

STATE OF WASHINGTON

INDEPENDENT SCIENCE PANEL


PO Box 43135
Olympia, Washington 98504-3135
(360) 902-2216 FAX (360) 902-2215

Kenneth P. Currens, PhD
Hiram W. Li, PhD
John D. McIntyre, PhD
Walter F. Megahan, PhD
Dudley W. Reiser, PhD

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TO: William Ruckelshaus
Monitoring Oversight Committee

FROM: Kenneth Currens, Chair



SUBJECT: Review of Comprehensive Monitoring Strategy, Vol. III (Version 6, 8/21/02).

With the development of the Comprehensive Monitoring Strategy (CMS) in its final stages, the Independent Science Panel has recently had its first opportunity to review the full technical details of the monitoring strategy. We plan on a thorough, independent review after it is completed. To help you assess the general technical merits of the strategy as you prioritize future actions and to help the project team identify potential shortfalls, however, we focused our present review and comments on the question “*Will the strategy provide scientifically defensible information for making decisions?*” As we have in the past, we also provide additional suggestions and editorial changes for the project management team.

Overall, the strategy, if it were implemented, would be an improvement over status quo monitoring efforts. The descriptions of current monitoring that introduce each section provide a revealing and useful view of how data collection has evolved separately within different natural resource agencies to address different management problems. The strategy, in contrast, identifies the critical questions and linkages that affect common public resources—salmon, salmon habitats, and watershed health—and suggests a coordinated approach. The strategy also addresses many of the elements that are necessary for a scientifically defensible, comprehensive monitoring program to answer those questions (Table 1). In particular, the strategy focuses on identification of goals and objectives, indicators and variables, and statistically based sampling.

Given these strengths, however, our review indicates a number of critical elements remain missing or are inadequately developed (Table 1). Most important is the inadequate development of statistical designs in some areas, standardized sampling protocols, and data quality control and assurance. Without these, it will be difficult to answer some of the critical questions associated with habitat in agricultural and urban areas, hydropower, hatcheries, and predation and competition with salmon. Performance measures, which were called for in SSB 5637 and by the Office of Financial Management, are also missing for some areas. Although the strategy acknowledges that these elements need to be developed, we recommend that the strategy identify the timeframe and process for completing these.

The strategy recognizes that different types of monitoring (implementation, status and trend, effectiveness, and validation monitoring) are complementary and necessary to guide management decisions and provide accountability. Each of these various types addresses a reason for uncertainty in

evaluating and making decisions. Without knowing whether management actions were implemented, whether conditions are changing, and whether the changes were caused by the management actions or something unrelated, it is difficult to make responsible decisions. Table 2 shows the kinds of monitoring necessary to address the objectives in the CMS for each of the key questions. Some topic areas lack the full complement of monitoring types. The strategy itself is largely focused on status and trend monitoring (Table 3). We recommend that when the full complement of monitoring types is not present, the strategy identify the uncertainties that this may or may not introduce. Additionally, in some cases, implementation or validation monitoring called for by the objectives was not described in the details of the strategy. We recommend that descriptions of the monitoring programs be compared to the stated objectives and that gaps be identified and addressed.

We are pleased to see a general discussion of adaptive management included in the strategy. This has several strong sections, including the recognition of the importance of watershed analysis and planning and the identification of governance alternatives for incorporating monitoring information into decision-making. The strategy would be much stronger if it also linked the general discussion of adaptive management and the detailed descriptions of the information that is actually being collected for each of the different objectives. The strategy suggests that the critical links in adaptive management are the performance measures. As noted earlier, these are missing or inadequately developed for many different objectives (Table 1). Furthermore, as performance measures are identified, it is critical that the utility of the indicators or indices of performance are scientifically validated. Decision-makers and the public want simple answers to whether we are being success or not. Performance measures can help provide those answers, but the basis for the measures and indicators must be scientifically sound. Without scientific validation that the indicators represent the level of risk (or cause and effect) that is important to guide decision-making, performance measures are likely to be controversial and unlikely to influence any important decisions. Finally, in this light, the general lack of validation monitoring, which could address this issue, is disturbing. To reiterate a point from our previous comments to you, we believe that validation monitoring, which is admittedly expensive and difficult, must be bolstered to meet the objectives in the CMS. Status and trend information will not be able to answer the hard questions about what works and what does not.

Also missing from the adaptive management discussion is a strategy for how information from different impacts (habitat, barriers, hydropower, hatcheries, harvest, fish predators, etc.) will be analyzed, evaluated, and integrated across the impacts. Performance measures address individual impacts and objectives, and managers may modify their actions based on their performance. This does not give decision makers the ability to evaluate and make choices between impacts, which in total affect salmon populations, salmon habitat, and watershed health. Understanding the relative severity of different impacts will require carefully controlled management experiments. We also recommend that the strategy incorporate hierarchical, decision-analysis tools to help address these kinds of questions.

In conclusion, we believe the CMS, if it were implemented, would be a big step forward in a coordinated approach to integrate scientific information and accountability into salmon, land, and water management. A number of essential elements remain to be developed, however. We also expect that the monitoring strategy will evolve and adapt. It is difficult to design a monitoring effort without considerable adjustment and refinement from the initial planning stage to the successful, fully implemented process.

The Action Plan for the CMS provides a tool for refining the monitoring program. From our perspective, for monitoring to be fully useful, it is critical to complete development and begin implementation of all the monitoring elements for those issues and impacts that are most important. As a first step, we recommend that once the most important issues or impacts are identified, the actions proposed in the draft

Table 1. Completeness of monitoring elements in the Comprehensive Monitoring Plan, Vol. III, Version 6. Dark boxes indicate monitoring elements were on the average well described and available; grey boxes indicate monitoring elements were described generally but not well developed or available; light boxes indicate monitoring elements were poorly described or missing.

Monitoring Plan Element	Ocean/ climate ¹	Habitat Process			Fish Pass.	Habitat Connect.	Hydro-power	Stream/Water		Near-shore	Fish Populations			Harvest	Hatchery	Comp. & Predation
		Forest lands	Ag lands	Urban lands				Flow	Quality		Abundance	Distribution	Diversity			
Goals & objectives																
Statistical design																
Indicators & variables																
Performance measures ²	NA															
Standard Protocols																
Data quality assurance																
Accessible data																
Integration into decision-making																

¹ CMS relies on monitoring by the National Oceanic and Atmospheric Administration.

² Identified in SSB 5637 and by the Office of Financial Management Budget Instructions 2003-2005.

Table 2. Types of monitoring called for by the CMS objectives (identified by their numbers) for different categories of impacts associated with salmon and watershed health.

Impact Categories	Types of Monitoring			
	Implementation	Status & trends	Effectiveness	Validation
Habitat	4, 17b, 17d, 17f, 17i, 17k, 19b, 19e, 21d	17a, 17e, 17h-I, 18a, 19a, 20a	17c, 17f-g, 17j, 17l, 18b, 19c-d, 20b-c, 20e, 21b-c	17e, 17f, 20d
Hydropower	8b	8a	8c	
Water	13	9a-b, 10a-b, 11, 15	12, 16	14
Fish populations		1a-d, 2, 3,		
Harvest	7b	7a, 7e		7c, 7d
Hatcheries	6a			6b
Fish predators & competitors		5a-d,		5e

Table 3. Distribution of types of monitoring described in the CMS.

Monitoring Types	Habitat Process				Fish Pass.	Habitat Connect.	Hydro-power	Stream/Water		Near-shore	Fish Populations			Harvest	Hatchery	Comp. & Predation
	Ocean/ climate	Forest lands	Ag lands	Urban lands				Flow	Quality		Abundance	Distribution	Diversity			
Implementation					✓	✓	✓	✓	✓					✓	✓	
Status & trend	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Effectiveness		✓	✓	✓	✓		✓	✓	✓							
Validation		✓						✓						✓	✓	

Action Plan should be compared with Table 1 (or a similar analysis) to identify gaps and actions. We look forward to helping with the refinement of the strategy.

Additional Comments and Suggestions

We recommend that considerable editorial attention be given to the document to improve consistency and clarity of presentation. Although we did not review the document for these kinds of details, the list of suggestions and comments below are examples of changes that would improve consistency and clarity and reduce redundancy.

Part I – Introduction

- 1) Figure 1 (page 8) – lists different types of monitoring without discussion. Provide reference to section where reader can find definitions.
- 2) Additional background and context setting information is needed in the Introduction so that the reader does not have to refer to different documents. How does this effort differ from previous (ongoing) monitoring programs completed by the state? What does the document contain and how do specific sections address important elements of the CMS.

Part II – Key Monitoring Questions and Goals

- 1) Text should explain how goals were derived and key questions developed.
- 2) Page 14, ?2 – Objective 2A – suggest changing ...improving... to “expanding”.
- 3) Page 14, ?3 – Objective 3A – suggest changing ...improving... to “changing”
- 4) Page 15, ?5 – Integrate objectives 5D and 5E together; ...reservoirs and determine whether.....
- 5) Page 16, ?8, “Are” rather than “What” hydroelectric.....why and why not? What measures are needed to more fully protect salmon at hydroelectric projects?
- 6) Page 16, ?8 – Objective 8C – add – “protecting, providing and “ ...restoring fish passage.
- 7) Page 16, ?9-12, Suggest rolling these 4 questions into a single question that captures all four themes.
- 8) Page 16, ?13-16, Integrate into a single question. (Fundamental question here is: “Is the State’s instream flow setting program effective in protecting and restoring salmon populations?”)
- 9) Page 16, ?13 – Objective 13A - ...instream flow necessary to “restore” and sustain salmonids.
- 10) Page 17, ?17 – Some of the objectives are redundant (e.g. 17A and 17H, 17H and 17J, 17B and 17C?); shorten and combine.
- 11) Page 18, ?19 – Suggest alternate question – Where are there human-caused physical barriers for salmon, what measures are being implemented to correct them, and how effective are the measures? Also – omit/combine redundant objectives (19C and D).
- 12) Page 18, ?20 – Alternate question – Where are freshwater habitats fragmented, what measures are being implemented to re-connect them, and how effective are the measures?
- 13) Page 19, ?21 – Need to capture notion of biological benefits; i.e. projects are cost effective for what – simply to produce the greatest amount of habitat that potentially does no good, or to produce observable gains in fish numbers?
- 14) It is not clear what value the ranking the importance (H, M, L) of the questions has in this document. Did it influence the development of the different monitoring elements? In our opinion these rankings (H, M, L) have little bearing on what a comprehensive monitoring program would look like scientifically. We suggest that this be moved to the Action Plan.

Part III – Strategy Framework

- 1) Entire section is at best, loosely connected. Introductory paragraph needs to highlight major themes to be discussed under the framework heading. Discussion of Strategy Implementation is confusing – seems like it discusses SSRS implementation rather than CMS – move this to Introduction section or omit. Statistical discussion (pages 26-30) provides too much detail for this

section; needs an introduction as to why statistics are important (ability to detect a change when it occurs; how about Type I and II errors re: hypothesis testing), important considerations, and then reference section that contains more specifics, including most of material presented.

- 2) Problem Assessment – Revise first sentence, which speaks about “adaptive management”, so that it relates the CMS. Edit Comment – Tables and figure numbering needs to be crosschecked in text.
- 3) Maintain consistent terminology for different kinds monitoring. It is not clear why there is no connection shown on Figure 3 between implementation and other monitoring types.
- 4) Page 25 – Figure 4 – Use a more sophisticated figure. This one under-represents factors influencing life history stage connections. It seems to assign all factors from juveniles to spawners to hydrologic effects and marine effects. It is not effective in showing the linkages between life history stages and monitoring types, if that was the intent.
- 5) Page 28 – Need to check statistics discussion. The way I learned it, the square root of the variance is the standard deviation not the standard error and the coefficient of variation is the standard deviation divided by the mean not the standard error divided by the sample size. Also, the relative size of the CI range above and below the point estimate is 78.4%, not 39.2%. The statement would be correct if it was worded “The relative size of the CI (omit “range”) above or below the point estimate is 39.2%”.
- 6) Page 30 – Strategy Interpretation – Weak – this seems to be a “Catch-all” section that simply refers to other parts of the document. This should be moved into Introduction.

Part IV – Adaptive Management and Governance

- 1) Section is well organized, well written and the authors should be commended. It could be improved by a better explanation of how adaptive management includes to institutional structure: science and governance. Much of this section is focused on how to better coordinate the state’s overall monitoring programs so they become more closely integrated and hence make use of the data more efficiently. The analytical effort needs better description. Although the strategy has adopted a classical frequentist approach to hypothesis testing, we believe that Bayesian statistics could complement this approach might also
- 2) An obvious omission in Figure 5 that depicts 4 “adaptive management” steps is the step ending with Evaluate. An adaptive management approach would include as a 5th step – Modify (based on information). This needs more description.
- 3) The section could also better expand to emphasize that the best monitoring plans are useless unless they are carried out through all stages of data collection, QA/QC, analysis, and interpretation.

Part V – Accessibility of Monitoring Information

- 1) Important and generally well-organized section. A figure like Figure 12 and 13 are especially useful, but Figure 12 is not completely accurate. For example, CWT information and other catch or hatchery release information is stored in the PSMFC database. SASSI does not currently do that.
- 2) This section should also have at least a subsection that addresses Data Validation issues.
- 3) Page 70 – Add definition of “best available science” in the glossary.
- 4) Page 74, par. 3 – Use “stakeholder” review rather “peer” review, if you are including the affected parties and general public. Peer review is a specific scientific process that should not be confused with the process described here.
- 5) Page 79 – Edit the first bullet so that it is understandable.

Part VI – Obtaining Accountability for Effectiveness of State and Federal Investments (note – header is mislabeled as Part V).

- 1) This section appears to be focused entirely specific monitoring elements centered on the Watershed Management Act and habitat projects. Although there is substantial information

presented, its connection to the other areas of the CMS is not clear. This section could almost be presented as a stand-alone document that is referred to in the CMS. If not, then it might be better as an appendix, with salient parts integrated into the main body of the report. For example, items presented on page 83 – Collaboration, Exchange of Information, Data Quality etc. are all things that have broad value to the CMS overall.

- 2) Page 87 – Salmon Funding Entities. Why does this section come after the references section for Part VI? This section appears to be the first that refers back to the series of questions in Part II, and then it does so with reference to question 21. The reader is going to think – what happened to questions 1-20? The reader needs to be able to understand how the questions are being addressed (e.g., in order, by the Hs, etc.).
- 3) Page 89 – Use consistent terms for different kinds of monitoring. Readers here will most certainly be confused by the listing and definition of three types of monitoring (implementation, effectiveness, and validation) here, the latter two which were given separate status as environmental monitoring types on Page 23, and the first separately defined on Page 25. Intensive monitoring is shown but not explained until Part VIII. Cross-referencing between and among sections is crucial to developing a useable document.
- 4) Pages 91-106 – This section needs better explanation about why it is in the document, because the linkage to CMS is not immediately obvious. QA/QC measures noted on page 93 are not QA/QC measures; nor are those on page 97.

Part VII – Recommendations for Monitoring Habitat, Water and Fish

- 1) This section would benefit from an introductory paragraph that summarizes what is to follow; questions and order of presentation, etc.
- A) Freshwater Habitat/Landscape Forming Processes
- 1) The organization of this section is confusing (why address Question 17 before Questions 1-3?). Especially confusing is the section on habitat effectiveness monitoring (riparian, wind buffer, instream riparian) and validation monitoring; also “intensive monitoring” (page 128).
- B) Fish Passage Barriers
- 1) Need consistency in headings within this section (and all others as well).
- C) Habitat Connectivity
- 1) Page 148 – edit – Check indicator numbering (should be 20 not 21).
 - 2) The section seemed incomplete and fragmented and could use more development.
- D) Hydropower
- 1) Section needs more up-front discussion about how hydropower projects can and have influenced fish populations; how FERC licenses currently impose monitoring; some limitations exist regarding what the state can do with hydro once a license is issued, etc.
 - 2) Page 142 – There appears to be a lack of connection between the objectives for this section and the scorecard approach for monitoring. We recommend you distinguish between what is actually being monitored and measured (e.g., fish survival, water temperature, etc.) and how you summarize or report success.
 - 3) Page 158 – FERC licenses are not necessary for 50 years as stated in the text. Most recent licensing activities are in the range of 30-40 years to provide more flexibility to resource agencies.
 - 4) Pages 166-170 – The CMS needs a consistent way of using and formatting references.
- E) Monitoring Steam Flow
- 1) This section needs an introduction to provide a context and need for evaluating instream flows, and also to note the inherent difficulties in defining valid fish-flow-habitat relationships.
 - 2) Too much detail is provided (beginning on page 174) in describing procedures from stage measurement, taking measurements from boats, bridges, etc. This type of information can be relegated or referred to in an appendix or simply by reference to appropriate documents.

3) The section needs a better description of the suite of potential metrics. Most troubling is the apparent reliance on a single monitoring indicator – WUA for measuring flows necessary to support all salmon life stages (Objective – 13a). WUA is but one metric that has been used to derive habitat: flow relationships, with the linkages to fish still being largely unproven or tested. Mention of toe-width method suggests other metrics also useful.

4) Page 172 – The discussion of IFIM is confusing, mis-stated, and needs careful review and revision. The IFIM is a process that invokes careful attention to all habitat elements that are influenced by stream flow – water temperature, habitat, sediment, etc. Within the IFIM framework resides a series of available computer models, of which the habitat based ones are termed Physical Habitat Simulation (PHABSIM) models and include hydraulic and habitat models. There are also water temperature models – e.g. SNTMP and others.

F) Salmon Abundance, Productivity and Distribution and Diversity

1) Detailed description of statistical analyses used for adult spawner monitoring is inconsistent with other sections. Other sections should provide similar information or alternatively this could be moved to an appendix.

2) This is (as it should be) one of the more detailed and complete sections of all. It should set the standard and format for all sections and therefore should be moved up-front in the presentation.

G) Hatcheries

1) To our knowledge, no best management practices have been established for hatcheries statewide. These need to be identified and the relationship to objective 6b (testing BMPs) described.

Part VIII – Intensively Monitored Watersheds

1) This section contains a good conceptual beginning for how and where validation monitoring might occur, but it needs more detail on the scope of the monitoring and how different parts will interact. For example, is this directed primarily at habitat projects or does it include other areas and impacts that questions that can only be answered by validation monitoring? Clarify if it does not include these, how will validation monitoring for other aspects of the CMS be addressed?