

Section 12.0

MONITORING, EVALUATION, AND ADAPTIVE MANAGEMENT

How do we know if we are implementing projects in the most effective manner? Could we be operating in a more cost-effective way? Are we recovering Chinook salmon and bull trout and helping protect coho populations as we had hoped? Effective long-term management relies on our ability to test and link specific hypotheses about habitat, harvest, and hatchery responses to management actions and refine our strategy and approach as needed. Targeted monitoring and evaluation will provide information to help us modify decisions and actions over time to improve effectiveness and efficiency.

12.1 What is adaptive management and how will it be used?

Adaptive management is an ongoing process used in complex decision-making to increase the chances of success by incorporating new data, information about successes and failures, and flexibility into a long-term management program.

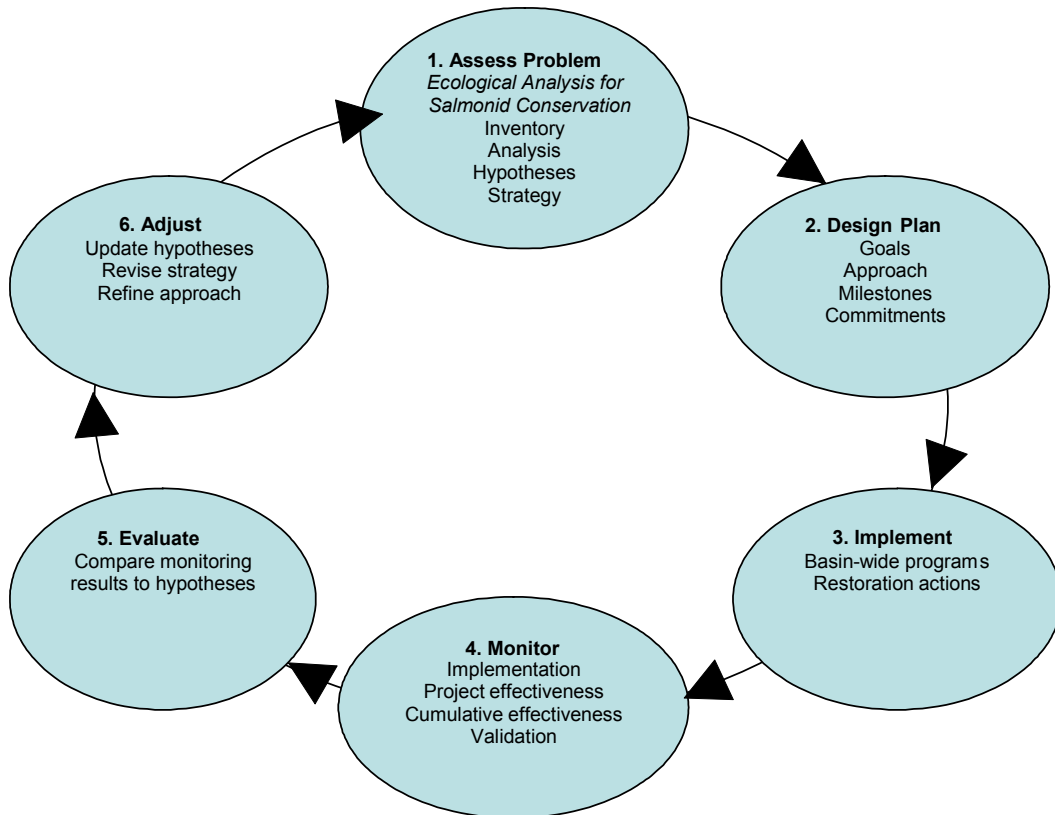
In the Snohomish River basin, an adaptive management approach will be used to maximize success in meeting the Forum's long-term vision of recovering Chinook salmon and bull trout to healthy and harvestable levels. This process will help to achieve the following objectives:

- Find the most effective approaches to meet the Forum's goals and encourage innovation
- Identify and address key gaps in understanding that may limit success
- Improve overall understanding of salmon recovery, including how to best spend limited resources for greater benefit
- Gain reliable feedback about the effectiveness of management decisions and protection and restoration actions
- Build a central knowledge base that will pass on the 'legacy' of the Forum's work to future decision-makers

What are the components of an adaptive management program?

An adaptive management program typically includes the following six steps. As explained below, the Forum has completed the first two steps and is embarking on the third. Steps four through six are explained in more detail in the remainder of this section. The steps are illustrated in Figure 12.1.

Figure 12.1 Adaptive Management Framework



1. Assess the problem. Defining the problem is essential in order to develop and select effective actions, including determining the appropriate scale and information needs. The *Ecological Analysis for Salmonid Conservation* was designed to identify and analyze the factors that have contributed to salmon decline, generate recovery hypotheses, and recommend a science-based recovery strategy and actions for salmon recovery. This work was coordinated with regional efforts to achieve consistency and to contribute to the development of the Puget Sound recovery plan.

2. **Develop an action plan.** In this step, management and monitoring plans are developed to identify actions and provide needed information about the effectiveness of those actions. This includes identifying hypotheses that are used as the basis for actions, and the methods to assess change in a way that provides useful information for management decisions.

The basin-scale hypotheses in Section 5.0, harvest and hatchery hypotheses in Section 6.0, and the description of how these work together in Section 7.0 create the foundation for the actions outlined in the Forum's vision, including habitat condition milestones (Section 8.0), recommended approaches (Section 9.0), and the basin-wide and sub-basin strategy group actions, including the sub-basin strategy group hypotheses (Sections 10.0 and 11.0). This section identifies how, when, and by whom these actions will be monitored and evaluated to determine their effectiveness, whether changes are needed and, if so, what they might be. The Forum's implementation commitments are described in Section 13.0.

3. **Implement the action plan.** In this step, the plan is put into action. This includes the actions described in Sections 10.0 and 11.0, as well as the monitoring, evaluation, and adjustments described in this section.
4. **Monitor implementation results.** Monitoring is conducted to determine whether the plan is being implemented as envisioned, the hypotheses correctly identified the problem, and the actions have solved or are solving the problem. Monitoring will supply data for the evaluation component of the plan, enabling trend analysis to determine the effectiveness and efficiency of combined actions. Monitoring will occur on several scales to help determine whether actions are being implemented, the effectiveness of the actions individually and cumulatively, and whether the hypotheses need modification.
5. **Evaluate.** In this step, monitoring data is analyzed and compared to the hypothesized outcomes or plan commitments. If the results are not as expected, a management action to refine the strategy or approach will be triggered. Analysis will be performed at several scales

to determine the effectiveness of individual projects, as well as that of combined projects and basin-wide programs.

6. **Adjust.** Monitoring and evaluation results will be used to help adjust the plan hypotheses, goals, and/or actions to reflect new information that was learned throughout the process. Adjustments are expected to help the Forum reach plan goals, refine goals if necessary, and improve efficiency.

Section 12.2 describes the four levels of monitoring, evaluation, and adjustment developed by the Forum to adaptively manage this plan, including implementation, direct effectiveness, cumulative, and validation. Sections 12.3 through 12.6 then describe each level in more detail, providing examples of the questions used to help evaluate monitoring results and, as necessary, trigger adjustments to improve the chances for successful salmon recovery.

12.2 Development and Implementation Structure of the Monitoring, Evaluation, and Adaptive Management Steps

Four levels of monitoring, evaluation, and adjustment are recommended in this plan. When used together, this information will allow the Forum to evaluate the effectiveness of actions and to adjust hypotheses and recovery roles. Each of the following four levels are at different time scales and address different types of questions:

- **Implementation:** Are we implementing actions that we committed to and at the rate needed to reach the 10-year milestones?
- **Direct effectiveness:** How well does a specific project work?
- **Cumulative effectiveness:** Are projects, when considered collectively, achieving the anticipated results?
- **Validation:** Are the basin and sub-basin strategy group hypotheses valid and are we achieving recovery across Puget Sound?

How did the Forum develop monitoring measures, evaluation criteria, and adjustment steps?

The Forum is interested in monitoring, evaluating, and adjusting the plan to address both ecological and socio-economic considerations. The four monitoring levels were developed as follows:

- **Implementation.** The Forum identified key questions for project implementers that will ensure that plan implementation is on track. The Forum also identified action triggers and steps that could be taken if actions are not being implemented as envisioned.
- **Direct or project effectiveness.** For ecological considerations, the Forum worked with the Technical Committee to identify physical and biological questions for individual projects, as well as evaluation measures. Monitoring protocols developed for Salmon Recovery Funding Board-sponsored projects were considered. For socio-economic considerations, the Forum identified important community goals and key monitoring-related questions for individual projects. Socio-economic information will be collected at the individual project level and evaluated basin-wide under cumulative effectiveness monitoring.
- **Cumulative effectiveness.** The Technical Committee developed key questions and identified and prioritized monitoring actions to address ecological considerations. Monitoring actions were identified for instream habitat, land cover, and fish population performance. Priority was given to actions that monitor a plan milestone or complete an important data set. Detailed information on these actions can be found in Appendix O. The Forum also identified action triggers and follow-up actions. For socio-economic goals, the Forum developed evaluation questions for project implementers collecting data, as well as action triggers and possible actions.
- **Validation.** In terms of ecological considerations, the Technical Committee identified key long-term research and monitoring questions and indicators related to the plan hypotheses. The group then identified and prioritized monitoring indicators based on whether they were linked

to a plan hypothesis. The Forum also identified action triggers and possible management actions linked to these indicators (more information on indicators can be found in Appendix O).

Who will participate in monitoring, evaluation, and adjustment recommendations?

Clearly defined roles and responsibilities are essential to ensure effective monitoring, evaluation, and adjustment. Roles and responsibilities are outlined below and identified further in Sections 12.3 through 12.6.

Snohomish Basin Salmon Recovery Forum. The Forum has had an initial discussion to identify its possible future roles and activities. These include tracking implementation of the salmon conservation plan, tracking effectiveness of the actions, and adjusting the plan over time to improve effectiveness. (The Forum’s other roles are outlined in Chapter 13.0.)

All implementers (including Forum members). Implementers will be responsible for collecting project-level data for submittal to Forum staff. Effective and efficient implementation and direct effectiveness monitoring will rely on active participation and coordination between Forum staff and project implementers (citizens, local governments, non-governmental organizations, Tribes, state agencies, and others).

Snohomish Basin Salmonid Recovery Technical Committee. A future role of the Technical Committee will be to provide technical support to the Forum on implementing and adaptively managing the *Snohomish Basin Salmon Conservation Plan*. This includes coordinating monitoring efforts and evaluating monitoring data to help guide adaptive management. The Technical Committee will be responsible for identifying ecological monitoring protocols and evaluating ecological data gathered for direct effectiveness, cumulative effectiveness, and validation monitoring. The committee will work closely with Forum staff on this effort and will help develop options for the Forum to consider in the adjustment step of the adaptive management process.

Forum Policy Development Committee. The Policy Development Committee will assist the Forum in evaluating the data gathered for implementation and the socio-economic aspects of direct

effectiveness and cumulative effectiveness monitoring. Using this information, as well as ecological analysis results, the committee will also help develop and recommend adjustment options for consideration by the Forum to most effectively and efficiently adapt the plan to the needs of the basin.

Forum staff. Forum staff will lead coordination of project and program implementation with local governments and agencies in the Snohomish River basin. Staff will track and/or lead monitoring, evaluation, and adjustment efforts in cooperation with the Forum and committees. Staff will also serve as the regional liaison.

Side bar: Some monitoring, evaluation, and adjustment information will need to be shared regionally. The reporting and feedback structure for such a step depends on the regional structure and organization that is yet to be determined by Shared Strategy and/or state and federal agencies.

12.3 Implementation Monitoring, Evaluation, and Adjustment

Implementation monitoring coordinates and documents the actions that have been accomplished toward plan goals.

Implementation monitoring. Project implementers would conduct implementation monitoring annually (with assistance from Forum staff as needed), and be asked to submit documentation to Forum staff about projects initiated and/or completed. The following categories of actions would be monitored, as appropriate: the number and size of capital and non-capital projects (including acquisitions), policies and programs (including regulatory measures), stewardship and outreach actions, enforcement, and monitoring.

Implementers will be asked the following questions:

- Was a project started or completed? For ongoing projects, was maintenance performed?
- What was accomplished on the ground? For restoration projects, this would include project type, location, acres involved, cost, and other information. For policies and programs, this

would include status of regulatory updates; types of stewardship, outreach, funding, and enforcement; and project monitoring programs.

- Were any problems encountered?
- If actions are not being implemented as envisioned, why not and what could be done to improve this?

Implementation Evaluation. This analysis will quantify how well and how quickly the plan is being implemented. The analysis would identify the differences between plan milestones, commitments, and actual implementation for both individual implementers and across the basin. The assessment would also help determine whether a trigger threshold has been crossed that requires a management action. Forum staff would complete this work annually with assistance from the Forum's Policy Development Committee. Staff and committee members would develop options and recommendations for Forum consideration to aid in decision-making and to keep the plan on track.

Evaluating individual implementers would address whether plan commitments are being implemented and, if not, why. At the basin level, the following questions would be answered:

- Overall, are actions (capital and non-capital) being implemented as envisioned and shown in the commitments? Is the rate of implementation and location of actions on track to meet the 10-year milestones? If not, why?
- What actions are being implemented and where? What types of actions are not being implemented and where? Why not?
- How much money is being spent on different types of actions and at different locations?

Side bar: Regional evaluation triggers and actions may be developed, although they have not yet been identified. Regional triggers could result in modifications to local triggers identified in this plan.

Implementation Adjustment. The Forum will determine annually if plan implementation needs adjustment based on whether actions have been taken and the combined rate of

implementation. The Forum will consider individual implementer's and basin-wide progress to make this decision. Note that different evaluation triggers would require different management actions.

Table 12. 1 illustrates the evaluation questions, triggers, and adjustment actions that could be taken if individual implementers were not able to meet their commitments. Table 12.2 shows the evaluation questions, triggers, and adjustment actions that could be taken if actions across the basin were not on track to meet the plan milestones and goals.

Table 12.1: Implementation Evaluation and Adjustment Options for Individual Implementers

Implementation Evaluation for Individual Sponsors	Management Action Trigger	Possible Action	Who
<i>Are commitments being implemented? Does the sponsor or Forum think that the implementer's rate is insufficient?</i>			
Commitments for capital projects, non-capital projects, policies and programs, stewardship and outreach, monitoring, and enforcement are not being implemented and/or sponsor or Forum expresses concern about the rate	Lack of funding is delaying implementation	Forum staff works with jurisdiction to identify additional founding sources	Staff, Forum, sponsor
	Lack of willing landowners is slowing implementation	Forum staff/chair meets with sponsor and landowner as appropriate to find solution if possible; sponsor identifies another project location	Staff, Forum, sponsor
	A key large project is delayed due to permit issues	Forum chair writes a letter to permitting agencies and staff to follow up with agency and regional organization	Forum, staff, sponsor, region
	Jurisdiction has changed political priorities	Forum chair or other members meets with the jurisdiction; Forum chair or staff discusses situation with and solicits support from regional organization as appropriate; for capital projects, non-capital projects, stewardship, and some monitoring, Forum asks whether organizations in the basin can do this work	Forum, staff, region

Implementation Evaluation for Individual Sponsors	Management Action Trigger	Possible Action	Who
Policy and program updates are not in place	Any reason	Forum chair or other member discusses situation with Forum member and writes a letter as appropriate	Forum, local jurisdiction
Project monitoring not in place	Any reason.	Forum staff works with jurisdiction to identify barriers and provides assistance as appropriate; staff raises issue with Forum about monitoring needs and resources	Staff, implementers

Table 12.2: Basin-Wide Implementation Evaluation and Adjustment Options

Basin-Wide Implementation Evaluation	Management Action Trigger	Possible Action	Who
<i>Overall, are actions (capital and non-capital) being implemented as shown in the commitments?</i>			
Overall, commitments for capital projects, non-capital projects, policies and programs, stewardship and outreach, monitoring, and enforcement are not being implemented and/or sponsors or Forum expresses concern about the rate	Lack of funding is delaying implementation	Forum and staff work to identify additional funding sources; Forum discusses situation with region	Staff, Forum, region
	Lack of willing landowners is slowing implementation	Forum requests that members increase or shift focus or methods for outreach and stewardship activities	Forum, Forum members

Basin-Wide Implementation Evaluation	Management Action Trigger	Possible Action	Who
	Projects are delayed due to permits	Forum chair writes a letter to permitting agencies, staff to follow up with agency and regional organization; Forum and local jurisdictions pursue a programmatic streamlined permit process for projects in plan, Forum discusses situation with region	Forum, staff, sponsor, region
Long-term monitoring is not occurring	Any reason	Forum staff works with jurisdictions, state, and region to identify barriers	Forum, staff, responsible jurisdictions
<i>What actions are being implemented and where in the basin? What types of actions are not being implemented, where, and why not?</i>			
Capital projects not focused in nearshore, estuary, or mainstem	Lack of funding	Forum and staff work to identify additional funding sources; Forum discusses situation with region	Forum, implementers, region
	Change in political priorities	Forum discusses situation with key jurisdictions and organizations, and region	Forum, region
Key project types not being implemented	Lack of funding	Forum and staff work to identify additional funding sources; Forum discusses situation with region	Forum, region
Policies not being updated or enforced	Change in political priorities	In addition to recommendations for individual jurisdictions, Forum discusses situation with region	Forum, region

12.4 Direct (Project) Effectiveness Monitoring, Evaluation and Adjustment

Direct effectiveness monitoring is used to determine which approaches and project types are most effective in protecting and restoring habitat to achieve the project milestones. It creates the foundation for longer-term monitoring and evaluation that occurs at the cumulative effectiveness and validation levels. Monitoring, evaluating, and adjusting for direct effectiveness occurs at the programmatic and project levels.

Direct effectiveness monitoring and evaluation seeks to answer specific questions about the effectiveness of individual projects. Table 12.3 (in prep) lists the types of capital projects that are likely to be implemented and their hypotheses. ***This table will be included in the final plan.***

Location of the table might change.

Direct Effectiveness Monitoring. Direct effectiveness monitoring examines individual programs, projects, and physical and biological responses to restoration actions, as well as socio-economic information. Project implementers would contribute data biannually (with assistance from Forum staff as needed) by submitting documentation to Forum staff. As appropriate per implementer, the following categories of actions would be monitored: the number and size of capital and non-capital projects (including acquisitions), policies and programs (including regulatory measures), stewardship and outreach actions, enforcement, and monitoring.

For capital projects, direct effectiveness monitoring data would follow permit requirements for individual projects. Consistent capital project monitoring protocols will be needed to ensure that implementers across the basin collect similar types of data. The Technical Committee will develop these protocols consistent with those used by the Salmon Recovery Funding Board.

Ecological Direct Effectiveness Monitoring Questions

The following general questions should be addressed through direct effectiveness monitoring. Specific questions are also included in Table 12.4.

- Did the restoration or protection project achieve the desired habitat condition?

- Did the project achieve the desired biological response? (E.g., Did the oxbow reconnection project result in more use by juvenile fish?)
- Did the project meet design standards and permit requirements?
- Did you learn of any methods that may result in comparable benefits for less cost?

Table 12.4: Direct Effectiveness Monitoring Questions and Indicators

Direct Effectiveness Monitoring Questions and Indicators	Priority	Who	Frequency
<i>Are projects and programs designed to restore needed habitat at the site-specific scale working? How can we improve project design or implementation so that projects and programs are more effective?</i>			
Fish Passage Enhancement Projects. Monitoring Data Needed for Evaluation: <u>Pre-Project:</u> % passable by juvenile and adult fish, linear length of habitat to be made accessible, abundance and life stage above barrier; <u>Post-Project:</u> Abundance of adults and/or redds upstream of project site, % passable by adult and juvenile fish	1st	Implementers: citizens, cities, counties, state, tribes, NGOs	Pre-and post-project monitoring per CIP standards
Instream Structure Enhancement Projects. Monitoring Data Needed for Evaluation: <u>Pre-Project:</u> #/area of pools, riffles, glides adjacent to project site; <u>Post-Project:</u> #/area of pools, riffles, glides (Note: SRFB monitoring protocols should be referenced and followed, where applicable)	1st	Implementers: cities, counties, state, tribes, NGOs	Pre-and post-project monitoring per CIP standards
Riparian Function Enhancement Projects. Monitoring Data Needed for Evaluation: Area revegetated, % survival, species composition	1st	Implementers: cities, counties, state, tribes, NGOs	Pre-and post-project monitoring per CIP standards
Livestock Exclusion Projects. Indicators: Area fenced, linear feet of access fenced off	1st	Landowners, NGOs (?), other implementers	Annually
Floodplain Reconnection Projects. Indicators: Stream morphology changes, changes in flow capacity	1st	Implementing jurisdictions: cities, counties, state, tribes,	Pre-project for comparison information, post-project every 5 years for long-term habitat change

Direct Effectiveness Monitoring Questions and Indicators	Priority	Who	Frequency
Acquisitions for Habitat. Indicators: Area of salmonid habitat to be protected and/or restored; Type of habitat to be protected and/or restored	1 st	Implementers: cities, counties, state, tribes, NGOs	Pre-project for comparison information, post-project every 5 years for long-term habitat change
Tidal Marsh and Nearshore Habitat Restoration Projects. Indicators: Acres and types of habitat restored	1 st	Implementers: cities, counties, state, tribes, Port, NGOs	Pre-project for comparison information, post-project every 5 years for long-term habitat change

Socio-Economic Direct Effectiveness Monitoring Questions

Project sponsors would answer the following questions (listed in Table 12.5) related to socio-economics to determine direct effectiveness and progress toward the Forum’s goals.

Table 12.5: Socio-Economic Goals and Project Monitoring Questions

Socio-Economic Goal	Project Monitoring Questions
Maximize plan efficiency	What was the project objective? Did you meet it? Were the cost estimates accurate?
Promote innovative solutions	Did the project design promote an innovative solution (e.g., live cottonwood posts, or logjams instead of riprap)
Avoid adverse impacts to agricultural viability	Was agricultural land that was previously or recently in production used for the project? If so, how many acres? Was this considered highly productively farmland by NRCS soils maps? Did the project help improve the productivity of the farm? If yes, how?
Protect health and safety (protect property from flooding)	Did the project increase or decrease flooding risks for people or structures? If yes to either, what was the increase or decrease in acres flooded?
Enhance the conservation ethic	How much money was spent on efforts to promote stewardship (i.e., technical assistance and outreach)?

Socio-Economic Goal	Project Monitoring Questions
Maintain recreational opportunities	Was public access provided? Were any recreational opportunities restricted or increased as a result of the project (i.e., access points along the river, logjam closures, etc.)? If yes, what is the restriction or increase?
Work cooperatively and respectfully with private landowners	Is the landowner satisfied with the project outcome? Were incentives used? Were informational meetings held with landowners or the community? Have adjacent landowners expressed concern about the project and outcome?
Improve availability of traditional and cultural plant materials	Were plants from the Tulalip Tribes plant list (Appendix N) used to help support cultural needs, as well as maintain biological and genetic diversity? If not, why?

Direct Effectiveness Evaluation. Sponsors can evaluate direct effectiveness to make sure their projects are on track. Forum staff can assist with this work if needed. Evaluating direct effectiveness by analyzing ecological and socio-economic data will occur when evaluating cumulative effectiveness (explained in Section 12.5).

Table 12.6 describes the evaluation and adjustment steps that project sponsors and the Forum can use to help ensure that individual projects are effective.

Table 12.6: Direct Effectiveness Evaluation and Adjustments for Sponsors

Project Type and Monitoring to be Evaluated	Direct Effectiveness Evaluation Questions	Action Trigger	Recommended Action	Who
<i>Are projects and programs designed to restore needed habitat at the site-specific scale working? How can we improve project design or implementation so that projects and programs are more effective?</i>				
Fish Passage Enhancement Projects. Implementing jurisdiction monitors to meet design standards of own CIP programs and permit requirements	Does the project increase the linear distance of habitat available for spawning and/or rearing salmonids? How much? Does the design standard help achieve the goals of the conservation plan? Can similar projects be designed to be more effective?	Project is unsuccessful; implementer does not or cannot meet design standards needed	Consults with SRFB protocols or local experts (state, county, others) for redesign	Implementers; Forum staff could help facilitate
Instream Structure Enhancement Projects. Implementer monitors to meet design standards of own CIP programs and permit requirements	Does the project meet the design standards of the implementing jurisdiction's CIP/permit requirements? Does it meet the objectives of the conservation plan? Does it increase the quality and quantity of habitat downstream?	Project not functioning as designed	Implementer consults with county, state, Technical Committee, or other experts for redesign	Implementers; Forum staff could help facilitate
Riparian Function Enhancement Projects. Implementing jurisdiction monitors to meet design standards of own CIP programs and permit requirements	Does the project improve the habitat for salmonids? Does survivorship after two years meet the project design and permit requirements?	Habitat is not improved; plant survival rates are below design	Implementer could increase maintenance, replant, plant larger trees, add fencing and/or consult with county, state, or other experts for improvement options	Implementers; Forum staff could help facilitate

Project Type and Monitoring to be Evaluated	Direct Effectiveness Evaluation Questions	Action Trigger	Recommended Action	Who
<p>Livestock Exclusion Projects. Implementer or landowner to monitor</p>	<p>Has the project effectively kept livestock out of waterbodies? How many feet of natural edge have been restored? If livestock continue to access the water, is it due to lack of funding to fence?</p>	<p>Habitat is not improved; landowner not using project as designed</p>	<p>Sponsor to work with landowner, landowner and/or sponsor to seek other ideas to make project functional</p>	<p>Implementers; Forum staff could help facilitate</p>
<p>Floodplain Reconnection Projects. Implementer monitors to meet design standards and permit requirements</p>	<p>Has the removal and/or setback (of dike, levee, riprap, road, etc.) reduced channel constraints and increased flow capacity? Has the stream morphology changed over time? Does the project result in increased habitat area and/or complexity for salmonids? After 10 years, has the project resulted in a significant change in channel complexity and capacity (see SRFB protocols)?</p>	<p>Project does not function as designed or improve habitat</p>	<p>Implementer consults with county, state, Technical Committee, or other experts for improvement options</p>	<p>Implementers; Forum staff could help facilitate</p>
<p>Habitat Acquisitions. Jurisdiction acquiring property for habitat monitors for habitat function and salmonid use</p>	<p>How much and what type of habitat is protected and/or restored by the acquisition? Does the acquisition help meet 5- or 10-year habitat condition goals? Is the acquisition addressing critical needs of the conservation plan? (If habitat can be restored for increased function, jurisdiction can refer property to plan project list for prioritization and sequencing.)</p>	<p>Insufficient habitat gains</p>	<p>Forum staff or Technical Committee to work with sponsor to identify potential for habitat gains</p>	<p>Implementers; Forum staff reports to Forum</p>

Project Type and Monitoring to be Evaluated	Direct Effectiveness Evaluation Questions	Action Trigger	Recommended Action	Who
Tidal Marsh, nearshore, and edge habitat projects.	How much and what type of habitat has been restored? How does this help meet the 5- or 10-year milestones?	Insufficient habitat gains	Forum staff or Technical Committee to work with sponsor to identify potential for habitat gains. Review implementation adjustment actions, if needed	Forum staff with implementers, Technical Committee, Forum

12.5 Cumulative Effectiveness Monitoring, Evaluation, and Adjustment

Cumulative effectiveness monitoring and evaluation is used to track the combined effectiveness of a series or group of projects implemented within a sub-basin or sub-basin strategy group. This information can help demonstrate the overall combined effectiveness of programs needed to support healthy fish populations in sub-basins and sub-basin strategy groups and the progress being made toward socio-economic goals. The Forum's socio-economic goals identified for direct effectiveness monitoring will be evaluated through this process, as well.

The highest priority ecological questions to be asked to determine cumulative effectiveness are:

- Relative to a baseline data set, how are physical habitat conditions changing across the basin in response to restoration actions and degradation?
- Relative to a baseline data set, how are land cover and other sub-basin scale conditions changing across the basin in response to restoration actions and degradation?
- Relative to a baseline data set, how are salmonid population characteristics changing over time?

Cumulative effectiveness monitoring. Cumulative effectiveness monitoring requires more time than implementation monitoring or direct effectiveness monitoring because it takes longer to see the cumulative responses from changes in habitat conditions. For example, meaningful cumulative monitoring results that can be evaluated for ecological trends will take several Chinook salmon life cycles to develop, or approximately 10 to 25 years.

Cumulative effectiveness monitoring should be performed on a basin and sub-basin scale by larger jurisdictions, such as King and Snohomish Counties, Tulalip Tribes, the U.S. Forest Service, Washington Department of Fish and Wildlife, and NOAA-Fisheries. Physical habitat inventories and land cover analysis should occur every five years, or more often on a rotational basis (i.e., large rivers one year, tributaries another). Biological monitoring should occur each year. The Technical Committee would analyze data in cooperation with Forum staff and the Policy Development Committee.

Cumulative effectiveness evaluation for ecological goals. Evaluating cumulative biological responses will take many years, though habitat trends can be observed more frequently (every five years) by analyzing land cover and other data. Annual data collection through implementation monitoring and direct effectiveness monitoring will also help provide a baseline for trend evaluation. Once adequate data are available, the cumulative effectiveness of actions can be evaluated.

Table 12.7 summarizes cumulative effectiveness monitoring indicators, evaluation questions, and management action triggers. More detailed information about cumulative monitoring priorities and data collection can be found in Appendix O.

Table 12.7: Cumulative Effectiveness Monitoring and Evaluation Questions for Ecological Considerations

Cumulative Effectiveness and Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
<i>Relative to a baseline data set, how are physical habitat conditions changing across the basin in response to restoration actions and degradation?</i>					
Monitor mainstem habitat condition trends. Indicators: Pool frequency, % pool area, LWD frequency, LWD jam frequency, length of channel edge	1st	King and Snohomish Counties	2007, 2010, 2013	Are habitat trends improving for salmonids in mainstem sub-basins? If so, are they improving enough to meet VSP/plan goals? If not, what do we change to meet needs?	< 20 new logjams by 2010; no net gain in pool areas and/or frequencies by 2010
Monitor mainstem bank condition and bank modification trends. Indicators: % Bank instability, % bank modifications	1st	King and Snohomish Counties	2007, 2010, 2013	Have restoration efforts along mainstem banks created needed natural edge?	< 5 miles of restored edge habitat along mainstems by 2010; no net gain in natural edge conditions due to losses from development/management practices or increased bank instability
Monitor marine and estuary shoreline connectivity. Indicators: % Armored, % feeder bluff, % piers/docks	1st	MRC, PSNRP, Tulalip Tribes	2008, 2010	Have restoration goals in the nearshore been achieved?	< ½-mile of nearshore shoreline restored by 2010; no net gain in natural nearshore beaches or shoreline
Monitor estuarine tidal marsh conditions trends. Indicators: Tidal marsh area by habitat type, blind tidal channel area	1st	Snohomish County	2008, 2010	Is there an increase in the amount of connected and accessible tidal marsh and blind tidal channels?	< 619 acres restored by 2010; no net gain in tidal marsh habitat

Cumulative Effectiveness and Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Monitor temperature and water quality trends. Indicators: Seven-day moving average of daily maximum temperatures, 303(d) listings	1st	Tribes, cities, counties, DOE, University of Washington	TBD	Are stream temperatures increasing? Have temperature increases reduced the habitat available for juvenile rearing and returning adults? Are the 303(d) listed segments being improved and delisted?	XXX?
Monitor tributary stream habitat trends. Indicators: Pool frequency, % pool area, LWD frequency, LWD jam frequency, bank instability, % surface fines in spawning gravel	2nd	Tulalip Tribes and counties	2009, 2012, 2015	Are habitat conditions improving?	<50% of lowland tributary habitat goals in Conservation Plan; no overall gain in habitat improvement in lowland tributary basins
Monitor floodplain habitat trends. Indicators: Area of slough/pond habitat; Length of side-channels	2nd	Counties	2008, 2010, 2014	Have off-channel floodplain habitats increased through implementation of restoration actions? Has a net gain in off-channel floodplain habitat been achieved?	<68 acres of off-channel floodplain restoration achieved by 2010; no net gain in overall acreage of floodplain habitat by 2010
<i>Relative to a baseline data set, how are land cover and other sub-basin scale conditions changing across the basin in response to restoration actions and degradation?</i>					
Monitor forest cover and riparian forest condition trends. Indicators: % Mature forest cover, % woody vegetation (mature evergreen, medium evergreen, deciduous, shrub/small tree).	1st	King and Snohomish Counties	2008, 2015	Are sub-basin forest cover and riparian forest cover increasing or decreasing along EDT reaches?	<127 acres of riparian forest planted in mainstem sub-basins by 2010; <50% of lowland tributary riparian forest goals (along EDT reaches) by 2010; net loss in forest cover in any sub-basin strategy group

Cumulative Effectiveness and Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Monitor impervious surface.	1st	Snohomish County	2010	Is impervious surface increasing across the entire basin or is it contained to the urban streams sub-basin strategy group? How is the plan performing in the different sub-basin strategy groups?	Significant gains in impervious surface outside the urban streams sub-basin strategy group; gains exceed amount modeled in the <i>Ecological Analysis for Salmonid Conservation</i>
Monitor road density trends. Indicators: Road length/sub-basin area	2nd	King and Snohomish Counties	TBD	Is road density decreasing in headwater streams sub-basin strategy groups?	Gains exceed amount modeled in the <i>Ecological Analysis for Salmonid Conservation</i>
Monitor fish access at culverts. Indicators: # of blocking culverts, # fixed, miles of access restored	2nd	State, counties, Tulalip Tribes and NGOs	2010	How much access has been restored? How many miles of habitat are blocked?	< 30 culverts improved by 2010
Relative to a baseline data set, how are population characteristics changing over time?					
Monitor trends in total escapement, recruitment and characteristics for each stock throughout system. Indicators: Escapement, recruitment, # of natural origin stock, # of hatchery origin stock, length distribution, age distribution, sex ratio, timing	1st	WDFW, Tulalip Tribes, NOAA Fisheries	Annually	How does the annual enumeration compare to the previous year? Can a trend be detected?	Co-managers note significant changes from past and predicted results; co-managers request Forum action

Cumulative Effectiveness and Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
<p>Monitor trends in smolt abundance and characteristics for each stock throughout system. Indicators: Number, length, timing, # of hatchery origin fish, # of natural origin fish</p>	1st	WDFW, Tulalip Tribes, NOAA Fisheries	Annually	How does the annual enumeration compare to the previous year? Can a trend detected?	Co-managers note significant changes from past and predicted results; co-managers request Forum action

Cumulative effectiveness adjustment for ecological goals. While cumulative effectiveness monitoring and evaluation is used to track the combined effectiveness of plan projects and programs at the sub-basin or sub-basin strategy group scale, cumulative effectiveness adjustment selects the action that will steer the plan and its implementing jurisdictions toward meeting the shared recovery goal. To determine if adjustment is needed, data from individual projects being monitored (direct effectiveness monitoring) will be combined into a cumulative evaluation. For example, each culvert replacement project completed across the basin would be compiled into a list that totals the amount of habitat made accessible to salmonids.

Cumulative effectiveness adjustment will be based on recommendations from the Technical and Policy Development Committees to the Forum regarding the comparative effectiveness of certain projects. The committees will evaluate the rates and types of projects and programs implemented (implementation monitoring), the effectiveness of individual projects (direct effectiveness monitoring), and make recommendations to the Forum for increased (or decreased) activities in certain habitat types, geographic areas, or in certain jurisdictions. The evaluation would be conducted biannually and respond to the following questions:

- What are the comparative benefits of different project types?
- What are the benefits relative to the costs for individual projects and project types?
- Are the cumulative benefits from similar project types meeting biological and socio-economic needs?

Cumulative effectiveness monitoring and evaluation will also yield basin-wide trend analysis based on large-scale studies such as annual spawner surveys and smolt outmigration enumeration. These studies will provide data to help Technical and Policy Development Committee members determine if implemented actions will be adequate to reach the plan's long-term goals. Cumulative effectiveness evaluation of basin-wide trends will enable the committees to make recommendations to the Forum for more effective and efficient management and plan implementation.

For example, if data from the smolt outmigration study reveals a trend of increased habitat productivity that can be attributed to the combined effects of habitat restoration in the basin (or along one of the mainstem rivers), then the adjustment recommendation may be to “not adjust” and continue implementing the same types of projects at the same rate (see Table 12.8). If, however,

the outmigrant data shows that one mainstem is being adequately restored while the other is not, the adjustment recommendation may be to allocate more habitat improvement funding or projects to the underperforming mainstem.

In this way, data gathered through implementation monitoring, direct effectiveness monitoring, and cumulative effectiveness monitoring can be connected and can inform the cumulative effectiveness adjustment. As the Forum implements, monitors, learns, and adjusts at smaller scales based on implementation and direct effectiveness monitoring, the combined benefits of learning will be incorporated in the larger-scale cumulative picture.

Table 12.8 illustrates the triggers, responses, and responsibilities for the three priority cumulative effectiveness questions related to ecological needs. The evaluation trigger is a summary of the more detailed evaluation triggers in Table 12.7.

Table 12.8: Possible Cumulative Effectiveness Adjustments for Ecological Considerations

Evaluation Trigger (from Table 12.7)	Possible Actions	Who
<p>If physical habitat conditions have not improved sufficiently or have declined. This applies to the mainstems, marine and estuary shoreline connectivity, tidal marsh, and water quality.</p>	<p>Forum staff to work with Technical Committee to determine possible reasons; Forum staff reviews this information with Forum. If issues are related to implementation, take actions identified in Section 12.3. If issues are related to projects, take actions identified in Section 12.4. Let implementers know whether certain types of projects should be increased or decreased (encourage what is working in other areas).</p>	<p>Staff, Technical Committee, Forum, implementers</p>
<p>Forest cover and riparian habitat conditions have insufficient gains or have declined.</p>	<p>Forum staff to work with Technical Committee to determine possible reasons; Forum staff reviews this information with Forum. If issues are related to implementation, take actions identified in Section 12.3. If issues are related to projects, take actions identified in Section 12.4.</p>	<p>Staff, Technical Committee, Forum, implementers</p>
<p>Fish population numbers decline or do not improve.</p>	<p>Co-managers to consult with Technical Committee and Forum about actions, region maybe involved</p>	<p>Co-managers, Technical Committee, Forum, region</p>

Cumulative effectiveness evaluation and adjustment for socio-economic goals. Similar to the cumulative evaluation and adjustments for ecological goals, the information gathered as part of direct effectiveness monitoring will be analyzed to determine the combined impacts of actions across the basin on the plan's socio-economic goals. Forum staff would conduct this evaluation biannually with assistance from the Policy Development Committee. Table 12.9 shows the Forum's socio-economic goals, cumulative evaluation questions, management triggers, and possible actions to address thresholds that have been triggered.

Side bar: Adjustments to the plan actions based on either ecological or socio-economic needs must consider potential impacts on the other.

Table 12.9: Cumulative Effectiveness Evaluation and Possible Management Actions for Socio-Economic Considerations

Socio-Economic Goal	Cumulative Effectiveness Evaluation Questions	Action Trigger	Possible Management Actions
Maximize plan efficiency	What has been the cost relative to the gain?	TBD	TBD
Promote innovative solutions	Are we promoting innovative actions?	Many private and public landowners express concerns that they want more project or program flexibility	Forum staff follows up with individual jurisdictions or other public agencies and reports back to Forum and landowners; Forum staff arranges a joint meeting to help resolve; Forum writes a letter to agencies if needed
Avoid adverse impacts to agricultural viability	Have we impacted the viability of farming? What was the total amount of agricultural land used? How much was highly productive according to the NRCS?	Landowners express concerns to Forum staff and/or Forum	Forum and staff work with farm community to identify solutions (such as project locations, landowner use of property). Forum requests that agencies and organizations increase or improve outreach and/or technical assistance.
Protect health and safety (protect property from flooding)	Have we increased or decreased the frequency that people and structures are exposed to flooding?	1. If decreased, make information known 2. If increased, make information known and work with sponsors to correct	1. Forum staff works with other agencies and NGOs to make this information available through existing newsletters 2. Forum staff notifies project sponsors of landowner concerns about project actions. Sponsor to follow up.

Socio-Economic Goal	Cumulative Effectiveness Evaluation Questions	Action Trigger	Possible Management Actions
Enhance the conservation ethic	Have we invested sufficiently in outreach, technical assistance, and stewardship programs?	<ol style="list-style-type: none"> 1. No or very limited funding increases or program expansions over 2005 levels 2. Technical assistance not focused in high priority areas 	<ol style="list-style-type: none"> 1. Forum contacts regional organizations about situation; Forum staff works to identify other sources of funding 2. Forum and/or Forum staff discuss needs with agencies and organizations that provide this assistance to encourage redirection of actions
Maintain recreational opportunities	Have recreational opportunities increased or decreased (e.g., access to rivers, along rivers, and closures due to logjams)? Have run sizes increased so that there is more recreational fishing?	<ol style="list-style-type: none"> 1. Numerous complaints related to access restrictions 2. No change above current recreational fishing opportunities 	<ol style="list-style-type: none"> 1. Forum to write letters and/or meet with sponsors and recreational groups about these projects to identify a solution 2. See actions under implementation, cumulative effectiveness for ecological considerations, and validation section
Work cooperatively and respectfully with private landowners	Are we promoting and using incentives? Are we working with willing landowners? Have we held informational meetings with landowners and the community?	Complaints to or about project sponsors regarding lack of cooperation and/or informational meetings; complaints from adjacent landowners	Direct concerns to Forum staff. Forum staff to contact sponsor and let Forum chair know of situation. Forum staff or Forum to encourage sponsor to hold informational meetings.
Improve availability to traditional and cultural materials	Have we worked to improve the availability of traditional and cultural materials by planting native plants that are important to Tulalip Tribes?	Tulalip Tribes communicate concerns to Forum staff	Forum staff follows up with sponsors (make sure they know about the list of important tribal plants, see Appendix N) and reports back to Forum and Tulalip Tribes

12.6 Validation Monitoring, Effectiveness, and Adjustment

Validation monitoring, evaluation, and adjustment tests and refines the ecological recovery hypotheses and recovery strategies in this plan (similar regional questions are likely to be addressed across Puget Sound). Validation monitoring can also test the effectiveness and sensitivity of the models used to determine the effects of actions on the abundance, productivity, diversity, and spatial structure of the fish populations. Results of the direct and cumulative effectiveness steps will be combined and evaluated with fish population information. Additional research to fill substantial data gaps, such as the extent and importance of current and predicted low flow problems on salmon and the integration of habitat, harvest, and hatchery hypotheses and strategies, would also be addressed in this phase.

The highest priority questions to be addressed in the validation phase include:

- Are the hypotheses regarding habitat-limiting factors correct?
- Are hypotheses regarding harvest management correct?
- Are hypotheses regarding hatchery management correct?
- Are hypotheses regarding the integration of habitat, harvest, and hatchery correct?
- Are hypothesis regarding the linkages between land use, watershed processes, and habitat correct?
- Do model outputs closely approximate the real world?

Validation monitoring and evaluation. Table 12.10 summarizes the monitoring measures, priorities, evaluation questions, management actions, and adjustment triggers linked to validation monitoring. More detailed information on validation monitoring measures and priorities can be found in Appendix O.

Table 12.10: Validation Monitoring and Evaluation Questions and Triggers

Validation Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
<i>Are hypotheses regarding population structure correct?</i>					
Evaluate population structure assumptions through further genetic analysis and field surveys to document spawning timing and distribution	2nd	Co-managers	5-10 years	Is there a spring Chinook population in the Snohomish River basin? Are Pilchuck spawners genetically distinct? How can we better our understanding of diversity and spatial structure across the Snohomish River basin?	Identifying a distinct population would necessitate adjustment in hypotheses and the management framework
<i>Are hypotheses regarding habitat-limiting factors correct?</i>					
Evaluate use of mainstem and floodplain rearing habitat by juvenile Chinook and other salmonids	1st	NWFSC, Tribes, counties	2-5 years	Is an increase in rearing area in mainstem and floodplain habitats resulting in the anticipated increase in juvenile densities? How does monitoring data reconcile with our assumptions of how fish use these habitats?	If monitoring data reveals that hypotheses regarding juvenile utilization of habitat is incorrect, adjustment is needed
Evaluate juvenile salmonid use of the Snohomish River estuary and nearshore	1st	NWFSC, Tulalip Tribes	1-2 years	Is an increase in rearing area in estuarine habitats resulting in the anticipated increase in juvenile densities? How does monitoring data reconcile with our assumptions of how fish use these habitats?	If monitoring data reveals that hypotheses regarding juvenile utilization of habitat is incorrect, adjustment is needed

Validation Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Evaluate density-dependence for Snohomish River basin Chinook stocks	1st	NWFSC, University of Washington (?), Tulalip Tribes (?)	TBD	How does density-dependent migration and mortality in different life stages affect restoration projects and the overall recovery strategy (i.e., effect of large pink runs on recovery efforts)?	If study data yields results that should be incorporated into plan activities, actions may be reprioritized or sequenced differently
Evaluate egg-to-fry survival and causes of mortality at key spawning locations	2nd	Tulalip Tribes (?)	TBD	How does egg-to-fry survival affect fry-to-smolt survival? Does fine sediment and/or scour result in a major source of mortality?	If data relating to scour and survival rates differs from assumptions, management action is needed to adjust model inputs and management recommendations
Conduct quantitative limiting factors analysis and habitat-population performance modeling for coho, bull trout, steelhead, and other salmonid species	3rd	TBD	TBD	Adapting EDT for other salmonid species (i.e., coho, bull trout, steelhead) may identify and clarify recovery approaches that have multiple benefits for multiple species. Using this new information, where are we achieving maximum multi-species benefits?	As new models are created and used, outputs should focus and sequence management actions
<i>Are hypotheses regarding harvest management correct?</i>					
Double-indexed coded-wire tagging program to track marine survival harvest rates	1st	Co-managers	TBD	How is harvest distributed? What is the estimated harvest exploitation rate and marine survival rate?	If data gathered differs from harvest hypotheses, adjustment is needed

Validation Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Refine estimates of freshwater and marine survival for fingerlings and smolts	1st	Co-managers	TBD	What is the estimated productivity, and how is this reflected in harvest management guidelines? Are observed survival patterns correlated with environmental conditions? (Analysis will test EDT and SHIRAZ model inputs.)	If data gathered differs from harvest hypotheses, adjustment is needed
Quantification of the contribution of hatchery-origin adults to natural spawning for each stock	1st	Co-managers	TBD	Are the estimations of NOR accurate? Are annual exploitation rates accurate?	If data gathered differs from harvest hypotheses, adjustment needed
<i>Are hypotheses regarding hatchery management correct?</i>					
Marking hatchery fish to distinguish them from wild fish	1st	Co-managers	TBD	Does information gained from additional mark-and-recapture studies with hatchery fish help us understand hatchery/wild interactions?	If assumptions are not accurate, change management actions
Determine extent and magnitude of predation and competition generated by hatchery populations on wild populations as juveniles	1st	Co-managers	TBD	Are assumptions pertaining to hatchery/wild interactions accurate?	If assumptions are not accurate, change management actions
Determine the extent of hatchery gene contribution to wild populations	1st	Co-managers	TBD	Have hatchery practices that contribute gene flow to wild populations stopped or been reduced? What is the impact of including naturally spawning hatchery fish in escapement estimates?	If assumptions are not accurate, change management actions

Validation Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Determine the extent of inbreeding within hatchery populations	1st	Co-managers	TBD	How does this information assist management decision pertaining to hatchery/wild interactions?	Use new data to redesign, if necessary
<i>Are hypotheses regarding integration of the H's correct?</i>					
Refine integration of harvest, hatchery and habitat in EDT and SHIRAZ modeling runs to evaluate interactions	1st	Co-managers, NOAA Fisheries, Snohomish County	TBD	Are assumptions pertaining to interaction of hatchery, harvest, and habitat accurate? Do models use them accurately?	If assumptions are not accurate, change management actions
<i>Are hypotheses regarding linkages between land use, watershed processes, and habitat correct?</i>					
Evaluate the mechanistic linkages in the basin between land cover, watershed processes, and instream habitat	1st	Snohomish County, University of Washington, NWFSC	TBD	Are assumptions pertaining to interaction of hatchery, harvest, and habitat accurate? Do models use them accurately?	If assumptions are not accurate, change management actions
Model changes in peak flow characteristics (i.e., timing, magnitude, frequency and duration) attributable to land use practices, climate change, and water withdrawal	1st	NOAA Fisheries, Universities, Tribes	TBD	Is our understanding of the relative importance of factors contributing to alteration of peak flow timing, frequency, magnitude, and duration of flows adequate? Do we need refinement to better make management decisions?	If assumptions are not accurate, change management actions
Identify key locations of upwelling and downwelling in mainstem and major tributaries	2nd	TBD	TBD	Are upwelling and downwelling locations mapped? Do we know which are most important to salmonid recovery?	XXX?

Validation Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Develop sediment budgets in areas of high sediment yield	2nd	TBD	TBD	Does the sediment budget yield different assumptions or change our priorities pertaining to basin-wide efforts?	If assumptions are not accurate, change management actions
Model hillslope stability; inventory location and magnitude of mass wasting events	2nd	TBD	TBD	Does data gathered from this study change how we manage for erosion, sediment contribution, and mass wastings?	If assumptions are not accurate, change management actions
Historical analysis of habitat conditions and fish use in nearshore, Skykomish River and small tributaries	2nd	State, Universities, PSNRP, MRC	TBD	Once this historic analysis is complete, how does it change our strategy for recovering salmonids in the basin? How do we change to use what we have learned?	If assumptions are not accurate, change management actions
Nearshore and estuary sediment transport and water circulation modeling	2nd	NOAA, HAZMAT, Tribal, MRC	TBD	Are assumptions pertaining to ecological interaction correct? Does the model use them accurately?	If assumptions are not accurate, change management actions
Research role of LWD in estuary and nearshore environment	2nd	University of Washington (?)	TBD	Are assumptions pertaining to the role of LWD in estuary and nearshore habitats correct? Does the model use them accurately?	If assumptions are not accurate, change management actions
<i>Are model outputs a close approximation of the real world?</i>					
Further refinement and sensitivity analysis of the EDT model	1st	Snohomish County, Mobrاند Biometrics, Inc.	TBD	Can we increase the certainty of our model results? If so, how?	Model assumptions are tested and improved when possible

Validation Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Further refinement and sensitivity analysis of SHIRAZ model	1st	NWFSC	TBD	Can we increase the certainty of our model results? If so, how?	As data from new studies becomes available, it should be used to redirect and reprioritize management actions, model inputs, and project sequencing as appropriate
<i>What other data can guide land management and support plan implementation?</i>					
Establish new flow gauging sites	2nd	USGS and counties	TBD	Does information from new studies and experiments yield data that can be used to better address water quantity and flows?	As data from new studies becomes available, it should be used to redirect and reprioritize management actions, model inputs, and project sequencing as appropriate
Identify and map channel migration zones	2nd	Counties	TBD	Are assumptions pertaining to interaction of hatchery, harvest, and habitat accurate? Does the model use them accurately?	As data from new studies becomes available, it should be used to redirect and reprioritize management actions, model inputs, and project sequencing as appropriate

Validation Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Inventory spawning and rearing locations for sand lance, surf smelt, and herring	2nd	MRC, State, ACOE, Universities	TBD	Are assumptions pertaining to interaction of hatchery, harvest, and habitat accurate? Does the model use them accurately?	As data from new studies becomes available, it should be used to redirect and reprioritize management actions, model inputs, and project sequencing as appropriate
Life history and habitat use for juvenile and adult forage fish (sand lance, surf smelt, and herring)	2nd	MRC, state, ACOE, Universities, tribes, federal agencies	TBD	Are assumptions pertaining to interaction of hatchery, harvest, and habitat accurate? Does the model use them accurately?	As data from new studies becomes available, it should be used to redirect and reprioritize management actions, model inputs, and project sequencing as appropriate
Inventory eel grass beds	3rd	MRC, state, ACOE, Universities	TBD	Are assumptions pertaining to interaction of hatchery, harvest, and habitat accurate? Does the model use them accurately?	As data from new studies becomes available, it should be used to redirect and reprioritize management actions, model inputs, and project sequencing as appropriate
Conduct basin-wide inventory of non-native fish species in lotic and lentic environments	3rd	WDFW, Tribes, University of Washington (?)	TBD	How are invasive fish species impacting recovery efforts? How shall management actions be changed or reprioritized to address exotic fish species if they are deemed to be a problem?	If studies show that exotic invasive fish species are adversely impacting salmon recovery, management actions should be reprioritized to address

Validation Monitoring Indicators	Priority	Who	Frequency	Evaluation Questions	Management Action Trigger
Conduct basin-wide inventory of non-native plant species in lotic and lentic environments	3rd	TBD	TBD	How are invasive plant species impacting recovery efforts? How shall management actions be changed or reprioritized to address exotic plant species if they are deemed to be a problem?	If studies show that exotic invasive plant species are adversely impacting salmon recovery, management actions should be reprioritized to address
Additional stream water typing	TBD	TBD	TBD	How do additional studies (to be completed) provide an enhanced picture of recovery effort success? How does the evaluation of new data clarify regional habitat and model assumptions?	TBD
Additional culvert inventory	TBD	TBD	TBD	How do additional studies (to be completed) provide an enhanced picture of recovery effort success? How does the evaluation of new data clarify regional habitat and model assumptions?	TBD
Improve the road layer to increase resolution and consistency across watershed	TBD	TBD	TBD	How do additional studies (to be completed) provide an enhanced picture of recovery effort success? How does the evaluation of new data clarify regional habitat and model assumptions?	TBD

Validation Adjustment. After validation monitoring data are analyzed and evaluated, the plan hypotheses will likely need to be updated to reflect new learning. Hypotheses in the forms of model inputs, ecological interaction assumptions, and fish performance that serve as the plan’s foundation will benefit from adjustments. For example, we might learn that our assumption that increased juvenile rearing habitat in the mainstem river corridors is not resulting in the expected juvenile densities. We could also learn that deforestation in the headwaters is contributing to more significant degradation downstream than originally estimated. These scenarios show how 10 years of data may be used to update and refine model inputs, the understanding of ecological linkages, and habitat value assumptions. Validation adjustment provides the opportunity to update the broad-picture understanding of the basin and make adjustments for the next 10-year interval to improve effectiveness.

Table 12. 11 describes validation triggers, possible actions, and responsibilities for five priority categories.

Table 12.11: Validation Triggers and Actions

Type of Action Trigger	Possible Actions	Who
Validation monitoring and research support reveal need to refine habitat hypotheses	Technical Committee works with Forum to adjust these and related actions. Forum reports changes to regional level.	Technical Committee, Forum
Validation monitoring and research support reveal need to refine harvest hypothesis	Co-managers adjust these and related recommendations with the Technical Committee and then with the Forum. Co-managers address these at the regional level with Forum cooperation.	Co-managers, Technical Committee, Forum
Validation monitoring and research support reveal need to refine hatchery hypothesis	Co-managers adjust these and related recommendations with the Technical Committee and then with the Forum. Co-managers address these at the regional level with Forum cooperation.	Co-managers, Technical Committee, Forum

Type of Action Trigger	Possible Actions	Who
Validation monitoring and research support reveal need to refine hypothesis related to integration of habitat, harvest, and hatchery	Co-managers, Technical Committee, and Forum work cooperatively to adjust these and related recommendations. Forum and co-managers work to address these at the regional level.	Co-managers, Technical Committee, Forum
Model needs to be adjusted to reflect new or improved information	Co-managers, Technical Committee, and NOAA Fisheries work cooperatively to address these. Technical Committee consults with Forum on need for new model runs and possible related adjustments.	Co-managers, Technical Committee, Forum, NOAA Fisheries

12.7 What data gaps have been filled?

Since 1999, substantial progress has been made to (1) fill data gaps, (2) analyze available data to develop a salmon recovery strategy for the Snohomish River basin, and (3) provide a solid technical foundation for this plan. Some key accomplishments include:

- Smolt trapping on the Snoqualmie and Snohomish Rivers (Tulip Tribes)
- Sampling to document juvenile salmon use in the Snohomish estuary (NOAA Fisheries and Tulip Tribes)
- Bull trout monitoring in the Snohomish River, estuary, and nearshore (Pentec for the U.S. Army Corps of Engineers)
- Habitat and bank condition surveys of large rivers and tributary streams in the Snoqualmie Valley (King County)
- Tolt River habitat and fish use surveys (City of Seattle and Washington Trout)
- Habitat and bank condition surveys in the Skykomish and Snohomish Rivers and major tributaries (Snohomish County)
- Reach analyses in the confluence reach of the Snohomish River and the braided reach of the Skykomish River (Snohomish County)
- Historic habitat conditions analysis for salmonids in the Lower Snoqualmie River mainstem and valley floor (King County and University of Washington)

- Analysis of land cover, including forest cover, riparian conditions, and impervious surface, using 1991 and 2001 Landsat Satellite Imagery (Snohomish County)
- Completion of harvest and hatchery management plans (Tulalip Tribes and Washington State Department of Fish and Wildlife)
- Completion of the *Salmonid Habitat Limiting Factors Analysis* (2002) (Washington State Conservation Commission)
- Habitat conditions assessment on a sub-basin scale in the *Habitat Conditions Review* (2002) (Technical Committee)