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MONITORING AND EVALUATION STRATEGY

For

Habitat Restoration And Acquisition Projects

Washington Salmon Recovery Funding Board

2003

This is a draft document and is available for public review and critique.

All contents are subject to change.

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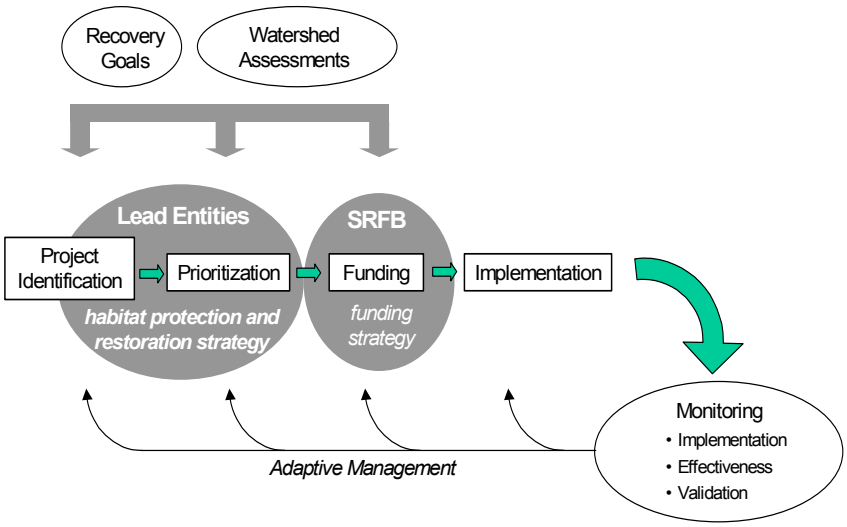
OVERVIEW

The Salmon Recovery Funding Board (SRFB) was established in 1999 to fund salmon habitat restoration and protection projects and related activities. Starting in 2000, the SRFB established policies authorizing the types of projects eligible for funding and an evaluation process for selecting projects.

The SRFB, in their Policies and Guidelines, identified implementation, effectiveness, and validation monitoring as key components of their adaptive management model.

Figure 1. SRFB Adaptive Management Model



As part of past application processes, the SRFB has required applicants submit a monitoring plan that permitted up to 20 percent of the grant to be expended on monitoring.

This document is intended to address elements of Washington's Comprehensive Monitoring Strategy (CMS), and it provides:

- **Overall SRFB effectiveness and validation monitoring strategy;**
- **Prioritized monitoring by type and category;**
- **Estimated costs over the next ten years; and**
- **SRFB-NOAA Fisheries-OWEB-BPA agreed upon reporting metrics.**

Habitat restoration projects typically have a "nested hierarchy" of interrelated objectives and results. Projects individually operate at the site and reach scale, and when rolled up, operate at the watershed scale. This "nested hierarchy" also typically has associated monitoring at each level. For example, a riparian vegetation project might have the following series of objectives and associated levels of monitoring.

→Plant trees (Implementation monitoring Level 0)
→Did the trees live? (Level 1 design criteria)
→Increase shading of stream (Effectiveness monitoring Level 2)
→Reduce stream temperature (Effectiveness monitoring Level 2)
→Increase local salmon abundance (Effectiveness monitoring Level 3)
→Increase watershed salmon abundance (Validation [intensive] monitoring Level 4)

Implementation monitoring is related to project effectiveness monitoring, which in turn is related to validation monitoring. Doing one without the other would seriously limit the extent to which the SRFB could document whether the projects it funds have been effective in meeting SRFB goals.

Project Implementation (Compliance) Monitoring - Level 0

Implementation monitoring determines whether an action was implemented. It requires simply a yes/no answer and no environmental data. It is usually a low cost monitoring activity. Project monitoring is conducted by SRFB staff for all funded projects. The SRFB intends to monitor 100% of projects for implementation and compliance with pre-project design objectives and criteria.

Monitoring Effectiveness of Projects in Meeting Engineering and Design Criteria – Level 1

Many projects use design specifications that are intended to have benefits to fish. Over time, environmental or other circumstances can affect how well a project originally built to meet design criteria continues to meet those criteria. Projects for which engineering design criteria are utilized can be monitored to determine how well those criteria are achieved by the project over time. For example, fish passage projects involving culverts, weirs, dams, etc., are only effective as long as debris, floods, and other factors have not rendered an engineered solution ineffective. Therefore, the SRFB intends to monitor all categories of engineered projects to see how well they continue to meet their engineering and design criteria. Engineering and design criteria will be examined for the following monitoring categories:

- MP-1 Fish passage structures
- MP-2 Instream structures
- MP-3 Riparian plantings
- MP-4 Livestock exclusions
- MP-5 Constrained channels
- MP-6 Channel connectivity
- MP-7 Spawning gravel placement

- MP-8 Diversion screening
- MP-9 Estuarine habitat

Monitoring Effectiveness of Projects on Habitat – Level 2

Effectiveness monitoring measures environmental parameters to ascertain whether the actions implemented were effective in creating a desired outcome at the project site or reach scale. For example, did the planted trees produce shading for the stream is the first level of a cause and effect hypothesis? The entire hypothesis may be stated something like the following: If I plant trees near the stream, then they will grow and produce shade. The shade will help lower water temperature and stabilize the shoreline (Level 2 outcomes) and this will improve the fish habitat leading to more fish (Level 3 and 4 outcome). Project effectiveness monitoring is generally used to evaluate Level 2 outcomes, which are directly affected by the project. The relationships between the project and Level 2 and Level 3 and 4 outcomes are usually less direct. Watershed processes occurring upstream or upslope from the project increasingly influence higher-level outcomes. Outcomes not directly influenced by the project are usually best addressed at the watershed scale through validation (intensive) monitoring (Level 4). Most projects are implemented at a small scale, with defined sets of actions intended to protect or enhance specific habitat features or habitat-forming processes. An enhancement technique may be difficult to implement properly but very effective or, conversely, easy to implement but rarely effective. Implementation, effectiveness, and validation monitoring are necessary to evaluate specific projects or classes of projects. The SRFB intends to monitor effectiveness of projects on habitat by monitoring changes in habitat parameters for the following project categories;

- MP-2 Instream structures
- MP-3 Riparian plantings
- MP-4 Livestock exclusions
- MP-5 Constrained channels
- MP-6 Channel connectivity
- MP-7 Spawning gravel placement
- MP-9 Estuary restoration/creation
- MP-10 Habitat acquisitions

Monitoring Effectiveness of Projects on Local Fish Abundance – Level 3

Interest in evaluating the effectiveness of projects on fish abundance in the local project area is common to most restoration and funding entities. However, the current project effectiveness monitoring literature shows a wide variety of results in the ability to associate changes in fish abundance. Some studies have been unable to detect statistically significant changes in abundance in the project area after several years, while others have been able to show increases. As noted by the Independent Science Panel (ISP 2002) and others, detection of increased fish abundance at the project or reach level should not be interpreted to mean that overall abundance or productivity of the stream (e.g., smolt abundance) at the watershed scale has also increased. The

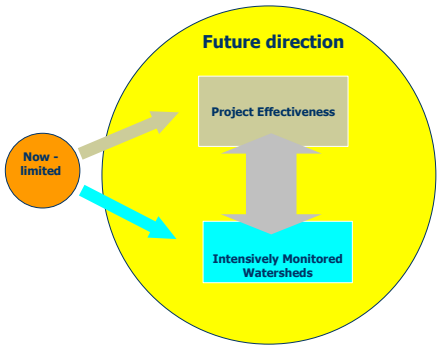
linkages to smolt production can only be done through validation monitoring in intensively monitored watersheds. The SRFB intends to monitor fish abundance at the project level for the following project categories:

- MP-1 Fish passage structures
- MP-2 Instream structures
- MP-6 Channel connectivity

The SRFB also intends that this level of project effectiveness monitoring (to determine local fish response) will be linked to level 4 (intensive) monitoring as outlined below to the extent possible.

Intensive (Validation) Monitoring Level 4

This type of monitoring is the only type of monitoring that can establish "cause and effect" relationships between fish, habitat, water quality, water quantity, and management actions. It operates at the watershed scale to evaluate projects and programs that conduct, promote, or regulate, activities meant to protect or enhance habitat, water quality, or fish production. As an example, one might study the impacts of categories of riparian habitat projects on a salmon in a specific stream. The common theme of these studies is to develop an understanding of the linkages between management actions and the responses in numbers of fish produced.



This type of monitoring is the most complex and technically rigorous, which often requires measuring many parameters to detect the variable affecting change. Counting juvenile and adult fish is essential. Once determined, the relationships between restoration actions and the numbers of fish produced in an intensively monitored watershed (IMW) may or may not be able to be directly extrapolated to other watersheds depending upon the strength of the information obtained. However, intensively monitored watersheds can be assumed to represent the overall responses of watersheds with similar characteristics and limiting factors to the same restoration impacts.

This part of the SRFB Monitoring Strategy pertains to monitoring that addresses how management and habitat restoration project activities, and their cumulative effects, specifically affect fish production. As is discussed in greater detail below, validation monitoring (or as termed here, intensive monitoring) is the only way this can be achieved (ISP 2002). Status and trends, effectiveness, and implementation monitoring are not able to determine causal relationships between management activities and fish production. Other types of monitoring are unable to answer questions like "to what extent did our recovery actions lead to more fish?"

The SRFB intends to support intensive monitoring in watersheds carefully chosen to allow efficient and meaningful results. Support will include initial development work in selected watersheds so that scientifically sound and integrated monitoring efforts can be most effectively linked to habitat project monitoring work in levels 2 and 3.

Compared to other types of monitoring, intensive or validation monitoring requires the greatest extent of scientific rigor and integration in monitoring design development and analysis of results, over a substantial time period. Interest in this type of monitoring has been expressed by various entities and opportunities for potential partnerships will be utilized.

EFFECTIVENESS MONITORING STRATEGY

Key Elements of the Strategy

Level 1-3 monitoring at the project or reach scale

- The Board staff will determine the overall sampling regime and sample size by project category.

- After the SRFB has selected projects to fund for a particular "Round", a subsample of the selected projects will be randomly selected by the staff for monitoring.

- The staff will use professional, qualified independent monitoring entities to field sample habitat restoration and acquisition projects at the reach or project level using Board adopted protocols, metadata, and procedures.

- The Board will use habitat assessment protocols developed by the nationally recognized Environmental Monitoring and Assessment Program administered by the U.S. EPA, as recommended in "*Washington's Comprehensive Monitoring Strategy*" and adopted by the Oregon Watershed Enhancement Board and the U.S. Forest Service (see "*SRFB Sampling Protocols*").

- The Board staff will be responsible for analyzing the results of monitoring from the monitoring entities, and to report to the Board and others the cumulative results of monitoring. In order to efficiently use monitoring dollars, a stratified random sample of projects by category will be taken. The sample will be sufficient to be 95% certain that the results of the projects sampled is within 5% of the true percentage of projects that are successful. Based upon past projects, approximately 68% of the projects by category should be sampled during Phase 1.

- Volunteers and project proponents may choose to monitor their projects as part of the sampling regime outlined in this Strategy. However, monitoring funded by the Board will meet requirements detailed under "*Required Elements For Locally Monitored Projects*" on page 23 of this Strategy.

- Not less than 5% of annually appropriated federal and state funds will be available to test effectiveness of projects designed to restore habitat and projects that protect habitat by acquisition at the site or reach scale.

- The Board staff will ensure that monitoring is "phased" so that future monitoring can be built upon knowledge gained from initial monitoring. Phase 1 monitoring will occur between 2003 and 2014. After 2014, results will be evaluated to determine what, if any, changes to the SRFB monitoring strategy are warranted.

Level 4 intensive monitoring at the watershed scale

- For long term intensive watershed scale monitoring, the Board will support development of IMWs in a few identified watersheds where the cumulative impacts of SRFB funded restoration projects can be assessed for their effects on total watershed salmon production and productivity.

- A portion of funded habitat restoration projects will be linked to and embedded in IMW designs. The number and kinds of projects placed in IMWs will be determined by the limiting factors identified in the IMWs and the monitoring design.

- Up to 5% of annually appropriated federal and state funds will be available for Board support of intensively monitored watersheds.

- Implementation of IMW efforts will use a phased approach. A team or consortium comprised of IMW partners and others will contribute to and help guide feasibility, design, implementation, analysis, and reporting activities. Key checkpoints will be identified based on experimental design timelines and frameworks for review of interim progress and results from IMW work.

Priorities for Project Effectiveness Monitoring

Table 1 is an adaptation from data provided by Roni et al. (2002). It captures the overall qualitative value of each category of SRFB projects in terms of response and certainty. SRFB files provide average costs associated with implementing the various projects. Monitoring efforts are prioritized using multiple considerations detailed in Table 3.

These considerations include response time, probability that monitoring will be definitive enough to determine effectiveness of the project type, earliest reporting date, and cost of monitoring. It is expected that not only will monitoring determine the overall effectiveness of each project, but it will provide data on the overall longevity of SRFB project habitat restoration types and the amount of variability in success of projects types both in terms of overall statewide, but in terms of geographic areas of the state.

Response time will determine the number of years required to monitor. A culvert replacement may have fish utilizing the project area within one year. For most fish passage projects, a measurable response is expected within 5 years. For projects such as riparian vegetation restoration, response time may take 5 to 20 years. Therefore, the Board will extend monitoring over a longer time span to determine effectiveness.

The last column in Table 1 provides monitoring priorities for different types of projects. Some project categories rank high based upon their overall ability to detect change in a timely manner. These rankings are not intended to reflect the funding priority of the project type for restoration. Some projects are not very conducive to monitoring and, therefore, rank low. Instream projects, although marked low in terms of certainty and response, are considered a high priority for monitoring because they are the second

most often funded restoration project category. Nevertheless, monitoring may show that they are one of the least effective types of projects over time.

Monitoring for some project types and parameters may be too costly for the information obtained. Conifer conversions, nutrient enhancement projects (carcasses and fertilization) are very difficult to monitor and take extensive investments in time and money. Therefore, the Board will not monitor these project categories for effectiveness.

Table 1. Project effectiveness monitoring time frames and priorities modified from Roni et al. (2002). Shading represents categories with relatively long overall response times and low probabilities of success. Crosshatching represents categories with medium overall response times and probabilities of success. Light shading represents categories with short overall response times and high probabilities of success. Monitoring priority in most cases reflects the composite of response times and success probabilities.

SRFB Category	Action	Response (years)	Longevity (years)	Success probability	Success variability	Cost of average project	Monitoring Priority
Fish Passage	Culverts, barriers	1-5 Score 10	10-50+ Score 10	H	L	$203,000 Opens 3.2miles $63,000/mile	H
	Off channel	1-5	10-50+	H	L	$508,000 Opens 1.4 miles 48 acres	H
	Instream diversion	1-5	10-50+	H	L	$170,000 Screens 8.4 diversion/project $17,000/screen	H
Estuarine	Habitat restoration	5-20	10-50+	M-H	M	$196,000	H
	Road removal	5-20	Decades-centuries	H	L	$196,000	H
	Road alteration	5-20	Decades-centuries	M-H	M	$196,000	H
Riparian vegetation	Fencing	5-20	10-50+	M-H	L	$261,000	H
	Riparian replanting	5-20	10-50+	M-H	L	$261,000	H
	Grazing strategies	5-20	10-50+	M	M	$261,000	L
	Conifer conver-sion	10-100	Centuries	L-M	H	$261,000	L
Instream habitat	Artificial log structure	1-5	5-20	M	H	$221,000	H
	Natural LWD	1-5	5-20	M	H	$221,000	H
	Artificial log jams	1-5	10-50+	M-H	M	$221,000	H
	Boulder placement	1-5	5-20	M	M	$221,000	H
	Gabions	1-5	10	M	M	$221,000	H
Nutrient enhanceme nt	Carcasses	1-5	Unknown	M-H	L		L
	Fertiliza-tion	1-5	Unknown	M-H	M		L
Create new habitat	Off channel	1-5	10-50+	M	H		H
	Estuarine	5-10	10-50+	L	H		H
Upland Habitat						$156,000	L

H= High, M= Medium. L= Low

Experimental Design And Statistical Design

The Board wishes to determine if there is a measurable change in the habitat and fish indicators in the area restored by the Board (Impact) compared to other areas (Control) where the Board has not taken action. We cannot measure the variance between the means of measurements in the Impact and the Control because we cannot assume the differences between the Impact and Control sections in each project will remain constant. The magnitude of the true difference between Impact and Control changes over time, thereby making it impossible to evaluate any times by location interactions.

Therefore, the Board will employ a "Before" and "After" Control Impact (BACI) design similar to one described by Stewart-Oaten et al. (1986). A BACI design samples the Control and Impact simultaneously at both locations at designated times before and after the impact has occurred. The object is to see whether the difference between Impact and Control abundances has changed as a result of the projects. The plan is to compare the before and after periods by a *t*-test for a difference between the mean of the before differences and the mean of the after differences for the projects sampled. The tests also assume that the observed differences calculated at different times are independent.

To implement the design, we will monitor the number of projects proposed for funding in each category based upon the calculated sample size needed to obtain statistically significant information in the shortest amount of time. If there are insufficient projects funded in any one year to obtain a proper sample size, then replicates of the design will be used in multiple years until the critical sample size is reached.

Each of the projects in each replicate will utilize one impact reach in the proposed project area and a paired control area near the project in an area with similar reach characteristics. In Year 0 (one year prior to project construction), (Before) sampling of the project Control and Impact reaches is completed. After the restoration project has been completed, the Control and Impact areas for each of the projects in each replicate will be sampled for three or more years (After) for changes in the selected habitat and/or fish abundance indicators. The variance associated with Impact and Control areas will not be known until sampling has occurred in Year 0 of both Impact and Control areas. After Year 0, a better estimate of the true sample size needed to detect change will be available. Cost estimates and sampling replicates may need to be adjusted at that time.

At the end of the effectiveness monitoring testing, there will be one year of "Before" impact information for all projects in each replicate for both Control and Impact areas, and multiple years of "After" impact information for the same Control and Impact areas for each of the projects within each replicate. Testing for significant trends for some projects can begin as early as 2005.

Depending upon circumstances, the results may also be tested for significance, using a linear regression model of the data points for each of the years sampled and for each of the indicators tested.

Table 2 contains a summary description of the project category, the indicator that will be used to measure a significant change in habitat or fish conditions, the metric used to measure the indicator, and the statistical rule in terms of confidence in the results. It also contains the decision criteria at which the Board will consider a change meaningful. For example, under MP-1 Fish Passage in the table, a statistically significant change of 5% in the juvenile population in the area upstream of the project may be observed, but would not be considered a meaningful change unless is was greater than or equal to 20%. The test type is the kind of statistical test that will be employed upon completion of the monitoring.

Table 2. SRFB Effectiveness monitoring statistical design table for habitat restoration/protection projects

SRFB Project Category	Monitoring Category	Level	Indicators	Metric	Test Type	Decision Criteria
Instream Passage	**MP-1 Fish Passage**	Level 1	Eng. Design	Yes/No	None	≥ 80% of projects are Yes by Year 5
		Level 3	Juvenile salmon	#/m^2	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 5
		Level 3	Adult salmon	#/mile; redds/mi	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 5
Instream Habitat	**MP-2 Instream habitat**	Level 1	Artificial Instream structures	#	None	80% or more remaining by Year 10
		Level 2	Mean residual pool vertical profile area	m^2	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	Mean residual depth	cm	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 3	Juvenile salmon	#/m^2	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 3	Adult salmon	#/mile; redds/mi	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
Riparian Habitat	**MP-3 Riparian plantings**	Level 1	# of plantings	#	None	50% or more remaining after 10 years
		Level 2	Mean percent canopy density at the bank Densiometer Reading	1-17 score	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10

SRFB Project Category	Monitoring Category	Level	Indicators	Metric	Test Type	Decision Criteria
		Level 2	3-layer riparian vegetation presence (proportion of reach)	%	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
Riparian Habitat	**MP-4 Livestock exclusions**	Level 1	Exclusion Area	Yes/No	None	Effective if 80% of projects are Yes
		Level 2	Mean percent canopy density at the bank Densiometer Reading	1-17 score	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	3-layer riparian vegetation presence (proportion of reach)	%	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	Actively eroding banks	%	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
Instream Habitat	**MP-5 Constrained channel**	Level 2	Mean residual pool vertical profile area	m^2	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	Mean residual depth	cm	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	Mean bank full cross sectional area taken from mean bank full width and height	Ave. m^2	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 5% change between impact and control by Year 10
Instream Habitat	**MP-6 Channel Connectivity**	Level 1	Reconnected channel	Yes/No	None	Effective if 80% of projects are Yes
		Level 2	Mean residual depth	cm	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	Mean residual pool vertical profile area	m^2	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 3	Juvenile salmon	$\#/m^2$	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10

SRFB Project Category	Monitoring Category	Level	Indicators	Metric	Test Type	Decision Criteria
		Level 2	Mean percent canopy density at the bank Densiometer Reading	1-17 score	BACI Paired T test	Alpha=0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	3-layer riparian vegetation presence (proportion of reach)	%	BACI Paired T test	Alpha=0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 3	Adult salmon	#/mile; redds/mi	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
Instream Habitat	**MP-7 Spawning gravel**	Level 1	Gravel placed in stream	acreage	None	Effective if 80% of gravel placed at projects remains by Year 10
		Level 2	Percent gravel embedded at mid-channel and margins	Percent	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	Percent substrate embedded	Percent	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 2	Percent substrate as fines	Percent	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
		Level 3	Adult salmon	#/mile; redds/mi	BACI Paired T test	Alpha =0.05 for one-sided test. Detect a minimum 20% change between impact and control by Year 10
Instream Diversion	**MP-8 Diversion Screening**	Level	Screen design criteria	Yes/No	None	Effective if 80% of screened diversions at projects meet design by Year 5
Estuarine/ Marine Nearshore	**MP-9 Estuarine Habitat restoration**	In progress				
Protection	**MP-10 Acquisitions**	In progress				

Estimated Costs

Project effectiveness monitoring (levels 1 - 3):

Annual costs will vary depending upon the number of projects by category and the level of monitoring sought. Level 1 monitoring of engineered structures and solutions is the cheapest effectiveness monitoring because it does not require extensive environmental measurements, but relies upon previous studies to document that the design is effective. Verification that the design remains functional is the sum of monitoring. Table 3 provides the estimated cost to monitor each category of project for Level 1, 2, and 3.

The third column in Table 3 displays the number of years that project monitoring will occur pre- and post-impact. The years sampled post impact may not be consecutive years, but may be staggered over a longer time span to allow for habitat response.

The column displaying sample size per replicate is based upon the number of randomly drawn samples needed to detect with certainty (a= 0.5) whether the projects in that category are effective. Since we do not know the overall proportion of projects expected to be effective ahead of time, for the purposes of estimating sample size, the proportion is assumed to be 0.5. Therefore, approximately 70% of the projects should be sampled initially until an estimate of the true proportion can be obtained.

Total cost for each of the levels was calculated by finding the product of the cost per project and the number of projects sampled.

Grand Total is the sum of each of the total costs for each monitoring Levels 1-3.

Average Cost Per Year shown in the last column is found by dividing the Grand Total by the number of years sampled.

Table 4 provides a tentative schedule over the next ten years. It reflects the need for multi-year monitoring (e.g. Fish Passage 1 and 2) to obtain sufficient numbers of projects to detect a statistically significant change in the indicator. Table 4 also reflects the estimated annual cost to monitor project effectiveness for the eight project categories completed to date.

Watershed intensive monitoring (level 4):
The SRFB's intensive watershed monitoring strategy evolved from initial work on Index Watershed Monitoring from funding by the Legislature and the Board to the departments of Fish and Wildlife and Ecology (Summers 2001; Seiler et al. 2002). The cost of Index Monitoring work totaled $1,263k per biennium, which provided concurrent water quality and smolt monitoring in five locations in the state. The Board's current monitoring strategy refines and transitions that previous investment into an intensive watershed monitoring approach. Further detail on the IMW approach, tasks, timelines, partners/contributions are described separately in the IMW plan. That plan identifies initial work to be performed in two groups of IMW streams in: (1) Hood Canal – Big Beef, Stavis, Anderson, Seabeck creeks; and (2) Lower Columbia– Abernathy, Mill, Germany creeks. A complementary effort by IMW partners is funded separately and will be performed on a group of North Coast streams. In addition, potential IMWs in eastern Washington and potential related funding partners are being explored. The present package of intensive monitoring continues work in the three Lower Columbia streams that were included as part of Index Watershed Monitoring in 2002. The cost for smolt monitoring in six of the seven IMW streams is roughly $300,000 per year ($600,000 per biennium); costs for the seventh stream are covered by other funding. The Board acknowledges that funding of smolt monitoring in the other streams for which SRFB funds were previously provided (roughly $500,000 per biennium) is desirable and consistent with the CMS, but is outside the scope of the IMW framework.

Table 5 illustrates the projected annual costs for the intensive watershed monitoring work outlined here. Total costs will ultimately depend on the number of IMWs implemented in the state. The Board's contribution to IMWs will include enumeration of fish in IMW streams ($300,000), and the contributions from partners (e.g., funding, in-kind). Costs will change as IMW work progresses through various stages from scoping/design, through implementation/data collection, to final analysis/reporting.

Table 3. Level 1 –3 project effectiveness monitoring estimated time frames and costs per replicate.

Action Effectiveness Monitoring	Number of years sampled. Total time to end of replicate	Sample Size per replicate	Cost per Project Level 1	Total Cost Level 1	Cost per Project Level 2	Total cost Level 2	Cost per Project Level 3	Total Cost Level 3	Grand Total per replicate	Ave. Cost per year
MP-1 Fish Passage Culverts, bridges, fishways, logjams, dam removal	4 sample years 6 years total	15	$2,700	$40,500	0	0	$25,288	$379,320	$419,820	$104,955
MP-2 Instream habitat Channels, deflectors, weirs, large wood	5 sample years 11 years total	15	$900	$13,500	$6,750	$101,250	$43,875	$658,125	$772,875	$154,575
MP-3 Riparian plantings	5 sample years 11 years total	10	$2,700	$27,000	$4,500	$45,000	0	0	$72,000	$14,400
MP-4 Livestock exclusions	5 sample years 11 years total	3	$3,100	$9,300	$4,500	$13,500	0	0	$22,8000	$4,560
MP-5 Constrained channel (dikes, rip-rap, fill, roads)	5 sample years 11 years total	2	$2,450	$4,900	$6,750	$13,500	0	0	$18,400	$3,680
MP-6 Channel Connectivity (Off channel habitat, wetlands)	4 sample years 6 years total	5	$1,800	$9,000	$5,400	$27,000	$43,875	$658,125	$694,125	$173,531
MP-7 Spawning gravel	5 sample years 11 years total	3	$900	$2,700	$6,750	$20,250	$27,000	$81,000	$103,950	$20,790
MP-8 Diversion Screening	4 sample years 6 years total	2	$2,700	$5,400	0	0	0	0	$5,400	$1,350
MP-9 Estuarine Habitat restoration	In progress	4								
MP-10 Acquisitions	In progress	14								
Total										

Annual Cost and Sampling Schedules

The following tables (Table 4) illustrates the schedules for sampling each level of monitoring for the major categories of projects for Level 1-3. Note – Table 5 identifies the costs and schedule for IMWs.

Table 4. Combined costs and schedule for Level 1- 3 monitoring.

Year	Sample	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MP-1 Passage 1	15	$104,955	$104,955	$104,955			$104,955	Evaluate					
MP-1 Passage 2	15		$104,955	$104,955	$104,955			$104,955					
MP-2 Instream 1	15	$154,575	$154,575		$154,575		$154,575	Evaluate				$154,575	
MP-2 Instream 2	15		$154,575	$154,575		$154,575		$154,575					$154,575
MP-3 Riparian 1	10	$14,400	$14,400		$14,400		$14,400	Evaluate				$14,400	
MP-3 Riparian 2	10		$14,400	$14,400		$14,400		$14,400					$14,400
MP-4 Livestock 1	3	$4,560	$4,560		$4,560		$4,560					$4,560	
MP-4 Livestock 2	3		$4,560	$4,560		$4,560		$4,560					$4,560
MP-5 Constrained Channel	2	$3,680	$3,680		$3,680		$3,680					$3,680	
MP-5 Constrained Channel	2		$3,680	$3,680		$3,680		$3,680					$3,680
MP-6 Connect 1	3	$173,531	$173,531		$173,531		$173,531					$173,531	
MP-6 Connect 2	3		$173,531	$173,531		$173,531		$173,531					$173,531
MP-7 Spawning gravel	3	$20,790	$20,790		$20,790		$20,790					$20,790	
MP-7 Spawning gravel	3		$20,790	$20,790		$20,790		$20,790					$20,790
MP-8 Diversion 1	2	$1,350	$1,350	$1,350			$1,350						
MP-8 Diversion 2	2		$1,350	$1,350	$1,350			$1,350					
MP-9 Estuary 1	4												
MP-9 Estuary 2	4												
MP-10 Acquisition 1	14												
TOTAL		$476,491	$952,982	$581.446	$476,491,	$371,536	$476,491	$476,491	$0	$0	$0	$173,535	$347,066

Table 5. Costs and schedule for Level 4 intensive watershed monitoring. Total costs for two IMWs are included; they are not intended to reflect only the SRFB contribution.[1] Costs for fish sampling are noted separately for the first three years.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Phase 1: pre-implementation	$300,000 (fish) $350,000 (other)										
Phase 2: initial implementation		$300,000 (fish) $250,000 (other)									
Phase 3: full implementation			**$400,000 (fish)** $500,000 (other)								
Total (for 2 IMWs)	**$650,000**	**$550,000**	**$900,000**	**$1,000,000**	**$1,000,000**	**$1,000,000**	**$1,000,000**	**$1,000,000**	**$1,000,000**	**$1,000,000**	**$1,000,000**

[1] Current partners include: CMER, UW/ONRC, EPA; in-kind contributions from NWFSC, EPA, BIA, tribes, local groups.

Monitoring and Reporting Metrics

The ability to communicate effectively the results of habitat restoration and acquisition projects and other salmon recovery activities is a continual challenge. Those individuals working closely with habitat and fish issues speak in technical terms and metrics not well understood by others. On the other hand, "decision-makers" at the highest levels of government, in the U.S. Congress and State Legislature want to know the answers

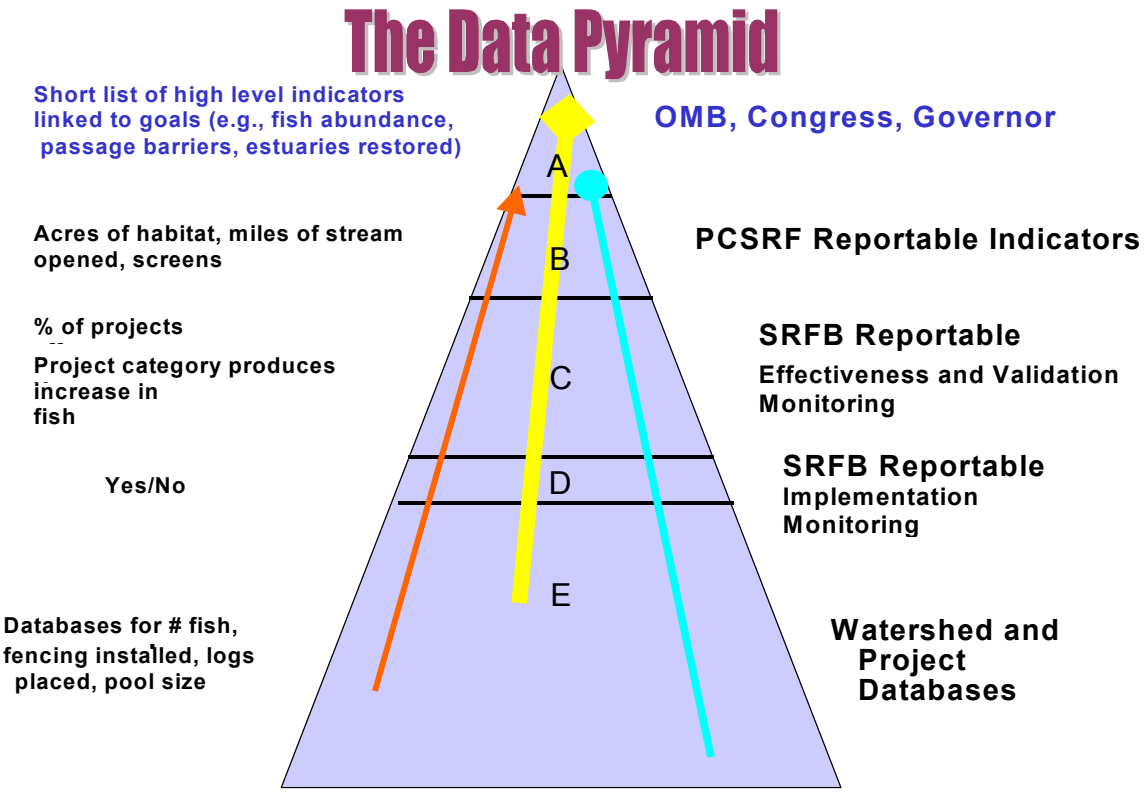


Figure 2. The Effectiveness Monitoring Data Pyramid

to basic accountability questions about the money they have appropriated to solve the salmon crisis. They seek answers to questions like: Have our efforts done any good? How many new fish have been produced? How much more money is needed? How much longer until we achieve success? These basic questions cannot be answered, unless a significant amount of existing and new information is obtained and rolled up in a manner that, to date, has typically not been done. To get answers to the most basic questions requires a variety of more detailed and complex underlying information. Figure 2 illustrates a data pyramid, reflecting the hierarchical nature of "information "chains that link detailed data up through intermediate layers to the highest level performance measures.

An effort is underway to reach agreement on common metrics designed to measure success in recovering habitat and salmon in the Pacific Northwest. Coordination is underway between the major funding entities including: Oregon Watershed Enhancement Board (OWEB), SRFB, Bonneville Power Administration, Northwest Power and Conservation Council, U.S Forest Service, and the Pacific Coastal Salmon Recovery Fund partners administered by NOAA Fisheries. Implementation monitoring metrics (Level D in the Pyramid) agreed upon to date are shown in Table 7 for habitat restoration projects. Additional work is underway to agree upon effectiveness monitoring metrics and the key few performance measures reportable to Congress, the Governor and the Legislature.

Category	SRFB	Implementation Monitoring
Fish Screening Projects	In-Stream Diversions	Number of screens installed Flow rate (cfs) of diversions treated Duty (quantity of water allowed) in acre-feet
In-Stream Habitat	In-Stream Habitat Restoration	# of miles treated
Fish Passage Improvements	Culvert replacement Dam removal Debris removal	# of blockages removed # of miles accessed
Riparian Habitat	Fencing exclusions	# of miles treated # of acres treated # of acres of invasive species controlled
Upland Habitat		# of actions # of acres treated
Roads		# of miles of road decommissioned, upgraded, closed
Water Quantity		Amount of water (cfs) # of gauges installed % of lease/purchases with gauges
Water Quality		Water Quality limitations addressed by project
Wetland Activity		# of acres restored # of acres created # of acres invasive species controlled
Estuarine	Estuarine/Marine Nearshore	# of acres restored # of acres created # of acres invasive species controlled
Land Acquisitions		# of acres protected # of miles of stream protected

Table 7. Implementation and effectiveness monitoring indicators of performance.

REQUIRED ELEMENTS FOR LOCALLY MONITORED PROJECTS

Lead Entities, Salmon Recovery Regions and others desiring to conduct monitoring for their proposed restoration projects as part of the Board's monitoring program shall meet the following requirements:

- Comply with and utilize SRFB "Sampling Procedures, Designs, and Projected Costs" manuals.
- Utilize applicable SRFB "Sampling Protocols".
- Submit a written monitoring plan detailing the timelines, costs, responsible organization, and plans for pre and post project monitoring.
- Report data in a timely manner to the PRISM database using required flat file format and metadata standards.
- Participate in QA/QC audits.
- Meet all reporting deadlines.

QUALITY CONTROL/QUALITY ASSURANCE

Field Sampling Audit

The SRFB will employ a consultant to annually report results from an audit of 25% of ongoing habitat effectiveness monitoring projects, randomly selected to determine how well they have implemented the monitoring design and field sampling Quality Assurance Protocols and Procedures.

Data Management Audit

The SRFB will employ a consultant to annually audit on a random basis 25% of ongoing habitat effectiveness monitoring projects to determine if they are following the procedures for entering data into PRISM.

REPORTS

Progress Reports

Entities involved in project effectiveness and intensive monitoring must present to the SRFB in writing progress reports after the sampling season for each monitoring year. These reports will indicate how the monitoring relates to the SRFB's project effectiveness monitoring program, and linkages between project effectiveness monitoring and intensive watershed monitoring. Intensively Monitored Watershed reports will be jointly prepared by monitoring parties.

Final Reports

Entities involved in project effectiveness and intensive monitoring must present to the SRFB a final report, in writing, after the sampling for all years is completed. Final

reports shall include monitoring objectives, assumptions, designs, field and statistical/analytical methods, results, and recommendations. Intensively Monitored Watershed reports will be jointly prepared by monitoring parties, and will describe linkages to project effectiveness monitoring. Final reports from all entities will include:

- Estimates of precision and variance for data collected
- Confidence limits for data collected
- Data and metadata required for PRISM database
- Determination of whether project met decision criteria for effectiveness
- Analysis of completeness of data, gaps, and sources of bias

The SRFB will periodically review results of monitoring during a regular meeting. PRISM database will be used as the repository of summarized monitoring information contained in Table 6, and will be reported and available over the Interagency Committee for Outdoor Recreation web site and the Washington Natural Resources Data Portal.

Monitoring Program Review

To facilitate information sharing and coordination, and to improve the effectiveness of the Board's monitoring program, entities receiving SRFB funds for project effectiveness and intensive monitoring will be prepared to participate in an annual or biennial monitoring program review convened by SRFB staff. This may involve oral presentation and discussion of monitoring results.

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