TFW-AM9-96-007

Proposal for a TFW Monitoring Strategy to Determine the Effectiveness of Forest Practices in Protecting Aquatic Resources

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for the
TFW Monitoring Steering Committee
November 12, 1996

EXECUTIVE SUMMARY

The purpose of this "white paper" is to present a monitoring strategy designed to answer questions regarding the effectiveness of forest practices in protecting aquatic resources on state and private land in Washington State. The strategy was developed by the TFW Monitoring Steering Committee in response to a request from the TFW Policy Committee water quality subcommittee.

The white paper identifies effectiveness monitoring goals, objectives and issues; presents a framework for a monitoring strategy; discusses options for implementation and concludes with a proposal for a pilot project. A review of effectiveness monitoring programs in other states and descriptions of monitoring approaches for eight monitoring objectives are included as appendices.

Effectiveness monitoring programs in seven states and one Canadian province were examined to identify suitable models for Washington. Some were inappropriate because they relied on subjective evaluations or did not address salmonid habitat issues important in Washington. Programs in Oregon, California and Alaska were most relevant but were not entirely suitable because they are not tailored to two unique features of Washington's forest management system, our Watershed Analysis process and our TFW cooperative management system. Our strategy is designed to utilize these assets while drawing on applicable elements of the other programs.

The focus of our effectiveness monitoring strategy is eight key monitoring objectives based on important questions monitoring should answer. These objectives address the effectiveness of:

1. riparian measures to maintain or restore stream temperature;
2. riparian measures to maintain or restore large woody debris;
3. measures to reduce or eliminate management-induced mass wasting;
4. measures to reduce management-induced surface erosion;
5. measures to reduce management-induced changes in hydrology;
6. measures to maintain or restore fish passage;
7. measures to prevent adverse impacts from forest chemicals; and
8. forest practices when applied on a watershed-scale in avoiding harmful cumulative effects to salmonid habitat and water quality.

To evaluate effectiveness we must determine if practices were done properly (implementation monitoring), whether they had the desired effect on input processes, stream channels and habitat (effectiveness monitoring), and whether the desired conditions actually provide for protection of aquatic resources (validation monitoring). To accomplish this, we recommend a monitoring strategy with an implementation element, an input process element, a resource trend element, a validation element and a supporting research element. Primary emphasis is placed on monitoring input processes and triggering mechanisms because they are directly affected by forest practices and can be monitored for a reasonable cost. Secondary emphasis is placed on more expensive monitoring of trends in aquatic resource conditions because resource protection and recovery is the fundamental management objective. We envision applied research where scientific investigation is needed to interpret monitoring results or determine why effectiveness varies.

We propose to evaluate effectiveness by determining whether forest practices measures are

successful in maintaining or restoring desired resource conditions (water quality standards or Watershed Analysis resource conditions indices) or avoiding adverse changes in input processes. An alternative approach (utilized in Alaska) of comparing stream reaches affected by management practices with unmanaged reaches or basins appears unfeasible in Washington due to the scarcity of comparable undisturbed sites in many regions of the state where forest management occurs.

Several scenarios for implementation of the monitoring strategy were examined. We recommend a multi-objective, watershed-based strategy implemented through TFW by the CMER Monitoring Steering Committee. The watershed-based approach is most compatible with Watershed Analysis (WA). We recommend a strong linkage with WA because many resource assessment products provide a "current condition baseline" for input process and resource conditions that can be repeated to determine changes over time. This approach will reduce monitoring start-up costs and provide information needed for the WA five year review process. We propose initial monitoring of a "core" sub-group of watersheds where WA has been done, selected from regions across the state. Implementation can be expanded in stages by adding other issues or watersheds needed to evaluate management programs such as standard rules, Total Daily Maximum Load agreements (TMDLs) or Habitat Conservation Plans (HCPs).

Many TFW participants would have roles in implementation of this strategy. Project design and data analysis, storage and interpretation would be the responsibility of the TFW Ambient Monitoring program, under direction of the Monitoring Steering Committee (MSC). TFW participants could participate in collecting monitoring information, reviewing results and developing adaptive management alternatives. The MSC would be responsible for finalizing effectiveness evaluations and convening adaptive management advisory committees, consisting of TFW participants, as needed. CMER would review and approve information and recommendations provided by MSC and forward them to the TFW Policy Committee for consideration and appropriate action.

The entire set of monitoring objectives and issues we identified are too numerous to handle simultaneously and must be prioritized. We recommend tackling riparian measures, sediment, fish passage and resource conditions initially because:

1. these issues are relevant to future TFW policy discussions,
2. they will be important issues in Watershed Analysis five year reviews,
3. baseline information is available from Watershed Analyses, and
4. monitoring approaches and methods are available.

We recommend beginning implementation with a two-year pilot project conducted by the TFW Monitoring Steering Committee to address priority effectiveness issues. The pilot would focus on evaluating the effectiveness of Watershed Analysis prescriptions in watersheds approaching the five year review and comparing the effectiveness of standard rules applied under similar conditions. Forested watersheds from both the east side and west side would be selected to provide a regional perspective on effectiveness. WAUs representative of other management programs such as TMDLs or HCPs could be added at a future date, with priority placed on those approaching the Watershed Analysis five year review.

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ACKNOWLEDGMENTS

We would like to thank the Washington Forest Protection Association and the Washington Department of Natural Resources for providing support for this project. We would also like to thank the numerous TFW participants who attended the workshops and provided comments on draft versions of the document. Your suggestions and comments helped immensely.

INTRODUCTION

In May, 1996 the Timber Fish and Wildlife Policy Committee's water quality subcommittee sent a memo to the TFW Cooperative Monitoring, Evaluation and Research Committee (CMER) requesting a strategy to answer the following question:

> *"What is the effectiveness of cooperative and regulatory measures for protection and recovery of the public resources of water and fish (aquatic resources) affected by forest practices (pursuant to the forest practices, water pollution and hydraulic acts)?*"

CMER assigned this task to the Monitoring Steering Committee. This document contains our response to the TFW Policy Committee. The purpose of this document is to:

- examine past efforts to evaluate forest practices effectiveness in Washington and other states
- establish goals and objectives for a TFW effectiveness monitoring program
- design a framework for the monitoring strategy and identify components it should contain
- define the scope of the monitoring strategy
- define effectiveness and establish criteria for evaluating it
- identify specific effectiveness monitoring questions and issues and identify the information needed to answer these questions
- develop specific monitoring approaches for each question, and
- discuss options for implementing the TFW effectiveness monitoring strategy

Background on Effectiveness Monitoring and Adaptive Management

Adaptive management is a fundamental principle underlying the TFW forest management system. When the TFW management system was developed, the participants realized that their ability to make management decisions was limited by lack of adequate scientific information. Development of programs and practices to protect aquatic resources was guided by available information, and the management structure was designed to be flexible and respond to new scientific information as it became available. Effectiveness monitoring is an essential component of successful adaptive management. Adaptive management consists of a cycle involving four stages: 1) planning; 2) implementation, 3) monitoring, and 4) evaluation. The results of the evaluation are then used to make improvements, and the cycle begins again. In practice, emphasis typically is placed on planning and implementation, while monitoring and evaluation of results are neglected. This proposal presents recommendations and options for development of a monitoring and evaluation component to support TFW adaptive management.

History of Effectiveness Monitoring and Evaluation in Washington

Past effectiveness monitoring and evaluation efforts in Washington State have focused on the effectiveness of the best management practices (BMPs) that are incorporated into the forest practices rules to protect water quality. Prior to TFW, forest practices effectiveness monitoring was primarily conducted by the Washington Department of Ecology with EPA Clean Water Act funding. Examples of the projects conducted included studies of: 1) the adequacy of

Washington's forest practices rules and regulations in protecting water quality (Sachet et al., 1980), 2) stream side management zones (Hobbs and Halbach, 1981), 3) slash removal (Task LSD Subcommittee, 1979) and 4) road construction and operation (Wooldridge, 1979a; 1979b). Since TFW was implemented in 1988, a series of effectiveness studies have been sponsored by the TFW Cooperative Monitoring, Evaluation and Research Committee's water quality steering committee. These projects have been conducted by the Department of Ecology. Topics that have been examined include BMPs for aerial application of pesticides (Rashin and Graber, 1993); effectiveness of riparian management zones in protecting stream temperature (Rashin and Graber, 1992), and effectiveness of BMPs to control surface erosion (Rashin et al., 1994).

Effectiveness Monitoring in Other States

We also reviewed effectiveness monitoring programs in other states to determine the applicability of their strategies and methods to effectiveness monitoring in Washington State. Programs from South Carolina, Florida, Idaho, Montana, Alaska, British Columbia, Oregon and California were reviewed. A summary of this information can be found in Table 1. Detailed descriptions of these programs are located in Appendix A.

South Carolina, Florida, Idaho, Montana and British Columbia lack a process-based evaluation procedure that encompasses causal linkages between forest practices, triggering mechanisms, watershed input processes and effects on salmonid habitat. Consequently, they are not suitable templates for evaluating the effectiveness of relatively sophisticated management programs, such as Watershed Analysis being implemented in Washington State.

Programs in Oregon, California and Alaska (Sealaska Co.) examine the effects of forest practices on watershed processes and salmonid habitat. Each contains technical components that may be useful for effectiveness monitoring in Washington. None provide an entirely suitable model for effectiveness monitoring in Washington because they do not incorporate two assets unique to Washington: our Watershed Analysis procedure and our cooperative TFW management structure.

Summary of Background Information

In summary, past monitoring efforts in Washington State have not yet answered many questions about forest practices effectiveness for several reasons. Limited availability of funding has restricted the number and scope of past effectiveness studies. The past emphasis of the TFW Ambient Monitoring program has been on development of methods and support of cooperator efforts to assess the status of resource conditions rather than on evaluating effectiveness. CMER has not systematically identified effectiveness questions and developed an organized strategy to pursue them. While past TFW efforts provide a foundation to build on, a coordinated strategy that focuses efforts on unanswered questions is needed to guide future action. Other states provide useful examples of effectiveness monitoring programs, however a custom monitoring strategy is needed to take advantage of the unique aspects of Washington's forest practice management system.

Table 1. Summary of effectiveness monitoring programs in other states and provinces.

State/ Pro-vince	Purpose	Monitoring objectives and issues	Approach	Effectiveness determination	Single vs multi-objective	Watershed vs site-by site	Who does it?	Adaptive Management	Advantages (A) / Disadvantages (D)
MT, ID	Determine effect of forest practices on water quality.	Sediment input from forest roads, RMZs, and harvest units. Riparian shade, LWD, and toxic chemicals.	Subjective questionnaire completed by team of professionals in field.	Mt-compliance equals effectiveness Id- various stakeholders review data and reach consensus on effectiveness.	Single	Site by site	State agency	Mt- no formal process. ID- Dept. of Envr. Quality submits recom-mendations to Forestry Board	MT and ID: A- quick, low cost. D- subjective, narrow scope.
FL, SC	Determine effect of forest practices on water quality.	BMP compliance for roads, stream crossings, log decks, SMZs, & harvesting. Other objectives: sediment input, slash input; riparian canopy cover, vegetative cover and bank stability.	Compliance question-naire done by team of professionals in field. Quantitative data for bioassessment and habitat. Florida compares managed vs. reference conditions.	Compliance = effectiveness for both states. Fl- gets bioassessment data and determines effectiveness later. S.C.- 75-77% of reference condition.	Multiple objective assessment of cumulative effects.	Site by site	State agency	No formal process.	Florida: A- establishes baseline conditions, long term trends, produces biennial conclusions. Statewide. D- subjective, narrow scope, unclear linkage to forest practices and rules. SC: A- cheap, quick, statewide. D- subjective, narrow scope, unclear linkage to forest practices and rules.
OR	Determine effects of forest pract-ices on water & air quality, forest prod. &wildlife.	Riparian LWD, shade, snags. Sediment (surface erosion and mass wasting). Stream temperature.	Quantitative monitoring data collection for resource condition & input processes.	Data compared with objectives in rules, state water quality standards or with scientific literature	Multiple objectives with separate monitoring projects.	Flexible, site by site with storm impacts by watershed.	State agency	Yes: Results forwarded to State Board of Forestry.	A- LWD modeling, desired future condition written into forest practice rules, multi-objective, long term, design flexibility, adaptive management mechanism. D- stakeholders not involved,
CA	Determine effect of forest practices on water quality and fish habitat.	Surface erosion from roads, stream crossings, and skid trails. Mass wasting. Riparian shade/stream temperature, LWD and nutrients.	Quantitative data for resource conditions. Semi-quantitative survey by team for hillslope processes, compliance, & overall effectiveness.	In stream: still resolving this question. Hillslope: professional judgement of field observation.	Multiple objectives that vary by watershed based on resource risk assessment.	Watershed	State agency	They have a feedback mechanism, but no formal process.	A- Multi-objective, sophisticated, objective data includes input process and resource condition monitoring. D- Expensive, requires high level of training and quality assurance/control.
AK	Determine effect of forest practices	Riparian LWD, density, loading, recruitment, and blowdown. Sedimentation: bank erosion, pool area and	Quantitative data comparing changes in resource conditions following logging with unmanaged systems.	Significance of detected change in logged basins vs. pre-harvest and unlogged basins.	Multiple objectives, but each objective implemented	Watershed	Private Co.	No formal process.	A- Multi-objective design, objective data, long term study of unmanaged baseline conditions and trends. Covers whole SE region. D- expensive, data highly variable and

State/ Pro-vince	Purpose	Monitoring objectives and issues	Approach	Effectiveness determination	Single vs multi-objective	Watershed vs site-by site	Who does it?	Adaptive Management	Advantages (A) / Disadvantages (D)
	on water quality and fish habitat.	spacing, bed substrate.			separately.				difficult to interpret, no adaptive mgt.
B. C.	Effect of forest practices on critical resources	Resource problems determined by district, region, and HQ managers.	Approach varies depending on the problem being pursued.	Information will be evaluated by agency committee.	Single objective, determined regionally	Site by site Admin. Unit	Provincial govern-ment.	Specialists recommend changes to government.	A- Addresses specific problems identified by field personnel. D- lack of coordination and efficiency.

PROPOSED TFW EFFECTIVENESS MONITORING STRATEGY

In developing our proposed TFW effectiveness monitoring strategy, we have been guided by a philosophy that the monitoring program should be a practical management tool designed to: 1) provide answers to specific questions about the effectiveness of forest practices in protecting aquatic resources, 2) document trends in the conditions of aquatic resources in managed forest watersheds, and 3) produce information that identifies why practices are or are not effective so that suggestions for improving effectiveness can be provided for use in adaptive management.

In this section, we focus on identifying the questions that effectiveness monitoring needs to answer and the information that is needed to answer them. We identify goals and objectives for the program, lay out a framework for the monitoring strategy and necessary components, and discuss how to define and evaluate effectiveness.

Effectiveness Monitoring Goal and Objectives

The goals and objectives are directed at providing information needed to evaluate the effectiveness of forest practices in protecting or restoring aquatic resources. To provide direction for the monitoring strategy, we began by establishing a goal based on the question posed by the TFW Policy Committee. The proposed goal for the TFW effectiveness monitoring strategy is:

> *To determine the effectiveness of cooperative and regulatory measures for protection and recovery of aquatic resources affected by forest practices conducted on state and private lands in Washington State.*

To accomplish this goal we identified a series of objectives built around eight functional questions that monitoring should answer about the effects of forest practices on aquatic resources. Following the process-based approach used in Watershed Analysis, each objective is based on a causal linkage between forest practices and associated changes in watershed input processes and aquatic resources. For each objective, a series of site-specific monitoring issues, watershed scale monitoring issues and research questions are identified. The specific issues break each monitoring objective into smaller, manageable pieces and provide a focus for developing testable hypotheses and designing efficient sampling programs to provide the information needed.

Table 2 presents the eight monitoring objectives and the specific monitoring and research issues identified for each. Due to the large number of potential monitoring issues identified, it will be necessary to prioritize issues to develop a monitoring strategy that is feasible to implement.

Detailed descriptions of the proposed monitoring approach and effectiveness evaluation for each objective are presented in Appendix B. The monitoring approaches are designed to determine:

- which regulatory programs and voluntary measures produce the desired effect;
- how the effectiveness of various measures and programs compares, and why they vary;
- how regional and local factors such as climate, geology, hydrology, elevation and vegetation influence effectiveness;

- how effectiveness varies over time.

Table 2. Eight key effectiveness monitoring objectives and associated monitoring and research issues.

Objectives	Monitoring Issues	Research Issues
Objective 1. To determine if forest practices are effective in maintaining (or restoring) desirable stream temperatures.	1. Are various riparian management measures effective in meeting shade targets? 2. Are riparian management measures effective in meeting water quality standards for stream temperature? 3. How do factors such as water type, channel width, elevation and aspect influence effectiveness? 4. How does the effectiveness of RMZs change over time? 5. How is the capability of riparian stands to provide shade and maintain suitable stream temperatures changing over time on a watershed scale?	1. What effect does riparian harvest adjacent to Type 4 and 5 waters have on on-site and downstream water temperatures? 2. What is the effect of canopy removal on winter stream temperature? 3. Is shade the only major RMZ influence on stream temperature? 4. Are water quality standards set at appropriate levels to protect aquatic resources? 5. What is the best way to measure shade? 6. Is shade provided by brush and deciduous trees comparable in function to shade provided by conifers? 7. How do channel morphology and other site-specific factors influence the effectiveness of shade? 8. How does debris flow disturbance influence stream temperature regimes? 9. What is the effect of coarse sediment buildup on stream temperatures?
Objective 2. To determine if riparian management measures are effective in maintaining (or restoring) large woody debris recruitment over time.	1. Are RMZ measures along fish-bearing waters effective in providing large woody debris recruitment to channels of various widths? 2. How effective are riparian stand conversion practices? 3. How effective are road location and construction practices at avoiding impacts to riparian LWD recruitment? 4. How does riparian harvest on Type 4 and 5 waters affect LWD recruitment and loading? 5. How is the capability of riparian stands to recruit LWD changing over time on a watershed scale?	1. Does artificially placed LWD function effectively in channels? 2. How do LWD recruitment rates from RMZs compare with LWD export and decay rates in stream channels? 3. How much LWD recruitment is needed in Type 4 and 5 waters? 4. What are the effects of riparian timber harvest along Type 4 and 5 waters on indigenous organisms? 5. Are WA resource condition indices for LWD adequate to protect aquatic resources? 6. What proportion of LWD originates from mass wasting under natural conditions? 7. How can future LWD recruitment and LWD loading be modeled and predicted? 8. Do minimum width RMZs on Type 3 waters < 5 feet provide adequate LWD? 9. What are LWD recruitment rates in east side forests?
Objective 3. To determine if forest practices are effective in reducing or eliminating management-induced mass wasting and debris flows.	1. Are timber harvest measures effective at preventing management-induced mass wasting? 2. Are road construction practices effective at preventing management-induced mass wasting? 3. Are road maintenance procedures effective at preventing management-induced mass wasting on existing roads? 4. Are selective harvest techniques effective at preventing deep-seated landslides? 5. Are methods used to identify areas of mass wasting hazard effective? 6. What is the recovery time for stream channels and habitat affected by mass wasting? 7. Is the rate of management-induced mass wasting decreasing over time on a watershed scale? 8. How widespread is habitat disturbance from mass wasting on a watershed scale?	1. How is the movement of deep seated landslides affected by forest management practices such as road construction and timber harvest?

Objectives	Monitoring Issues	Research Issues
Objective 4. To determine if forest practices are effective in reducing management-induced surface erosion.	1. Are road design and construction practices effective at preventing surface erosion on new roads and landings? 2. Are culvert spacing requirements effective in preventing erosion of road surfaces and ditch lines? If surface erosion does occur, is it delivered to stream channels? 3. Does road maintenance prevent surface erosion on existing roads? 4. Are timber harvest practices effective at preventing surface erosion? 5. Is surface erosion decreasing over time on a watershed scale?	1. How can the background rate of sediment production in forested landscapes be better determined? 2. Is there a correlation between the density of roads in a watershed and the amount of surface erosion and resource effects? 3. How can the effect of various levels of surface erosion on aquatic resources be determined? 4. What is the relationship between basin-wide background sediment yield and the effects of surface erosion generated sediment on water quality and aquatic organisms?
Objective 5. To determine if forest practices measures are effective in reducing management-induced changes in hydrologic response.	1. How effective are road construction and drainage disposal practices in preventing excessive interception, diversion, and concentration of road drainage to individual hazard areas? 2. To what extent are forest practices effective in preventing cumulative impacts from excessive interception, diversion, and concentration of road drainage to hazard areas? 3. How effective are road construction practices in providing for adequate maintenance of wetland hydrologic function? 4. How effective are Rain-on-snow regulations and prescriptions in preventing damage to resources from increases in peak flows?	1. How does snow water accumulation vary by canopy density and physiography in each of the forest cover types commonly found in Washington? 2. How does the timing and rate of snow melt vary by canopy density and physiography in each of the forest cover types commonly found in Washington? 3. Under what conditions do changes in snow accumulation and melt result in adverse material impacts to aquatic resources? 4. Under what conditions do road drainage networks produce changes in runoff or stream discharge of sufficient magnitude to cause adverse material impacts to aquatic resources?
Objective 6. To determine if forest practices are effective maintaining or restoring fish passage.	1. How effective are culvert installation practices in allowing for adult and juvenile migration of anadromous and resident salmonids? 2. What is the effect of forest practice related fish passage blockages on the distribution of salmonids on a watershed scale?	1. What is the best method of identifying passage blockage for each salmonid species? 2. What factors cause culverts to become barriers over time and how can they be avoided? 3. What are the best techniques to provide fish passage at road crossings in high gradient streams?
Objective 7. To determine if forest practice measures are effective in preventing adverse impacts to water quality and aquatic organisms from the use of forest chemicals.	1. How effective are aerial application measures to prevent entry of forest chemicals into stream channels, lakes and wetlands? 2. How effective are aerial application operators at identifying and avoiding Type 4 and 5 waters without surface water? 3. How effective are ground application techniques at preventing chemical input into stream and wetlands? 4. What percentage of the stream network is affected by chemicals in a given year?	1. Do large-scale applications of forest fertilizer cause downstream effects such as eutrophication? Under what conditions? 2. What are appropriate measures of effects of forest chemicals on aquatic organisms? 3. How significant are post-application rainfall events as a source of chemical input to stream systems? 4. Does application of persistent chemicals lead to accumulation in surface or groundwater? 5. Do forest herbicide applications change the composition of RMZs and WMZs? 6. What are the effects of silvicultural use of highly toxic pesticides on aquatic systems?
Objective 8. To determine if forest management programs are effective in maintaining (or restoring) salmonid habitat and water quality when cumulative effects are considered.	1. Are aquatic resources (salmonid habitat, water quality, aquatic organisms) receiving adequate protection from cumulative effects of forest practices? 2. How are aquatic resource conditions responding to forest management programs over time ?	1. How should trends in aquatic resources other than salmonids he addressed? 2. Can the effectiveness of measures applied during conversion of forest lands to other uses be monitored by examining resource trends over time? 3. Are stream channel and habitat restoration activities effective in increasing productive aquatic habitat? 4. What are appropriate methods of assessing resources trends and cumulative effects on a watershed scale? 5. Can trends in resource abundance be used to measure effectiveness?

Approach to TFW Effectiveness Monitoring

This section provides information on the overall approach to accomplishing the effectiveness monitoring goals and objectives presented in the previous section, including the framework and scope of the monitoring strategy and an approach to evaluating effectiveness.

Conceptual Framework and Elements of the TFW Effectiveness Monitoring Program

Some forest practices affect aquatic resources directly. An example of a direct effect is an improperly installed culvert that blocks salmon migration. Monitoring of direct effects is usually straightforward because there is a direct causal linkage between practice and effect, and the effect usually takes place on-site. However, forest practices more frequently impact aquatic resources indirectly by altering physical processes that maintain fish habitat and water quality. Examples of physical inputs that can be altered by forest practices include sediment (mass wasting and surface erosion), large woody debris recruitment, hydrology, and solar energy. For example, failure of a saturated road fill can trigger a landslide that delivers sediment to a stream channel, altering downstream spawning and rearing habitat. In this case, the effect travels along a causal linkage between the practice (logging road), the input process (landslide), the stream channel and the fish habitat (Figure 1). Impacts on aquatic resources may be separated in time and space from the practices that initiated them and may be integrated with effects of other activities and natural events, making monitoring and interpretation of resource effects problematic.

In these situations, it is possible to monitor for changes in either the input processes or resource conditions (Table 3). Monitoring of input processes is advantageous because: 1) the linkage between practice and input process is usually direct and occurs on-site; 2) feedback on effectiveness can be obtained without waiting for resource damage to occur; and 3) monitoring of input processes is relatively inexpensive. However, input process monitoring requires assumptions about the effect of altering the input processes on aquatic resources and doesn't provide information on resource condition trends. Monitoring of resource conditions is advantageous because it provides direct reading on the resources of concern to resource managers and the public. However, it is often more expensive than input process monitoring. Because the linkage to specific practices is also less direct, it is often difficult to separate the effects of specific practices from the effects of other activities and natural variation.

In order to answer effectiveness monitoring questions thoroughly and efficiently, we recommend a monitoring strategy that combines monitoring of input processes and resource conditions along with a supporting research component. We propose an approach with the following elements:

- Implementation element. This element is needed to determine where and when activities are occurring and whether they are conducted according to the specified requirements or prescriptions, etc. Some of this information is already collected by DNR.
- Input process element. Monitoring of input processes and triggering mechanisms provides information on the effects of forest practices on LWD recruitment, shade, sediment, and hydrology. Input process monitoring is the core component of our strategy

because it provides extensive information rather quickly and inexpensively. This permits evaluation of practices on a statewide scale to identify any major effectiveness problems and allows comparison of various measures and programs over a range of local and regional conditions.

- Resource trend element. The resource trend element involves the establishment of a network of sites to monitor trends in habitat and water quality. Resource trend monitoring will provide information on changes in the condition of critical aquatic resources in response to disturbance and recovery, and will help evaluate the cumulative effects of multiple forest practices.
- Validation element. This element will be used to validate relationships between the altered input processes and resource conditions, verifying predicted changes in resource conditions due to changes in input processes.
- Supporting research element. This element provides focused research in situations where better knowledge of the factors affecting the causal linkage is needed. This will improve our ability to design and interpret input process monitoring results in terms of resource effects, increase confidence in our ability to understand and evaluate causal linkages, and help determine why measures are effective in some situations and not others.

This balanced approach has a number of advantages. It uses resources effectively by placing emphasis on input process monitoring, which can be applied over large areas relatively inexpensively, allowing comparison of measures and programs across regional boundaries. Input process monitoring will be anchored by a network of more intensive in-stream monitoring sites used to validate the assumptions of input process monitoring and detect cumulative effects by documenting changes in resource conditions. The research component would be focused on investigating "key situations" where understanding of causal mechanisms is inadequate to interpret monitoring results or determine why effectiveness varies.

The monitoring strategy will not be complete without adaptive management feedback mechanisms to translate findings into refinements in practices that improve effectiveness. A number of potential mechanisms exist for various programs and measures, such as the Watershed Analysis five year reviews, plan-specific evaluation procedures for Habitat Conservation Plans (HCPs) and Total Maximum Daily Load Agreements (TMDLs), and the Forest Practices Board (FPB) process for revising the standard rules and FPB manual. Determining the linkages between a TFW effectiveness monitoring strategy and adaptive management processes is an important issue with both technical and policy aspects that will require participation by the TFW Policy Committee.

Scope of the TFW Effectiveness Monitoring Strategy

To define the scope of the TFW effectiveness monitoring strategy, we carefully examined the Policy Committee's question for guidance and defined the terms "forest practices", "cooperative and regulatory measures", and "water and fish (aquatic resources)".

Forest practices are defined in the Washington Forest Practice Act and Forest Practices Rules as:

> "Any activity conducted on or directly pertaining to forest land and related to growing, harvesting, or processing timber, including but not limited to: road and trail construction; harvesting, final and intermediate; precommercial thinning; reforestation; fertilization; prevention and suppression of diseases and insects; salvage of trees; and brush control."

The following cooperative and regulatory measures were taken from the Forest Practices Act and

rules and should be evaluated as they apply to the protection of aquatic resources:

- Standard forest practices rules
- Watershed Analysis prescriptions
- Voluntary protection measures (such as Resource Management Plans)
- Alternate plans
- Road maintenance and abandonment plans
- "Orphaned roads" hazard reduction plans (only 1 exists)

The following programs or measures are also included because they can affect how forest practices are conducted in some circumstances:

- Clean Water Act TMDLs agreements related to forest practices and aquatic resources
- Hydraulic Project Approvals (HPAs) related to forest practices
- Shorelines Management Act provisions related to forest practices and aquatic resources
- Habitat Conservation Plans (HCPs) related to forest practices and aquatic resources
- Voluntary aquatic habitat restoration measures on forest lands

Although the stated intent of the Forest Practices Act is to protect fisheries, water quality and water quantity, these terms are not specifically defined in the Act or the forest practice rules. The rules contain a definition for "resource characteristics", measurable characteristics of fish, water and capital improvements, that is used in Watershed Analysis. Resource characteristics include physical fish habitat (including temperature and turbidity); turbidity in hatchery water supplies; and turbidity and volume for areas of water supply. The rules also address water quality, stating that "promulgation of all forest practices regulations shall be accomplished so that compliance with such forest practices regulations will achieve compliance with the water quality laws". Forest practices rules pertaining to water quality protection are co-adopted by the Washington Department of Ecology.

Based on this information, we defined water and fish as:

- physical fish habitat for anadromous fish and resident game fish
- turbidity affecting hatchery and public water supplies
- water volume (for areas of physical fish habitat and water supplies)
- state water quality parameters relating to the physical, biological and chemical integrity of water bodies

<u>Defining and Evaluating Effectiveness</u>

Determining what constitutes "effectiveness" and how it can be measured is a critical step in developing an effectiveness monitoring strategy. It is often unclear what level of protection is intended to be afforded by forest practices rules or management programs. Without an agreed upon definition of effectiveness and criteria to measure it, questions about effectiveness can not be answered. Webster defines effective as "producing a decided, decisive, or desired effect". Based on Webster's definition, and the information above, a working definition of effectiveness is:

"Forest practice measures are effective if they achieve desired fish habitat, water quality and water quantity conditions."
When current conditions are already in the desirable range, effectiveness is accomplished by applying forest practices in a manner that prevents significant impacts to fish habitat, water quality

and water quantity, or changes in the watershed input processes that affect these conditions. When current conditions are below target, this is accomplished by preventing significant impacts and allowing, or stimulating, natural recovery processes.

Evaluation of the effectiveness of forest practices has several aspects:

- Are potential effects of specific forest practices addressed by regulatory/voluntary measures?
- Were the measures implemented properly? (implementation monitoring)
- Do the measures achieve the desired effect on input processes, stream channels and habitat over time? (effectiveness monitoring and baseline/trend monitoring)
- Are the desired conditions adequate to provide resource protection and recovery (validation monitoring).

There are several possible approaches to measuring effectiveness.

- Where natural systems exist in conjunction with managed areas, it may be possible to measure changes in resource conditions in managed systems and compare them with changes in natural systems to determine the effects of forest practices. This approach requires the existence of natural systems with similar climate, physiography and channel characteristics to those of the managed systems. Since natural systems are increasingly rare in Washington State, particularly in areas of intensive forest management, this approach does not appear to be feasible in many areas of state and private forest land in Washington State.
- Another approach to evaluating effectiveness is to compare conditions following forest practices with established target (desired) conditions. This approach is used in Watershed Analysis and the state water quality standards. This approach is advantageous in situations where natural systems are not available for comparison. However it can provide misleading results if the target conditions: 1) are too general and do not reflect local variation in conditions due to factors such as geology, hydrology or climate, or 2) do not adequately characterize the complex interactions within natural systems that create productive habitats.
- Finally, it may be possible to evaluate effectiveness by measuring changes over time following forest practices. This approach is particularly useful when resource conditions are below target at the time the practice occurs. In these situations, the practices is effective if it allows, or encourages, improvement over time.

We believe the last two approaches are most useful for evaluating effectiveness on state and private forest land in Washington State. These approaches require that the "desired effect" is known, and progress towards achieving it can be measured. This implies that there are goals or targets for protection and recovery of aquatic resources and changes in watershed input. In the absence of a known desired effect, determining effectiveness becomes more subjective and arriving at conclusions is difficult.

The following attributes should be used to establish "desired effects" for aquatic resources and watershed input processes. Target conditions to evaluate effectiveness should be relevant to aquatic resources, sensitive to forest practices, linked to management programs, and feasible to measure.

Fish habitat. Watershed Analysis uses resource condition indices (criteria for salmonid habitat attributes) to evaluate stream channels. Examples of resource condition indices include: pool frequency, surface area and cover; abundance of LWD and key LWD pieces; spawning gravel

quantity, quality, scour and fine sediment levels; access to spawning areas; and presence of winter rearing and adult holding habitat. Resource condition indices are used in the Watershed Analysis review process to evaluate effectiveness (WAC 222-22-090).

Water quality. The Washington Department of Ecology adopts state water quality standards pursuant to the federal Clean Water Act. Forest Practices rules are designed so compliance with the regulations will achieve compliance with water quality laws. Therefore, it is appropriate to use numeric and narrative state water quality standards to evaluate protection and restoration of water quality. Examples of applicable numeric standards include stream temperature and turbidity. An example of an applicable narrative standards is, "deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent on those waters, or adversely affect the public health...".

Water volume. Water volume is mentioned as a parameter in the resource characteristics section of the forest practices rules but there is no goal or standard for measuring effectiveness. Establishing a "desired effect" for water volume is necessary before effectiveness can be monitored. Where instream flows are established, they provide a target for low flow water volume. Evaluation of changes in magnitude and frequency of storm events is a possible approach to evaluate peak flow effectiveness. Water volume also affects water quality parameters such as temperature and sediment, so it is integrally connected to the evaluation of water quality.

Watershed input processes. Watershed Analysis identifies several key input processes that affect fish habitat and water quality including mass wasting, surface erosion, peak flows, solar radiation and large woody debris recruitment. Monitoring of the input processes is efficient because they are directly affected by forest practices and effectiveness can be assessed without waiting for downstream resources impacts to occur. Establishing a "desired effect" for input processes is necessary before effectiveness can be monitored. Effectiveness in the context of input processes typically is approached in terms of delivery, i.e. whether the practice causes an adverse change in watershed inputs to the stream channel.

IMPLEMENTATION

After identifying and prioritizing monitoring objectives and developing monitoring approaches, the next step is to implement the monitoring program. In developing implementation options, we were confronted with issues such as determining the appropriate roles for various TFW parties, identifying an organizational structure and overcoming the logistical challenges of a statewide sampling program. The purpose of this section is to identify important attributes of a TFW effectiveness monitoring program, discuss the pros and cons of various implementation scenarios, recommend a preferred option for implementation and propose a pilot implementation project.

Important Characteristics of a TFW Effectiveness Monitoring Implementation Effort

Some attributes of a successful TFW effectiveness monitoring program are listed below.

- Personnel. Production of the high quality monitoring data needed to evaluate effectiveness

requires dependable, stable, well-trained personnel, with expertise in data collection methods. Dedication and commitment to the job are essential.

- Logistics. Effectiveness monitoring will require sampling of representative conditions in forested watersheds across the state. The implementation effort needs to have efficient data collection capability throughout the state.
- Data Quality. Evaluation of forest practice effectiveness requires high quality, consistent, accurate, repeatable data that is comparable between regions and years. Data should be collected with standard, repeatable methods, backed by a thorough training and quality assurance program.
- Data Analysis, Storage and Access. Effectiveness monitoring will generate large amounts of data requiring analysis and storage. A stable location for the database/information center and a long-term commitment to maintain the system are needed. Ease of access is critical.
- Data Interpretation and Evaluation. Objective data interpretation and evaluation are critical functions in effectiveness monitoring. Clear definition of roles and responsibilities and established procedures for fair and efficient evaluation are crucial to success. A procedure to interpret data, judge effectiveness, and review results needs to be established.
- Adaptive Management. Processes and procedures for using information developed by effectiveness monitoring to modify and refine forest practice measures should be identified. The appropriate parties to develop and implement recommendations will vary depending on the management program.
- Participation. Successful implementation of a TFW effectiveness monitoring program and adaptive management process depends on active participation from TFW parties. The program must offer a framework that provides opportunities for (and encourages) TFW participants to identify and prioritize monitoring questions and issues, participate in study design and site-selection, collect and access data, review effectiveness evaluations and participate in developing solutions.
- Funding. Implementation of an effectiveness monitoring program will require a substantial commitment of resources over an extended period of time. Stable, long-term sources of core funding and contributions and participation from a range of interested parties will be needed.
- Coordination With Other Monitoring Programs. To maximize efficiency, the TFW effectiveness monitoring program should coordinate and collaborate with other monitoring programs within and outside the state.
- Landowner incentives. The program should incorporate incentives that encourage landowner participation.

Discussion of Implementation Issues

We identified several key issues that present choices on how the effectiveness monitoring implementation effort could be structured and organized. A discussion of these issues follows, including advantages and disadvantages of various options relative to the attributes identified in the previous section.

Scenarios for Roles and Responsibilities in Program Implementation

Two models for implementation of an effectiveness monitoring program have been identified. Scenario 1 places a state agency in the lead role with primary responsibility for all aspects of effectiveness monitoring. This model is based on states such as Oregon, where monitoring is

implemented by the state Department of Forestry. Under this option an appropriate state agency (WDNR, WDOE or WDFW) would be responsible for operating the monitoring program, including sampling design, data collection, evaluation and adaptive management. Results would be reported directly to the Forest Practices Board. TFW parties would have an advisory role with opportunities to participate in data collection and public review of evaluations.

Advantages:

- State agency would take ownership in the project and responsibility for funding.
- Streamline organizational structure with clear responsibilities.

Disadvantages:

- Lack of ownership and limited participation opportunities for TFW participants.
- More difficult to establish cooperative relationship with TFW participants.
- Narrow funding base.

Scenario 2 is to use the TFW CMER participants and program. Under this option the program would be run under auspices of the TFW Monitoring Steering Committee. The TFW Ambient Monitoring Program would be responsible for monitoring design and the core data collection effort. Participation of TFW parties in monitoring would be actively encouraged. Evaluation of effectiveness would be accomplished through CMER. Recommendations would be forwarded to the TFW Policy Committee and affected jurisdictions. This option is quite different from the effectiveness monitoring programs implemented by other states.

Advantages:

- Takes advantage of existing CMER/MSC monitoring structure and experience.
- Incorporates opportunities for participation and communication with TFW participants, potentially increasing support for the program.
- Opens up opportunities for a broader funding base.
- Takes advantage of the participation of key decision-makers in the TFW Policy Committee.

Disadvantages:

- Long-term future of CMER and the monitoring steering committee is uncertain.
- Ability of CMER to evaluate effectiveness is untested.
- It is uncertain how various jurisdictions would respond to effectiveness information developed by CMER.

<u>Scenarios for Organization of Tasks: Single Objectives vs. Coordinated Monitoring</u>

Earlier we identified eight effectiveness monitoring objectives based on questions the monitoring program should answer about riparian shade, LWD recruitment, mass wasting, surface erosion, hydrology, fish passage, forest chemicals and trends in aquatic resource conditions. An important organizational issue is whether to isolate each objective/question and develop separate projects for each, or to approach them in a coordinated fashion. Past effectiveness monitoring efforts in Washington have tackled effectiveness issues separately, with projects developed for single issues. In contrast, Watershed Analysis takes a more holistic approach to management, and Watershed Analysis monitoring plans address issues in a coordinated manner.

Scenario 1. Implement separate projects for each monitoring objective.

Advantages:

- Flexibility to select objectives, fund them separately, and spread implementation over time.
- The limited scope of single objective projects makes them more manageable.
- Ability of personnel to specialize in one type of data collection and analysis.

Disadvantages:

- Lack of coordination among objectives inhibits analysis of cumulative effects and interaction between processes and effects.
- Inefficiencies associated with time and cost of starting short-term, single objective projects.
- Problems recruiting and training quality personnel for short-term seasonal/temporary employment.
- Loss of opportunity to use data to support multiple monitoring objectives.

Scenario 2. Implement a coordinated monitoring effort to achieve multiple monitoring objectives.

Advantages:

- Easier logistics and greater efficiency because of ability to use regional teams to do a variety of monitoring activities year-round.
- Greater data collection efficiency and data quality from having committed personnel.
- Better capability to analyze cumulative effects and watershed-scale questions.
- Greater efficiency because some data can be used to support multiple objectives.

Disadvantages:

- More planning is necessary to coordinate effort among various objectives and manage more complex projects.
- Personnel must be trained to collect a variety of different types of data.
- Greater funding commitment is required to initiate multiple monitoring objectives simultaneously.

<u>Scenarios for Geographic Organization of the Implementation Effort</u>

Another important issue is how to deploy the sampling effort across the state. This issue is somewhat related to the project organization issue discussed above. Two options have been identified, selecting random sampling sites throughout the state for each project, or focusing monitoring efforts in selected watersheds or WAUs in each region of the state.

Scenario 1. State-wide, random sampling approach to monitoring.

Advantages:

- Random sampling method provides potential to draw statistically valid conclusions on conditions throughout state.
- Large pool of potential sampling sites.

Disadvantages:

- The logistics of sampling scattered sites is more difficult and expensive.
- Not effective for holistic understanding of watershed processes and forest practices effects.

Scenario 2. Regional, watershed-based monitoring approach.

Advantages:

- Better linkage with Watershed Analysis.
- Logistics are easier and more efficient because sampling for multiple objectives occurs in one watershed.
- Conducive to providing a better understanding of multiple impacts on a watershed scale.
- The number of watersheds sampled can be expanded incrementally if cooperator interest or funding increases.

Disadvantages:

- Selected watersheds may not be representative of conditions in all watersheds.

Recommended Approach for Implementing the TFW Effectiveness Monitoring Strategy

Our recommendation is to: establish a multi-objective, regional watershed-based monitoring strategy implemented on a pilot project basis by TFW CMER and the Monitoring Steering Committee.

Our preference for this option does not mean that the other scenarios have fatal flaws. We believe an effectiveness monitoring program incorporating other implementation options is also viable.

We recommend implementing the monitoring strategy as a TFW CMER program because it takes advantage of CMER technical expertise and existing TFW monitoring structure and experience. This option should create a greater comfort level with TFW participants based on familiarity with CMER and the TFW Policy Committee. Evaluating effectiveness in the TFW CMER arena and forwarding recommendations to the TFW Policy Committee will increase opportunities for participation by interested TFW parties.

A coordinated monitoring plan for multiple objectives will take advantage of logistical and personnel advantages and enhance understanding of cumulative effects. We recommend using a regional, watershed-based approach because it is most compatible with Watershed Analysis and the multi-objective coordinated monitoring recommended above, and will allow synthesis of information on a watershed scale. Establishing a regional, watershed-based effectiveness monitoring strategy will maximize opportunities for TFW parties such as tribes, industry, environmental organizations and state agencies to participate in local monitoring activities. These efforts would be coordinated with the monitoring activities of other TFW participants.

Since no single monitoring approach will be appropriate for all objectives, the monitoring strategy should provide flexibility to accomplish various objectives most efficiently.

Roles and Responsibilities

The recommended implementation option provides roles and responsibilities for a wide range of participants in the monitoring strategy (Figure 2). A discussion of these roles follows:

TFW Policy Committee

- determine priorities for the effectiveness monitoring program
- determine appropriate action based on information and recommendations from CMER

- oversee implementation of adaptive management

CMER

- review and approve monitoring study design, sampling plans, data interpretation
- review and approve MSC effectiveness evaluations and recommendations of adaptive management advisory committee and forward to TFW policy group for action
- act on budget requests from monitoring steering committee
- review and approve project reports

Monitoring Steering Committee

- finalize effectiveness evaluations
- review and approve monitoring study design, sampling plans, data interpretation
- review and approve project reports and recommendations
- convene adaptive management advisory committee as needed

Adaptive Management Advisory Committees

- convened by the CMER Monitoring Steering Committee
- composed of TFW participants and others with scientific and operational expertise
- address specific problems and develop recommendations to improve effectiveness

TFW Ambient Monitoring Program Manager

- provide statewide interpretation of data, initial effectiveness evaluation
- oversee regional implementation efforts, supervise regional coordinators, technical staff
- produce technical reports
- review and coordinate regional study design, sampling plans
- project administration

Regional Coordinators

- communicate with regional TFW cooperators, encourage participation and coordinate cooperative monitoring efforts
- provide regional study design, sampling plans, study site selection
- direct field sampling, supervise/provide logistical support and administration for field teams
- provide regional data analysis, effectiveness evaluation and report preparation

TFW Participants

- participate in monitoring activities
- review and provide feedback on regional study design, sampling plans
- review effectiveness evaluation, participate in developing solutions
- potential source of funding and in-kind support

Other Affected Agencies

- act on adaptive management recommendations
- provide feedback on project design and results
- potential source of funding and in-kind support

As an alternate approach, the effectiveness monitoring program could also be successfully implemented by one or more state agencies. Opportunities for TFW participation could be incorporated in this scenario, however they would be more limited that in the recommended option above. For example, CMER could provide input on technical aspects of the monitoring program and the conclusions reached about effectiveness, while the TFW Policy Committee could act as a sounding board for adaptive management recommendations.

Process for Evaluating Effectiveness and Developing Adaptive Management Recommendations

Following data collection, initial analysis and interpretation of data would be done by the TFW Ambient Monitoring Program and reports would be submitted to the Monitoring Steering Committee (MSC), CMER and TFW participants for review. These reports would summarize monitoring data and assess whether the information is adequate to draw conclusion regarding effectiveness. If the information was determined to be adequate, recommendations on effectiveness based on the established criteria would be included in the report. If necessary, recommendations for focused research would be included. It would be the responsibility of the MSC to review the information in the report and the comments received, and determine whether the conclusions drawn about effectiveness were valid. The committee can request additional monitoring or develop a proposal for focused research if needed. Following review by CMER and the MSC, a final report would be developed based on the findings of the MSC. MSC would also pass on research proposals to CMER.

In cases where the practices were found to be ineffective (or partially effective), the monitoring steering committee would establish an adaptive management advisory committee to provide recommendations on how to change practices to achieve the desired conditions. The committee would be composed of: 1) people with scientific expertise in the appropriate disciplines; 2) people with operational experience applying the practices being examined; 3) representatives of resource management organizations; and 4) representatives of landowners and operators. It would be the responsibility of this group to evaluate options and report back to the MSC with options for changes in practices to achieve effectiveness. The Monitoring Steering Committee would be responsible for reviewing the report, attaching their recommendations and submitting them to CMER. Following CMER review and approval, the package would be submitted to the TFW Policy Committee for action.

Linkage with Watershed Analysis

The monitoring strategy proposed would be closely linked with Watershed Analysis. Watershed Analysis is a unique resource for effectiveness monitoring in Washington State. Linking effectiveness monitoring to Watershed Analysis provides a number of benefits. Much of the information collected during Watershed Analysis is useful for monitoring purposes. Using this information reduces the time and cost of monitoring, providing additional benefit for the initial expenditure of time and money invested in conducting Watershed Analysis. Information collected during the assessment process can be used as a monitoring baseline for current conditions, allowing trends to be detected by repeating the measurements over time. Table 4 shows various products of the Watershed Analysis assessment modules that can be used as monitoring tools to achieve various effectiveness monitoring objectives. In addition, the cause and effect relationships identified in the causal mechanism reports and linkages between multiple factors developed during

synthesis will help with interpretation of monitoring results on a watershed scale. Finally, the Watershed Analysis five year review process provides a means of utilizing effectiveness monitoring information for adaptive management.

Table 4. Some Watershed Analysis standard products and their potential usefulness for effectiveness monitoring.

MONITORING OBJECTIVE	WA PRODUCT NAME	WHAT IS IT?	USE IN MONITORING?
1. STREAM TEMPERATURE	Map D-4. Target and estimated canopy closure.	Shows the target shade level based on stream class and elevation; also shows actual shade estimated from aerial photos.	Measure shade at harvest sites to determine if approaching target shade or moving away. Document trends in shade on watershed scale over time.
2. LWD	Map D-1 Riparian condition.	Shows species, density, and age of stream side vegetation from aerial photos.	Measure/count LWD recruitment to determine if approaching or moving away from target riparian LWD recruitment situations.
3. MASS WASTING	Map A-1. Mass Wasting Inventory.	Shows all landslides, debris flows, etc. from examination of aerial photos over time.	Determine association of site activity with mass wasting events. Document trends on watershed scale over time.
4. SURFACE EROSION	Roads spreadsheets. Background calculations.	Spreadsheets show how much sediment is contributed to streams from road system; background rate provides context for evaluating hazard from the level of sediment from roads.	Re-evaluating road sediment from time to time will allow determination of trends in road sediment; background rate provides context in which to evaluate importance of road sediment contributions.
5. HYDROLOGIC RESPONSE/ROADS	Not usually evaluated in WA (could be added as a standard product of WA).		Need to evaluate road drainage network for potential hydro impacts.
6. FISH PASSAGE	None required, though often evaluated when considered a problem (could be added as a standard product of WA).		Need to evaluate where there are blockages to fish passage if not evaluated for WA; re-evaluate after changes are made to blockages.
7. CHEMICALS	Not evaluated in WA; will be partially included in new Water Quality module.		Need to determine what to evaluate.
8. CUMULATIVE EFFECTS	All WA products.	Current conditions of inputs and resources; cause-and-effect linkages synthesized from	Forms the foundation for effectiveness evaluation of other issues; WA automatically re-evaluated

		information produced.	on 5-yr interval.

Selection of Sampling Areas

Given the large amount of state and private forest land in Washington, it is impossible to sample all or most streams or sites where forest practices occur. Consequently, an effectiveness monitoring strategy that relies on sub-sampling is essential. Our strategy proposes to maximize efficiency by concentrating intensive monitoring in a sub-sample of forested watersheds. We recommend dividing the forested portions of the state into regions which are further sub-divided into WAUs (10,000-60,000 acre sub-basins delineated for conducting Watershed Analysis). Within each region, a core set of WAUs would be selected to represent:

- Different management practices and programs
- Physiographic, hydrologic and climatic conditions in the region
- Land ownership and forest practices operations in the region
- Areas of critical resources such as fish stocks of special interest, water supplies etc.

The number and location of WAUs selected for monitoring may initially vary for different monitoring objectives. For example, it may be possible to cover a much larger area with an aerial photo inventory of mass wasting than with stream surveys to monitor in-channel habitat trends. However, it is our goal to conduct as many monitoring activities as possible in the same WAUs to focus monitoring efforts, increase efficiency, and enhance our understanding of the interaction between various forest practices on a watershed scale. We recognize that it may be advantageous to utilize alternate sampling designs in some situations where the watershed-based sampling scheme is not conducive to achieving the objective.

The choice of WAUs as the sampling unit also allows for monitoring efforts to be increased incrementally by adding WAUs as additional resources become available. Additional WAUs could also be added as more Watershed Analyses are completed or HCPs are brought on line.

Under this system, evaluating the effectiveness of various programs and practices would initially be done regionally using the results of monitoring in representative WAUs within each region. Regional information would be compiled to evaluate and compare effectiveness.

Coordination With Other Monitoring Efforts

Implementing the TFW Effectiveness Monitoring Strategy through CMER's Monitoring Steering Committee will take advantage of the existing expertise and infrastructure within the TFW Ambient Monitoring Program. Organizing the monitoring effort on a regional/watershed basis with a regional monitoring coordinator will facilitate coordination with local monitoring efforts. One of the duties of the regional monitoring coordinator would be to identify local monitoring efforts and to promote cooperation between local efforts and the TFW effectiveness monitoring program. In addition, opportunities exist for coordination on a broader scale. We are currently establishing communication with the federal team developing a monitoring program for the Northwest Forest Plan in order to explore the possibility of collaboration. Opportunities to collaborate with monitoring efforts by the Oregon Department of Forestry, USFS, EPA, WDOE, USGS, tribes and timber industry should be explored.

Pilot Project Proposal

We recommend a strategy of staged implementation for the effectiveness monitoring program, beginning with an initial pilot project. A pilot project has the following advantages:

- allows testing and refinement of the effectiveness monitoring strategy before resources are committed to a full-scale monitoring effort;
- produces initial data that can be used to further prioritize monitoring issues and efforts;
- provides a product that demonstrates the utility of the monitoring program and could be used in efforts to obtain additional funding;
- allows time to organize, coordinate and fund participation by TFW cooperators in a larger scale effort.

Pilot Project Description

The pilot project would focus on evaluating the effectiveness of Watershed Analysis prescriptions in watersheds approaching the five year review and comparing the effectiveness of standard rules applied under similar conditions. Forested WAUs from both the east side and west side would be selected to provide a regional perspective on effectiveness. Priority monitoring objectives include riparian function (LWD and stream temperature), sediment, fish passage and aquatic habitat condition. WAUs representative of other management programs such as TMDLs or HCPs could be added at a future date, with priority placed on those approaching the Watershed Analysis five year review

Staged Implementation

Following the pilot project, the program will be revised as necessary and can be implemented on a larger scale. Implementation can be scaled up over time as shown in Table 5, allowing improvements to be made as experience is gained. Following the pilot stage, we recommend funding a core-level program that includes regional coordinators with field crews and aerial photo, database and GIS support. The priority of the core effort would be to focus on evaluation of standard rules and WAUs with Watershed Analyses to provide data for the five year reviews.

Regional coordinators are a key element in successful implementation of the effectiveness monitoring strategy. Through contact with personnel from industry, tribes, environmental groups, regional WDNR, WDFW and WDOE offices, an extensive amount of additional monitoring support and effort can be generated.

Barriers to Implementation

Several potential barriers to implementation have been identified.

Funding. Funding the recommended effectiveness monitoring program will involve substantial costs. A rough estimate of personnel requirements has been provided in Table 5. Estimating costs more precisely will require more detailed development of sampling plans.

Table 5. Rough estimate of the personnel requirements (FTEs) to implement effectiveness monitoring in incremental stages.

	Stage 1 (2 regions)[a]	**Stage 2 (3 regions)[b]**	**Stage 3 (6 regions)[c]**	**Stage 4 (6 regions, 12 crews)[c]**
Program management	1.0	1.0	1.0	2.0
Database/GIS support	0.5	0.5	1.0	1.0
Aerial photo interpretation	0.5	0.5	1.0	1.0
Regional monitoring coordinators	1.0	3.0	3.0	6.0
Field crews				
Field scientists	2.0	3.0	6.0	12.0
Field technicians	2.0	3.0	6.0	12.0
Total FTEs	7.0	11.0	18.0	34.0

[a] east side and west side regions; [b]east side, coastal, and west cascade regions; [c] northeast, east cascades, northwest cascades, southwest cascades, Olympic and Willapa regions.

Logistics. The logistics of coordinating effectiveness monitoring data collection around the state are intimidating. We believe the regional structure suggested above, and the emphasis on participation by local TFW cooperators is the most efficient means of overcoming logistical challenges.

Technical Capability. Implementation of the proposed TFW effectiveness monitoring program will require a scientific understanding of the relationship between forest practices and the resources of concern, as well as significant technical capability to collect, analyze, interpret and present information so valid conclusions can be drawn. Utilization of the existing TFW Ambient Monitoring Program infrastructure will provide some of the necessary technical capability, including standard methods, a database for data storage and analysis, training, and quality assurance. Use of these services will increase efficiency and reduce start-up time and cost. However, additional methods for collecting data on input processes and channel conditions are needed. For some objectives, such as LWD recruitment, further development of predictive models of the relationship between riparian stand characteristics and LWD recruitment and loading is needed. In addition, a substantial list of research issues has been identified for each of the objectives. Coordination with the CMER research program will be necessary to accomplish the necessary supporting research. Additional analytical tools are available through the Salmon/Steelhead Inventory and Assessment Program (SSHIAP) being implemented through NWIFC.

Access to Sites

Access to monitoring sites will be necessary to successfully undertake an effectiveness monitoring plan. Provisions for obtaining access to monitoring sites will need to be addressed prior to implementation.

How to Proceed

We suggest the following steps to proceed with implementation of the monitoring strategy.
1. Response from the TFW Policy Committee to CMER providing feedback on the white paper. We need to know:
   - Does the recommended strategy meet your needs? If not, do you prefer one of the other options? What revisions would you like to see, and why?;
   - Did we identify the important objectives and issues you are interested in? Would you like to add, delete or prioritize objectives?;
   - Should we make the revisions and proceed with the next stage of development of the effectiveness monitoring strategy?
2. CMER/MSC prioritizes objectives, develops details of the pilot effectiveness monitoring program including cost estimates, methods, selection of pilot watersheds and identification of partners and submits it to TFW Policy Committee for review.
3. Identification of funding for the pilot monitoring effort.
4. Implementation of the pilot monitoring program.
5. Evaluation of the pilot monitoring program.
6. Decision on future direction.

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