active coordination with regional recovery efforts.

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TABLES

APPENDIX A

MEETING NOTES

WRIA 9 Adaptive Management Work Group Meeting Summary

May 10, 2006
10:00 to 12:00PM
King Street Center

Attendees:

Gordon Thomson-WRIA 9
Paul Schlenger- Anchor Environmental
Gregg Ruggerone-NRC
Joan McGilton-City of Burien
Dennis Clark-WRIA 9
Mike Schiewe-Anchor Environmental
Aaron Nix-City of Auburn
Julie Hall-SPU
Jennifer Knauer-King County
John Koon-King County

1. Welcome and Introductions:

- The meeting began with welcome and introductions. Gordon covered expectations and goals. The Work Group has 6 two-hour sessions to assist in developing a Monitoring and Adaptive Management Plan for WRIA 9. The goal is to develop a realistic, clear, and concise plan.
- Mike emphasized that WRIA 9 Chinook are only one of the 22 independent populations of Chinook salmon in Puget Sound, and that a delisting decision will not be greatly influenced by the status of the WRIA 9 population; he also emphasized that the population is heavily influenced by hatchery production. He noted his bias is toward emphasizing monitoring individual projects; however, the Plan should also address population-level monitoring of the VSP parameters. Mike also posed the question-How do we make this effort adaptive?

2. Round table discussion of key big picture questions:

a. Realistic goals:

- The discussion centered on what makes the most sense to monitor. The basics are outline in chapter 9 of the Habitat Plan.
- The key questions to address when monitoring individual projects are: Did we implement the project as planned, and did we get the expected result? The latter would include both the physical changes expected as well as the biological changes expected.
- A recommendation was made to include check-in dates to measure progress toward implementing the overall program (e.g., five-year and 10-year reports to summarize how we're doing).
- Monitoring should address how much habitat is gained and whether Chinook are utilizing the habitat.

- VSP monitoring will likely require a long-term commitment that State and Federal funding will continue. The AM Plan needs to state what needs to be done re: VSP monitoring.

b. Conservation Hypotheses:

- There was general agreement that the Habitat Plan conservation hypotheses were not designed to be tested in a statistical sense. Instead, they were the principles that became the framework for identifying and prioritizing habitat actions. As we implement and assess the effectiveness of individual projects we will be contributing to a validation of the conservation hypotheses…but not explicitly testing them.
- Active vs. passive project monitoring was raised. Do we gather data/monitor all projects implemented, or do we identify selected projects that are representative of a class of projects (e.g., levee setbacks; riparian restorations, etc.) and design more targeted monitored?
- Design strategies for new projected need to be informed by what we have already learned. This is a key to adaptive management.
- Project implementation and monitoring should focus on actions or projects that link to the Tier 1 conservation hypotheses.
- It was noted that long-term project maintenance should be an integral part of project planning and implementation. We should encourage a "culture" that includes monitoring and maintenance as a "required" part of a project plan.
- Need to take advantage of opportunities to involve the public in project monitoring.
- Need to explicitly consider how information is factored into future choices.

c. Project monitoring vs. VSP monitoring:

- Both project monitoring and VSP monitoring are needed and should be addressed by the AM Plan.
- Important too lay out what we think needs to be done for validation monitoring.
- VSP monitoring complicated by the fact that 60% of spawning Chinook in WRIA 9 are first generation hatchery fish.
- The AM Plan needs to be clear about what we can do and can't do regarding VSP monitoring.
- Landscape scale, water quality, and subwatershed monitoring also necessary.
- Overall agreement by the Work Group to focus on project monitoring.

d. Duration of post-construction monitoring:

- There was general agreement that five years of monitoring spread over time (10 years?) is realistic, but "longer is always better."
- Duration of monitoring might vary depending on the type of project.
- The AM Plan should explicitly note of new State and Federal wetland guidelines and address minimum monitoring requirements.
- Need to address what constitutes baseline pre-construction monitoring.

e. On-going monitoring:

- There is a need to conduct an inventory of what is currently occurring (e.g., spawning ground surveys, smolt trapping), and make an assumption about how long into the future these activities are likely to continue.

f. Steelhead:

- There was general agreement that the focus of the AM Plan should be on Chinook. However, the Plan should note where monitoring addresses multiple species.

g. Contingencies:

- Need to demonstrate the added value of integrating monitoring into project implementation.
- Success/failure workshops were suggested to keep interested parties informed about what is going on.
- Need to focus on that which we can control, but need to be aware of what's affecting every population (e.g. global warming, harvest).
- Need to be explicit in the AM Plan regarding guidance from Shared Strategies.

WRIA 9 Adaptive Management Work Group Meeting Summary

May 24, 2006
10:00 to 12:00PM
King Street Center

ATTENDEES:

Gordon Thomson-WRIA 9
Mike Schiewe-Anchor Environmental
Ann Kenny-Port of Seattle
Joan McGilton-City of Burien
Jennifer Knauer-King County
Dennis Clark-WRIA 9
John Koon-Green River Flood Control Zone District

1. Welcome and Introductions:

- The meeting began with welcome and introductions. Gordon reviewed the calendar for remaining Work Group meetings, noting there is an option for an additional meeting in the last week of July or first week of August if needed. Gordon also noted that the Shared Strategies H-integration workshop is scheduled for June 20 and 21 and encouraged everyone in the Work Group to attend.
- Corrections to the May 10, 2006 Work Group meeting summary were made. Gordon said he would final the summary and email it to all Work Group members the following week.

2. Discussion of Monitoring and Adaptive Management Plan

a. General organization of the plan:

- Gordon and Mike explained differences between the draft Monitoring and Adaptive Management Plan outline included in the May 24 meeting packet and the preliminary draft Monitoring and Adaptive Management Plan Gordon distributed in April, noting that the draft outline incorporated thinking from the May 10 meeting discussion, and although formatted differently than the April draft would include many of the same elements, particularly the adaptive management chapter.
- Mike covered the background section of the draft outline, noting that its purpose is to describe the WRIA 9 Watershed and the development of the Habitat Plan, and address the relationship of WRIA 9 to the rest of the Puget Sound watersheds and to the ESU.

b. Types of monitoring to be described in the plan:

- Under the Project –Specific Monitoring section (2.1), effectiveness monitoring would include physical effectiveness monitoring and maintenance.

- Watershed-wide monitoring (section 2.2) would include progress toward implementing the overall Habitat Plan, changes in selected environmental indicators (emphasizing progress toward achieving Necessary Future Conditions), and VSP monitoring.
- A question was posed regarding existing conditions as a baseline and how to establish a baseline. No specific conclusions were reached regarding how to establish a baseline; however, it was agreed that the plan needed to address this issue. This effort will likely require a mapped-based inventory of current conditions.
- A discussion ensued regarding how to document habitat improvements that accrue through implementation of local programs and regulations carried out by individual jurisdictions. It was noted that NPDES permits may require measurable outcomes that could be a source of some these data. However, this probably would not be the case for most programs. The Work Group generally agreed there is a need for tracking habitat changes that result from local programs and regulations monitoring, particularly those that include some degree of effectiveness monitoring. There was discussion regarding whether program/regulatory monitoring should be included in the environmental indicators section (2.2.2) or as a separate section before section 2.2.
- It was noted that King County Environmental Indicators, PSNERP, and PSAT data sources could be useful in WRIA 9 monitoring, and should be considered in the Plan. It was also noted that NOAA is still working on what their expectations are regarding monitoring data. The Work Group agreed that management of VSP data would be best handled on a regional, Puget Sound-wide basis.
- There was strong support for moving the data management section (currently Section 4.4) to a more prominent position document, perhaps ahead of the integration section. It was felt that data management is essential to a successful monitoring and adaptive management program.
- The potential role of quantitative modeling (vis-à-vis what action to take if we are not making progress towards recovery) was discussed. It was agreed the plan should address the option for use in 5 to 10 years if we are not achieving our goals.

c. Integration of hatchery and harvest issues:

- The role of the All-H Analyzer tool was also discussed. It could perhaps be useful in developing the H-integration section of the Plan. Mike said he would research what outputs are generated by the calculator, and how it might be incorporated.

3. Development of Project Specific Monitoring Elements

- Mike reviewed the project list types and the Table 1 handouts from the meeting packet.
- Under implementation monitoring, it was noted that a distinction needs to be made between construction implementation and construction effectiveness monitoring for plantings. It was also noted that some plantings occur over a period of several years and that this needs to be taken into account when determining when a project has been "completed."

- Under the Performance Standards column it was noted that design drawings and approved modifications should be included.
- Under physical effectiveness monitoring a number of questions were raised regarding what is the baseline, the use of reference sites, monitoring the effects in the immediate project area, and how much pre-construction monitoring should occur. No conclusions were reached, but the discussion served to highlight the issues that will require additional attention.
- It was noted that a more detailed treatment of a few representative projects would be a valuable way to communicate what a project-specific monitoring program would include.
- It was noted that monitoring of WRIA 9 projects could be complemented by monitoring of common project types elsewhere in Puget Sound. Effectiveness monitoring of generic projects elsewhere could provide information to improve management in WRIA 9. In other words, it should not be necessary at the project level to monitor every project for effectiveness or even one project of every type (e.g., side channel reconnection, tributary mouth restoration).
- People agreed that two of the six common project types in WRIA 9 would be most worth monitoring for effectiveness given their importance to increasing habitat productivity:
    - Levee/revetment removal or setback
    - Creation of shallow water or marsh habitat (especially in the Duwamish transition zone)
- Overlap with local jurisdiction permit monitoring requirements was discussed. It was suggested that it would be useful to distinguish between monitoring that might be required for construction permits vs. that which might be required to track project effectiveness.
- It was noted that recommendations made in the WRIA 9 Monitoring and Adaptive Management Plan could guide how other watersheds and Shared Strategies proceed.

4. Wrap-up

- Mike said he would ask Paul Schlenger to contact Tom Nelson (King County WLRD) regarding the KCD monitoring project.
- Gordon said he would pass along information from the Friday, May 26 Shared Strategies monitoring meeting to the Work Group.
- Gordon said he would query Paul Hickey regarding Tacoma Water's HCP monitoring program for the Upper Green.
- Gordon said he would contact those Work Group members who were absent and encourage them to attend future meetings.
- Mike reviewed future Work Group meetings as follows:

  Adaptive Management on June 7
  Watershed-wide monitoring on June 28 (will also include H-integration)
  VSP monitoring on July 5.

WRIA 9 Adaptive Management Work Group Meeting Summary

June 7, 2006
10:00 to 12:00PM
King Street Center

ATTENDEES:

Gordon Thomson-WRIA 9
Mike Schiewe-Anchor Environmental
Ann Kenny-Port of Seattle
Joan McGilton-City of Burien
Julie Hall, SPU
Kirk Lakey, WDFW
Chris Sergeant, Shared Strategy
Dennis Clark-WRIA 9

1. Welcome and Introductions:

- Chris Sargent from Shared Strategy and Kirk Lakey from WFDFW were introduced.
- The minutes from the May 24th meeting were approved.

2. Shared Strategy adaptive Management-Chris Sergeant

- Chris provide a handout summarizing the goals of the pending June 20-21 H-integration workshop.
- The workshop is intended to emphasize the importance of coordinating actions among harvest, hatchery, and habitat managers, to describe the steps to advance H-integration and how they relate to adaptive management including tools such as the All H Analyzer (AHA).
- Chris talked about the need to identify limiting factors and VSP parameters as an organizing tool for evaluating questions and metrics.
- The workshop agenda should be available during the week of June 12.
- Kirk Lakey mentioned the AHA calculator is being updated for Fall 06.
- Chris also provided a comment on the draft annotated outline for the WRIA 9 AM plan. He recommended "breaking out" biological effectiveness monitoring into its own validation monitoring category. (Chris had to leave for another meeting).

3. Adaptive Management Approach for WRIA 9

a. General comments:

- Mike began by posing the question, who is the audience for the WRIA 9 AM Plan? It was agreed by the Work Group that the WRIA Watershed Forum is the primary audience because they establish the work program for the WRIA. It was also recognized that we will deal with limiting factors and delisting criteria as best we can.

- Mike reviewed table 1 (updated from the previous draft). As a general comment, the Work Group recommended replacing the reference to "success/failure" with less stark terms.

b. Project specific:

- Gordon noted that Tom Nelson is working on developing pre and post construction monitoring templates for marine and mainstem projects. Gordon also recommended stating explicitly when a report was required from the Adaptive Management Technical Committee in the process column.
- Questions posed included how do we report results (in particular success) and who does it? Much of this will likely become the responsibility of the AM Technical Committee.
- Mike recommended the four questions addressing "biological effectiveness" in table 1 be consolidated into two.
- RE: do we want to establish statistically significant changes; Dennis suggested identifying "sample" projects for statistical evaluation.
- Julie queried, is the idea to tweak each project based on results of implementation/effectiveness monitoring or to look at all projects to inform the success of future projects (also How does Shared Strategy intend to address this?).
- Gordon suggested we'd likely do both. Also monitor those projects that are most "replicable." There is also a need for "reference sites."
- Dennis asked if there is a role for the WRIA in monitoring a project instead of the project implementer to assure objective results. Julie suggested we could address this issue with an on-call consultant for project implementers to use.
- Overall consensus that we need to role in monitoring as part of project funding.

c. Watershed wide:

- Dennis and Gordon will "word smith" the benchmarks column.
- Julie recommended metrics be in acres/lineal miles etc.
- Agreed we need to add a column to table 1 for example metrics.
- Do we make explicit options in the case of "barriers"?
- Gordon and Dennis will work on identifying watershed wide "programs."
- Need to address environmental indicators such as necessary future conditions. This feeds into the Shared Strategy effort Chris addressed earlier in the meeting.
- Possible indicators include length bulkheads removed/added, width of channel migration zone, impervious surface, forest cover (need to distinguish between urban and rural). Good place to use multispectral analysis. **The group agreed to email Environmental Indicator needs to Gordon who would compile a master list for the June 28th meeting.**
- Group agreed that an annual State of the Watershed report is needed.
- Questions: How does population level monitoring relate to necessary future conditions, do we look at trends in meeting VSP goals, and how do we monitor juvenile abundance?

4. Wrap-up

- Watershed-wide monitoring on June 28 (will also include H-integration). VSP monitoring on July 5.

WRIA 9 Adaptive Management Work Group Meeting Summary

June 28, 2006
10:00 to 12:00PM
King Street Center

ATTENDEES:

Gordon Thomson-WRIA 9
John Koon- Green River Flood Control Zone District
Kirk Lakey- WDFW
Chris Sergeant- Shared Strategy
Dennis Clark-WRIA 9
Mike Schiewe-Anchor Environmental
Jennifer Knauer- King County

1. Comments on June 7 Workshop Minutes:

- The minutes from the June 7th meeting were approved. Minor editorial changes were made by Dennis Clark

2. Debrief from Shared Strategy H-Integration Workshop:

- Gordon and Chris summarized the H-integration workshop. Gordon noted that the table discussions were useful because habitat, hatchery, and harvest folks were in the same room discussing the issues. Gordon also noted that the Shared Strategy proposal for watersheds to submit H-integration work plans by August/September was met with resistance because Lead Entities are in the middle of the SRFB process at that time.
- Chris mentioned that Shared Strategy intends to have a regional adaptive management plan ready by the end of 2006.
- Work Group members were interested in what kind of data NOAA Fisheries is expecting for tracking progress toward VSP improvement. This is a Big Question. Chris said the Feds are working through Shared Strategy but haven't yet developed what VSP data they expect to see.

3. Revisit Adaptive Management Topics:

- Gordon and Dennis reviewed their edits to the AM matrix. Overall the Work Group was satisfied with the results but understood additional work needs to be done, particularly in determining amounts of habitat to be restored during the 3, 5, 8, and 10 year time frames. *The matrix will also be revised to indicate the restoration goals are cumulative.*

- Mike will do additional work on the matrix to compress the biological effectiveness questions from 4 to 2.
- Jennifer recommended expanding the definition of restoration to include creation and enhancement. The term is currently used expansively to include creation, enhancement, rehabilitation, and substitution, but could be explained further in the matrix or in the text of the AM Plan.
- It was recommended that "creation" be replaced with "completion" in reference to habitat restoration targets.
- Under program and regulatory monitoring, the Work Group agreed that a check in with jurisdictions after three years was appropriate to determine the percentage of applicable programs implemented.

4. Discussion of Environmental Indicators:

- Mike said the purpose of environmental indicators (E.I.) is to "see how we're doing." E.I.'s are a reporting tool for the benefit of the watershed Steering Committee and Forum, and will probably not be used by the Feds for delisting purposes.
- Dennis reviewed the King County E.I. draft. One benefit of the King County E.I. program is that the data are being collected or will be collected.
- Mike reviewed the E.I. matrix prepared by Anchor. He noted the first page of E.I.'s are those most likely to be evaluated, and suggested using necessary future conditions as a goal. Mike also noted that E.I.'s are meant to be watershed wide and not project specific.
- It was noted that most of the page 1 E.I.'s related back to the Habitat Plan.
- Page 2 of the E.I. matrix are those that are "nice to do" but probably not essential. They are also more expensive because they rely primarily on collection of field data instead of aerial photo and map interpretation.
- The primary issue is determining what E.I. information you want, what it tells you, and what you want to do with the information.
- The Work Group agreed to revisions to the E.I. matrix as follows:
  -delete E.I. "miles of side channel" and "number of pocket estuaries" on page 1.
  -add LWD to the spawning gravel distribution E.I. on page 1, or include on page 1 as a separate E.I..
  -do not use page 2 E.I.'s except for LWD.
- Dennis suggested adding the benthic inventory integrity insect (BiBi) counts to the water quality E.I.. Dennis will follow up on where the data are currently being collected.
- The King County Shoreline Master program update was noted as a potential source of data.
- Chris noted that Rick Hauer from the University of Montana has developed a state-of-the-art multispectral monitoring technique that could be useful. It is very detailed using both over-flight and on the ground monitoring and is also very expensive.

5. Wrap-up

- John asked how we are addressing other monitoring efforts, e.g. King County, SRFB. We agreed we should coordinate efforts to the extent we can.
- Kirk noted that the NMFS adopted Forest and Fish HCP adaptive management plan is considered the most current habitat A.M. plan and may be worth looking at.
- Gordon reminded the group that the next meeting is scheduled for Wednesday July 5th, and that the Wednesday July 19 is rescheduled to Thursday July 20, from 1 to 3 in the King room.
- Kirk Lakey and Any Applebee from WDFW will present the results of the AHA calculator to the Group at the final meeting on Monday, July 30 from 10 to noon in the King room.

WRIA 9 Adaptive Management Work Group Meeting Summary

July 5, 2006
10:00 to 12:00PM
King Street Center

ATTENDEES:

Gordon Thomson-WRIA 9
Ann Kenny-Port of Seattle
Joan McGilton-City of Burien
Chris Sergeant- Shared Strategy
Dennis Clark-WRIA 9
Mike Schiewe-Anchor Environmental
Jennifer Knauer- King County

1. Comments on June 28 Workshop Minutes:

- The minutes from the June 28th meeting were approved. Minor editorial changes were made by Dennis Clark
- Dennis reported back on the use of BIBI as a possible environmental indicator measure. Based on a discussion with Gino Lucchetti from King County DNRP, its use would be limited to tributaries and would not be useful for the main stem of the Green River.

2. VSP Discussion

- Mike handed out a "primer" on VSP based on a similar document he prepared for WRIA 8.
- Mike noted that if only one VSP parameter could be monitored that "productivity" is generally the most important. Mike also noted that the WRIA 9 focus on productivity and spatial structure effectively includes abundance and life history diversity.
- Much of the discussion centered on roles and responsibilities of WRIA 9, Washington State, and NOAA Fisheries. In particular, it was agreed that NOAA needs to provide guidance to WRIA 9 regarding how to deal with a hatchery that allows a large number of hatchery fish to spawn naturally. It was noted that the Governor's Monitoring Forum is also looking at appropriate data for measuring Puget Sound VSP effectiveness.
- It was noted that productivity changes will take many years to see statistically.
- The Work Group agreed that VSP expectations with respect to what data to collect and data management needs to come from NOAA. As a practical matter, the Work Group also agreed that WRIA 9 does not have the capability to collect and manage long term VSP data and should focus its monitoring and adaptive management efforts on projects.
- The Work Group agreed that WRIA 9 needs to tie project implementation to minimization of risks to productivity.

- Mike noted that NOAA is interested in examining the potential to establish a spring Chinook population in the Upper Green based on White River brood stock.
- Chris noted that NOAA has established a general delisting framework and habitat listing factors that may be useful. Chris said he would email the link to Gordon who will distribute it to Work Group members.
- Limiting factors should be addressed in the WRIA 9 adaptive management plan. The WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment report can be used as the source for that information.

3. Wrap-up

- Gordon reminded the group that the next meeting is scheduled for Thursday July 20, from 1 to 3 in the King room. The WDFW presentation on the AHA calculator is scheduled from Monday July 31 from 10 to noon in the King room.

WRIA 9 Adaptive Management Work Group Meeting Summary

July 31, 2006
10:00 to 12:00PM
King Street Center

ATTENDEES:

Gordon Thomson-WRIA 9
Dennis Clark-WRIA 9
Mike Schiewe-Anchor Environmental
Paul Hage-Muckleshoot Tribe
Kirk Lakey-WDFW
Gin Lucchetti-King County
Andy Applebee-WDFW
Doug Osterman-WRIA 9

1. Data Management

- The first hour of the meeting was spent discussing data management needs and capabilities for implementing Habitat Plan.
- Gordon described the current King County CIP data base for tracking WRIA 9 projects, and handed out a sample page illustrating the information that is currently tracked. The data base is available on-line via the WRIA 9 web site and can be reviewed without a password. Gordon said he would email the Work Group the data base web link.
- Mike described the monitoring elements for the plan (i.e. project, watershed shed-wide, and VSP).
- It was noted that WRIA 9 needs to track environmental indicators and tie them to limiting factors as part of watershed-wide monitoring.
- VSP monitoring would come from WDFW spawning ground surveys and smolt traps.
- Data management issues that will need to be addressed include data sharing agreements re: who has access to the data, who can update and revise data, etc.
- Dennis noted that we also need to track programs. We have done this in table format as part of the Near Term Action Agenda implementation.
- Kirk noted that WDFW does not have a centralized data base. Most data bases in the department are individual project data bases and were developed as a new program was implemented. This is similar to King County's and the Muckleshoot Tribe's experience.

2. All-H Calculator

- The remaining two hours of the meeting were spent reviewing and discussing the AHA calculator. Andy Applebee and Kirk Lakey form WDFW provided an overview of the calculator and then demonstrated its application to WRIA 9.
- The AHA calculator was developed by the Hatchery Scientific Review Group (HSRG) in 2002. WDFW has about 2-3 years experience using the calculator to address Puget Sound Coho and Chinook.
- Andy noted the calculator is a gene flow tool.
- Andy demonstrated application of the AHA calculator to the Green-Duwamish system.
- The current AHA calculator for the Green/Duwamish assumes a productivity of 8 recruits per spawner and a capacity of 20,000.
- WDFW intends to progressively release fewer hatchery juveniles from Soos Ck. to reduce competition with NORs.
- Kirk and Andy left a copy of the AHA calculator with WRIA 9 staff. We hope to meet with Kirk and Andy again once we've had a chance to play around with the calculator ourselves.

3. Wrap-up

- Gordon thanked the group for their participation. Anchor Environmental will work on a drafting the Monitoring and Adaptive Management plan for peer review while Gordon is on vacation during the month of August. Gordon will finalize the draft after he returns (August 28th) and email the document to the Work Group for a two week review and comment period. Technical reviewers in addition to those who participated on the Work Group will also be included. A final draft will be presented to the WRIA 9 Steering Committee in October and to the WRIA 9 Forum for their approval in November.

APPENDIX B
EXAMPLE OF EXPANDED LEVEE MONITORING

MONITORING LEVEE SETBACK/FLOODPLAIN CONNECTION PROJECTS

Levee setbacks and floodplain connection projects are a primary type of habitat improvement project identified in the WRIA 9 Salmon Habitat Plan that can be constructed to rehabilitate natural processes along a stretch of river while maintaining the integrity of the flood control system. Monitoring of the physical effectiveness of these projects is necessary to ensure the structural integrity of the flood control system and to understand the sustainability of the physical habitat conditions created by the project. Monitoring of the biological effectiveness is necessary to understand whether the type of project and/or project design actually produces a beneficial biological response that can promote recovery of the Chinook population.

In this section, a monitoring approach is described that elaborates upon the physical effectiveness monitoring outline provided in Table 3 of the main report. In addition to the monitoring activities described here, regulatory agencies may require additional monitoring as part of the permit requirements. Additional elaboration in biological effectiveness monitoring has not been included because it depends highly on project specific considerations. Consideration of size, location, availability of reference sampling locations all contribute to the development of the biological monitoring program. Equally important are the restoration objectives of the project. As described in Pess et al. (2005), the project objectives dictate the appropriate sampling design.

In WRIA 9, the Green River Flood Control Zone District (GRFCZD) is responsible for maintaining river facilities, including levees and revetments, along the heavily developed Lower Green River. The boundaries of the GRFCZD extend from river mile (RM) 33.85 where State Route 18 crosses the river downstream to RM 6.5 where State Route 99 crosses the river. The Cities of Auburn, Kent, and Tukwila, as well as unincorporated portions of King County occur along this portion of the river.

Monitoring Objectives

The primary objectives of the physical effectiveness monitoring of this type of project are to:

1) Ensure that the structural integrity of the flood control structure remains intact; and
2) Assess the spatial extent and accessibility of created habitat.

Another objective of the monitoring approach is to be consistent with the performance monitoring elements related to physical effectiveness that King County, as supervisors of

the GRFCZD, committed to in a Biological Assessment (KCDNR 2001) prepared for consultation with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) to address potential Endangered Species Act (ESA) liability.

Monitoring Schedule

The physical effectiveness and sustainability monitoring will be scheduled for post-construction years 0, 5, and 10. The post-construction Year 0 monitoring will serve as "as-built" monitoring and will be conducted be conducted immediately following construction. The post-construction Years 5 and 10 monitoring will be conducted during the late summer low flow period. For example, if project construction is completed in October 2008, then the post-construction Year 0 monitoring will occur in October or November 2008, the Year 5 monitoring will occur during a summer low flow period in 2013, and the Year 10 monitoring will occur during a summer low flow period in 2018. In addition, photographs of the site will be taken from fixed locations every summer and winter.

Additional long-term monitoring will occur during and after major storm or flow events that have the greatest potential to affect the structural integrity of the levee or revetment. Major storm events are defined as 10-year recurrence interval storms and major flow events are those in which flows exceed 9,000 cubic feet per second. The storm event monitoring will occur after the storms, but may require additional monitoring during the next subsequent low flow period in order to assess conditions along the lower portions of the structure. Given the role of levees and revetments in flood control and public safety, it is recommended that storm event monitoring is conducted in perpetuity.

Monitoring Area

The monitoring area will include the entire project area, as well as adjacent upstream and downstream portions of the river that may be affected by the project (e.g., experience channel scour or bank erosion). The extent of upstream and downstream monitoring will be site specific and can be determined by the design engineers using the area's baseline information that contributes to the project design.

Monitoring Approach

Post-Construction Monitoring in Years 0, 5, and 10

The post-construction Year 0 monitoring will focus on collecting information to characterize the "as-built" conditions at the site in order to ensure that construction activities successfully adhered to the design drawing and approved modifications. This information will also serve as the new baseline that all subsequent monitoring results will be evaluated against.

The post-construction monitoring in Years 5 and 10 will entail collecting detailed topographic data along throughout the shoreline, including the upland, bank, and in-water portions. The topographic data collection efforts would need to include the collection of channel morphology data along the wetted portion of the survey area. Topographic data collection should extend upstream and downstream of the project area with the extent determined based on site specific considerations of how far project effects could extend.

Topographic data can be collected using a total station that collects horizontal and vertical position data. Data collection is recommended to be conducted in one of two ways. One option is to collect data along transects that run perpendicular to the river direction. Transect spacing could be varied based on the size of the project, but transects spaced every 30 feet is a reasonable default distance. Additional transects running approximately parallel to the river direction can also be useful. A sufficient number of data points should be collected along each perpendicular transect to allow for interpretation of 1 foot changes in elevation. Another option that provides a more complete picture, but entails greater effort, is to collect numerous data points throughout the survey area in order to allow for the creation of computer generated 1 foot elevation contours. For such an effort, data points should be collected throughout the survey area at locations of gradient changes, areas of apparent erosion, and at the waterline.

During the collection of topographic data, observations of bank failure, including slide, slumps, and surface erosion should be noted. If areas of bank erosion are identified, sufficient topographic data should be collected to characterize the extent and magnitude of bank failure.

Water level recorders positioned at the inlet of the created floodplain habitat would provide important information on when the area becomes inundated. This gage could be calibrated to the U.S. Geologic Survey gaging stations in the watershed. Alternatively, stage-discharge relationships using the topographic data can be useful to generally estimate when the created habitat becomes inundated.

Monitoring During and After Major Storm or Flow Events

During and after major storm or flow events, visual inspection of the levees will be conducted to investigate signs of bank failure, including slides, slumps, and surface erosion. Depending on the flows at which these surveys are conducted, the occurrence of inconclusive signs of erosion, and the perceived completeness of the visual inspections, additional inspections during the period of low summer flows may be advisable.

Semi-annual Photographs from Fixed Locations

Photographs will be taken from fixed locations throughout the project area to document the stability of the site and the succession of the riparian vegetation. Photographs will be collected each year during an established winter and summer time period.

Data Analysis

Data collected during the post-construction year-0 monitoring event will be analyzed to assess adherence to design drawings and approved modifications. The water level data (or stage-discharge relationships) will provide information to estimate the flows necessary for the created habitat areas to become accessible. Using this information, the spatial extent of inundated and accessible created habitat can be estimated over a range of flows and compared to the design objectives. An additional analysis of recent historic and minimal flows will provide information on the amount of time and portion of the year when the created habitat can be expected to be accessible.

Data collected during post-construction Years 5 and 10 can be analyzed to determine locations of scour or accretion within the channel and for areas of apparent erosion along the banks. The channel information is useful for understanding whether potential

damaging undercutting or scour is occurring within the project area, including upstream and downstream areas. The upland and bank data can also be analyzed to evaluate whether the inlet or outlet of the created habitats have changed elevations such that accessibility may have changed.

Analysis of monitoring information collected during and after major storm events or flow events will focus on identifying signs of bank failure that may compromise the structural integrity of the levee and/or the quality of the created habitat. If a major storm or flow event appears to have altered the bank or channel topography, additional topographic data collection may be useful to understand the extent of the changes and to determine whether the levee or revetment design is causing adverse erosion or sedimentation.

The semi-annually collected photographs can be compared to previous photographs to document the site's stability and riparian vegetation succession.

Effectiveness Criteria

Construction Matches Designs Drawings

The monitoring data collected during the post-construction Year 0 survey will be evaluated to ensure that the project was constructed as designed, including approved modifications. If the constructed project does not achieve the intended design specifications, project modifications may be desirable to ensure the habitat restoration elements are satisfactorily completed. However, at this point of the project, it would be up to the project sponsor and the contract language to determine whether the contractor is obligated to adjust the project construction.

No Evidence of Bank Failures

Any signs of bank failure, including slides, slumps, or surface erosion will require evaluation of whether site maintenance actions are necessary.

No Evidence of Adverse Erosion or Sedimentation

Any signs of adverse erosion or sedimentation along the banks or within the channel will require evaluation of whether site maintenance actions are necessary. This evaluation would be conducted by the project sponsor and/or GRFCZD.

Accessibility Established to Intended Portion of Floodplain

The accessibility of the restored areas will be established as intended for the target life stage(s) of salmon during the intended portions of the year. The accessibility will be compared to the accessibility expected by the design and possible adjustments to the project design may be considered by the project sponsor, the GRFCZD, and/or the ITC.

Reporting

The project sponsor will be responsible for conducting and reporting the monitoring efforts. The ITC should be notified at the onset of monitoring efforts associated with major storm or flow events. Separate monitoring reports will be conducted after each of the post-construction years 0, 5, and 10 monitoring efforts, as well as the major storm and flow event monitoring efforts. The reports will include methods, results, and analysis. Each report will document any signs of bank failure, as well as any required or recommended maintenance activities.

The post-construction years 0, 5, and 10 monitoring reports will include an analysis of the topographic data compared to the year 0 and most recent monitoring data. The semi-annual photographs will be included in the ensuing post-construction year monitoring report.

Monitoring reports will be provided to the WRIA 9 Technical Committee, the GRFCZD, and any regulatory agencies that may require monitoring.

REFERENCES

KCDNR. 2001. Lower Green River Levee and Revetment Repairs Construction Years 2001-2003 Batched Biological Assessment for Puget Sound Chinook and Coho Salmon, Bull Trout and Bald Eagle. Second Draft Report Prepared by King County Department of Natural Resources, Water and Land Resources Division, Rivers Section. February 2001

Pess, George R., Sarah A. Morley, Julie L. Hall, and Raymond K. Timm. 2005. Monitoring Floodplain Restoration. *In* Monitoring stream and watershed restoration. P. Roni, editor. American Fisheries Society, Bethesda, Maryland.

APPENDIX C
EXAMPLE OF SHALLOW WATER HABITAT MONITORING

MONITORING SHALLOW WATER CREATION PROJECTS

Many of the juvenile salmon rearing areas in the lower portions of the Green/Duwamish River and estuary as well as the marine nearshore have been modified in ways that reduce the availability of shallow water habitats for the small fish. Creation of shallow water habitats are a primary type of habitat improvement project identified in the WRIA 9 Salmon Habitat Plan because these habitats can provide important foraging and refuge areas that promote juvenile salmon survival to the next life stage. Physical effectiveness monitoring of these projects is necessary to ensure they are constructed as designed and to understand the sustainability of the project design. Biological effectiveness monitoring is necessary to understand whether the type of project and/or project design actually produces a beneficial biological response that can promote recovery of the Chinook population. At this time, the scientific understanding of the physical sustainability and biological effectiveness is an emerging science; therefore, rigorous monitoring of projects in diverse locations within the watershed and over a range of sizes could significantly contribute to future habitat creation projects throughout the region.

In this appendix, a monitoring approach is described that elaborates upon the physical effectiveness monitoring outline provided in Table 3 of the main report. Additional elaboration in biological effectiveness monitoring has not been included because it depends highly on project specific considerations. Consideration of size, location, and availability of reference sampling locations all contribute to the development of the biological monitoring program. Equally important are the restoration objectives of the project.

Monitoring Objectives

The primary objectives of the physical effectiveness monitoring of this type of project are to ensure that over time the created habitat continues to be accessible and in a configuration/condition that provides high quality rearing habitat for juvenile salmon.

Monitoring Schedule

The physical effectiveness and sustainability monitoring will be scheduled for post-construction years 0, 1, 3, 5, and 10. The post-construction year-0 monitoring will serve as "as-built" monitoring and will be conducted be conducted immediately following construction. The post-construction years 1, 3, 5, and 10 monitoring will be conducted during the late winter (early March) after the winter storm period has passed. For example,

if project construction is completed in October 2008, then the post-construction year-0 monitoring will occur in October or November 2008, the year-1 monitoring will occur in March 2009, and the years 3, 5, and 10 monitoring will occur in 2011, 2013, and 2018, respectively. In addition, photographs of the site will be taken from fixed locations every summer and winter.

Additional long-term monitoring will occur during and after major storm or flow events that have the greatest potential to redistribute sediments within the created habitat and affect habitat quality. Major storm events are defined as 10-year recurrence interval storms and major flow events are those in which flows exceed 9,000 cubic feet per second.

Monitoring Area

The monitoring area will include the entire project area, as well as adjacent upstream and downstream (or updrift and downdrift) areas that may be affected by the project (e.g., altered sediment transport or scour). The appropriate extent of upstream and downstream monitoring will be site specific and can be determined by the design engineers using the area's baseline information that contributes to the project design.

Monitoring Approach

Post-construction Monitoring in Years 0, 1, 3, 5, and 10

The post-construction year-0 monitoring will focus on collecting information to characterize the "as-built" conditions at the site in order to ensure that construction activities successfully adhered to the design drawings and approved modifications. This information will also serve as the new baseline that all subsequent monitoring results will be evaluated against. The post-construction monitoring in years 1, 3, 5, and 10 will revisit monitoring locations established in the year-0 monitoring.

The topography of the created habitat and all appropriate upstream and downstream (or updrift/downdrift) areas will be characterized by surveying multiple transects that run across all elevations of the created habitat (i.e. perpendicular to the shoreline). These transect profiles can be surveyed using a total station that collects horizontal and vertical position data. Data points should be collected at each gradient change. Elevations should be tied back into established elevation benchmarks (e.g., USGS or Port

benchmarks). Transect spacing should be determined based on the size of the project and the heterogeneity of the created habitat, but would be expected to be between 40 and 100 feet along the created habitat. Additional transects running approximately parallel to the shoreline, for example at the waterline during different tide stages, can be useful for developing a more detailed perspective on the project area topography.

Sediment sampling will be conducted along each profile to characterize substrate sizes. It is recommended that two or three samples be collected per transect to characterize sediments in the upper and lower habitat elevations. If the created habitat is expected to possibly provide spawning habitat for marine forage fish species that spawn in the upper intertidal zone, sediment sampling should emphasize sample collection near mean higher high water. Substrate sizes can be characterized using the Wentworth scale or other appropriate method.

Monitoring During and After Major Storm or Flow Events

After major storm or flow events, visual inspection of the created habitat will be conducted to investigate signs of sediment redistribution that may affect site access or habitat quality. Depending on the findings of the visual inspection, a topographic survey of all or a portion of the project area may be informative to document changes.

Semi-annual Photographs from Fixed Locations

Photographs will be taken from fixed locations throughout the project area to document changes at the site. Photographs will be collected each year during an established late winter and summer time period.

Data Analysis

Data collected during the post-construction year-0 monitoring event will be analyzed to assess adherence to design drawings and approved modifications. Data collected during post-construction years 1, 3, 5, and 10 can be analyzed to identify areas of scour or accretion, as well as changes in the substrate size distributions at the site. Transect profiles in the project area should be compared to those upstream and downstream to determine if a naturally sloped beach is being sustained.

Analysis of monitoring information collected during and after major storm events or flow events will focus on identifying signs of significant site alterations that greatly diminish the habitat quality. The semi-annually collected photographs can be compared to previous photographs to document the site's stability.

Effectiveness Criteria

Increased Amount of Naturally Sloped Shoreline Shallow Water Habitat

The monitoring data collected during the post-construction surveys will be evaluated to determine whether the created habitat maintains a configuration similar to naturally sloped shorelines in the area.

No Reduction in Diversity and Quality of Habitat Over Time

The monitoring data collected during the post-construction surveys will be evaluated to determine whether the created habitat provides the intended (or acceptably beneficial) habitat diversity and quality.

Peak Flows or Tides Do Not Cause Adverse Erosion or Flooding

Any signs of adverse erosion or flooding along the shoreline will require evaluation of whether site maintenance actions are necessary.

Reporting

The project sponsor will be responsible for conducting and reporting the monitoring efforts. The Adaptive Management Technical Committee (ITC) should be notified at the onset of monitoring efforts associated with major storm or flow events. Separate monitoring reports will be conducted after each of the post-construction years 0, 1, 3, 5, and 10 monitoring efforts, as well as the major storm and flow event monitoring efforts. The reports will include methods, results, and analysis. Each report will document any signs of bank failure, as well as any required or recommended maintenance activities.

The post-construction monitoring reports will include an analysis of the topographic data compared to the year-0 and most recent monitoring data. The semi-annual photographs will be included in the ensuing post-construction year monitoring report.

Monitoring reports will be provided to the WRIA 9 Technical Committee and any regulatory agencies that may require monitoring.

WRIA 9 IMPLEMENTATION ORGANIZATION

Figure 1

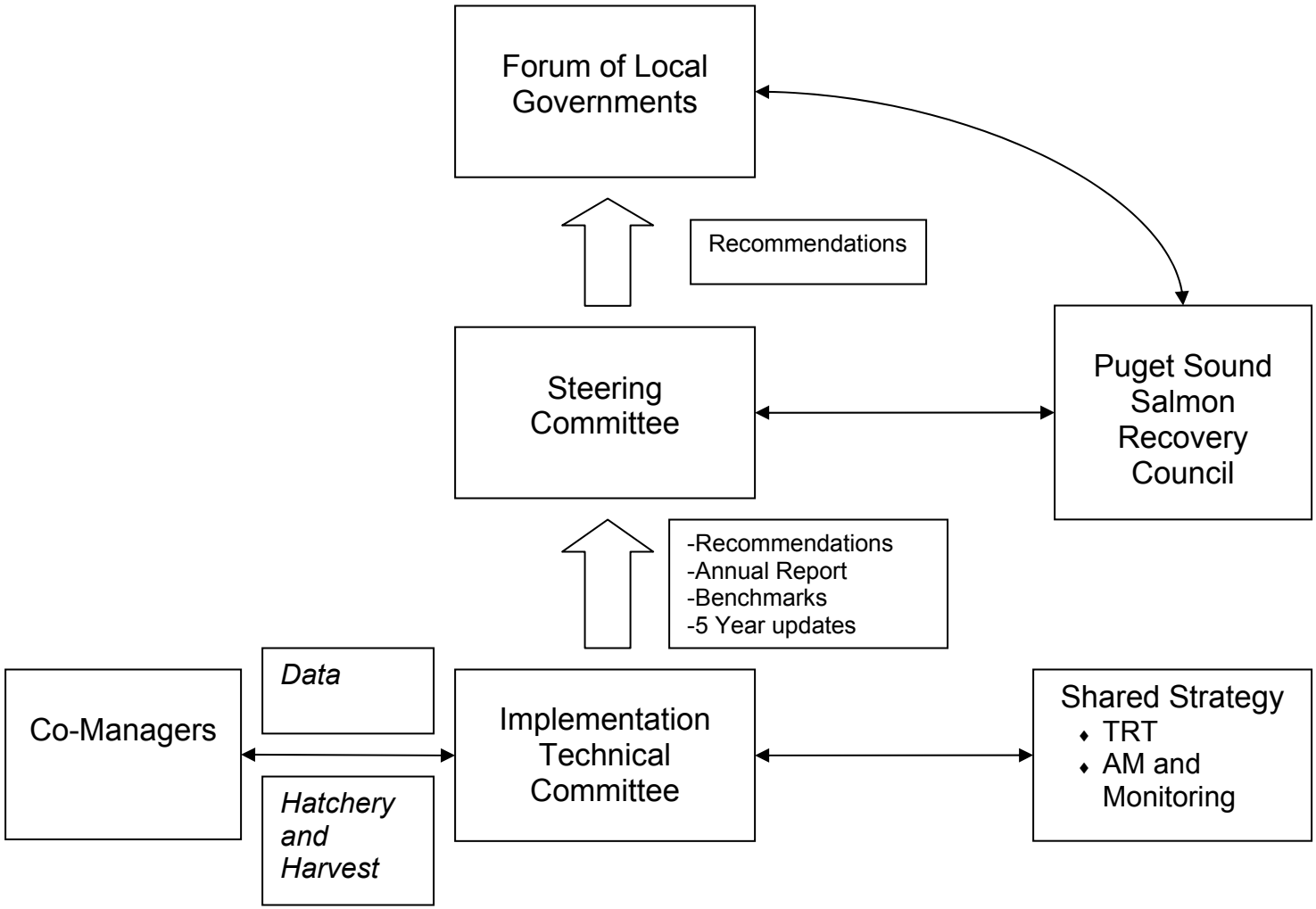

Table 1
Guidelines for Project Implementation Monitoring

Monitoring Schedule	Parameters to Monitor and/or Monitoring Techniques	Performance Standards	Monitoring Report Product
Pre-construction, if appropriate, and Year-0 post-construction[a]	• Size of area restored (e.g., setback area, side channel area, off channel area, marsh area, logjam pool area, pool area, riparian vegetation planting area, invasive vegetation removal area) • Length of river/nearshore construction area • Project area elevations relative to flow (e.g., at what flows does the area become inundated or provide access for juvenile and adult salmon?) • Amount of habitat (area) of targeted fish habitat restored or created (i.e., area providing desired depth, velocity, substrate conditions for target lifestages) • Photographs documenting structures configuration and mitigation measures (e.g., stream diversions or erosion controls	• Design drawings and approved modifications • Permit requirements	A completed Implementation Report (or checklist) documenting pre-construction and post-construction conditions. The report should include information on the parameters being monitored to allow for a tally of cumulative completed projects.

Notes:
a) The year in which construction is completed is considered Year-0 post-construction.

Table 2
Adaptively Managing Outcomes of Project Implementation Monitoring

Evaluation Component	Question: Does an individual project acquire, restore, rehabilitate, or substitute the type and amount of habitat that it was designed to include?
Information Necessary for Evaluation	Post-construction (or acquisition) "as-built" survey and comparison to project design.
Outcomes	Attained: Project provides the expected type and amount of habitat Incomplete: Project does not provide the expected type and amount of habitat
Adaptive Process for Addressing Outcomes	It is essential that project outcome expectations be made explicit at the project design stage. In the case of project specific implementation monitoring we expect that an incomplete outcome does not occur as a result of contractor error, but instead implementation required modifying the project(s) from conceptual vision for project. In this case, more than one project site may be necessary to achieve the habitat acreage needs. As a result, the response will focus on approaches to expand upon the existing project and/or identifying additional projects. It should be noted that the smaller than expected size of projects could possibly be predicted early during project development, especially if funding, landowner willingness, or regulations limit project size. Efficiencies of cost and effort could be realized if the process for addressing an incomplete outcome is begun as early as possible, particularly in earth moving projects that would encounter repetitive contractor mobilization and permitting costs. WRIA 9 Implementation Technical Committee (ITC) will describe for the WRIA 9 Steering Committee (Steering Committee) why the current project was limited in size and develop recommendations to address the issue(s) that caused the project's size to be limited. This could include identifying alternate funding sources, developing solutions for concerns of landowners, and identifying regulations that would need to be changed. If necessary, the ITC will prepare recommendations for other Habitat Plan projects that would provide the desired amount of habitat. The Steering Committee will consider the WRIA 9 staff and ITC recommendations, refine as appropriate, and provide recommendations to the WRIA 9 Forum (Forum). The Forum will consider Steering Committee recommendations and make commitments of staff or other resources to advance efforts to expand the current project or initiate the development of another project.

Table 3
Potential Project Objectives of the Project Elements

Project Element	Potential Objectives[a]
Levee Setback / Floodplain Connection	Restore channel edge habitats to create low velocity and shallow water habitat for juvenile salmonids Restore lateral channel migration to recruit sediments Restore lateral channel migration to create off-channel habitat Provide high flow refuge habitat for juvenile salmonids Provide expanded area for riparian vegetation buffer
Side Channel Creation or Reconnection	Provide side channels for juvenile salmonid rearing Provide side channels for adult salmonid spawning
Large Woody Debris Placement	Add habitat complexity that provides low velocity habitat for adults and/or juveniles Provide deep pool for adult holding Provide pool tailouts that provide spawning substrate Stabilize banks and channel conditions
Gravel Supplementation	Restore availability of spawning substrates (freshwater projects only) Restore habitat complexity Restore natural beach slopes and elevations (marine nearshore projects only) Provide structural support for undercut shoreline feature (marine nearshore projects only)
Riparian Revegetation	Increase amount of native vegetation Provide overhanging vegetation (long-term) Stabilize banks Provide woody debris for recruitment into river (long-term) Reduce the flashiness of stormwater run-off into the river Reduce water temperatures Increase terrestrial-origin prey resources available in river
Non-Native Invasive Vegetation Control	Remove non-native vegetation that limits space for desired native vegetation to grow
Creation of Shallow Water Habitat	Create low velocity and shallow water habitat for juvenile salmonids and their prey Restore upper intertidal habitat to allow for forage fish spawning Restore connectivity to potential sediment sources, e.g., feeder bluffs Provide expanded habitat for prey resource community production Provide expanded habitat for aquatic vegetation growth Restore natural beach slopes Provide expanded habitat for LWD debris recruitment
Creation of Salt Marshes/Mudflats	Provide low velocity and shallow water habitat for juvenile salmonids Provide expanded habitat for prey resource community production Provide expanded habitat for aquatic vegetation growth Produce detritus to support prey resource production Serve as filters to slow stormwater run-off and remove pollutants Serve as energy buffer to storm surges Provide high flow refuge habitat for juvenile salmonids
Soft Shoreline Armoring	Protect homes and property Increase connectivity of adjacent upland habitats and in-water habitats Build up upper intertidal portion of beaches (marine nearshore projects only) Increase sediment supply (marine nearshore projects) Restore natural beach slopes Increase shoreline complexity Reduce wave energy reflection into shallow water habitats Provide expanded area for riparian vegetation

Note:
a) Many of the objectives are written as "restoration" projects, but are intended to also apply to rehabilitation and substitution projects.

Table 4
Guidelines for Physical Effectiveness Monitoring of Individual Habitat Restoration, Rehabilitation, and Substitution Projects

Project Element	Monitoring Schedule[a]	Monitoring Techniques and Parameters	Performance Standards	Monitoring Reports
Levee Setback / Floodplain Connection	• Post-construction Year 0 • After major storm events (e.g., 10 year recurrence interval storms) or large flows (e.g., greater than 9,000 cubic feet per second [cfs]) • Photographs taken each summer from fixed locations	• Appropriate construction management oversight to compare activities to design drawings • Visual observation of structure for signs of failure, including upstream and downstream of project site • Visual observation of structure for signs of adverse erosion or sedimentation following major storm events or large flows • Topographic survey and channel cross-section analysis to determine the flows at which the restored floodplain habitat becomes inundated and accessible to salmonids • Annual photographs from fixed locations	• Design drawings and approved modifications • No evidence of adverse bank failures, including slides, slumps, and surface erosion • Major storms or large flows do not cause adverse erosion or sedimentation • River regains access to habitat at flow levels as designed	Year-0 post-construction monitoring report (or checklist) and annual report of findings following major storm events or large flows for years in which these events occur
Side Channel Creation or Reconnection	• Post-construction Years 0, 1, 3, 5, and 10 during late winter or early spring when juvenile salmonids could occupy the habitats[b] • After major storm events (e.g., 10 year recurrence interval storms) or large flows (e.g., greater than 9,000 cfs) • Photographs taken in late winter or early spring from fixed locations	• Appropriate construction management oversight to compare activities to design drawings • Visual observation of bank failure • Visual observation of signs of adverse erosion or sedimentation following major storm events or large flows • Topographic survey of upstream and downstream end of side channel to determine the flows at which the side channel becomes inundated and accessible to salmonids • Habitat survey to document habitat types and units along length of side channel • Substrate size survey along length of side channel with particular attention to location of suitably size substrates for salmon spawning • Annual photographs from fixed locations	• Design drawings and approved modifications • No evidence of adverse bank failures, including slides, slumps, and surface erosion • Major storms or large flows do not cause adverse erosion or sedimentation in the project area • Channel accessible during flows that occur when juvenile or adult salmon would utilize the area • No reduction in diversity and quality of instream habitat units over time through a broad range of stream flows • Project-specific thresholds for the acceptable amount of increased spawning or rearing habitat provided over time	Post-construction monitoring reports for Years 0, 1, 3, 5, and 10 that include observations made during storm events or large flows that occurred since the last monitoring report
Large Woody Debris Placement	• Pre-construction and Post-construction Years 0, 1, 3, 5, and 10 • After major storm events (e.g., 10 year recurrence interval storms) or large flows (e.g., greater than 9,000 cfs) • Photographs taken each summer from fixed locations	• Appropriate construction management oversight to compare activities to design drawings • Visual observation of bank failure, including upstream and downstream of project site • Visual observation of the position and number of installed pieces following major storm events or large flows • Visual observation of the number of installed pieces • If pool creation was an objective, habitat survey to document size and depth of pool created downstream of structure • If pool creation was an objective, substrate size survey in pool and pool tailout downstream of the structure and, if applicable, measurement of pool and tailout area providing suitable spawning substrate • Annual photographs from fixed locations	• Design drawings and approved modifications • No evidence of adverse bank failure related to LWD installation, including upstream and downstream • No adverse erosion that threatens the stability of LWD pieces or adjacent properties • No adverse shifting of structure pieces • No unintended recruitment of additional pieces • No adverse effects on habitat features, substrate, channel geometry or fish passage • Availability of targeted habitat parameters (e.g., spawn habitat, holding pool area/depth, refuge cover) within project reach increases between each sampling event or stabilizes	Pre-construction and post-construction monitoring reports for Years 0, 1, 3, 5, and 10 that include observations made during storm events or large flows that occurred since the last monitoring report
Gravel Supplementation	• Post-construction Years 0, 1, 3, 5, and 10 • After major storm events (e.g., 10 year recurrence interval storms) or large flows (e.g., greater than 9,000 cfs)	• Appropriate construction management oversight to compare activities to design drawings • Visual observation of adverse gravel scouring or deposition (includes area downstream of supplementation area) • Visual observation of signs of adverse erosion or sedimentation following major storm events or large flows • Visual observation of evidence of adverse impacts on channel capacity and/or additional flooding • Substrate size survey throughout supplementation area and downstream, as appropriate, to document distribution of placed materials	• Design drawings and approved modifications • No evidence of adverse gravel scouring or deposition • No evidence of adverse changes to channel capacity that leads to additional flooding • Project-specific thresholds for the acceptable portion of the added gravel that remains at the site or continues to provide habitat downstream of the site	Pre-construction and post-construction monitoring reports for Years 0, 1, 3, 5, and 10

Project Element	Monitoring Schedule[a]	Monitoring Techniques and Parameters	Performance Standards	Monitoring Reports
Riparian Revegetation	• Pre-construction and Post-construction Years 0, 1, 3, 5, and 10 • Photographs taken each summer from fixed locations	• Appropriate construction management oversight to compare activities to design drawings • Percent cover of native vegetation • Percent survival of planted vegetation • Growth and vigor of planted vegetation • Percent cover of each vegetation type (e.g., tree, shrub, grass) • Percent cover of non-native vegetation • Percent cover of riparian vegetation overhanging the stream channel • Percent canopy cover of riparian vegetation in project area • Annual photographs from fixed locations	• Design drawings and approved modifications • Greater than 80 percent native vegetation cover by Year 5 • Less than 10 percent non-native vegetation cover in any year • Greater than 90 percent survival by Year 1, greater than 80 percent survival by Year 3 • Native plants between 3 and 6 feet in height will exhibit shrub or sapling cover of greater than 50 percent survival by Year 5 • Increase in riparian vegetation overhanging stream channel	Pre-construction and post-construction monitoring reports for Years 0, 1, 3, 5, and 10
Non-Native Invasive Vegetation Control	• Pre-construction and annually Post-construction through Year-5	• Percent cover of non-native invasive vegetation • Percent cover of native vegetation • Visual observations of bank erosion in project area and beyond	• Less than 10 percent non-native invasive vegetation coverage • Increase in native vegetation cover over period of monitoring • No adverse bank erosion that threatens property or introduces a large amount of fine sediment to the river	Pre-construction and post-construction monitoring reports for Years 0, 1, 3, 5, and 10
Creation of Shallow Water Habitat	• Post-construction Years 0, 1, 3, 5, and 10 during spring when juvenile salmonids could occupy the habitats and when the winter storm season has passed • After major storm events (e.g., 10 year recurrence interval storms) or large flows (e.g., greater than 9,000 cfs) • Photographs taken in late winter or early spring from fixed locations	• Appropriate construction management oversight to compare activities to design drawings • Visual observations of erosion • Visual observation of signs of adverse erosion or sedimentation following major storm events or large flows • Topographic survey of area to determine the amount of habitat (area) created below ordinary high water • As applicable in tidally influenced areas, additional information on the amount of habitat created in different elevation strata (e.g., below mean lower low water (MLLW), between 0 and +4 feet MLLW, and between +4 and +12 MLLW) • Beach profiles (slope) and substrate along transects perpendicular to the shore • Percent cover of non-native invasive vegetation • Annual photographs from fixed locations	• Design drawings and approved modifications • No adverse bank erosion that threatens the project area of adjacent properties • Major storms or large flows do not cause adverse erosion or sedimentation in the project area • Stable amount (area) of created shallow water habitat, by elevation strata, if applicable • No non-native invasive vegetation in intertidal or low water areas	Post-construction monitoring reports for Years 0, 1, 3, 5, and 10
Creation of Salt Marshes/Mudflats	• Post-construction Years 0, 1, 3, 5, and 10 • After major storm events (e.g., 10 year recurrence interval storms) or large flows (e.g., greater than 9,000 cfs) • Photographs taken in summer from fixed locations	• Appropriate construction management oversight to compare activities to design drawings • Visual observation of erosion or accretion • Visual observation of signs of adverse erosion or sedimentation following major storm events or large flows • Topographic survey of area to determine the amount of habitat (area) created below ordinary high water • Vegetation survey to document species and distributions • Annual photographs from fixed locations	• Design drawings and approved modifications • No adverse bank erosion that threatens the project area of adjacent properties • Major storms or large flows do not cause adverse erosion or sedimentation in the project area • No non-native invasive vegetation • Project-specific thresholds for the acceptable amount of created habitat over time	Post-construction monitoring reports for Years 0, 1, 3, 5, and 10

Project Element	Monitoring Schedule[a]	Monitoring Techniques and Parameters	Performance Standards	Monitoring Reports
Soft Shoreline Armoring	• Post-construction Years 0, 1, 3, 5, and 10 • After major storm events (e.g., 10 year recurrence interval storms) or large flows (e.g., greater than 9,000 cfs) • Photographs taken in summer from fixed locations	• Appropriate construction management oversight to compare activities to design drawings • Visual observation of erosion at project site and adjacent properties • Visual observation of signs of adverse erosion or sedimentation following major storm events or large flows • Visual observation of evidence of instability in armor structure • Topographic survey of area to determine the amount of habitat (area) created below ordinary high water • As applicable in tidally influenced areas, additional information on the amount of habitat created in different elevation strata (e.g., below mean lower low water (MLLW), between 0 and +4 feet MLLW, and between +4 and +12 MLLW) • Beach profiles (slope) and substrate along transects perpendicular to the shore (at project site and reference sites) • Annual photographs from fixed locations	• Design drawings and approved modifications • No adverse bank erosion that threatens the project area of adjacent properties • Major storms or large flows do not cause adverse erosion or sedimentation • No evidence of instability in armor structure • Increased amount of intertidal area • Beach profiles and substrate in project area maintaining conditions similar to natural	Post-construction monitoring reports for Years 0, 1, 3, 5, and 10

Notes:
a) The year in which construction is completed is considered Year-0 post-construction.
b) Safety considerations may necessitate sampling during the summer low flow conditions, but the focus should be on collecting data that informs the habitat condition during the flows that juvenile salmonids would encounter in late winter and early spring.

Table 5
Adaptively Managing Outcome of Physical and Sustainability Monitoring

Evaluation Component	Physical Effectiveness and Sustainability Question: Does the project provide the expected habitat improvements?
Information Necessary for Evaluation	Post-construction monitoring to evaluate the size of area restored and relevant habitat features that determine the site's suitability (i.e., percentage of time inundated or accessible, desired microhabitat conditions). Multiple years of post-construction monitoring of these parameters will be needed to inform evaluations of stability.
Outcomes	Attained: After each post-construction monitoring event, the size, relevant habitat features, and sustainability all indicate that the desired habitat is being provided. Incomplete: After each post-construction monitoring event, the size and/or relevant habitat features are not providing the desired habitat amount or condition.
Adaptive Process for Addressing Outcomes	The ITC will evaluate whether the apparent shortcomings are a result of initial project design or are indicative of the project not being able to sustain the desired conditions. The ITC will determine whether project maintenance or more substantial project modifications would be necessary to provide the desired amount or quality of habitat. The ITC will prepare a summary for the Steering Committee that describes the problems with the project effectiveness and the options for how to remedy the habitat shortcomings. As possible this will include estimated costs and potential funding sources. The ITC will also provide its recommendation on a preferred option, as well as recommendations for how to make future projects of this type more effective and sustainable. The ITC will also recommend whether changes to the monitoring schedule or study design are needed to further evaluate site conditions. The Steering Committee will consider the ITC recommendations, refine as appropriate, and provide recommendations to the Forum. The Forum will consider Steering Committee recommendations and make commitments of staff or other resources to pursue new funding sources and/or implement the recommendations.

Table 6
Guidelines for Project-Specific Biological Effectiveness Monitoring of Individual Projects

Type of Projects or Focus of Monitoring	Monitoring Schedule[a]	Reference or Control Monitoring	Monitoring Techniques and Parameters	Performance Standards	Monitoring Reports
Juvenile Salmonid Monitoring	Pre-construction and Post-construction Years 0 through 5; monthly sampling between February and July	Natural or restored habitat that provides similar type and size of habitat as constructed project. Needs to be in same general area as constructed project.	• Beach seine or snorkel (night sampling preferred in freshwater if site logistics and safety issues permit doing so) • Observations to record, as possible: fish species, number observed, estimated total length, tags, fin clips, habitat conditions being utilized (e.g., water depth, velocity, cover, substrate), flow rates	• Increase in natural origin juvenile salmon use of site based on fish numbers and/or duration of use • Statistical evaluations (e.g., BACI paired t-tests) may be conducted if the size of sampling sites permits	Pre-construction report and Post-construction reports for Years 0 through 5; monthly sampling between February and July
Adult Salmonid Monitoring	Pre-construction and Post-construction Years 0 through 5; weekly or biweekly through spawning season	Redd surveys conducted by Muckleshoot Indian Tribe, King County, or WDFW can serve as reference monitoring to provide information on strength and timing of spawning run	• Drift-based and/or walking surveys of redds and live adults in restoration area • Observations to record: number of redds, fish species (if possible based on redd size, location, date, or fish siting), natural or hatchery origin salmon (if possible), habitat conditions at redd (e.g., water depth, velocity, cover, substrate), flow rates	• Increase in number of redds created by natural origin salmon	Pre-construction report and Post-construction reports for Years 0 through 5; weekly or biweekly through spawning season
Prey Resource Monitoring	Pre-construction and Post-construction Years 0, 1, 3, 5, and 10 in the spring (April, May, or June)	Natural or restored habitat that provides similar type and size of habitat as constructed project. Needs to be in same general area as constructed project.	• Epibenthic sampling using kick net (river) or epibenthic pump (nearshore) at multiple stations • Insect traps • Juvenile salmonid stomach content analyses	• Increase in abundance of macroinvertebrates, particularly those known to be common prey items of juvenile salmon	Pre-construction report and Post-construction reports for Years 0, 1, 3, 5, and 10 in the spring (April, May, or June)
Vegetation Monitoring	Pre-construction and Post-construction Years 0, 1, 3, 5, and 10 in the spring (May or June)	Natural or restored habitat that provides similar type and size of habitat as constructed project. Needs to be in same general area as constructed project.	<u>Riparian vegetation</u> • Planted vegetation survival rates • Invasive vegetation percent cover and species • Overhanging vegetation percent cover • Water temperature <u>Marsh and submerged aquatic vegetation</u> • Planted vegetation survival rates, if applicable • Vegetation species, percent cover, and spatial distributions	• 90 percent or greater planted vegetation survival after Year 1; 80 percent or greater planted vegetation survival after Year 3 • Less than 10 percent cover of invasive species • Increase in overhanging vegetation compared to earlier surveys	Pre-construction report and Post-construction reports for Years 0, 1, 3, 5, and 10 in the spring (May or June)

Notes:
a) The year in which construction is completed is considered Year-0 post-construction.

Table 7
Adaptively Managing Outcomes of Biological Effectiveness Monitoring

Evaluation Component	Biological Effectiveness Question 1: Are increased numbers of salmonids using the improved habitat?	Biological Effectiveness Question 2: Are salmonids using the habitat for longer periods of time?	Biological Effectiveness Question 3: What is the composition of NORs and HORs?	Biological Effectiveness Question 4: Did the physical changes and/or vegetation increase the abundance of diet items?
Information Necessary for Evaluation	Pre and post-construction observations of fish, benthic invertebrate and insect abundance and composition collected in a consistent and systematic study design. Reference stations should be included in the study design. Depending on the purpose of the reference station, possible locations include a nearby unimproved area similar to the pre-construction conditions at the project site or a nearby unimproved area similar to the post-construction conditions at the project site.			
Outcomes	Complete: Increased number of fish using improved habitat compared to pre-construction monitoring and/or reference station(s) fish numbers Incomplete: No observable increase in the number of fish using improved habitat.	Complete: Individual salmon are using the habitat for a longer period of time compared to pre-construction Extended period of use by the salmon population is also a success. Incomplete: Individual salmon are not using the habitat for a longer period of time compared to pre-construction or individual salmon are not using the habitat for equal or longer periods of time compared to a reference station.	Complete: a higher percentage of NORs using the habitat compared to pre-construction conditions or the reference area. Incomplete: a lower percentage of NORs using the habitat compared to pre-construction conditions or the reference area.	Complete: more benthic invertebrate and insect species that juvenile salmon prey upon occur at the site compared to pre-construction conditions or reference station conditions. Incomplete: fewer benthic invertebrate and insect species that juvenile salmon prey upon occur at the site compared to pre-construction conditions or reference station conditions.
Adaptive Process for Addressing Outcomes	The Implementation Technical Committee (ITC) will evaluate all four biological effectiveness questions to make a comprehensive assessment of whether the project is biologically effective. A preliminary step in this evaluation will be to determine whether there is sufficient monitoring data to evaluate the questions. If not, additional monitoring for the current project and future projects will be recommended. The ITC will determine if there area identifiable reasons for why the project is not biologically effective and if it can be fixed through modifications to the project or to WDFW hatchery practices. The ITC will prepare a summary of project effectiveness and remedy options for the Steering Committee to consider. This summary will include a recommendation of which option is preferred. The Steering Committee will consider the ITC recommendations, refine as appropriate, and provide recommendations to the Forum. The Forum will consider Steering Committee recommendations and make commitments of staff or other resources to pursue new funding sources and/or implement the recommendations.			

Table 8
Adaptively Managing Results of Watershed-wide Implementation Monitoring of the Habitat Plan

Evaluation Component	Question: Are habitat projects identified in Salmon Habitat Plan being implemented at a pace and in appropriate locations to meet 10-year implementation targets?
Information Necessary for Evaluation	Annual status updates of all project development efforts in each sub-watershed, including information about obstacles to implementation and whether implementation in 10-year time frame is feasible.
Outcomes	Attained: Meeting implementation benchmarks. Cumulative benchmarks: • By the end of Year 3 the following types of habitat are being actively developed, including securing funding, developing designs, and beginning permitting/agency coordination: 1. Nearshore -Protection of 1.5 miles of shoreline. -Restoration of 4,000 feet of shoreline. -Restoration of two pocket estuaries. 2. Duwamish -Restoration of 8 acres of shallow water habitat. -Restoration of 1 mile of shoreline bank. 3. Lower Green -Restoration of 5 acres of reconnected off-channel habitat, including riparian vegetation. -Completion of 4,000 feet of levee setback. 4. Middle Green -Restoration of 15 acres of reconnected off-channel habitat, including riparian vegetation. -Completion of 4,500 feet of levee setback. -5.5 miles of tributary improvement. • By the end of Year 5 the following types of habitat are being actively developed, including securing funding, developing designs, and beginning permitting/agency coordination: 1. Nearshore -Protection of 2.5 miles of shoreline. -Restoration of 6,700 feet of shoreline. -Restoration of five pocket estuaries. 2. Duwamish -Restoration of 10 acres of shallow water habitat. -Restoration of 1.5 miles of shoreline bank. 3. Lower Green -Restoration of 8.3 acres of reconnected off-channel habitat, including riparian vegetation. -Completion of 6,700 feet of levee setback. 4. Middle Green -Restoration of 25 acres of reconnected off-channel habitat, including riparian vegetation. - Completion of 7,500 feet of levee setback. -9 miles of tributary improvements. • By the end of Year 8 the following types of habitat are being actively developed, including securing funding, developing designs, and beginning permitting/agency coordination: 1. Nearshore -Protection of 4 miles of shoreline. -Restoration of 10,700 feet of shoreline. -Restoration of three pocket estuaries. 2. Duwamish -Restoration of 21.5 acres of shallow water habitat. -Restoration of 2.5 miles of shoreline bank. 3. Lower Green -Restoration of 13.3 acres of reconnected off-channel habitat, including riparian vegetation. - Completion of 10,700 feet of levee setback. 4. Middle Green -Restoration of 40 acres of reconnected off-channel habitat, including riparian vegetation. - Completion of 12,000 feet of levee setback. -14.4 miles of tributary improvements.

Evaluation Component	Question: Are habitat projects identified in Salmon Habitat Plan being implemented at a pace and in appropriate locations to meet 10-year implementation targets?
	• By the end of Year 10 the following types of habitat are being actively developed, including securing funding, developing designs, and beginning permitting/agency coordination: 1. Nearshore -Protection of 5 miles of shoreline. -Restoration of 13,500 feet of shoreline. -Restoration of six pocket estuaries. 2. Duwamish -Restoration of 26.5 acres of shallow water habitat. -Restoration of 3 miles of shoreline bank. 3. Lower Green -Restoration of 16.5 acres of reconnected off-channel habitat, including riparian vegetation. - Completion of 13,300 feet of levee setback. 4. Middle Green -Restoration of 50 acres of reconnected off-channel habitat, including riparian vegetation. - Completion of 15,000 feet of levee setback. -18 miles of tributary improvements. • Sub-watershed project distribution is consistent with Habitat Plan policy MS-1. Incomplete: Not meeting benchmarks.
Adaptive Process for Addressing Outcomes	Outcomes are based on what AM TC believes is achievable. The 3-year benchmarks are consistent with the WRIA 9 Habitat Plan 3 year Work Schedule. The ITC will prepare recommendations to Steering Committee of Salmon Habitat Plan projects that need to be initiated or accelerated in order to get the implementation timeline back on schedule. This recommendation will include consideration of: • do identified obstacles make one or more projects unlikely in the 10-year time frame • can identified obstacles be addressed through actions of WRIA 9 participants (e.g., securing landowner willingness or advocating for regulatory changes) • what projects should be initiated or accelerated that best compliment the other projects that are completed or underway to maximize progress toward attaining viable salmonid populations • if allocation of effort among estuarine transition zone, spawning areas, and rearing areas needs to be revised based on obstacles to project implementation • if necessary, how to re-allocate effort among areas to maximize progress toward attaining viable salmonid populations The WRIA 9 Steering Committee will consider the ITC recommendations, refine as appropriate, and provide recommendations to the Forum. Recommendations will further develop actions to address the same issues described above. The Forum will consider the Steering Committee recommendations and make commitments of staff or other resources to take action to remedy obstacles to implementation.

Table 9
Adaptively Managing Outcomes of Watershed-wide Implementation Monitoring of Programmatic and Regulatory Actions

Evaluation Component	**Question: Which Salmon Habitat Plan programs and regulatory actions have been implemented?** **Questions: How many WRIA 9 jurisdictions have implemented Salmon Habitat Plan programs and regulatory actions?**
Information Necessary for Evaluation	Annual status reports on Salmon Habitat Plan program and regulatory action implementation by WRIA 9 jurisdictions.
Outcomes	The WRIA 9 Salmon habitat Plan does not prioritize watershed-wide and subwatershed programs. Nonetheless, it is useful to know which programs have been implemented by WRIA 9 jurisdictions. Attained: Meeting implementation benchmarks. Cumulative benchmarks: • By the end of Year 3, each jurisdiction will have implemented or begun implementing 30 percent of those programs relevant to the jurisdiction. (Relevant programs are being identified in 2006 by jurisdiction staff working with WRIA staff.) • By the end of Year 5, each jurisdiction will have implemented or begun implementing 50 percent of those programs relevant to the jurisdiction. • By the end of Year 8, each jurisdiction will have implemented or begun implementing 80 percent of those programs relevant to the jurisdiction. • By the end of Year 10, each jurisdiction will have implemented or begun implementing all of those programs relevant to the jurisdiction. Incomplete: Not meeting benchmarks.
Adaptive Process for Addressing Outcomes	The ITC will prepare annual status reports for the Steering Committee. The WRIA 9 Steering Committee will review the 3-year status report and determine what programmatic and regulatory actions should be the focus of the next 3 years.

Table 10
Environmental Indicators for Evaluating Status and Trends of Conditions in WRIA 9

Environmental Indicator	Analysis Units	Potential Data Collection Methods	Implementation Considerations	Recommended Frequency	Suggested Analyses
Width and composition of vegetation in riparian buffer	By sub-area with separate analysis for mainstem, major tributaries, and nearshore	Remote collection and interpretation of aerial photos	Vegetation type categories that can be detected by photo interpretation need to be determined and consistently reported Ground-truthing of interpretation results will be needed	Every 5 to 10 years if resources available to collect, otherwise when possible using aerial photos collected from other sources	Change in amount of vegetation in riparian buffer; change in composition of vegetation in riparian buffer
Distributions spawning gravel (both natural and placed)	By sub-area	Low water field surveys	WDFW and Ecology (2004) and TFW (1999) provide substrate sizes that could be used in these surveys Survey at regular intervals (e.g., every 100 feet) Notes about portion of wetted channel and amount of fine material or embeddedness would be useful modifiers of substrate size information	Every 5 to 10 years if resources available to collect	Change in length of river with suitable spawning patches; change in number of suitable spawning patches; change in distribution of LWD
Woody debris pieces per bank-full width (natural and placed)	By sub-area with separate analysis for mainstem and major tributaries	Low water field survey to systematically survey pieces of medium, large, and key pieces of wood and log jams	Clear definitions of woody debris sizes will be needed (e.g., per R2 Resource Consultants 2002; Anchor Environmental 2004) Survey at regular intervals (e.g., every 100 feet)	Every 5 to 10 years	Number of medium, large, and key wood pieces Wood piece frequency by size
Water temperatures	By sub-area with separate analysis for mainstem and major tributaries	Remote water surface characterization using satellites; or ambient monitoring using handheld meter	Survey at similar flows for each month year to year Accompanying information on flow and air temperature will be useful	Monthly	Change in number of days exceeding 303(d) criteria
Miles of nearshore armored	By jurisdiction or other sub area classification	Remote collection and interpretation of aerial photos	Ground-truthing of interpretation results will be needed	Every 5 to 10 years if resources available to collect, otherwise when possible using aerial photos collected from other sources	Change in number of miles of armored nearshore in each jurisdiction
Water quality parameters other than temperature	By sub-area with separate analysis for mainstem and major tributaries	Continue WDOE's ambient monitoring at six stations in WRIA 9, including two in the Green River	Survey at similar flows for each month year to year Accompanying information on flow and air temperature will be useful	Monthly	Inter-annual variability in each 303(d) listed parameter
Number of impediments to fish passage	By sub-area with separate analysis for mainstem and major tributaries	Field assessment	WDFW (2000) protocols for fish passage assessment will be useful	Every 5 to 10 years	Comparison by sub-area; change in number in each sub-area

Table 11
Adaptively Managing Results of Watershed-wide Tracking of Environmental Indicators

Evaluation Component	Question: Are relevant environmental indicators improving?
Information Necessary for Evaluation	Baseline and 5-year or 10-year monitoring of each relevant environmental indicator using consistent data collection methodologies. Possible environmental indicators to investigate are: miles of side channels, widths of vegetated buffers, pool-riffle ratios, water temperatures, and miles of nearshore armored.
Outcomes	Attained: Improvement in the condition of each relevant environmental indicator Incomplete: Lack of improvement in all relevant environmental indicators
Adaptive Process for Addressing Outcomes	The ITC will prepare a summary of environmental indicator conditions in the watershed compared to the baseline conditions. The summary classifies all environmental indicators investigated as improving, staying the same, or degrading. This information will be compared to the watershed-wide implementation monitoring to gain insight on whether activities to date address the environmental indicators. If so, but the environmental indicator conditions continue to decline, then it means that habitat is being lost faster than it is be gained. The ITC will prepare recommendations of projects to conduct (or project timelines to accelerate) and policies, programs, and regulations that can be useful in stopping habitat loss and providing an overall improvement in habitat. These recommendations will include consideration of: • Are there incomplete projects in the Salmon Habitat Plan that could improve habitat conditions in ways that would appear in environmental indicator monitoring? • Does it appear that un-enforced regulations are contributing to the degradation and/or is there a need for additional regulations? The WRIA 9 Steering Committee will consider the ITC recommendations, refine as appropriate, and provide recommendations to the Forum. Recommendations will further develop actions to address the same issues described above. The Forum will consider the Steering Committee recommendations and make commitments of staff or other resources to take action to implement more projects, enforce regulations, or develop new regulations to address the issue(s).

Table 12
Adaptively Managing Population-Level Monitoring

Evaluation Component	Question: Are there improvements to abundance, life cycle productivity, spatial structure, and life history diversity?
Information Necessary for Evaluation	Baseline and routine (possibly annually) monitoring for each parameter using a consistent and systematic study design.
Outcomes	Attained: For each parameter (life stage productivity and spatial structure are priorities in first 10 years), improvements from baseline (and earlier evaluation times) and progress toward attaining the Necessary Future Conditions identified in the Salmon Habitat Plan. Incomplete: Lack of improvement from baseline (and earlier evaluation times) and no progress toward attaining the Necessary Future Conditions identified in the Salmon Habitat Plan.
Adaptive Process for Addressing Outcomes	The ITC will evaluate whether sufficient monitoring data are being collected to evaluate the population viability and make recommendations to the Steering Committee for how to address any shortcomings in the data collection. Much of these data are currently being collected by tribal or state biologists. Future needs may include WRIA funding to allow these critical monitoring efforts to continue. The ITC will prepare a recommendation for the Steering Committee on projects to conduct (or project timelines to accelerate) and policies, programs, and regulations that can contribute to improve habitat. The WRIA 9 Steering Committee will consider the ITC recommendation, refine as appropriate, and provide recommendations to the Forum. Recommendations will further develop actions to address the same issues described above. The Forum will consider the Steering Committee recommendations and make commitments of staff or other resources to take action to implement more projects, enforce regulations, or develop new regulations to address the issue(s).