Appendix F
Adaptive Management and Monitoring Program

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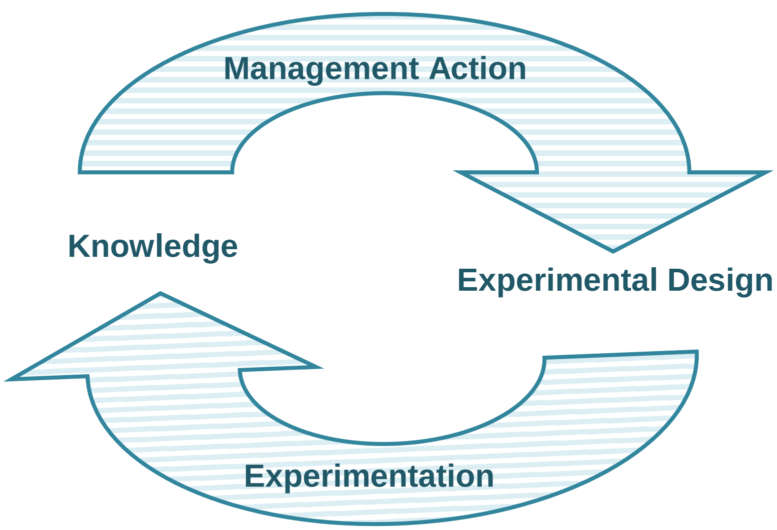
1. Introduction

Adaptive management emerged from the recognition that management of renewable resources requires that policy decisions be made in spite of biological uncertainty and data gaps. The term was originally defined by Holling in 1978 and expanded on by Walters (1986) as an approach "…to treat management as an adaptive learning process, where management activities themselves are viewed as the primary tools for experimentation." In the intervening years, adaptive management has become an approach to designing and implementing management actions as experiments, monitoring how the system responds to the management/experiment, evaluating the results of the action, and using the acquired knowledge to adjust future actions.

Because decisions made within the context of environmental management are often based on incomplete data and imperfect scientific understanding, adaptive management has become an essential component of natural resource management. Adaptive management is used to provide a decision-making process that can adjust resource management actions based on newly acquired science and the results of monitoring. The process is iterative by design, with management actions and experimentation linked as a way to increase the likelihood that natural resource management goals and objectives are achieved (Figure 1.1). For the process to be successful, it must begin with clearly defined goals and objectives, and ensure implementation of standardized procedures to track progress and guide change.

Figure 1.1 Relationship between adaptive management and monitoring.



For the Aquatic Lands Habitat Conservation Program, the Washington State Department of Natural Resources (Washington DNR) has chosen to combine adaptive management and effectiveness monitoring into a single program with two distinct phases:

- **Planning phase** –Define and refine objectives, uncertainty prioritization, conservation measures, decision criteria, monitoring plans and recruitment of interested parties.
- **Operational phase** – Implement , experiment , assess and, as necessary, adjust management actions.

1.1 Principles

The habitat conservation plan Adaptive Management and Effectiveness Monitoring Program is built on the following principles:

1.1.1 Encourage collaboration and participation

Although Washington DNR is the proprietary manager of state-owned aquatic lands, there are a number of governmental entities, tribes, businesses and individuals who regulate or use the land or associated biological communities. Therefore, DNR's Adaptive Management Program organizational structure will include an Advisory Team of invited individuals selected from Tribal governments, industry and state and federal agencies that have expertise to serve in an advisory role in the designing, implementing, and integrating adaptive management. These experts will assist in defining the objectives, methods and triggers for adaptive management. The support of external agency staff and other interested parties will decrease the potential for conflicts during the term of the habitat conservation plan (Stankey *et al.*, 2005, Williams *et al*. 2007), as well as provide opportunities for entities to share in the costs and benefits of reducing uncertainty.

1.1.2 Design scale-appropriate, science-based monitoring

Designing an effective monitoring and adaptive management program requires a clear strategy to establish priorities for the most important elements and critical uncertainties, as well as recognize that no program has the resources to monitor everything. Because of the complex interactions between biology, chemistry, and physical structure, this is particularly true in aquatic ecosystems. To address these interactions, Washington DNR has proposed use of flexible conceptual models (Section 3.3) that capture the complexities of the activity/ecosystem/species interactions, provide the opportunity to hypothesize potential responses, illustrate at what point management alternatives may be applied, and highlight where uncertainty is introduced. Field collection of data will focus on the types of habitat to be conserved (e.g., submerged vegetation) and limited to defined questions and uncertainties, with the scale of the question guiding the scale of the monitoring.

1.1.3 Embrace flexibility and an iterative process

Decision criteria will be developed with the recognition that the criteria may need to be updated and amended as our understanding of the system function increases. This iterative process allows for the incorporation of new, independently researched and published scientific information that is relevant to management of the habitat to be protected.

1.1.4 Promote conflict resolution

While adaptive management has helped make decision-making easier in the face of uncertainty, this approach has been criticized as weak from a conflict resolution perspective (Johnson 1999). Washington DNR will address this weakness through the use of a conflict resolution process led by a qualified and independent facilitator.

1.1.5 Acknowledge realistic design costs

DNR will maintain a sustainable level of funding for Adaptive Management that reflects the elasticity of Washington state's biennial budget. Washington DNR will carefully evaluate design costs over the course of the experiment, as well as potential costs of implementation before any research commitments are made.

2. Program Design

Washington DNR's habitat conservation plan Adaptive Management and Monitoring Program encompasses all aquatic lands directly owned by the state of Washington and managed by Washington DNR, underlying navigable[1] fresh, salt, and estuarine waters within the state of Washington. It does not include those lands that have been sold into private ownership, are managed by agencies other than Washington DNR, or are under waters that are not navigable for the purpose of establishing state title[2].

While the timeframe for this program—50 years—is the same as that for the habitat conservation plan and the incidental take permit, monitoring and decision criteria will be designed on interim timelines to allow the opportunity to adapt the management alternatives as necessary.

2.1 Goals and objectives

While this program is compatible with the goals and objectives of the habitat conservation plan [3], the goals and objectives for adaptive management and monitoring focus on monitoring changes in habitat. The goals of the program also frame the core parameters for effectiveness monitoring and direct the focus areas for the targeted studies.

2.1.1 Goal 1: Increase the quantity and improve the quality of covered species habitat on state-owned aquatic lands

Objectives

- Increase the area of aquatic vegetation coverage on state-owned aquatic lands
- Increased biodiversity of biological communities attached to and in state-owned aquatic lands (e.g., benthic invertebrates, aquatic vegetation).
- Increased area of restored or protected habitat on state-owned aquatic lands.

[1] Navigable waters are those lands that are capable of serving as a highway for commerce in their natural and ordinary condition, using customary modes of travel and trade on water. (WAC 332-30-106(41)).

[2] Washington DNR presumes "…all bodies of water meandered by government surveyors…" to be navigable for the purpose of establishing state title unless declared otherwise by a court. If there is a dispute about whether a water body is navigable for the purpose of vesting title in the state, the judiciary makes the final determination.

[3] Avoid and minimize effects to covered species and their habitats; Identify and protect important habitats for covered species; Improve and restore habitat quality to compensate for unavoidable effects of covered activities (Washington DNR 2010).

2.1.2 Goal 2: Decrease the quantity of known pressures to state-owned aquatic lands

Objectives

- Decrease the area of aquatic vegetation shaded by structures (e.g., overwater structures, log rafts).
- Decrease disturbance of sediment transport/deposition processes on state-owned aquatic lands.
- Decrease alteration of native sediment type or sediment chemistry.

2.1.3 Goal 3: Increase the effectiveness of management actions applied to state-owned aquatic lands

Objectives

- Design experimental treatments to evaluate the impacts of covered activities on habitat managed by Washington DNR.
- Design targeted studies to resolve uncertainties and improve understanding of the ecological function of aquatic vegetation, benthic communities, and sediment transport.

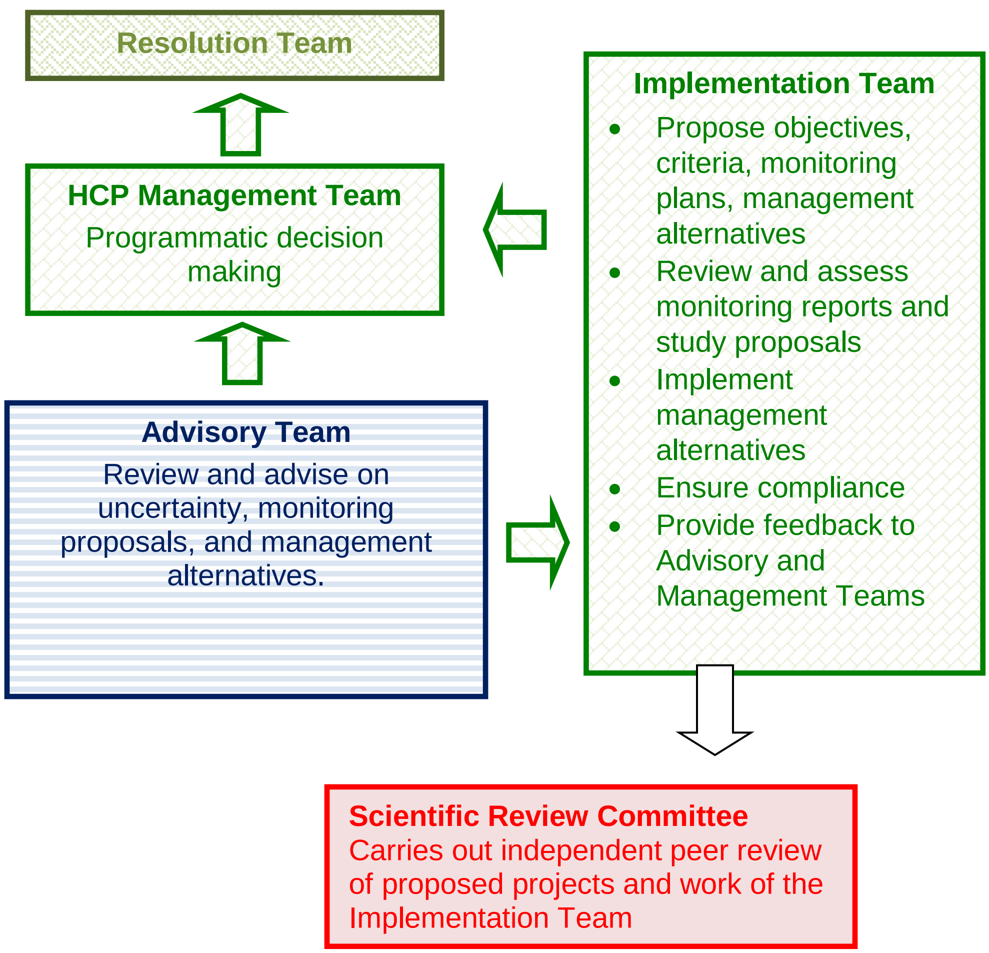
2.2 Organizational structure

The Washington DNR habitat conservation plan adaptive management and monitoring organizational structure consists of several groups that are responsible for initializing the set-up of the program, implementing the iterative phase, serving in an advisory role, providing peer review, and resolving disputes (Figure 2.1), These groups include the Implementation Team, the Advisory Team, a Management team and a Resolution team.

The Adaptive Management and Monitoring Program for habitat conservation plan is designed to incorporate strong interagency expertise and involvement by other interested parties. However, the program will be most successful if others who regulate or use state-owned aquatic lands reach agreement on the program's objectives; advise on approaches for reducing uncertainties; and research results justify adjusting management actions in the plan. Because the geographic scope of the habitat conservation plan is so large, involving diverse ecosystems and habitats as well as legal and political jurisdictions, adaptive management and monitoring require the resources of more than a single entity. Therefore, the scope of the adaptive management program is contingent on the level of resources provided to monitoring and assessment from interested parties other than DNR.

It is anticipated that much of the baseline information and broader scale status and trends monitoring data can be gathered and evaluated through existing external monitoring and modeling programs. Where data is unavailable or incomplete, Washington DNR will dedicate staff and funding for the necessary field sampling, analysis, and reporting. Other interested parties will be encouraged to identify and explore targeted studies relevant to their area of expertise or interest. To ensure participation by others, expectations regarding resource commitment and areas of uncertainty to be addressed will be explicitly defined and agreed upon early in the process. Involvement by others will be encouraged throughout the set up (planning) and iterative (process) phases of the habitat conservation plan.

Figure 2.1 Adaptive Management and Monitoring Program organizational structure**.**

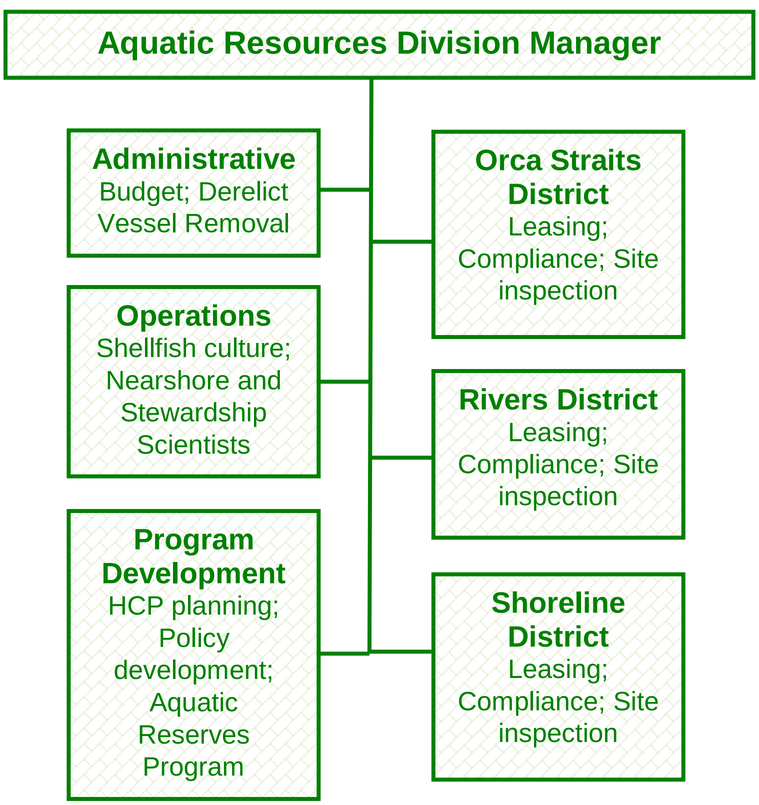


2.2.1 Implementation Team

The Implementation Team comprises agency staff responsible for the day-to-day operations, development. and implementation of both the habitat conservation plan and the Adaptive Management and Effectiveness Monitoring Program. There will be a core team comprising the research and monitoring staff from the Washington DNR's Aquatic Resources Division; land managers with contributions as needed from stewardship and nearshore science programs; planning and policy staff; assistant division managers; and program specialists (e.g., shellfish aquaculture, derelict vessel removal), and is organized under the current Aquatic Resources Division structure. Figure 2.2 illustrates the structure that currently exists. Only elements relevant to the habitat conservation plan are shown.

The team proposes objectives and management alternatives; implements the management actions; reviews and assesses monitoring results and targeted study proposals; collects data; ensures compliance with the terms and conditions of the habitat conservation plan; and provides summaries and recommendations to both the Technical Team and the Management Team.

Figure 2.2 Aquatic Resources Program organization structure (2012).



2.2.2 Advisory Team

The Advisory Team comprises interagency, tribal, and private sector scientists and technical staff. This Team's involvement is critical to successful initiation of the adaptive management and monitoring planning phase. They are responsible for providing input on management objectives and monitoring plans. While their work is collaborative, it is also intended to integrate technical and practical expertise on a specific subject matter into the overall discussion.

The Advisory Group will be led by the Aquatic Lands Habitat Conservation Plan Research and Monitoring staff, with members invited to participate by the Management Team. Members will be recruited based on expertise related to covered species and activities. Meetings frequency will be contingent on the pace of the decision-making process.

2.2.3 Scientific Review Committee

The Science Review Committee performs independent peer review of proposed projects and work of the Implementation Team to determine if it is scientifically sound and technically reliable. The SRC may also review relevant external work submitted to the Implementation or Advisory Teams. The Scientific Review Committee is contracted by the Management Team to carry out an independent scientific peer review process. The Science Review Committee comprises individuals who have experience in scientific research and who have no affiliation with the DNR habitat conservation plan. Members of the Advisory Team may nominate committee members, members are selected by a coordinator appointed by the habitat conservation plan Management Team. The habitat conservation plan Advisory teams recommends what products should be subject to review by the SRC; however, the SRC generally reviews final reports of Implementation Team studies, study proposals, final study plans, and pertinent studies not published in Advisory Team-approved, peer-reviewed journal. Other products that may require review include external information or data, work plans, requests for proposal and progress reports.

2.2.4 Habitat Conservation Plan Management Team

The Management Team is led by the Washington DNR Planning Program manager and includes the Aquatic Resources Division manager, Assistant Division managers, and the Aquatic Assessment and Monitoring Team lead. The team meeting frequency will be determined as the program becomes operational. This team is responsible for successful implementation of the habitat conservation plan operating conservation program, as well as programmatic decision-making related to adaptive management and effectiveness monitoring. Programmatic decisions will be made based on input from the Advisory Team and recommendations and identified issues from the Implementation Team. In the event that agreement cannot be reached among these two groups, the Management Team will attempt to resolve the issues. Where the parties do not achieve resolution, the matter given to the Resolution Team for consideration.

2.2.5 Resolution Team

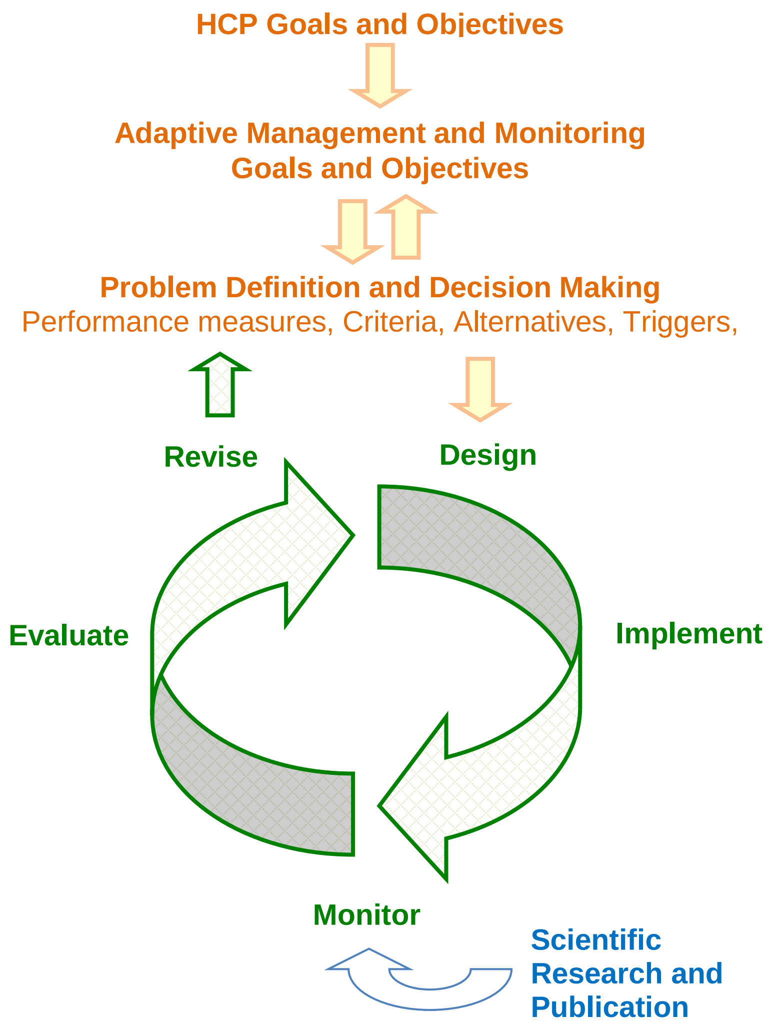
The group consists of an independent facilitator selected by Washington DNR; a representative from the Management Team; a senior-level manager from Washington DNR, NOAA Fisheries, and U.S. Fish and Wildlife; and an issue representative from the Technical Team. The function of the team is to negotiate a successful resolution of issues arising under the Adaptive Management and Effectiveness Monitoring Program and to ensure compliance with the habitat conservation plan, as well as applicable state and federal mandates.

When the Technical Team or Implementation Team are unable to agree on a matter of the Adaptive Management and Monitoring Program, issues will be elevated to the Management Team. If the Management Team is unable to reach agreement, issues will then be elevated to the Resolution Team. Decisions reached by either the Management Team or the Resolution Team are considered final.

2.3 Decision framework

The decision framework for this program follows the adaptive management cycle and incorporates pathways for the inclusion of external research in the evaluation of actions and monitoring (Figure 2.3). The decision- and problem-definition processes are guided by the goals and objectives of both the habitat conservation plan and the Adaptive Management and Monitoring Program, with risk and uncertainty assessed through targeted studies. Monitoring will occur on both a project (effectiveness) and programmatic basis Performance measures will be used to define desirable ecosystem responses to management actions (e.g. increased density in submerged aquatic vegetation with reduced shading), undesirable responses (e.g. increase in invasive vegetation), and other endpoints or parameters of concern.

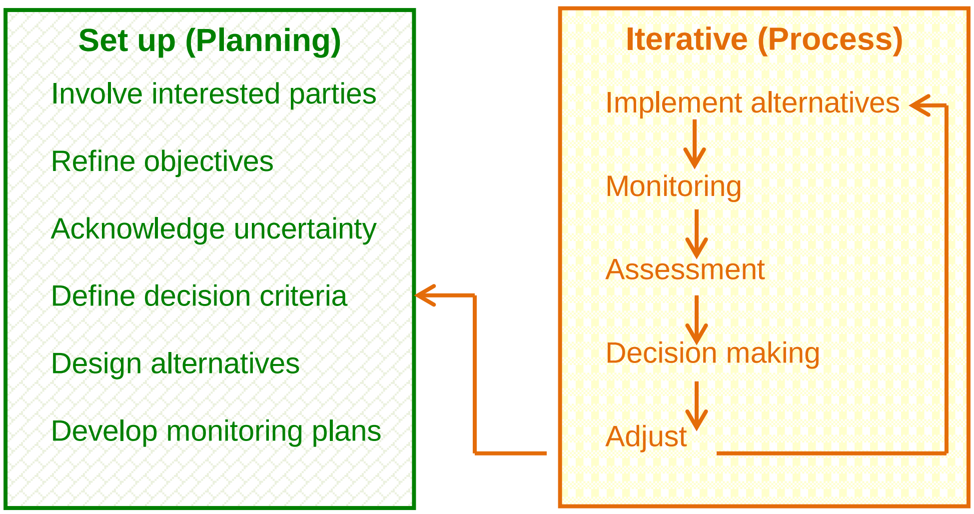
Figure 2.3 Decision framework indicating program and project scales of monitoring and targeted studies (modified from Murray and Marmorek, 2004).



3. Adaptive Management and Monitoring Set-up Phase

Developing an Adaptive Management and Monitoring Program consists of set up (planning) and iterative (process) phases (Figure 3.1). Although the two phases are addressed separately below, the individual elements are not necessarily sequential and frequently occur simultaneously during the se-up phase.

Figure 3.1 Illustration of the two phases of adaptive management and monitoring (modified from Williams et al., 2007).



3.1 Conceptual model development

Conceptual models that summarize the source/controlling factor relationship, and the hypothesized effects on the habitat of the protected species are helpful in making the link to potential management activities. To be most useful in an adaptive management framework, conceptual models will express, in visual schematic shorthand, a summary of our understanding of the ecosystem processes linked to the abundance and distribution of the species of interest. The models attempt to identify key case-effect relationships that provide the basis for monitoring specific ecological attributes and assist in identifying appropriate conservation measures. These conceptual models also aid in highlighting where and at what scale uncertainties exist (for example, as is often the case, the model indicates multiple causes producing a similar effect) and identifying where different management alternatives might be implemented. From their design, testable hypotheses can be framed. Figures 3.2 and 3.3 are sample conceptual models for over-water structures and log rafts. These models and the others developed for each covered activity can be expanded and with further detailed added as empirical information is collected.

Source, controlling mechanisms, and effects are identified in the overwater structure conceptual model (Figure 3.2) Also included are activities associated with the source- such as propeller wash or dredge maintenance for an overwater structure such as a dock. The associated activities are included under the "source" category (Pressures-Covered Activity in the illustration). Other broader environmental uncertainties, such as climate change, which would influence the controlling factors are identified in Table 3.1. These pressures may have similar direct and indirect effects as those hypothesized for the source activity, underscoring the need for monitoring reference sites and before-after comparisons. Both direct and indirect effects that can result from installation of an overwater structure are indicated. Direct effects have a direct causal relationship with the source activity and can have immediate impacts to habitat can cause indirect effects, which may cycle back to influence the controlling factors; or cause further indirect effects.

Figure 3.2 Conceptual model: overwater structures**.**

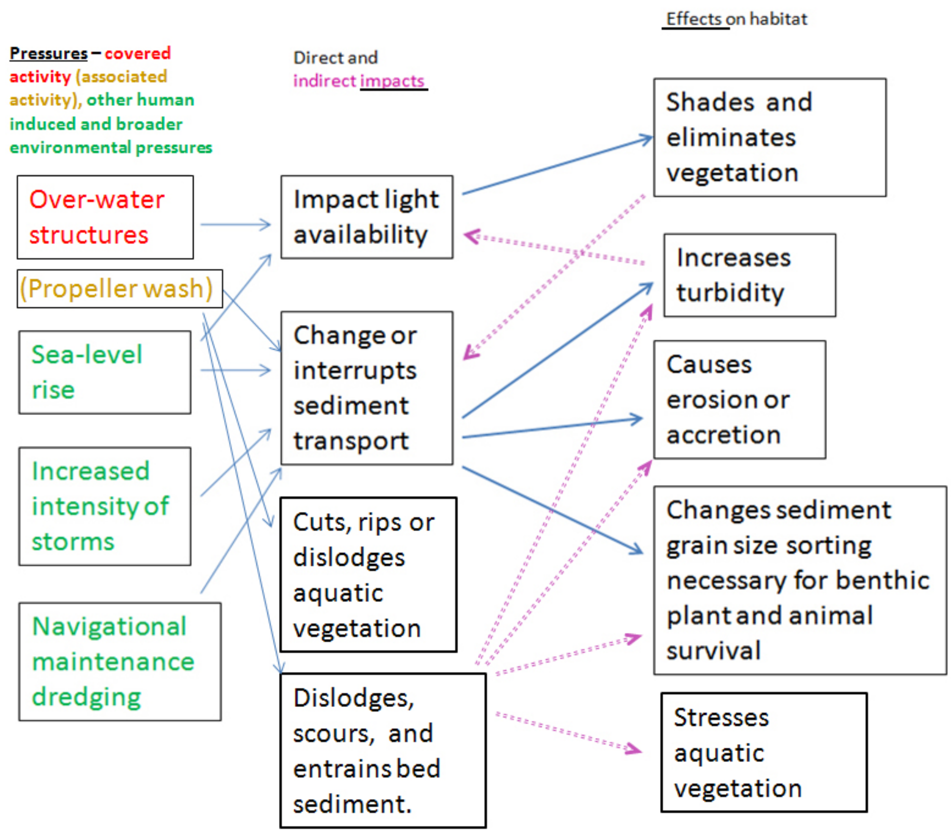
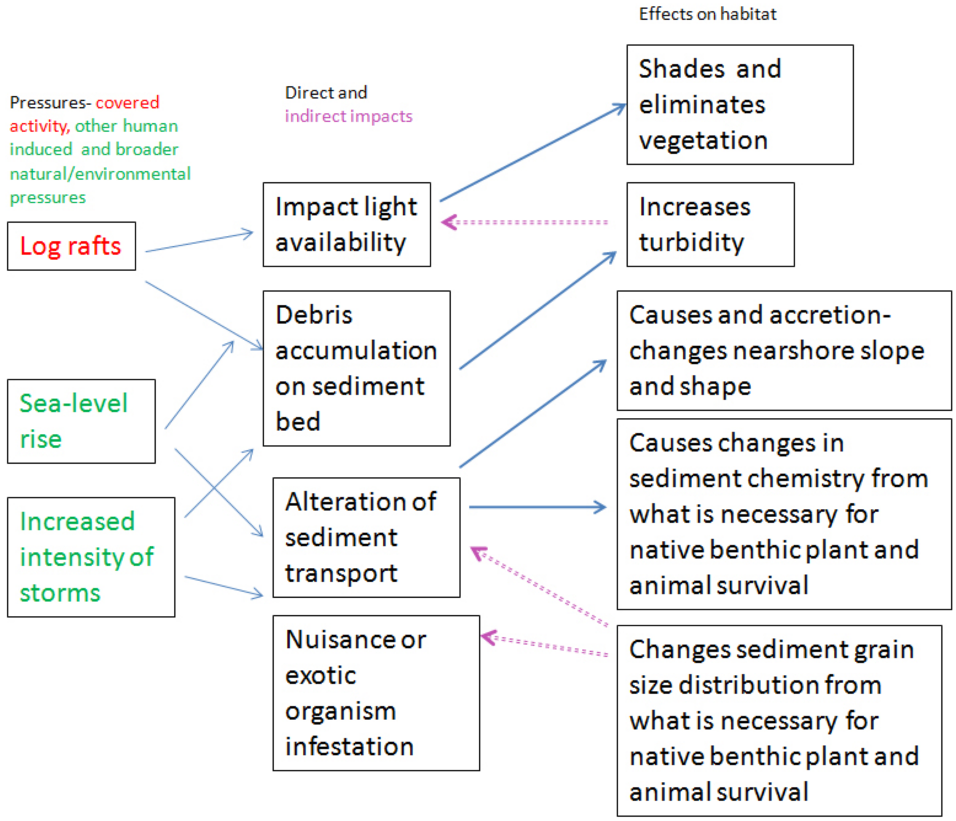


Figure 3.3 Log raft conceptual model



3.2 Uncertainty

A number of system-wide scientific uncertainties provide the context in which the site-level conservation measures will be applied. Large-scale, program-level uncertainties such as those in Table 3.1 limit the ability to predict accurate ecological responses to proposed actions and need to be prioritized and factored into the design of experiments, as well as decision making to ensure the success of the program. The list will be detailed and refined by the Technical Team during the setup phase of the process.

Table 3.1 - Program level uncertainty**.**

Programmatic Uncertainty	**Approach to Ensure Success**
Climate change, sea-level rise, increased storm frequency.	Require control sites for all project-scale and targeted monitoring.
Exotic species invasion	Incorporate reporting from Washington state exotic species work group and University of Washington/United States Department of Agriculture Exotic species modeling for the Current Research Information System (CRIS).
Catastrophic event (earthquake, volcanic eruption, oil spill, nearshore or submarine landslides)	Design opportunity for intake of data and information from independent research from other agencies including Washington Department of Ecology, United States Geological Survey, and the Army Corps of Engineers.

Uncertainty related to specific conservation measures and strategies was addressed by first evaluating the sources of uncertainty, and then determining how the uncertainty could be addressed through monitoring. Conceptual models (Section 3.1) assisted in identifying knowledge gaps regarding the relationship between covered activities, potential impacts on habitat from the activities, and effectively avoiding impacts through application of the proposed management actions.

The prioritization process filtered out broad policy-based measures and concentrated on those that applied measurable parameters, with measures developed from scientific sources considered most appropriate for a scientifically-based adaptive management program. These conservation measures have specific metrics (e.g. buffer distances, percentage ambient light requirements) or operational procedures (floats must use embedded anchors) designed to avoid or minimize impacts to habitat.

An understanding of the assumptions used in interpreting the cited research and rationale used in developing the conservation measures helped define sources of uncertainties associated with each measure. Uncertainty was grouped similarly to using the categories developed by Janssen et al (2003).

- Incomplete information.
- Natural variability.
- Model structure/approximations.
- Data limitations, sampling or analytical errors.
- Missing variables.
- Best professional judgment regarding extrapolation, interpretation or weighting of data input or results.
- Imprecision in defining objectives or assumptions.

This categorization helped to identify how uncertainties could be addressed through monitoring. For example, where 'incomplete information' is identified as a source of uncertainty, the monitoring plan would be designed to gather the missing data. Where uncertainty is associated with ‘natural variability,’ representative sampling across the range of natural conditions could be incorporated into the monitoring.

Table 3.2 summarizes the preliminary research proposed in this plan. Attachment A illustrates the full list of measures assessed, their classification (programmatic vs. activity specific), and monitoring elements. Further evaluation to determine whether to apply more passive or active adaptive management techniques for each measure will be undertaken by the Technical Team. This will involve an assessment of the relative level of uncertainty (low to high) associated with the listed measures, and whether the proposed experimental approaches are possible given the time, budgetary and political support available. Upon completion of the Technical Team’s evaluation, experimentation will be undertaken beginning with the highest priorities. Work on each priority will continue for a minimum cycle of two years per measure, with priorities re-evaluated every 10 years throughout the term of the habitat conservation plan. Attachment B outlines the strategy for the first 10 years of the plan.

Washington DNR has focused its baseline sampling on parameters that serve as good indicators for detecting habitat change associated with the specified activities: bathymetry, sediment characteristics (grain size, sorting), aquatic vegetation density and distribution, and benthic invertebrate assemblages. Effects to aquatic vegetation and benthic habitat received the highest priority for systematic observation for baseline, reference and targeted comparative studies.

Table 3.2 – Preliminary Research Proposal

Impact	Goal	Measure/s Elements	Uncertainty	Monitoring Elements
Prop Scour	Avoid damage to native aquatic vegetation	Docks with non-motorized boats - 8-meter (25 ft) buffer from the edge of the structure or the maximum distance shade will be cast by the structure, whichever is larger. Docks with motorized boats: - Vertical buffer greater than 2 meters (7 ft) of water separating the vessel from the vegetative canopy at the lowest low water within the diameter of the vessel's turning circle - Vertical buffer less than 2 meters (7 ft) within the diameter of the turning circle: A horizontal buffer distance of either 8 meters (25 ft) from the outside of the vessel; the maximum distance shade will be cast by the structure; or the diameter of the turning circle (3.5 times the length of the longest vessel), whichever is greater.	- Natural variability in vegetation distribution and density. - Existing shade models use a point source with limited consideration of light refraction in water. - Data limitations associated with photosynthetically active radiation (PAR) requirements for vegetation species. - Variability of optical depth. - Missing variables: Average boat size turning radius is applied - Buffer distance based on best professional judgment. - Impacts to unvegetated substrate. - Impacts associated with varying boat drafts.	*Baseline, control, and post installation:* Aquatic vegetation density and distribution; Bathymetry at site and within buffer area of structure; Sediment grain size characterization; Benthic invertebrate community composition and density.
Structural Shading	Minimize vegetative shading	Renovate structures to allow at least 30 percent of ambient light to reach the vegetative canopy.	- Natural variability of light requirements among different species of aquatic vegetation. - Value determined via best professional judgment, precautionary principal.	*Baseline, control, and post installation*: Aquatic vegetation density and distribution; Bathymetry at site and within buffer area of structure; Sediment grain size characterization; Benthic invertebrate community composition and density.

Impact	Goal	Measure/s Elements	Uncertainty	Monitoring Elements
	Minimize shading	Docks greater than 1.5 meters (5 ft) in width: - Unobstructed grating over at least 50 percent of the surface area, with 60 percent of the grated area unobstructed. Docks less than 1.5 meters (5 ft) in width: - Unobstructed grating over at least 30 percent of the surface area, with 60 percent of the grated area unobstructed. - Gangways must be 100 percent grated, with 60 percent of the grated area unobstructed.	- Natural variability in vegetation distribution and density. - Existing shade models use a point source with limited consideration of light refraction in water. - Data limitations associated with photosynthetically active radiation (PAR) requirements for vegetation species. - Variability of optical depth.	*Baseline, control, and post installation*: Aquatic vegetation density and distribution; Bathymetry at site and within buffer area of structure; Sediment grain size characterization; Benthic invertebrate community composition and density.
Increased Sedimentation	Avoid turbidity impacts on surf smelt and sand lance spawning habitat.	- A buffer of at least 0.6 meters (2 ft) vertical separation from the tidal elevation of the spawning bed or a buffer of 55 meters (180) ft horizontal distance from the lower edge of the surf smelt/sand lance spawning habitat zone for all in-water work with the potential to increase suspended sediments during spawning windows. - In-water work may occur during an outgoing tide when the water line is below 1.5 to 1.8 meters (5 to 6 ft MLLW).	- Natural variability in sediment characteristics, geomorphology, and nearshore currents. - Data limitations associated with alteration of geomorphology and sediment and impacts to species characteristics have not been well studies. - Buffer determined via best professional judgment, precautionary principal.	*Baseline, control, and post installation*: Bathymetry; extent, grain size and level of turbidity (NTU or mg/l); Sediment grain size; Benthic invertebrate community composition and density.

Impact	Goal	Measure/s Elements	Uncertainty	Monitoring Elements
	Avoid sedimentation and nutrient impacts to native aquatic vegetation.	Buffer distances calculated as the extent of the chronic and acute mixing zones defined in the current National Pollutant Discharge Elimination System (NPDES) permit.	- Incomplete information related to effects from nutrients on aquatic vegetation and benthic communities. - Mixing zone model considers dispersal of pollutants but not trapping of effluent particulates by macroalgae. - Missing variables related to biochemical and biophysical effects of flocculants on reproductive success. - Current outfalls siting relies on water quality standards for protecting human and aquatic organism health.	*Baseline and control*: Bathymetric survey within radial distance and down drift of discharge head; Bed surface grain size and sorting; Aquatic vegetation density and distribution; Assessment of aquatic vegetation epiphyte coverage. *Post installation – project site and control:* Bathymetric surveys to assess for any evidence of scour; No exceedances of identified standards; Changes within and beyond the established buffer for Sediment characteristics; Aquatic vegetation density and distribution; Fine sediment accumulation on aquatic vegetation and sediment bottom; Aquatic vegetation epiphyte loads.
Altered Substrate	Avoid/minimize physical/chemical alteration of the substrate.	- New and expanded log booming and storage activities must be sited at least 60 meters (200 ft) from existing native aquatic vegetation. - New and expanded finfish pens must be sited at least 150 meters (492 ft) from existing native aquatic vegetation	- Natural variability in flushing rates and geomorphology, and transport or accumulation of waste. - Best professional judgment, use of precautionary principle for effects from bark accumulation and effects to infaunal (wood waste and netpens).	*Baseline, control, and post installation*: Sediment characteristics within and beyond established buffer; Benthic infauna; Sediment total organic carbon; Aquatic vegetation density and distribution. *Wood waste only (baseline, control and post installation):* Bathymetry at, and down drift of log booming area; Flow modeling to determine extent of wood debris transport and deposition.

Impact	Goal	Measure/s Elements	Uncertainty	Monitoring Elements
Introduced of Toxins	Avoid/minimize contamination	No creosote, chromate copper arsenate, or pentachlorophenol treated wood, or other comparably toxic compounds may be used as part of the decking, pilings, or other components of any in-water structures.	Best professional judgment, use of precautionary principle	*Baseline, control, and post installation:* Benthic infauna sampling; Aquatic vegetation density and distribution; Physical and biological characterization of control sites.

3.3 Development of management alternative matrices

The initial management actions to be implemented for the Adaptive Management and Monitoring Program are the conservation measures presented in the main body of the habitat conservation plan. After the Technical Team agrees upon the goals and objectives for each monitoring element, and further detailed and refined the conceptual models for the elements, work will begin to on developing alternative management options for the existing measures. The alternatives will take the form of matrices that help to organize the relevant information and link the management alternative with hypotheses, performance criteria, triggers, and expected outcomes.

Once monitoring has commenced and a sampled parameter attains a trigger threshold, the Technical Team will be able to utilize the developed alternatives so changes can be immediately implemented. As the management alternatives are implemented, they will be added and adjusted to include a range of future scenarios and performance expectations.

The following is an example of a simplified management alternatives matrix for one of the covered activities: overwater structures. The matrix will be further developed by the Technical Team to specifically identify the habitat metric for each ecosystem, and to include proposed targets and timeframes for each set of management alternatives.

Table 3.3 Example management alternatives matrix for overwater structures.

Covered Activity	**Direct and Indirect Impact**	**Habitat Metric (timeframe)**	**Management Alternative 1**	**Management Alternative 2**
New overwater structures	Shades vegetation	Maintain the density and distribution of the (selected indicator) aquatic vegetation species for 3 years.	- No covered moorage or boat houses. - Grating on dock over 50% of surface area. - Apply maximum boat height to determine buffer using shade-extent model. - Linear buffer distance of 4.5 times the maximum boat length.	- Increase or decrease percentage of grating required on dock surface. - Increase or decrease duration of sun altitude considered in shade-extent model. - Apply a different linear distance buffer.
	Cuts rips or dislodges aquatic vegetation	Maintain density and vigor of aquatic vegetation.	- Vertical buffer of 1.5 meters (5 ft water depth) from surface of vegetation from lowest low water. - Floats, rafts and mooring buoys must use embedded anchors and midline floats to prevent dragging through vegetation.	Vegetated areas signed as 'no boat turning' zone.
Existing overwater structures	Shades vegetation	Increase density and distribution of indicator aquatic vegetation species.	Existing structures not at adequate buffer must be renovated to allow 30% of ambient light to reach sediment surface and 90% to reach water surface.	Change minimum ambient light requirement.

Covered Activity	Direct and Indirect Impact	Habitat Metric (timeframe)	Management Alternative 1	Management Alternative 2
	Changes or interrupts sediment transport	No sediment in-filling or creation of scour holes (indicated in bathymetric surveys for 5 years).	Maintain dredge basins to prevent trapping of sediment or creation of deep pockets in turning areas.	Apply sediment transport model to areas dredging hot spots.

3.4 Developing monitoring plans

Based uncertainties, proposed conservation measures, and the critical habitat needs of the covered species, preliminary baseline sampling will be undertaken by science staff from Washington DNR. Aquatics Sampling for sediment characteristics, bathymetry, benthic community characterization, forage fish presence, and aquatic vegetation density and distribution is being initiated at a number of state-owned aquatic lands marine and lake sites. Criteria used in geographically scoping baseline site selection include:

1. Areas that provide habitat for listed species.
2. Areas subject to frequent covered or programmatic activity authorization requests.
3. Areas included in existing status and trends level monitoring.

The components of baseline sampling include identification of reference site and data collection from these sites. With this collection of baseline data, an understanding of the natural variability for each parameter will be estimated, which will allow sampling designs including sample number, spatial, and temporal extents to be proposed. From here decision criteria can then be developed. Adaptive management ‘thresholds’ will be proposed which, when reached, trigger the need to change management actions. The adaptive management threshold will be chosen well before the estimated ‘critical endpoint’—the point beyond which change is irreversible. This will provide enough opportunity to monitor indicator response to a changed management action. An example of such decision criteria might be “ ≥ 20% loss of sediment volume in the bed beneath or adjacent to an authorized activity” a need to evaluate effectiveness of conservation measures where the ‘critical endpoint’ has been defined as “change of 40% or more in sediment volume is one standard deviation beyond the documented natural variability over a three year time period.”

The habitat conservation plan uses habitat monitoring as a substitute for species counts and will quantify the impact of covered activities as the amount of each species’ habitat affected. Monitoring will therefore focus on surveying and assessing changes to quantity and quality of covered species habitat on state-owned aquatic lands as opposed to monitoring changes to species populations. Habitat quantity and quality will be measured by indicator metrics that have support in the scientific literature such as total area of nearshore native aquatic vegetation, change in bank slope bathymetry or loss of native benthic diversity. Aspects fundamental to the monitoring include substituting habitat proxies for species counts and designing the monitoring to address uncertainty at multiple scales and intensities.

3.4.1 Monitoring scale

Monitoring will occur at several scales to address different kinds of questions, with data associated with general system-scale processes tracked to understand the context in which covered activities are occurring and to support programmatic decisions. For example, a catastrophic event such as a volcano eruption that deposits enough fine ash into rivers and lakes making areas uninhabitable by listed species. Catastrophic events may require a programmatic response to monitoring protocol—such as a change in the geographic focus of monitoring. Alternatively, scour holes indicated by bathymetric surveys in a specific embayment within a buffer distance around a marina would indicate a need for project-level management.

Sampling protocols developed for the Adaptive Management and Monitoring Program will adhere to the following principles:

- Power analysis will be conducted to determine the minimum number of sample units required for detection. Sampling designs with insufficient power to distinguish true change from natural variability can provide misleading results.
- Modeling and estimates of detection probability will be incorporated into the design when rare or sparse populations are relied on for indicator metrics.
- Supplement systematic sampling with opportunistic sampling and take advantage of extreme events as experiments.

Status and trends level monitoring

Monitoring for status and trends will occur at the programmatic scale. This will include pilot-testing for long-term monitoring approaches and will be designed for early warning detection. For example, a gradual declining trend of eelgrass in a large embayment can only be detected if monitoring occurs frequently enough and across a broad enough spatial extent to capture the change. Because the geographic scope for monitoring encompasses all state-owned aquatic lands, the work will need to be strategically divided to allow representative sampling from the various eco-regions given the limited staff and funding resources available. Washington DNR will identify existing monitoring programs and data-gathering efforts and wherever possible integrate them into the status and trends work. While some existing programs may provide fundamental data for the Adaptive Management and Monitoring Program, in other cases the work may be incorporated with modified protocols, sampling design or assessment methods.

Decision criteria developed for this scale of monitoring will include critical assessment endpoints and time frames that may direct adjustment of habitat conservation plan programmatic measures.

Project-level monitoring

Project-level monitoring will be required at individual sites to ensure that the conservation measures are effective. As with status and trends monitoring, decision criteria will include time frames and critical assessment endpoints to direct changes in future management actions. Project level monitoring will also be required for any compensatory mitigation authorized on state-owned aquatic lands.

Targeted studies

Targeted studies are more intensive than the project-level monitoring and will be triggered based on the agreed-upon decision criteria. Such criteria may involve scale of projects (e.g. number of acres impacted) or anticipated intensity of impacts. These studies require resource commitments from the other interested parties. Stakeholder input by and agreement with other interested parties in developing the decision criteria is essential. These studies will be designed to decrease uncertainty of specific management measures and will involve specific hypotheses, variable treatments, before, after, and control sampling.

3.5 Data management plan

The data management plan will be developed that includes a description of the acceptable data formats, storage, and backup security and include the following elements:

- A schedule for data stream intake or reporting. Data format and reporting schedule will vary depending on the habitat metric being measured.
- A method and schedule for data sharing that is detailed and agreed upon before baseline sampling is undertaken.
- Established a data review team to ensure quality control/quality assurance procedures are consistently followed.
- Acceptable data formats will be established to allow a seamless flow of data into the assessment phase.

3.6 Assessment methods and decision criteria

Assessment approaches and data analysis methods need to be designed to assist in adaptive management decision- making to avoid straying into analytical techniques that focus on addressing more broad ecological cause-and-effect questions. As important as gaining an improved understanding of ecosystem function is, the primary focus of Adaptive Management and Monitoring Program assessment is to verify that the monitoring data can provide the information necessary to assess performance of the elements of the habitat conservation plan. The assessment needs to be able to evaluate progress through time and identify which issues require a management response.

The assessment will address uncertainty regarding management impacts through comparison of baseline, project and reference site data. If data or information from any existing monitoring programs is incorporated into the Adaptive Management and Monitoring Program for status and trends/program-level monitoring, the assessment methods for these programs will be fully evaluated for how well these approaches address the decision-making needs of the program. If existing assessment methods are adequate as is, or with slight modification, the need for pilot testing of monitoring and assessment approaches is minimized.

Thoughtfully developed and agreed-upon decision criteria is fundamental to selection of the assessment approach. Using the conceptual models (Section 3.1, Conceptual Model Development), management alternatives matrices (Section 3.3 Develop Management Alternatives

Matrix), and prioritized uncertainties (Section 3.2, Prioritized Uncertainty) as a guide, the Technical Team will develop and quantify decision criteria for:

- Early warning indicators for program-wide adjustments (e.g. a catastrophe that induces a crash in a habitat indicator metric might trigger selection of a different habitat metric).
- Project scale assessment performance measures, (e.g. what change in aquatic plant density and distribution measured over what time frame is considered inherent natural variability of the population?).
- Project-scale critical endpoints (e.g. at what point is a decrease in a measured indicator considered irreversible?).
- Triggers for requiring intensive targeted studies (e.g. a marina of >X boat slips will only be authorized on state-owned aquatic lands if a targeted study regarding buffer distances is executed).

Thresholds and triggers describe monitoring values and other factors such as time periods that indicate the need to address a performance issue. To set thresholds, scientists use monitoring data assessments, indicator value predictions, and coordination with management regarding appropriate timeframes to allow for management alternatives analysis. This is the approach the Technical Team will apply to determine what action to take to avoid threat to covered species habitat.

Development of the assessment methods and decision criteria will be done in a manner that focuses on the following design elements:

- Ensuring that all experimental scales (status and trends, site-level, targeted studies) are incorporated to ensure adequate power to discern treatment effects from natural variability.
- Incorporation of safety margins for implementation of management alternatives before critical endpoints—when negative results or impacts are likely reversible.
- The ability to efficiently include newly emergent, relevant scientific information into the decision process.

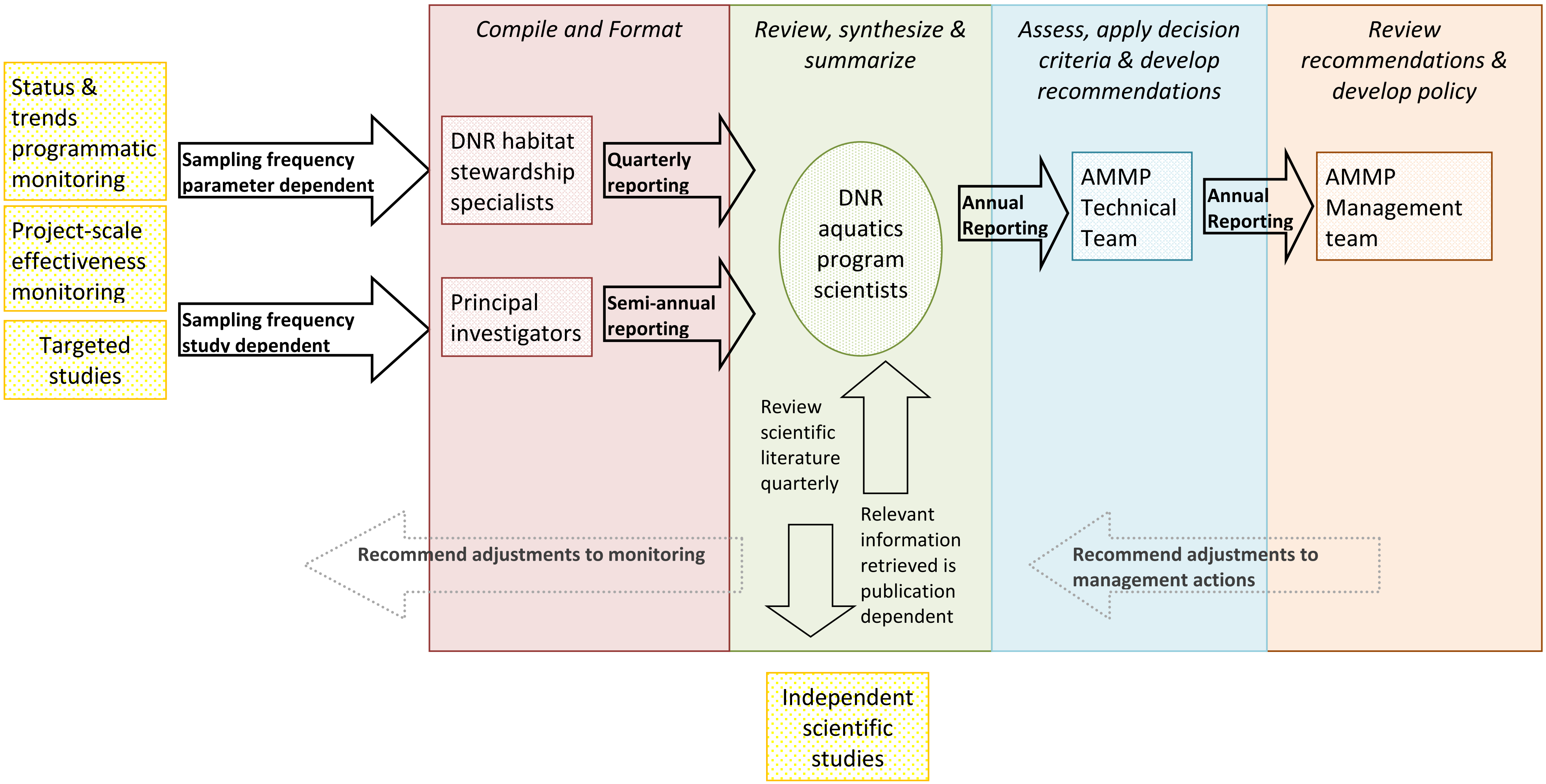
4. Adaptive Management and Monitoring Program Iterative Phase

As management alternatives, monitoring, assessment, and decision criteria are implemented improve our understanding , an iterative cycle of decision making, monitoring, and assessment will evolve. The sequence of activities is repeated over the course of implementing management actions. Throughout the repetition, learning occurs and the management strategies are adjusted based on what is learned.

To successfully link the monitoring to decision-making, a transparent, tightly-scheduled reporting system must be established prior to data gathering for monitoring. This Reporting-Feedback Framework will include a clear delineation of the responsible reporting entities, as well as the report review teams for all the required reports. This will include at a minimum, the project and program level monitoring reports (which may consist of just raw data in tabular or plot format), the targeted experiment findings, annual and multi-year assessment, and trend reports. It will also include timeframes and deadlines for scientists and managers to discuss any performance issues reported, evaluate and select management options, and recommend adjustments to management actions. Figure 4.1 is an illustration of a Reporting-Feedback Framework.

The cycle will continue either until the defined endpoint is reached or until all uncertainty regarding the ecological functions and management alternatives is eliminated.

Figure 4.1 Reporting-feedback framework.



5. References

Department of the Interior. U.S. Fish and Wildlife Service. Department of Commerce. National Oceanic and Atmospheric Administration. 2000. Availability of a Final Addendum to the Handbook for Habitat Conservation Planning and Incidental Take Permitting Process; Notice. Federal Register / Vol. 65, No. 106 / Thursday, June 1, 2000 / Notices. pg 35245.

Holling, C.S., editor. 1978. *Adaptive Environmental Assessment and Management*. John Wiley & Sons., New York.

Janssen P.H.M., Petersen A.C., van der Sluijs J.P., Risbey J.S., Ravetz J.R. 2003: RIVM/MNP Guidance for Uncertainty Assessment and Communication: Quickscan Hints & Actions List. RIVM/MNP Guidance for Uncertainty Assessment and Communication Series, Volume 2. RIVM, Bilthoven, 2003.

Johnson, B. L. 1999. Introduction to the special feature: adaptive management—scientifically sound, socially challenged? *Conservation Ecology* **3**(1):10.

Lee, K. N. 1999. Appraising Adaptive Management. Conservation Ecology 3(2):3.Lawrence, P.A. and Bennett, J., Improved planning and management in coastal environments using an adaptive management framework. *Water. Journal of the Australian Water Association*, 29(6), September/October, 2002.

Lee, K.N.,200.2 Appraising adaptive management, *Conservation Ecology*, 3(2), 3, 2002.

Morrison, M. L. 2000. Facilitating development of Multiple-species Conservation Reserves and Habitat Conservation Plans: A synthesis of recommendations. *Environmental Management* vol 26:S1:3-6

Murray, C. and Marmorek, D.R. 2004. Adaptive Management: A spoonful of Rigour Helps the Uncertainty Go Down 16th *International Annual Meeting of the Society for Ecological Restoration*, Victoria, British Columbia, Canada August 23-27th, 2004.

Murray, C. and Nelitz,M. 2008. Review of Diavik and EKATI Adaptive Management Plans. Prepared by ESSA Technologies Ltd., Vancouver BC for Fisheries and Oceans Canada, Yellowknife, NT 23p

National Oceanic Atmospheric Administration (NOAA) Fisheries Service. 2007. Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance Prepared by Northwest Region and Northwest Fisheries Science Center. Seattle, WA. 56p.

Noss, R.F. and Cooerrider, A.Y. 1994. *Saving Nature's Legacy: Protecting and Restoring Biodiversity*. Island Press. Washington D.C.

Scholes, R.J. and von Maltitz, G. 2007. GEF Desertification Indicators Meeting, Jan 8-9,2007, Rome Italy

Stankey, G.H., Clark, R.N, Bormann, B.T. 2005, Adaptive management of natural resources:theory, concepts and management institutions. Gen. Tech Rep. PNW-GTR-654. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station 73p

Susskind, L. Camacho, A.E. and Schenk, T. 2010, Collaborative planning and adaptive management in Glen Canyon: A cautionary Tale *Columbia Journal of Environmental Law*, March 2010 vol 38:1:1-55

United States Army Corps of Engineers (USACE). 2010. Draft Comprehensive Everglades Restoration Plan (CERP) Adaptive Management Guidelines Integration version 3.2. Written in partnership with South Florida Water Management District. For current information see http://www.evergladesplan.org/pm/progr_data_mgmt.aspx

United States Department of Agriculture, Forest Service: U.S. Department of the Interior, Bureau of Land Management [USDA USDI] 1994. Record of Decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the Northern spotted owl, Attachment A: standards and guidelines.

Walkerden, G. 2005. Adaptive management planning projects as conflict resolution processes *Ecology and Society* 11(1): 48.

Walters, C. 1986. Adaptive Management of Renewable Resources. Macmillan,New York.

Williams, B.K., R.C. Szaro and C.D. Shapiro 2007 *Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group,* U.S. Department of the Interior, Washington D.C.

6. Attachments

Attachment – Uncertainty Prioritization.

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements
1	Programmatic	New and expanded docks, wharves, piers, marinas, rafts, floats, shipyards and terminals must be at least a specified buffer distance from existing native aquatic vegetation attached to or rooted in substrate. The buffer distance for structures, docks, piers, wharves, rafts and floats not associated with motorized watercraft is either 8 meters (25 ft) from the edge of the structure or the maximum distance shade will be cast by the structure, whichever is larger. To avoid prop dredging and prop scour associated with motorized watercraft. For docks, piers, wharves, rafts and floats associated with motorized watercraft, the horizontal buffer distance for structures associated with watercraft is 8 meters (25 ft) from the outside of the vessel whenever there is a vertical buffer of 2 meters (7 ft) of water above the vegetative canopy at the lowest low water within the diameter of the turning circle. When the vertical buffer is less than 2 meters (7 ft) within the diameter of the	- Natural variability- Aquatic vegetation native to different ecosystems have different PAR requirements and different levels of resilience or vulnerability to boat operations and activities. - Model structure or approximations- Most available shade models use a point source with limited consideration of light refraction in water. - Data limitations, sampling or analytical errors - Average daily PAR requirements have been empirically derived for a limited number of plants; optical depth varies with water clarity and increased shade will have varying effects depending on a combination of the bio requirements and physical limitations at a site. - Missing variables-. Average boat size turning radius is applied - Best professional judgment- Buffer distance from overwater structure and	Baseline sampling prior to construction for: - Aquatic vegetation density and distribution. - Bathymetry at site and within buffer area of structure. - Sediment grain size characterization. - Benthic invertebrate community composition and density. - Physical and biological characterization of control sites. Post construction monitoring at project and control site for change in: - Bathymetry. - Aquatic vegetation density and distribution. - Sediment grain size. - Benthic invertebrate community composition and density.

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements
		turning circle, the horizontal buffer distance will be either 8 meters (25 ft) from the outside of the vessel, the maximum distance shade will be cast by the structure, or the diameter of the turning circle, whichever is greater. For this measure the turning circle is defined as 3.5 times the length of the longest vessel to use the structure.	boat is based on estimated impacts to aquatic vegetation from shade and operations. - Imprecision in defining objectives or assumptions - It is not clear how a buffer distance from vegetation necessarily protects the nearshore substrate from disturbance. This disturbance would still occur to unvegetated sediment near the structure.	
2	Programmatic	Existing docks, piers, rafts and floats that are not located at the appropriate buffer distance from existing native aquatic vegetation attached to or rooted in substrate must be moved, or renovated so that they allow at least 30 percent of ambient light to reach the vegetative canopy. The value of 30 percent was chosen because it is the minimum light value required by vegetation protected under this habitat conservation plan. Timeframes for relocation and renovation will be based on the expected lifespan of the materials used in the structure. Ambient light is measured as	- Natural variability- Light requirements vary among different species of aquatic vegetation. - Best professional judgment- Apply precautionary principle; Fresh et al. (2006) report a relationship between improved eelgrass bed quality and increased grating is detectable only when a threshold of at least 50% grating is achieved.	Baseline sampling Prior to modification of overwater structure for: - Aquatic vegetation density and distribution. - Bathymetry at site and within buffer area of structure. - Sediment grain size characterization. - Benthic invertebrate community composition and density. - Physical and biological characterization of control sites. Post modification monitoring at project and control site for

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements
		the amount of light between the wavelengths of 400 to 700 nanometers, the photosynthetically active range.		change in: - Bathymetry. - Aquatic vegetation density and distribution. - Sediment grain size. - Benthic invertebrate community composition and density.
3	Programmatic	For sites adjacent to sand lance and surf smelt spawning areas all in-water work that has the potential to increase suspended sediments in the spawning area during the spawning period, will require a buffer of at least 0.6 meters (2 ft) vertical separation from the tidal elevation of the spawning bed or a buffer of 55 meters (180) ft horizontal distance from the lower edge of the surf smelt/sand lance spawning habitat zone. In-water work may occur during an outgoing tide when the water line is below the lower edge of a surf smelt/sand lance spawning habitat zone (1.5 to 1.8 meters or 5 to 6 ft MLLW).	- Natural variability- Sediment characteristics, geomorphology, and nearshore currents vary by site in marine areas of the state. - Data limitations, sampling or analytical errors – Direct and indirect effects to forage fish spawning from activities that alter site geomorphology and sediment characteristics have not been well studies. - Best professional judgment-Precautionary principle is applied to require distances and depth needed between aquaculture activities and forage fish area to minimize sediment disturbance that may cause harm to spawning forage fish.	Baseline sampling prior to establishing an activity that has the potential to increase turbidity for: - Bathymetry at site and within buffer area. - Sediment grain size characterization. - The extent, grain size and level of turbidity (NTU or mg/l). - Benthic invertebrate community composition and density. - Physical and biological characterization of control sites. Post establishment monitoring at the project and control site for change in: - Bathymetry. - The extent, grain size

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements
				and level of turbidity (NTU or mg/l), including time frame of elevated levels, generated by the activity. - Sediment grain size. - Benthic invertebrate community composition and density.
4	Programmatic	New outfalls must be located at a distance from existing, native aquatic vegetation attached to or rooted in the substrate sufficient to avoid impacts to said vegetation.	- Incomplete information- Direct impacts from nutrients in the water column to aquatic vegetation and benthic community not well studied. - Model structure or approximations- Model considers dispersal of pollutants in water column- does not consider trapping of effluent particulates by macroalgae. - Missing variables- Effluent from secondary water treatment plants contains high levels of nutrients (nitrogen and phosphorus) in the water as well as bound organics in a flocculant form. While nutrient loading in water can have biochemical effects on aquatic vegetation, flocculants can	Prior to installation of outfall: - Bathymetric survey within radial distance and down drift of discharge head. - Baseline sampling for: ▪ Bed surface grain size and sorting. ▪ Aquatic vegetation density and distribution. ▪ Assessment of aquatic vegetation epiphyte coverage. ▪ Physical and biological characterization of control sites. ▪ Benthic invertebrate community composition. and density.

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements

			have biophysical impacts when leaves and seeds are coated that prevents or stresses reproductive success.
			- Best professional judgment- Current outfalls siting relies on water quality standards for protecting human and aquatic organism health.
				Post outfall installation monitoring at project and control site:
				- Bathymetric surveys to assess for any evidence of scour.
				- No exceedances of identified standards.
				- Changes within and beyond the established buffer for:
				  - Sediment characteristics.
				  - Aquatic vegetation density and distribution.
				  - Benthic invertebrate community composition.
				  - Fine sediment accumulation/siltation on aquatic vegetation and sediment bottom.
				  - Aquatic vegetation epiphyte loads.

5	Overwater structures	To minimize prop dredging and prop scour associated with motorized watercraft, the horizontal buffer distance for structures associated with watercraft is 8 meters (25 ft) from the outside of the vessel	See uncertainty for Relative Priority #1	See uncertainty for Relative Priority #1

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements
		whenever there is a vertical buffer of 2 meters (7 ft) of water above the vegetative canopy at the lowest low water within the diameter of the turning circle. When the vertical buffer is less than 2 meters (7 ft), the horizontal buffer distance will be either 8 meters (25 ft) from the outside of the vessel, the maximum distance shade will be cast by the structure, or the diameter of the turning circle, whichever is greater. For this measure the turning circle is defined as 3.5 times the length of the longest vessel to use the structure		
6	Overwater structures	The portions of piers, elevated docks, and gangways that are over the nearshore/littoral area must have unobstructed grating over at least 50 percent of the surface area. Floating docks 1.5 meters (5 ft) or greater in width, must have unobstructed grating over at least 50 percent of the surface. Floating docks less than 1.5 meters (5 ft) in width must have unobstructed grating over at least 30 percent of the surface. All grating material must have at least 60 percent functional open space. Grating	See uncertainty for Relative Priority #1	See uncertainty for Relative Priority #1

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements
		requirements can also be met if the combination of grated surface area and grating open space are equal to or better than the above standards.		
7	Overwater structures	Gangways must incorporate 100 percent grating with 60 percent functional open space.	See uncertainty for Relative Priority #1	See uncertainty for Relative Priority #1
8	Programmatic	No creosote, chromate copper arsenate, or pentachlorophenol treated wood, or other comparably toxic compounds may be used as part of the decking, pilings, or other components of any in-water structures such as docks, wharves, piers, marinas, rafts, floats, shipyards and terminals. Treated wood may only be used for above water structural framing and may not be used as decking, pilings or for any other uses. During maintenance, existing treated wood must be replaced with alternative materials such as untreated wood, steel, concrete, or recycled plastic, or encased in a manner that prevents metals, hydrocarbons and other toxins from leaching out.	Best professional judgment- Apply precautionary principle. Treated wood structures placed in or over flowing waters will leach copper and a variety of other toxic compounds directly into the water (Weis and Weis 1996, Brooks 2000, FPL 2000, Hingston et al. 2001, Poston 2001, NOAA 2003). Benthic organisms may uptake and be impacted by these contaminants.	Baseline sampling prior to replacement of treated wood: - Benthic infauna sampling - Aquatic vegetation density and distribution. - Physical and biological characterization of control sites. Monitoring post replacement for change in: - Benthic infauna - Aquatic vegetation density and distribution.
9	Log Booming	New and expanded log booming	- Natural variability-	Baseline sampling prior to

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements
	and Storage	and storage activities must be kept at least 60 meters (200 ft) from existing native aquatic vegetation attached to or rooted in substrate.	Variability in flushing rate, geomorphology of shore and bathymetry of nearshore will affect transport and accumulation of woodwaste, vulnerability to impacts differs among different species of aquatic vegetation. - Best professional judgment- Apply precautionary principle- Pease (1974) reports bark debris covered the sediment bottom within a radius ranging from 50 ft up to 200 ft at the two oldest active dumping sites studied.	log storage/booming: - Characterization of sediment grain size and sorting. - Benthic infauna. - Hydrologic current or drift in the area. - Sediment total organic carbon. - Bathymetry at, and down drift of log booming area. - Aquatic vegetation density and distribution. - Flow modeling to determine extent of wood debris transport and deposition. - Physical and biological characterization of control sites. Monitoring post activity commencement project and control site: - Bathymetric surveys to ensure scour impacts do not exceed accepted standards. - Extent of wood debris deposition. - Sediment total organic carbon - Changes in:

Relative Priority	Measure Classification	Measure	Highlighted Uncertainty	Monitoring Elements
				▪ Sediment characteristics within and beyond established buffer. ▪ Aquatic vegetation density and distribution within and beyond established buffer ▪ Accumulation of fine sediment within and beyond established buffer. ▪ Aquatic vegetation density and distribution beyond buffer edge.
10	Programmatic	New and expanded finfish aquaculture netpens must be located at least 150 meters (492 ft) from existing native aquatic vegetation attached to or rooted in substrate.	- Natural variability-Variability in flushing rate, geomorphology of shore and bathymetry of nearshore will affect the rate of accumulation of fish waste and feed, vulnerability to impacts differs among different species of aquatic vegetation. - Best professional judgment-Apply precautionary principle-Caroll et al. 2003 "detected environmental effects(faunal) up to several hundred meters	Baseline sampling prior to installation of net pens: - Sediment grain size and sorting characterization. - Sediment total organic carbon. - Benthic infauna - Aquatic vegetation density and distribution. - Physical and biological characterization of control sites. Post installation monitoring within and beyond established buffer at both the project and control site for

Relative Priority	**Measure Classification**	**Measure**	**Highlighted Uncertainty**	**Monitoring Elements**
			from the fish farm." Mussel raft impacts similar to finfish netpen impacts.	change in: - Sediment characteristics. - Sediment total organic carbon - Aquatic vegetation density and distribution - Fine sediment accumulation/siltation