Chapter 9:
Monitoring and Adaptive Management

Adaptive Management Framework

The 2005 Salmon Habitat Plan outlined a science-based blueprint for prioritizing Chinook salmon recovery efforts in the Green/Duwamish and Central Puget Sound Watershed. This Plan Update reflects an ongoing commitment to adaptive management to ensure prioritization and sequencing of investments reflect best available science and maximize benefits to Chinook salmon, in terms of established viable salmon population criteria. WRIA 9 convenes a regular Implementation and Technical Committee (ITC) to oversee monitoring and adaptive management of the Salmon Habitat Plan. The ITC informs monitoring priorities, evaluates plan implementation and recovery progress, and makes formal policy and funding recommendations to the Watershed Ecosystem Forum.

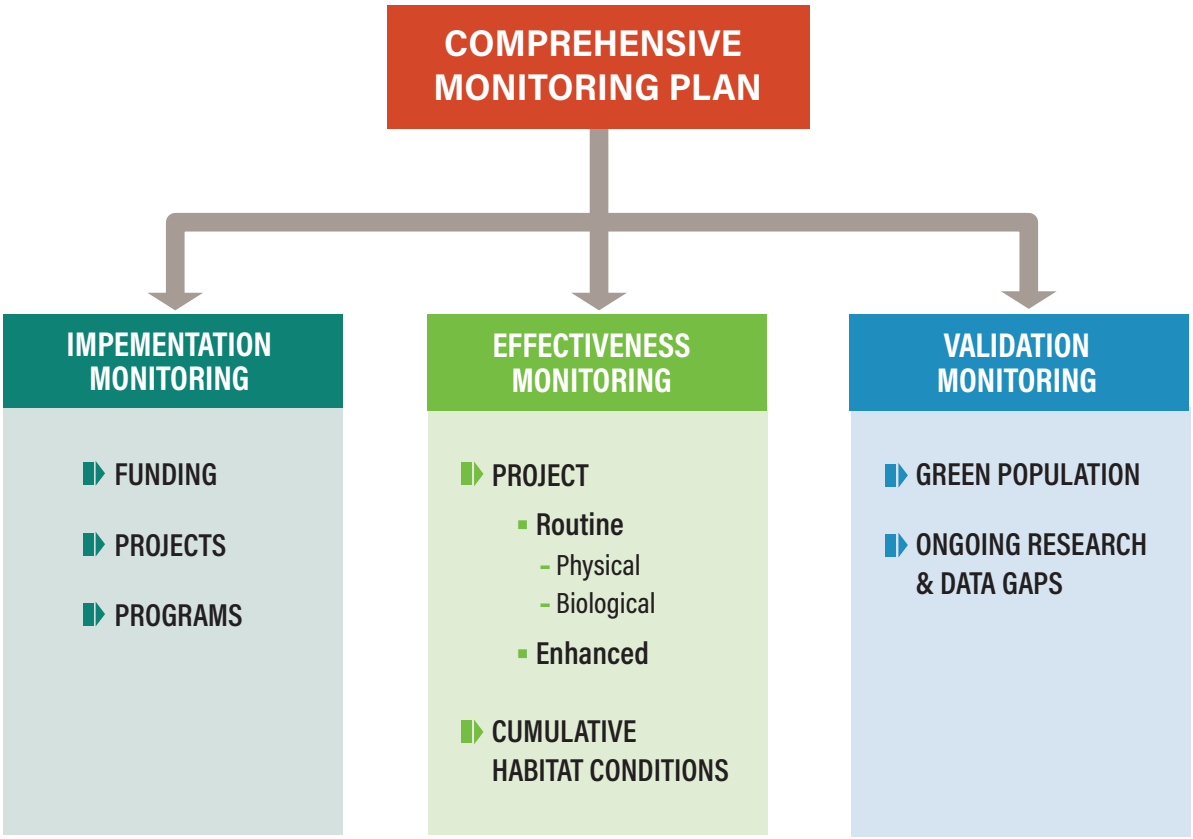
In 2020, WRIA 9 developed a Monitoring and Adaptive Management Plan (Appendix F) that outlines a framework to:

- Prioritize research and monitoring investments to address important data and knowledge gaps;
- Support status and trends monitoring to assess established habitat-related recovery goals and viable salmon population metrics;
- Promote collaboration among partners engaged in research and monitoring within the watershed; and
- Guide adaptive management of the Salmon Habitat Plan.

The WRIA 9 Monitoring and Adaptive Management Plan (MAMP) outlines three categories of monitoring intended to help evaluate and inform strategic adaptation of recovery efforts (Figure 31). Each category of monitoring is intended to answer underlying questions related to implementation progress, effectiveness of actions, and overall impact on Chinook recovery.

- **Implementation Monitoring:** Is the plan being implemented as intended? Are we on track to meet established habitat targets?
- **Effectiveness Monitoring:** Are habitat projects functioning as expected? Are habitat status and trends improving throughout the watershed?
- **Validation Monitoring:** Are salmon recovery efforts benefiting the Green River Chinook salmon population (i.e., VSP criteria)? Are the underlying scientific assumptions of the plan accurate?

Figure 31. *Types of monitoring used to evaluate management strategies and adapt them as necessary.*



Periodic assessment of these questions allows watershed partners to reassess plan implementation, underlying recovery strategies, and/or reallocate resources to maximize outcomes.

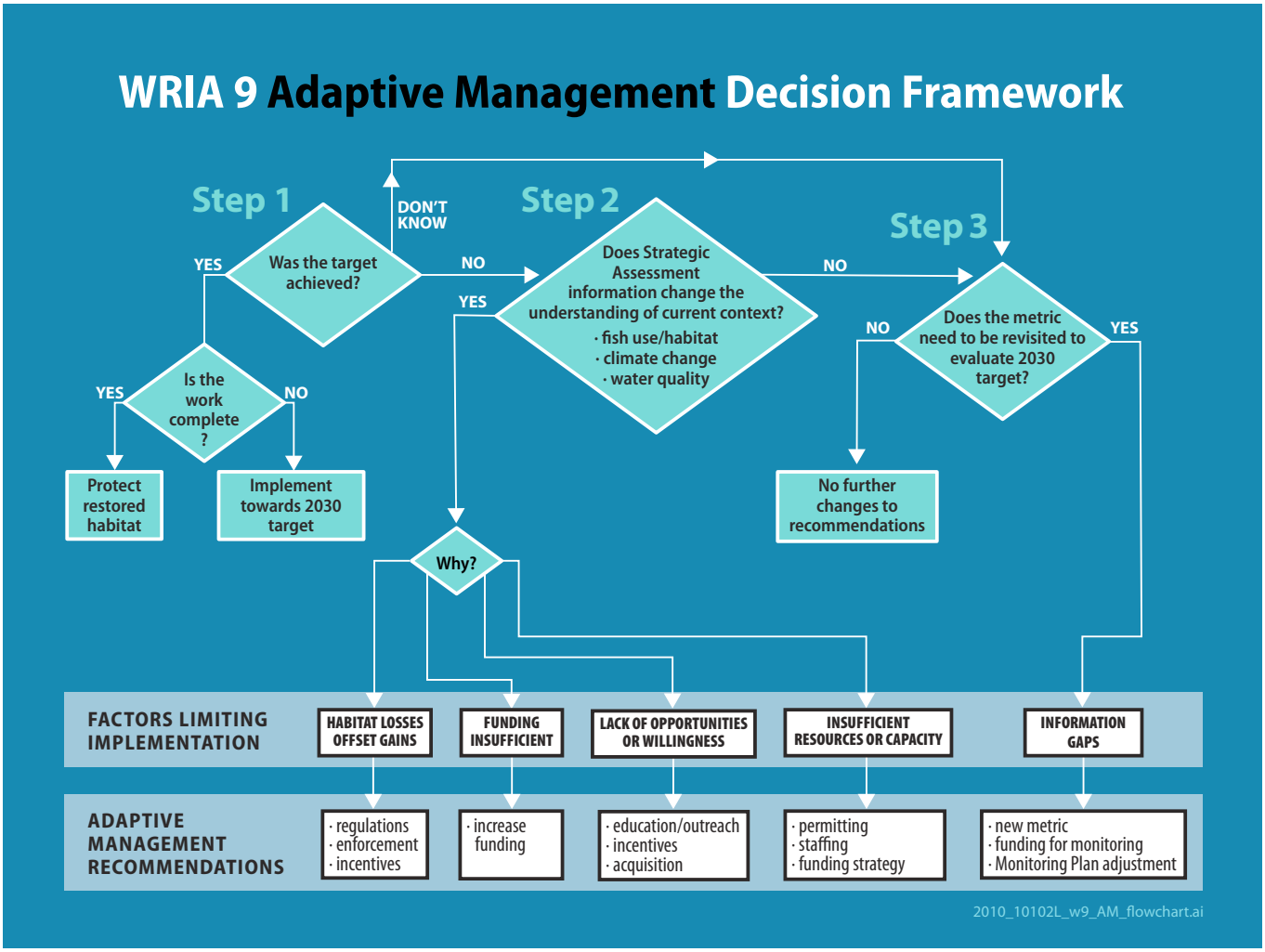
Implementation Monitoring

The Plan Update outlines numeric targets for key habitats (Table 2, Chapter IV) linked to Chinook salmon productivity and recovery. The targets are intended to inform tracking and assessment of plan implementation (i.e., projects constructed, specific habitat gains, funding secured) in relation to established long-term goals. Regular evaluation of implementation progress feeds into an adaptive management decision framework (Figure 32). This framework connects decision makers (i.e., Watershed Ecosystem Forum) with important monitoring and research findings, informing corrective actions to recovery strategies when necessary.

Effectiveness Monitoring

Effectiveness monitoring is designed to assess if habitat restoration projects are functioning as intended and achieving physical and biological performance standards. It includes both project-level and cumulative habitat conditions. Capital habitat project implementation can take over a decade from conceptual design to construction and costs millions of dollars. Effectiveness monitoring is essential to ensure large capital investments maximize benefits to salmon and help identify potential design improvements and cost efficiencies that can be adapted into future projects.

Figure 32. *Adaptive management decision framework.*



Routine Monitoring

Routine project effectiveness monitoring evaluates whether restored habitat is functioning the way it was intended 3-10 years after the project is built. Project specific monitoring plans should be designed to assess project-specific goals and objectives. Project sponsors are encouraged to begin development of a monitoring plan at the project's 30 percent design milestone to allow for pre-project monitoring that can be essential for verifying if future changes are due to the project's actions or natural variability. The MAMP (Appendix F, Table 2) outlines routine physical and biological monitoring recommendations based on project type and subtype. The highlighted indicators and metrics are designed to be relatively affordable and consistent with regulatory permit monitoring requirements. Project sponsors are generally expected to undertake routine monitoring for WRIA-funded projects and report monitoring results to the ITC.

Enhanced Fish Monitoring

Enhanced monitoring is focused on understanding how fish use a restoration project type. Unlike routine project monitoring, which asks whether a certain type of habitat was created and sustained, enhanced monitoring is meant to evaluate how fish utilize the habitat, and which restoration techniques convey the most benefit. Projects should be evaluated with a combination of Before-After Control-Impact or reference/control sites research designs. Enhanced fish monitoring is outside the scope of monitoring for many project sponsors, nor is it frequently required by regulatory agencies. Due to the costs associated with enhanced monitoring, WRIA 9 intends to continue to financially support enhanced fish monitoring of select projects. The MAMP (Appendix F, Table 3) also outlines a prioritization framework (certainty of benefit, process-based vs. engineered design, project type frequency, and project cost) for WRIA-directed invest-

ments to support enhanced monitoring. Monitoring results should be reported to the ITC and inform necessary maintenance and/or design modifications.

Cumulative Habitat Conditions

The Salmon Habitat Plan outlines a suite of projects, programs, and policies intended to improve cumulative habitat conditions across the watershed. Monitoring status and trends in cumulative habitat conditions allows us to assess the overall effectiveness of plan implementation. It provides data on the net change (improving, no change, degrading) in specific habitat conditions over time that supports evaluation of habitat restoration in relation to ongoing impacts to, and loss of, habitat. This information will help identity any gaps in the watershed's approach to salmon recovery and help (re)direct partner resources to potential areas of concern. The MAMP (Appendix F, Table 4) outlines priority habitat metrics recommended for inclusion as part of a periodic cumulative habitat assessment that are consistent with the WRIA 9 Status and Trends Report 2005-2011 (ITC 2012). The WRIA 9 ITC should complete a cumulative habitat conditions every five years.

Validation Monitoring

Viable Salmon Population Criteria

The National Oceanic and Atmospheric Administration (NOAA) developed the viable salmon population (VSP) concept as a tool to assess the conservation status of a population. NOAA defines a viable salmonid population as "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). Four parameters are used to assess population status: abundance, productivity; spatial structure, and diversity. These measures of population status indicate whether the cumulative recovery actions in our watershed are improving the population's overall viability and long-term resilience.

The MAMP (Appendix F, Table 5) outlines recommended metrics to evaluate VSP criteria that should be monitored to assess the population status of the Green River Chinook salmon population. Additional NOAA-approved VSP targets are presented in Chapter IV, Table 1. Although VSP parameters are not a direct measurement of habitat conditions, habitat availability, distribution and quality are inherently reflected in VSP criteria. Tracking trends in the recommended VSP parameters allows resource managers to evaluate how the population is responding overtime to the net impact of conservation actions and ongoing land use development activity in the watershed. Over a long enough timeframe, results can also inform recalibration of recovery strategies if the conservation status of the population does not improve or continues to decline.

The VSP concept – and conservation status of Green River Chinook salmon – is influenced by a variety of factors outside the scope of this plan (i.e., habitat). The Puget Sound Salmon Recovery Plan emphasizes that the conservation status of the Puget Sound Chinook salmon Evolutionary Significant Unit is ultimately linked to the "Four H's" – habitat, hydropower, hatcheries and harvest. "Each of these factors independently affects the (Shared Strategy Development Committee 2007) status of salmon populations, but they also have cumulative and synergistic effects throughout the salmon life cycle. The achievement of viability at the population and ESU level depends on the concerted effort of all three factors working together, not canceling each other out, and adjusting over time as population conditions change" (Shared Strategy Development Committee 2007).

Research and Data Gaps

The Salmon Habitat Plan Update reflects an update to the scientific framework (i.e., Strategic Assessment) of the original 2005 Plan. New scientific data improved our understanding of the functional linkages between environmental stressors, habitat, and population productivity, abundance, diversity and spatial distribution. This information is reflected in updates to the WRIA 9 recovery strategies and embedded projects, policies, and programs. Best avilable science is used to recalibrate the magnitude and sequencing of our strategic investments, maximizing the effectiveness of our investments.

Numerous data gaps and uncertainties remain. Ongoing investments in research and monitoring will be essential to informing adaptive management of recovery strategies and ensuring that plan imple-

mentation and associated funding decisions remain science driven. Additional information on research priorities and data gaps can be found in the Habitat Use and Productivity, Temperature, Climate Change, and Contaminant white papers in Appendices A-D. These papers build on the existing 2004 WRIA 9 Chinook Salmon Research Framework which utilized a conceptual life-cycle model to organize and prioritize research efforts to inform recovery planning.