Assessing The Effectiveness of California's Forest Practice Rules In Protecting Water Quality

Recommendations For A Pilot Monitoring Project and Longer Term Assessment Program

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Monitoring Study Group
of the State Board of Forestry

with assistance from

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Executive Summary

This report recommends to the California State Board of Forestry (BOF) the essential elements of a pilot monitoring project with which to launch the longer term assessment of the water protection provided by the Forest Practice Rules. The report was prepared by a panel of state, federal government, timber industry and fisheries specialists in forestry and water quality protection and it draws on earlier efforts, particularly the 1987 State Water Resources Control Board's "208 Team Report" and the 1991 report of the Board of Forestry's Best Management Practices Effectiveness Assessment Committee, or "BEAC".

While the immediate objective of this report is to initiate a pilot project that would test the methods to be used in monitoring the Forest Practice Rules, the authors have taken the opportunity to explain the proposed pilot project in the larger context of the State of California's commitment, dating from 1977. *This demonstrates that the FPR are Best Management Practices ("BMPs"), a term used in the federal Clean Water Act.*

Future steps will include: 1) the BOF's consideration of these recommendations and adoption of a pilot project by July 1993; 2) implementation of the pilot monitoring project; 3) adoption of monitoring improvements indicated by the pilot effort; and 4) development and implementation of an ongoing monitoring program for assessing and improving California's FPR to assure that they are the most prudent means for protecting the public's use and enjoyment of the waters of this state from potential adverse effects of timber harvesting activities.

Part 1. Development of the Monitoring Program -- History and Purpose

Foreword

This report of the Monitoring Study Group (MSG) recommends to BOF and to the public the necessary elements of a proposed short-term pilot project. This pilot program will lay the groundwork for the longer-term monitoring and assessment of the water quality protection capabilities of the state's Forest Practice Rules (FPRs) -- the rules by which the Board regulates timber harvesting activity on state and private lands. Both the pilot project and the longer term monitoring program are part of an overall monitoring strategy known as the Best Management Practices Effectiveness Assessment Program, (BEAP). The BEAP programs that are recommended draw on prior efforts by the State Water Resources Control Board, Department of Fish and Game, California Department of Forestry and Fire Protection, and the Board of Forestry aimed at measuring water quality impacts to lakes and streams attributable to timber harvesting activities. These earlier initiatives focused research efforts and state-wide public workshops hosted in 1991 by the Board-appointed Best Management Practices Effectiveness Committee (BEAC).

In addition to technical information, the BEAC hearings identified the wide array of concerns the public has regarding the effect of timber harvesting activities on stream and lake resources. The MSG members drew from the BEAC's findings and recommendations report, and their expertise in water quality monitoring, in making the pilot project recommendations contained in this report.

Background

The State of California, acting through its State Water Resources Control Board (SWRCB) and under the authority of the State's *Porter-Cologne Water Quality Act*, has the responsibility for the implementation of the federal *Clean Water Act* (CWA) under a delegation of authority from the U.S. Environmental Protection Agency (EPA). The SWRCB has, in turn, assigned the BOF and CDF first-hand responsibility for the control of nonpoint source water pollution (i.e., from dispersed sources) that might arise from timber harvesting on private lands. The U.S. Forest Service, Pacific Southwest Region, has been delegated the responsibility for water quality management related to timber activities on National Forest lands in California. The Forest Service program was certified by the EPA in 1981 for controlling nonpoint source pollution from timber harvesting activities. This includes both water quality monitoring and program implementation.

Timber harvesting operations can adversely affect stream and lake water quality. Domestic water supplies and cold-water fish habitat have been identified as being particularly sensitive to the effects of timber harvesting operations. In the short term, timber harvesting operations involving log skidding, road and landing construction, road maintenance, and riparian canopy removal can accelerate sedimentation, increase water temperatures beyond the tolerance of salmonids, and affect aquatic food resources. Studies on the Caspar Creek Experimental Watershed in Mendocino County, are examining long term effects resulting from clearcutting practices on stream flow and sedimentation. Studies in British Columbia's Carnation Creek watershed (Hartman & Scrivner, 1990) have indicated logging-related negative changes in a drainage occur over decades.

The CWA contemplates the control of nonpoint water pollution sources (NPS) primarily through the use of BMPs. In the case of regulated activities (the State of California has regulated timber harvesting on private lands since the 1940's), it is necessary for regulators to demonstrate that their rules, together with the program for implementing those rules, are the "best management practices" available for the protection of water quality necessary to support the public uses of streams and lakes.

Beneficial Uses

Protection of water quality includes those actions necessary to support the public's "beneficial uses" of water. Beneficial uses include domestic and municipal water supply, preservation and enhancement of fish and wildlife habitat, and recreation. These beneficial uses are identified in the Regional Water Quality Control Board Basin Plans. The quality of water needed to protect each beneficial use, expressed in physical or chemical parameters, is also listed in the Basin Plans. The quality of water needed to protect each beneficial use is defined by numerical chemical criteria or narrative standards expressed as water quality objectives in the Basin Plans. The Basin Plans also contain an implementation section which describes the measures, which include specific prohibitions, action plans, and policies that form the basis for the protection of water quality.

When protections of different beneficial uses demand differing physical or chemical criteria, regulators usually gear water quality safeguards to the most sensitive use. Two of the most sensitive uses are cold-water fisheries and domestic water supplies. Therefore, to produce a manageable study these two items were chosen as a focus. Understanding beneficial uses and their corresponding protective criteria is key in designing any monitoring program. The program must be designed to measure conditions and parameters related to the objectives set for the particular beneficial uses.

The BOF must adequately demonstrate that the FPR and their implementation procedures provide adequate protection of the beneficial uses of water before EPA can certify these rules as Best Management Practices. Certification of the Rules by EPA is necessary to complete the delegation of authority to the BOF for the implementation of the federal CWA. Development of a monitoring program to evaluate the implementation and effectiveness of the FPRs is necessary to show substantial progress needed to satisfy EPA.

Cold-Water Fish

One of the beneficial uses of clean water which the monitoring program must emphasize is cold water fish resources. In California, fish native to cooler waters include the members of the salmon and trout family (salmonids), and include resident (all trout species) and anadromous forms, such as steelhead, Chinook (king) salmon, Coho (silver) salmon, and coastal cutthroat trout. Most of these species are sensitive to changes in their habitat, and therefore, are useful indicators of adverse water quality changes.

Major concerns related to the potential effects of timber harvesting activities on various life stages of cold water fish are:

- sedimentation of spawning gravels which reduces the survival rate of eggs and emerging fry;
- sedimentation of rearing pools which can reduce the areas in which juvenile fish can feed, grow and hide and which increases the potential for predation;
- stream temperature increases in summer to levels which are stressful or lethal to local fish populations;
- barriers to upstream or downstream migration caused by excess debris or poorly installed culverts;
- lack of instream cover resulting from insufficient large woody debris in riparian areas;
- impacts on invertebrate habitat which decrease food availability.
- agradation of channels which reduces in-channel wet area habitat during summer flows.

The Monitoring Program needs to address these possible life cycle impacts in its assessment of the Forest Practice Rules effectiveness for in protecting cold water fish as a beneficial use.

Domestic Water Supply

CDF is required to protect domestic water sources from adverse effects resulting from timber operations. Domestic water sources which may be affected include surface water diversions, spring boxes, wells adjacent to streams utilizing under flow, and on- and off-stream storage reservoirs.

Major concerns related to the potential effects of timber harvesting activities on domestic water supplies are: 1) significant increases in turbidity of surface water at the intake which can be a vector for bacteria; (2) plugging of the surface water intake with sediment, and (3) sedimentation of reservoirs, which reduces the storage capacity. Excess turbidity requires that water suppliers provide additional treatment to meet state drinking water standards for turbidity. For individual users, sediment-laden water creates a nuisance for household water uses, adds additional wear on pumping and conveyance equipment, and can block small intake sites.

Mapping the location of small domestic surface water sources serving five to 200 connections in areas with commercial timberlands is in progress under a CDF contract. This information will be helpful in THP preparation and review as well as in monitoring the possible water quality effects on domestic water sources.

The Certification Process

The BOF's journey toward EPA certification of its FPRs as BMPs is an ongoing process. Discussions among EPA, the State and the interested public concerning ways to assess the effectiveness of the Rules as BMPs began in earnest in 1977. After reviewing its rules and adding several new provisions relating to stream protection in 1983, the BOF requested the SWRCB certify its rules as BMPs. In June 1984 the SWRCB certified the FPRs as BMPs on the condition that the BOF would make further, specific improvements to its FPRs and that it would develop a monitoring program by which to assess their effectiveness.

The "208 Team" Report

The FPR assessment effort contemplated by the SWRCB was begun in 1986. The BOF joined with the SWRCB to evaluate the water quality related rules using a qualitative approach. Known both as the "Forest Practice Rules Assessment" and "208 Team Report" (after section 208 of the federal CWA concerning NPS controls), this 12-month effort employed a team of four professionals (one each from the SWRCB, the California Department of Fish and Game, CDF and the forest products industry) to examine a sample of timber harvest sites.

The study provided a snapshot of how the FPRs had been applied and whether, if applied correctly, the rules appeared to have protected water quality. In its 1987 report, the team concluded that the BOF's program could adequately protect water quality from timber harvesting activities, with certain improvements. The improvements the team recommended included increased training for both foresters and timber operators, improved enforcement of the rules, specific rule changes and the development of an ongoing rules-and-water-quality monitoring process. **The focus of this report is the continuing development of that rules-and-water-quality monitoring process.**

Based on the "208 Team Report" recommendations, the Board of Forestry, California Department of Forestry and Fire Protection and the State Water Resources Control Board entered into a Management Agency Agreement (MAA, January 1988) which specified needed administrative and FPR changes. In July 1988, EPA approved the designation of the BOF/CDF as the joint management agency for water quality on private timber lands, but withheld approval of the FPRs as BMPs until completion of the MAA recommendations. In its decision, EPA identified the development of a monitoring program as a critical element of the MAA.

The Monitoring Study Group

An Interagency Monitoring Task Force was formed in 1989 in response to EPA's request for an ongoing field assessment of the FPRs' effectiveness. Now known as the Monitoring Study Group (MSG), it includes representatives from the U.S. Environmental Protection Agency (EPA), BOF, CDF, SWRCB, the North Coast Regional Water Quality Control Board (NCRWQCB), DFG, the timber industry (California Forestry Association), and the licensed foresters' association (CLFA).

The Monitoring Study Group reviewed its options and concluded that the design of a monitoring program to assess the effectiveness of the BMPs for water quality protection was a subject of increasing concern and should fully involve the public. It recommended that the BOF appoint a citizen's advisory committee to assist the public involvement process and employ outside help to assist the citizen's committee in preparing recommendations for the MSG and the BOF.

The BEAC

In early 1991, the BOF named a 19-member "Best Management Practices Effectiveness Assessment Committee" (BEAC). William M. Kier Associates, specialists in natural resources planning and management, was selected to assist the BEAC and BOF. The BEAC first met in late April 1991 and prepared plans to involve the interested public in shaping the BMP Effectiveness Assessment Program. A newsletter was prepared and distributed to the public, **"Stream 'Reach"**, that explained the purpose of the proposed water quality monitoring program and announced the dates and places of the BEAC's public meetings.

The BEAC held seven public meetings in June and July 1991, in the following timber communities: Fort Bragg, Eureka, Redding, Nevada City, Sonora, Santa Rosa and Santa Cruz. The BEAC considered over 100 oral and written testimonies provided by the public. With the record of the meeting discussions and their own professional judgments, the BEAC arrived at recommendations and presented them to the BOF in its December 1991 report.

The BEAC's report presents the full array of public issues and professional judgments regarding a comprehensive assessment of the FPRs. From the BEAC's wider public discussion and analysis, the MSG drew much of its guidance concerning the pilot monitoring project that is recommended. The MSG has added more technical detail to the BEAC recommendations and information needed to make the program a reality. This trial monitoring program will enable the MSG to refine a long-term BEAP and its objectives over time.

The Rule-making Process

California's Forest Practice Rules have been a source of controversy since the Z'Berg-Nejedly Forest Practice Act was adopted in 1973. The main reason for this increasing concern is that California's population continues to grow steadily, much of it into the state's forested regions. In addition, and the resulting conflict between timber management and competing social demands for land and water has grown proportionally.

There was little said regarding water quality in the forest practice statutes of the 1960's. Today, both the Z'Berg-Nejedly Forest Practice Act and the FPRs provide substantial guidance concerning water quality protection. Registered professional foresters (RPFs) who prepare timber harvest plans (THPs) in accordance with the BOF's Rules, for the review and approval by CDF must consider:

- **site preparation** in a manner which "prevents substantial adverse effects to soil resources and to fish and wildlife habitat, and prevents degradation of the quality and beneficial uses of water" (14 CCR 915); and
- **roads and landings** that shall be planned, located, used and maintained in a manner which "minimizes damage to soil resources and fish and wildlife habitat; and prevents degradation of the quality and beneficial uses of water" (14 CCR 923); and
- **timber operations** that shall be conducted to "prevent damage to residual trees, fish and wildlife habitat as identified in the THP or contained in the rules, reproduction, and riparian vegetation; to prevent degradation of the quality and beneficial uses of water; and to maintain site productivity by minimizing soil loss" (14 CCR 914); and
- **watercourse protection** to "insure the protection of the beneficial uses that are derived from the physical form, water quality, and biological characteristics of watercourses and lakes" (14 CCR 916). RPFs must conduct a field examination of all watercourses within the area of the timber operations and include them in a map in the THP submittal along with specified watercourse and lake protection zones (WLPZs); and, importantly,
- **cumulative impacts** to determine whether the environmental effects of a particular harvesting project, even though minor in themselves, might interact with identifiable past or future projects -- on-site or downstream -- in ways that, taken together, cause "significant environmental impacts," (14 CCR 898) as that term is used in the California Environmental Quality Act of 1970 (CEQA).

These general requirements are supported by a number of more specific rules regarding the conduct of timber operations.

Monitoring Implementation of THPs

The first essential step in monitoring the effectiveness of forest practice rules as Best Management Practices is to be certain that each rule is properly implemented. This step begins during the THP process. It is at this initial stage that CDF and agency review team members **must ensure that appropriate practices are included in each** THP. The review must whether a pre-harvest inspection is needed to insure that the proper practices for the site and conditions found in the harvest area have been identified.

The second critical step in monitoring the rules is to **make certain that each practice specified in the THP is properly implemented.** To do so, the FPRs must be adequately implemented in the field by the Licensed Timber Operator (LTO). **Adequate implementation of, and compliance with, the rules are the primary focus of post-harvest inspections conducted by CDF field inspectors.**

To ensure uniform and correct implementation of Forest Practice Rules, CDF has a policy establishing a formal internal audit of employees making forest practice inspections. The intent of these compliance inspections is to: 1) improve uniformity of FPR application; 2) identify practices which are or are not providing adequate forest resource protection; 3) identify rules which need modification; 4) **identify problems where FPRs need to be developed; 5) identify practices which are or are not best management practices**; and 6) identify individual inspectors who are: a) performing at or above expected levels, and b) inspectors that are performing below normal performance standards, or c) inspectors that are not consistently applying departmental and Board of Forestry rules, regulations, and policies.

Development of an improved implementation monitoring program was a requirement of the BOF/CDF management agency designation approved by EPA in 1988. In its approval, EPA also specified periodic reporting of compliance and enforcement activities be made available to the SWRCB and EPA. CDF has been reluctant to release the results of internal compliance inspections where internal personnel matters are reported. In its report, the BEAC recognized that a publicly accountable compliance monitoring program was critical to evaluating the effectiveness of the entire forest practice program. To that end, the BEAC recommended that CDF develop a compliance program aimed at providing assurance of forest practice implementation. The BEAC further recommended that the evaluation program be conducted in a manner that would allow other agencies and the public an opportunity to review CDF efforts.

Assessment, Monitoring Program Objectives

Overall Objectives of the Effectiveness Assessment Program

The primary purpose of the BEAP is to develop and implement a monitoring program. The proposed program will be directed toward evaluating the water quality protection value of the BOF's FPRs implemented as Best Management Practices.

On the basis of its review of BEAC recommendations and its own deliberations, the MSG developed objectives for the monitoring programs. The overall objectives of the proposed BOF forest practice rules assessment program are:

1. Determine whether critical problem areas are being recognized and appropriate practices are being specified.
2. Determine whether rules to be considered as BMPs are, in fact, being adequately applied on-the-ground (implementation monitoring).
3. Determine, both qualitatively and quantitatively, whether properly implemented forest practices meet applicable water quality standards (compliance monitoring).
4. Determine whether specific forest practices as implemented are effective in meeting their immediate intent (effectiveness monitoring).
5. Determine whether the specific practices implemented for a particular project adequately protect the most sensitive beneficial uses of water, domestic and municipal water supplies, and cold water fish spawning and rearing habitats (project monitoring).
6. Provide the results of the above determinations to the Board of Forestry and the public in a timely manner to contribute effectively to the Board's program for reviewing and, where necessary, strengthening the Forest Practice Rules' performance as BMPs.
7. Acknowledge the evolution in the understanding of forestry-related water quality interaction and provide a mechanism by which monitoring procedures and BMPs may be modified over time including a periodic evaluation of the monitoring program to determine its effectiveness in relation to its objectives.

Specific Monitoring Program Objectives

The monitoring program should:

1. Implement feasible monitoring methods for data collection and analysis, that complement, rather than rely upon on long-term, research-oriented methods.
2. Determine changes, if any, in the quality of cold water fish habitat in stream areas below timber harvest sites and logging roads where BMPs have been applied.
3. Include an outreach effort to gather existing information and to place priority on monitoring those sites where such information is available.
4. Place priority on monitoring sites involving domestic water supply watersheds and/or cold water fisheries.
5. Identify and target sites that exhibit the highest risk to sensitive beneficial uses.
6. Develop techniques needed to measure discharge and sediment delivery rates to watercourses.
7. Recognize sites within a watershed with the best opportunity for monitoring critical areas within that watershed.
8. Determine the sensitivity of parameters selected to measure effect on the beneficial uses.

Part 2. Building on Evaluation Efforts

Previous Evaluations

The Monitoring Study Group (MSG) reviewed the full range of prior and current evaluation efforts related to current monitoring program objectives. Those efforts that are directly related to the development of the pilot and longer term programs are discussed below. To the extent possible, every effort has been made to utilize findings from past activities. For the ongoing or proposed studies, the BOF and the Monitoring Study Group need to develop a feedback mechanism that allows new information to be incorporated into the long-term monitoring program.

In developing the BEAP monitoring program, the MSG decided it was important to build upon previously completed BMP evaluation efforts by the Board of Forestry: (1) the Final Report of the Forest Practice Rules Assessment Team to the State Water Resources Control Board (1987), also known as the "208 Report"; and (2) the Recommendations for Evaluating the Effectiveness of the California Forest Practices as the Best Management Practices (BMPs) for the Protection of Water Quality prepared by The Best Management Practices Effectiveness Assessment Committee (BEAC)(1991).

Fortunately, the intervening six years has brought the importance of monitoring issues into sharper focus along with a better grasp of monitoring guidelines and a more practical perspective for establishing a useful monitoring program. The more pertinent conclusions and lessons learned from past evaluations are summarized below as a basis for the improved approach contemplated by the BEAP monitoring program.

Lessons Learned

208 Report

The 1985-86 208 Team's effort was an exploratory monitoring effort. One of its goals was to assist the development of an ongoing monitoring program, such as the one proposed. Two of the original four team members are also involved with the current MSG. Several important lessons were learned by the 208 Team and that knowledge has been used in developing the pilot program. One broad lesson was that, with few exceptions, the standard forest practices set forth in the FPR work fairly well in protecting the quality and beneficial uses of water except where sensitive site conditions exist or where sensitive physical or biological resources are at risk.

BEAC Report

While the "208 Report" was a narrowly focused study, the BEAP was deliberately broad to draw on the full range of public concerns regarding the effects of timber harvesting practices on water quality. Based on their concerns and experiences, the public recommended a wide range of monitoring techniques and approaches. The BEAC organized these approaches into specific guidelines for the proposed monitoring program. The recommendations to the MSG and BOF are contained in the BEAC Report (1991) and are summarized page 16. The MSG drew from these recommendations and the experience of the 208 Team to develop its more specific recommendations the monitoring programs.

For ease in understanding, the BEAC arranged its Report recommendations into categories of WHO-WHERE-WHEN-WHAT-HOW. Those categories are used here to summarize and compare the approach used by the 208 team and the recommendations of the BEAC Report. For each category, the MSG evaluation of the 208 Report approach is discussed in terms of the lessons learned, followed by the recommendations of the BEAC.

WHO performed the study

The 208 Team study was conducted by a multi-disciplinary team made up of agency and industry specialists (see page 5). The lessons learned from this approach include:

- The mix of disciplines proved valuable in the field evaluations, in recognizing the "resources-at-risk" and in data interpretation.

- There was value in having a fresh perspective from people not on the THP Review Teams. Time is needed to familiarize such a monitoring team with the interpretation of practices in the field.

- It took an unreasonable amount of effort for one team to evaluate all areas of the state.

The BEAC concluded that an interagency, multi-disciplinary monitoring team similar to the 208 Team should be used, with some modification:

- CDF should coordinate the effort.

- To ensure objective evaluation, representatives from the DFG, Regional Water Quality Control Boards and SWRCB should be included.

- A member of the public or Resource Conservation District from the local area should be involved in the evaluation efforts.

- The monitoring program needs several teams throughout the state with one team for each CDF Region, at a minimum.

- Monitoring methods should be "calibrated" between teams to ensure comparability of results.

WHERE the study was performed

One hundred timber harvest sites on private forest land throughout northern and central California were examined by the team. These THP sites were chosen from a total of 2528 THPs filed and operated under the then-current Rules. The presence of Class I, II or VI water bodies within or adjacent to the harvested area was one criterion used to stratify the selection process. The lessons learned from the study include:

- CDF's THP files often did not contain the type of information needed for screening candidate plans, such as whether or not the timber operations were completed prior to the filing of a completion report.
- It was difficult to stratify THPs because information such as the presence of water body classes or other factors used in stratification was not contained in a central database.
- Use of special selected sites could result in an unrecognized bias of results that should not be used to draw conclusions regarding the larger population of THPs.

The BEAC recommended a stratified random sampling procedure be used to include a sufficient number of THP sites at different levels of water quality risk to assess BMP performance across a wide range of conditions. Selection considerations for those THP sites to be monitored included:

- Sites with winter accessibility,
- Highly erodible soils and steep, unstable slopes,
- Riparian and fish habitat areas,
- Areas with some existing data such as from USGS gaging stations,
- Watersheds proposed by the public (see BEAC Report, Appendix B).

Areas that were considered priorities for collection of water quality data within each site included:

- Sampling sites placed above and below, or upstream and downstream, of the THP, the practice, and domestic water supply intakes;
- Class III ephemeral streams as potential pathways of sediment.

WHEN the study was performed

The "208 study" was limited to one year (Dec. 1985 - Dec. 1986). Due to time constraints, only one visit per site was feasible, therefore variables such as weather, stream flow or variations in water quality conditions were not considered. The MSG has concluded that:

- More than one year is needed to make multiple field inspections to monitor the changes in, or duration of, observed effects on a site.
- Changes in stream and aquatic habitat must be directly observed and quantitatively measured in order to be properly analyzed.
- Various conditions are important for on-site evaluation including, high flow, low flow, high temperature.
- A longer term effort is needed to trace off-site impacts.
- Resource conditions should be compared before and after harvest operations.

The BEAC recognized the timing of the monitoring should depend upon the method being used and the beneficial use being evaluated:

- For cold water fisheries, effects on critical life cycle periods should be evaluated, including stream temperatures during the rearing phase in summer to late fall.

- Winter storm runoff periods are the best time to measure sediment movement in streams to document adverse effects on domestic water supplies as well as fish spawning and rearing habitat.

- For soil erosion and sediment evaluation, sampling should occur:
    - during and after winter and before grass growth,
    - when saturated soil conditions are reached.

- Both short and longer-term monitoring should be performed.

WHAT was evaluated

The 208 Team evaluated only THPs that were adopted in October 1983. The study focused on the field evaluation of any rule which could directly or indirectly affect protection of the quality and beneficial uses of water, and an implementation of those rules by CDF and the private sector. The lessons learned were:

- A reasonable cross-section that is representative of all THPs is needed to extrapolate FPR and BMP effectiveness to the entire THP population.
- Implementation monitoring is necessary before evaluating Rule/BMP effectiveness.

The BEAC recommended that the monitoring program evaluate all of the current forest practice erosion and stream protection measures represented as BMPs. In order of priority, the BMPs to be monitored are those which pertain to:

1. Logging roads and landings
2. Watercourse and lake protection
3. Harvesting practices and erosion control
4. Cumulative impacts assessment

HOW the evaluations were conducted

The 208 Report assessed rule effectiveness using qualitative methods. No measurements were made due to time and fiscal constraints. Field evaluations focused on beneficial-uses-at-risk from timber operations, and on the effects that the practices had on resources-at-risk at each site. The study was not designed to make a systematic assessment of cumulative effects, nor could any conclusions or recommendations be made regarding such effects. The lessons learned from this approach included:

- Determination of adverse effects, particularly to off-site resources, was inadequate in many cases.
- Measurements of instream conditions were needed to better evaluate effects, including temperature increases, instream gravel build-up, loss of pools and large organic debris, and lower spawning success due to fine sediment.

The BEAC Report recommended the use of both qualitative and quantitative measurements. Monitoring approaches should include:

- A method similar to that developed by the U.S. Forest Service (California),
- Coordination with CDF's internal compliance inspections,
- Variable measures, depending upon the BMP being evaluated,
- Simple and direct methods, capable of being repeated by a completely different team,
- Development of a photo set to illustrate the types and rates of soil erosion for uniform evaluation.

Suggested criteria for parameters to be measured include:

- The parameters and methods should be tailored to fit the water quality impacts possible from the BMP at that site.
- Methods to be used should provide consistent and practical measurements and be accomplished within the program budget.

Data Management and Analysis

The 208 Team developed and used a computer database in making its final assessment of the adequacy of the Rules. Data from the site evaluations was organized by Rule number and linked to the THP number. The output from the database was referenced by THP number and Rule number in the same format as had been originally recorded during the site visit. The rating scores were tallied by individual Rule, and by THP; and subtotals were made by Rule category and by CDF District for analysis.

- The lesson learned from this approach is that setting up a database is time consuming and requires a full understanding of the objectives to be achieved prior to developing the database system.

The BEAC recognized that management of the water quality-related data that will be generated from the monitoring program is crucial to the evaluation efforts. Reliable analysis will be depend on good data management. Their recommendations included:

- The U. S. Forest Service's data storage and retrieval system should be reviewed and similar procedures adopted, where applicable.
- A User's Guide should be developed to ensure consistency in data management.
- Standard summary forms should be generated, with yearly transmittal of summarized data provided to the involved agencies.

According to the BEAC report, ensuring that everyone learns from the results of the monitoring effort is the function of effective "feedback loops". The results should be used to:

- Help correct the problem in the field (BMP Implementation Phase);
- Identify those BMPs which are not adequately protecting water quality;
- Find ways to improve those BMPs deemed inadequate;
- Inform the RPFs and the BOF about their effectiveness and the need for any improvements.

Related Ongoing Monitoring Programs and Studies

Several other monitoring efforts related to the BOF's program are currently underway. One is a parallel program on California's National Forests; there are two projects are in progress testing the usefulness of certain instream methodologies; and there are two research-level analyses of the long-term effects of logging activities on water yield and quality.

U.S. Forest Service's BMP Evaluation Program

The California regional office of the U.S. Forest Service (USFS) has recently developed a process to evaluate the implementation and effectiveness of its BMPs in attaining water quality objectives (USFS, 1992). The program has been tested in the field for two years, and is being effected in each national forest through the use of training sessions and a detailed handbook and procedural guide. While the USFS administrative process and its specific BMPs are, for the most part, different from those of the BOF and CDF, the proposed state BMP monitoring program can still benefit from the USFS effort.

The process is composed of three primarily qualitative evaluation components: 1) administrative, 2) on-site, and 3) in-channel. Forest Service personnel, as individuals or teams, complete standardized evaluation forms for each category of BMPs related to a particular resource activity. Administrative evaluations are broad-scale, post-project assessments of multiple BMPs at the project level, such as for timber sale planning or a prescribed burn. Assessments are made subjectively while in the project area, as to how well the prescribed BMPs met the project objectives.

On-site evaluations are used to collect representative, objective data at the site of BMP implementation. Based on field observations and measurements, this component assesses both BMP implementation and BMP effectiveness using qualitative rankings on the evaluation forms. Effectiveness is determined after the practices have been exposed to seasonal hydrologic events but before conditions are masked by site recovery (i.e., at least one, but not more than two winter seasons). Both "representative" projects and sites "of greatest concern" are selected. Random sites are selected according to defined methods where statistical tests are desired, while "special concern" sites are pre-selected for non-statistical analysis. (See Appendix C for an example of an evaluation form.)

In-channel evaluations are intended to objectively assess the cumulative result of multiple BMPs for a project and to indicate the effects on beneficial uses. The evaluation techniques need to distinguish between natural and management related impacts. If in-channel evidence reveals that problems have occurred, then intensive, non-random investigations of on-site sources of nonpoint pollution are initiated upstream of the problem site. A detailed, specific Monitoring Plan is developed by the Forest for each in-channel evaluation effort, to be focused in watersheds "of most concern". Comparisons are made of different sites, as between "treated" and "control" stations (above/below project or paired watersheds), and/or of different times (the before, during and after periods).

To assist analysis of the on-site evaluation data, a standardized BMP data base program has been developed. Data storage, retrieval and analysis are performed through the USFS's Data General ORACLE system and are the responsibility of the Forest Hydrologists. Reporting methods for each type of evaluation are also defined, with the final report forwarded annually to the Regional Office. Where BMP deficiencies are noted, action plans are to be prepared to correct the problem(s).

North Coast Regional Water Quality Control Board

In its Water Quality Control Plan for the North Coast Region, the Regional Board has specific objectives to protect beneficial uses from undesirable effects due to discharges from logging-related activities. However, the lack of a quantitative method for objectively assessing the effects, particularly on cold water fish habitat, has hindered the Regional Board in its evaluation efforts.

To remedy this situation, the North Coast Regional Board is implementing a plan, in cooperation with CDF, to explore various instream monitoring techniques. This monitoring plan is testing the hypothesis that upslope watershed disturbances impact fish habitat and are measurable. If certain parameters and techniques are found useful and feasible, they will be considered by the Regional Board for incorporation into the Regional Plan as new water quality criteria.

Three parameters, focusing on in-channel characteristics, have been selected for testing. The sampling involves the selection of a minimum number of low gradient reaches of mainly third order streams, in both managed and unmanaged (control) watersheds, stratified by geologic type. The range of habitat values found in the managed reaches will be compared with that found in the control reaches. Field work is being performed during the low flow period from June to October 1992, with project completion expected by June 30, 1993. This effort will complement that of the BOF Pilot Monitoring Project and may lead to improvements in the Long-term Monitoring Program.

Redwood Sciences Lab: Pool Sediment Evaluation

Research by the U.S. Forest Service's Redwood Sciences Laboratory (Pacific Southwest Research Station) in Arcata is seeking to provide forest managers with better ways of assessing, monitoring, and predicting the effects of forest management on fish populations. One promising method is the measurement of fine sediment volume in pools (Lisle and Hilton, 1991).

This new method assumes that the relative volume of fine sediment in pools is a sensitive index of a channel's response to the volume of sediment delivered. As the supply of sediment increases in a channel, fine sediment (sand and fine gravel) becomes more abundant on the bed surface and is concentrated in pools during low flow. Fine sediment volume can be measured by probing with a metal rod along transects. The fraction of residual pool volume filled with fine sediment becomes an index which can be used for comparison between sites (e.g., upstream, downstream of an activity) or over time (e.g., annual comparisons of the same pools).

The intent of the study is to expand the data set of fine-sediment volume in pools, which was originally developed in the Trinity River Basin, by including greater variety in geology and physiography of channels and basins in Franciscan, and Sierra terranes. Undisturbed basins will be targeted to establish background conditions. Fine sediment and the residual volume of 15 or more pools will be measured in each sampled stream reach. Disturbed basins will only be included where recent sediment yields and inputs have been measured.

Redwood Sciences Lab: Watershed Diagnosis

The USFS's researchers in Arcata will also be conducting a study in 1992-93 to tie together various management issues and approaches to watershed assessment (Reid and Ziemer, 1992). This follows a previous analysis for CDF by Dr. Leslie Reid (1991) regarding the strengths and weaknesses of current cumulative watershed effects (CWE) analysis methodologies. The next step is to develop a "tool box" of predictive methods for evaluating changes in hydrology and sediment production, which can then be used to help focus monitoring efforts. Recommendations for new research studies needed to fill gaps in current analysis and measurement methods will be another product of this study.

Caspar Creek Watershed Study

Since 1962, the Caspar Creek watershed in CDF's Jackson Demonstration State Forest, located in coastal Mendocino County, has been the site of several ongoing watershed studies. Researchers from both CDF and the U.S. Forest Service's Pacific Southwest Experiment Station have evaluated the effects of various forest practices on water and sediment discharge in both the South Fork (1047 acres) and the North Fork (1195 acres) subbasins (Ziemer, 1991).

This intensive level of research monitoring has required the installation of some permanent and semi-permanent stream flow measurement and sediment collection devices. A rectangular weir with a v-notch was constructed at each fork in 1962. Hydrologic data, including streamflow, precipitation, suspended sediment and bedload measurements, have been continuously collected on these two sites since 1985. For the North Fork phase, an extensive network of flumes with pumping samplers have been installed.

In addition to the streamflow and sediment studies, the Pacific Southwest Experiment Station has been conducting studies on water transport through soil pipes and subsurface soil drainage. The University of California has been measuring the effects of timber harvest on stream biology and water dissolved nutrients.

While the South Fork phase is monitoring the impacts of road construction and selective tractor logging, the North Fork phase of the study is currently monitoring the impacts of clearcutting a portion of the North Fork using upper slope road construction, emphasizing cable yarding techniques. The objective of the latter study is to evaluate possible "cumulative" effects of logging from the headwaters to the weir (Henry and Sendek, 1985). Logging began in 1989 and was completed in January 1992. In addition, the study seeks to identify sediment sources throughout the watershed and to evaluate the magnitude and movement of sediment. A first evaluation report is expected in 1994-95.

CDF Inventories

In response to the public concerns reported in the BEAC Report, CDF has initiated two contracts for inventories aimed at assisting the monitoring and evaluation program. An **Inventory of Highly Erosive Watersheds** and an **Inventory of Small Community Domestic Water Sources** will identify specific resources-at-risk. These inventories will also help foresters and CDF staff to identify critical resources during the Timber Harvest Plan preparation process.

Inventory of Highly Erosive Watersheds The purpose of this project is to map watersheds in the commercial timber zone based on their erosion hazard, integrating both surface and mass erosion processes. A method to rate the potential erosion hazard will be developed to arrive at a comparative rating for each watershed's overall erosion sensitivity. This information will be displayed on watershed maps which will be available at the CDF Ranger Unit offices. The inventory is scheduled for completion in September 1993.

Inventory of Domestic Water Sources The Forest Practice Rules require that CDF utilize mitigations to protect community drinking water sources from adverse impacts resulting from timber harvest and roading. In order to protect these resources from timber operations, foresters must be aware of their locations. This inventory will identify the location of sources with five to 200 connections in commercial timber zone areas with state, private and federal ownership. Maps will be developed to show water source locations. This information will also be available, in map form, at the local CDF offices. The inventory is planned to be completed in May 1993.

Other Research Projects

This discussion of projects and studies is not intended to be exhaustive. There are other monitoring studies being conducted by the agencies including the DFG, the Coastal Conservancy, the Regional Water Quality Control Boards, and the University of California. Interest in monitoring the effects of resource management on fisheries and water quality has grown immensely in the past ten years. Other groups such as the Salmonid Restoration Federation, the Watershed Management Council, and the Pacific Coast Federation of Fishermens' Associations, California Licensed Foresters Association, and the Society of American Foresters, have sponsored studies and conferences to communicate to the public and other researchers the findings of such studies. The proceedings from these conferences are an excellent starting point to locate information pertaining to forestry and fisheries-related monitoring efforts that have been undertaken in California. One of the remaining challenges is to incorporate this growing body of information into an ongoing and feasible monitoring program.

Part 3. Purpose of the Best Management Practices Assessment Program: Long Term Monitoring

As discussed in Part 1, a requirement of the Management Agency Agreement between the SWRCB and the BOF and CDF and for EPA's approval of the BOF's BMP program is to establish whether or not the Forest Practice Rules protect water quality. To meet this requirement, the Board of Forestry is committed to establishing an ongoing long-term monitoring program to demonstrate whether or not the Rules provide effective and adequate water quality protection.

In developing the recommendations for a monitoring program, the Monitoring Study Group began with the objectives outlined by the BEAC, and modified them based on its monitoring expertise (See pages 9-10). Once the objectives were in place, the actions needed in a long-term monitoring program were identified to satisfy those objectives. The MSG then selected activities to be tested during a short term pilot project. The ultimate goal of both the pilot study and the MSG is to establish an ongoing monitoring program that will evaluate the effectiveness of current and future Rules/BMPs. The issues and assumptions for a long-term monitoring program are set forth on page 26.

Questions to be answered by the Monitoring Program

In addition to the objectives presented on pages 9-10 of this report, the following specific issues must be addressed for each THP that is monitored.

- Were BMPs used in the necessary locations.
- Were appropriate BMPs correctly implemented as prescribed by the Rules.
- Are properly applied BMPs adequately protecting water quality and beneficial uses. (Did they work as expected?)

Assumptions

The following assumptions were made for both the long-term and pilot monitoring programs. These assumptions are derived from the Monitoring Objectives discussed above.

1. Four types of monitoring will be done: implementation, effectiveness, project, and trend monitoring (see MacDonald et al. 1991).
2. The beneficial uses of water of most concern are cold-water fisheries and domestic/municipal water supplies; as a result, sediment discharge and thermal pollution are the only nonpoint water quality problems to be assessed.
3. Program monitoring, or evaluating the institutional policies of the agencies, is broader than the scope of this effort. The proposed monitoring program, however, will contribute substantially to evaluating the strengths and weaknesses in rules implementation.
4. The BOF Rules will continue to change. Effectiveness monitoring will evaluate the pertinent rules and will be supplemented with evaluations of new rule versions.
5. This effort will emphasize use of an effective and credible approach which will provide information for managers, decision makers, and the public. Field observations plus qualitative and quantitative data will be used to link timber management activities with water quality changes (BMP implementation to stream impacts).
6. The methodology for the program should be subject to review and change over time, as new field techniques and improved knowledge about hillslope and channel processes develop. Such change much recognize and address potential effects on earlier measurements.
7. The long term monitoring of cumulative impacts is limited to identification of changes in parameters (trend monitoring) over time in selected channel research. Baseline monitoring will be included to the extent that change over time will be identified. Sampling intensity is likely to be inadequate to determine whether specific standards are being met (compliance monitoring).

General Purpose and Objectives of the Long-term Monitoring Program

A long-term monitoring program is generally intended to provide feedback needed to make informed management, policy, or regulatory decisions, not to provide evidence of a quality which is needed for legal or scientific purposes.

This long-term monitoring program is intended to provide an ongoing assessment of the effectiveness of the State's Forest Practice Rules, as implemented, in protecting the most sensitive beneficial uses of water (i.e., coldwater fisheries and domestic water supplies) through implementation monitoring, effectiveness monitoring, and project monitoring.

This long-term monitoring program is <u>not</u> intended to : 1) directly address all cumulative watershed effects, 2) measure undisturbed watersheds to establish baseline watershed conditions, or 3) determine whether specific water quality criteria or standards are being met.

Part 4. The Pilot Monitoring Project

General Purpose and Objectives of the Pilot Program

Pilot programs are intended to provide initial information which is needed by technical personnel, statisticians, and managers to develop efficient and effective program design, sampling procedures and protocols, and data management.

By implementing a Pilot Monitoring Project first, the BOF will be able to gain practical experience before making the larger commitment to a long-term monitoring program. The Pilot Project will test the proposed long-term monitoring approach on a smaller scale and shorter time frame to identify feasible monitoring techniques for the long-term program.

This pilot program is intended to:

- Familiarize technical personnel of participating organizations with sampling devices, procedures, and protocols, thus improving the reliability of subsequent data.
- Provide a set of data for management, analysis and evaluation, thus improving the linkage between the measurements and the monitoring objectives.
- Ensure that the parameters, methodologies, types of sites , and the data management procedures provide meaningful results and are cost-effective. This will minimize the probability of changes which could preclude statistical comparisons with earlier data.

- Evaluate procedures and methodologies which are designed to assess:

  1. Whether resources-at-risk and the threats to them have been adequately evaluated, appropriate protection measures have been specified, and specified measures have been implemented (**implementation monitoring**).

  2. The effectiveness of individual forest practices in achieving their immediate objectives either: a) on the hillside (i.e., prevent or reduce disturbance of soil, loss of ground cover, loss of tree root strength, disturbance of groundwater hydrology, and reduction of slope stability in order to prevent or minimize soil exposure and detachment, sheet rill, or gully erosion, and mass wasting); or b) near water bodies (i.e., prevent damage to stream banks and channels and to the beneficial functions of near-stream vegetation) (**effectiveness monitoring**).

  3. Combined effectiveness of hillside and streamside forest practices used on a specific project in achieving protection of the most sensitive beneficial uses (i.e., cold water fisheries and domestic water supplies) (**project monitoring**).

  4. Effectively manage (i.e., input, store, retrieve, and analyze) data generated by the monitoring program to provide meaningful information to decision-makers.

- Provide managers with reliable information regarding the costs, time commitments, and resources needed to establish and maintain a long-term monitoring program.

Because of its limited time frame, the pilot project is <u>not</u> intended to : 1) measure long-term changes in parameters (trend monitoring), 2) measure pre-project "undisturbed" baseline conditions (baseline, inventory, or assessment monitoring), 3) provide reliable conclusions from implementation monitoring, effectiveness monitoring, or project monitoring, 4) assess cumulative watershed effects, or 5) determine whether specific water quality criteria or standards are being met (compliance monitoring). However, some of these items may be incidentally achieved.

Several assumptions must first be made explicit about the expectations for the Pilot Monitoring Program:

- Due to the short-time frame, conclusions about overall Rule/BMP effectiveness will be limited to those procedures, conditions and practices addressed by the pilot study.
- The logistics, costs and data analysis of the pilot program will mimic the range of parameters (e.g., upslope and instream sites; winter and summer periods) which may be used in the long-term program.
- Unless shown to be inadequate or impractical, the same parameters used in the Pilot Program will be used in the long term program.
- The test data will be analyzed and evaluated to help determine if monitoring objectives will be met by the proposed approach.
- Efforts will be made to complement other concurrent monitoring activities in both site selection and parameter selection.

The Monitoring Study Group recommends the procedures described below for implementing a Pilot Monitoring Project, and similarly, a Long-term Monitoring Program. Since the key components of an effective monitoring program can be organized under a "WHO-WHAT-WHERE- WHEN-WHY and HOW" approach, project/program requirements will be presented under these categories. The WHY of the project and program is the Objectives, and without these clear statements of attainable ends, the monitoring effort will flounder. These General and Specific Objectives are listed in Part 1 (pages 9 and 10).

Monitoring Implementation of the Rules

As emphasized in the public testimony to the BEAC and in the findings of the 208 Review Team, the essential first step in assessment is to ensure that the Rules/BMPs have been adequately selected and implemented. **Poor implementation of the required practices during timber operations is the most common cause of significant impacts** (SWRCB, 1987). While CDF presently has an internal audit procedure to promote uniform and correct forest practice compliance, the scope includes issues besides BMP implementation and effectiveness. Some results of these audits are also not available to the public since personnel evaluations are included. **Changes need to be made to CDF's procedures to assure both successful BMP implementation and accountability to the public.**

Recommendation 1. ***Appropriate practices must be included in the Timber Harvest Plan.***

CDF staff and the interagency, inter-disciplinary THP Review Team analyze THPs for the adequacy of the proposed measures to protect water quality, **emphasizing high risk or sensitive conditions (see following discussion) and non-standard practices.** A pre-harvest inspection of the THP area is conducted when needed to address review team concerns. Inappropriate or inaccurate practices are noted in the Pre-harvest Inspection Report (PHI), along with recommendations for appropriate practices. Correction is a condition of THP approval.

While this procedure is basically in place, the Pilot Program needs to evaluate whether high risk and sensitive conditions, and non-standard practices receive adequate attention. Other agencies and disciplines (i.e., fisheries biologists, geologists, hydrologists) are not always present at THP preharvest inspections, and the potential for water quality problems is not always adequately addressed when nonstandard practices are used. Of the 218 substantive requirements reviewed in the 208 team Report, only 29 could not be "flexed" via an exemption, exception, in-lieu practice, or alternative practice (Gaylon Lee, SWRCB, pers. comm.). While recent Rule revisions have removed some of these options, the inherent flexibility of the Rules means that nonstandard practices can be better or worse than standard practices.

Recommendation 2. ***Designated practices must be implemented.***

To evaluate implementation adequacy, completed THPs in the monitoring program sample should be inspected by a "post-harvest inspection team" composed of the proposed Monitoring Team and, where possible, the CDF Compliance Officer, RPF, LTO, and landowner before the first winter. The Monitoring Team will be responsible for performing evaluations, including:

a. Development of a new implementation rating form for each group of BOF Rules related to practices that potentially affect water quality. The form will be based those used for the USFS's Best Management Practices Evaluation and the 208 Team's field assessment. The USFS's BMP Evaluation handbook and procedural guide should be used to assist with development of evaluation methods.

b. Coordination of on-site implementation (and effectiveness) monitoring inspections with those conducted by the CDF Compliance Officers, whenever possible.

c. Inform the RPF, LTO, landowner or other appropriate entities, as soon as possible, of situations where rules were improperly applied or not applied. If the problem is not corrected in time for the monitoring effort, then the rule, as applied or not applied, will still be evaluated during effectiveness monitoring in order not to bias the sample. The problem would also be noted for the Implementation record.

d. Annual reporting of the Implementation evaluation results which should be made available to the public.

Who Should Do the Monitoring

The BEAC report recommended that the agencies responsible for conducting the monitoring program should be CDF, DFG, RWQCB, and SWRCB to assure an objective and credible BMP effectiveness evaluation process.

The MSG felt that the program should incorporate a consolidated state agency approach tapping the experience and information of field staff from the Regional Boards, DFG, and CDF. CDF will act as the coordinating agency under the guidance of the MSG. This would create a "separation of interests" which would include non-supervisory participation by CDF staff and enhance feedback into the regulatory loop. From the standpoint of garnering resources for the long-term program, the MSG and the involved agencies will need to develop institutional arrangements that specify: a) project administration; b) personnel and resource commitments; and c) the fiscal support required to implement the program.

The ability to carry out these recommendations is dependent upon funding and personnel assignments within CDF and other interested agencies. The state's fiscal difficulties were not yet apparent during the MSG deliberations regarding the monitoring program recommendations presented below. These new circumstances may mean budget cutbacks for all state agencies and require consideration of less cost alternatives for both the pilot and long-term programs which were not discussed by the MSG. The MSG recommendations are discussed below with the lower cost options for both the pilot project and the long-term program presented in Part 5.

In order to understand the resource needs for an ongoing long-term program, a pilot program has been proposed to test the proposed monitoring methods within a short period. Because the institutional arrangements discussed above are not yet in place, and without such arrangements it would be difficult to reassign full-time agency personnel to perform the task under the anticipated time frame, the MSG recommended that the pilot monitoring project be performed by a private contractor or an agency that would have the capability of carrying out the program quickly. Information gathered concerning the feasibility and adequacy of monitoring techniques, and data gathering and analysis would be used to flesh out the long-term program structure and direction.

Recommendation 3. ***Agencies with assistance from outside consultants shall develop and implement a pilot program.***

The MSG will develop a work plan. The pilot program will be developed with interagency oversight by CDF, the BOF, the SWRCB and DFG. The following are specific recommendations for the pilot project:

a. Personnel conducting the Pilot Program shall have expertise in the following areas: (1) familiarity with BOF Rules, (2) familiarity with water quality monitoring (soil erosion, stream habitat, water quality) and (3) professional training in the following: a) geology, soil science forest hydrology, fishery science, forestry; b) resource management, timber harvesting, forest road construction and maintenance, or erosion control.

b. The agencies and the MSG will review the results of the pilot project and make final recommendations regarding a long-term program. Final decisions regarding the long-term monitoring program will be made by the BOF and the SWRCB.

c. Management from the DFG, the SWRCB, and CDF should direct their staff to participate in the pilot monitoring program. A goal of the project will be to provide on the ground training in monitoring techniques for agency field staff. **This agency linkage is important to ensure public credibility and to provide continuity with agencies involved in conducting the long-term monitoring program.**

d. Opportunities to observe both implementation and effectiveness monitoring should be provided to interested members of the public and the RPF who authored the THP. Public representatives for the Pilot Project should be selected by the MSG, based on resource management knowledge, interest, and availability, especially for wet-weather field assessments. Land owner permission will be needed for public representative participation. Requests for participation should be sent to the MSG, through the BOF, in time for adequate consideration and selection.

e. The Pilot Project should make recommendations regarding the number of teams and the level of agency resources needed to implement the long-term monitoring program.

Recommendation 4. ***Selection of THP monitoring sites for the pilot project should test the same range of water quality conditions as those in the long-term program.***

While a statistical approach to selecting the potential sites is desirable for the long term program (see Part 5), it will not be possible in the pilot project because of the small number of sites to be evaluated. Instead, the most effective method to select this range of potential problems for the pilot effort is to:

a. Select at least 10 new THPs in one CDF District for testing, based on the recommendations of the Preharvest Inspection Teams, to obtain the following distribution:

   - 40% THPs at extreme water quality risk sites
   - 30% THPs at high risk sites
   - 20% THPs at moderate risk sites
   - 10% THPs at low risk sites

b. Sites should be clustered to ensure reasonable access by the consultant monitoring team.

c. Choose only THP sites accessible during wet weather.

"Water quality risk" is based on the experienced judgment of the THP Review Teams. High and extreme risk sites include, but are not limited to, those areas with: a high potential for mass wasting, highly erodible soils, Class I streams, steep slopes (> 50%), downstream domestic water supplies, winter operations, watersheds with extensive harvesting or 'in lieu' practices, and critical riparian areas.

The sampling design and selection criteria for the long-term program are discussed in Part 5.

Selection Within Monitoring Sites

Monitoring site selection within or adjacent to the THP depends upon the type of proposed instream parameters and hillslope processes being evaluated (see Appendix B for proposed methodology). In-channel sediment, for example, tends to deposit in pools and lower gradient reaches, and such deposits may be concentrated considerably downstream of the THP site. Hillslope soil is deposited downhill (and eventually off-site) when eroded through various erosion processes: surface (sheet and rill), gully, streambank, and mass wasting. Monitoring the movement of hillslope sediment close to the site of Rule/BMP implementation is critical for effective assessment. In-stream monitoring sites shall be located at appropriate sites to allow effective measurement of the impacts of timber operation.

When To Monitor

Recommendation 5. ***The proposed time period in which to conduct the Pilot Program:***

The recommended time period is:

Spring '93	Initiate contract; review Rules; develop field evaluation forms.
Spring '93	Select THPs and perform pre-harvest monitoring.
Summer-Fall '93	Evaluate whether Rules were implemented adequately; refine field evaluation forms.
Fall-Winter '93 - '94	Perform onsite effectiveness reviews and wet weather monitoring.
Spring '94	Develop database and analyze winter data.
Summer '94	Perform instream monitoring.
Fall '94	Analyze summer data and complete report.

Critical time periods for monitoring depend upon the individual factors and parameters to be measured, indicated in the following stages:

- Pre-harvest condition:
- Post-harvest condition, pre-storm runoff:
- Storm runoff period (after saturated soil conditions occur):
- Post-storm runoff period (before sediment deposits become obscured):
- Summer low flow period:

The specific timing (time of year), frequency (number of times per year), and duration (number of years) for each proposed hillslope and instream parameter is described in Appendix B. Recommendations for determining frequency and duration for the long-term program are offered in Part 5.

Recommendation 6. ***The Pilot Program should give primary attention to testing the following PASSSFA (Parameter Selection System for Streams in Forested Areas) rated parameters with confidence factors of 90 or above:***

- Temperature
- Pool parameters
- Bed material size and sorting
- Riparian vegetation
- Large woody debris

The specific methodology for applying each parameter for the Pilot Project is described in Appendix B.

Other Considerations

It may be necessary, in addition, to relate site-specific parameter selection to the size of the stream channel potentially impacted. First, second, and third order streams may require different parameters or methods than fourth and fifth order streams in order to obtain useful evaluations. Some parameters may also need to be measured qualitatively.

To track the sources of sediment upslope from the stream, turbidity measurements can be used as a forensic or source and search tool instead of the more expensive tools used for trend monitoring. For example, water samples taken by a grab sample or by a stationary split sampler at approximately the same time during storm runoff can be obtained upstream and downstream of a THP site. The turbidity levels can be read on-site using a portable turbidimeter. If a significant increase in turbidity is seen at the downstream site, then it becomes more important to track down the sediment source(s) at that time.

The sediment may be coming from: (1) the harvesting site, which means the individual practice(s) contributing sediment need to be identified in the field; (2) roads off the THP site; (3) stored sediment in swales, ditches or channels, which may be caused by previous activities; or (4) streambank erosion. If no significant increase in turbidity is detected, then the sediment source is from an upstream source off-site. (In granitic watersheds, turbidity will not work well as an indicator since sand-sized sediment tends to move as bed load rather than as suspended load.)

New monitoring methods, some of which are more simplified procedures, are being continuously developed. For example, Lisle and Hilton (1991) recently developed a relatively easy technique to measure fine sediment in pools. In other cases, more research on certain parameters may still be needed before they can be practically applied and interpreted in an effectiveness monitoring effort.

What Rules/BMPs Should Be Assessed

Many specific elements of the FPRs have been proposed as BMPs to protect water quality. The 208 Team identified 218 rule requirements related to the protection of water quality, representing more than 700 differently numbered rules. Except for improperly implemented rules, however, most of the observed water quality related problems involved a relatively small number of these rules on harvest sites with sensitive hillslope and in-channel site conditions.

Recommendation 7. ***The current rules (as of January 1993) should be evaluated, especially those pertaining to roads and landings and watercourse protection zones.***

Some of these controversial rules (i.e., for roads and landings and watercourse areas) have since been revised and are now being implemented (BOF, 1989a, 1989b). The adequacy of these improvements in protecting water quality will be evaluated in the long-term monitoring program.

In addition, the Critical Sites Erosion Study (Durgin et al, 1989; Lewis and Rice, 1989) surveyed plots on THPs harvested in 1978-79 and concluded that roads and landings were responsible for most of the mass movement erosion, especially on slopes greater than 58% and on non-cohesive soils. The BEAC report recommended that the rules pertaining to logging roads and landings be the first priority for monitoring, followed by watercourse and lake protection, harvesting practices and erosion controls, and cumulative impacts assessment.

TABLE 1. RECOMMENDED PARAMETERS, LOCATION FOR SAMPLING, AND RELATION TO BENEFICIAL USES[1]

Parameter/ Method	Location	Beneficial Use Analysis
HILLSLOPE		
Surface erosion (USFS, 1992)	Hillslope below BMP	Qualitative and quantitative data to rate recent erosion. Relate to potential sediment delivery to stream for fish habitat and domestic water supply.
Mass failure volumes (USFS, 1992	Downslope of THP	Estimate of sediment to stream for potential effect on cold water fish and domestic water supplies.
Photos (Magill, 1989)	Rule sites Instream Upslope	Sources of sediment delivery to stream. Visual effects to complement quantitative data. For both cold water fish and domestic water supply.
IN-CHANNEL		
Turbidity	In/Below THP area	"Forensic tool" to help seek source of sediment in non-granitic watersheds.
Pool Sediment Lisle & Hilton 1991)	Above, In, Below site	Cold water fish rearing habitat changes.
Bed material size	Riffles, Above, In, Below	Cold water fish spawning habitat changes.
Temperature	Above/below	Effect of riparian vegetation changes in WLPZ on cold water fish habitat

1/ Each parameter, unless otherwise referenced, is described and its measurement concepts discussed in MacDonald et al (1991), Appendix B. Refer also to Appendix A: only those at or above a confidence factor of 90 are recommended for instream monitoring.

How Monitoring Should Be Done

Recommendation 8. ***Use of both hillslope and in-channel evaluations are needed to fulfill monitoring program objectives.***

The selection of the appropriate monitoring parameters to apply is determined by the program's objectives. If only individual BMPs are to be evaluated, then effectiveness monitoring would direct the effort upslope and outside the stream channel. However, the program's objectives, particularly General Objective #3 and Specific Objectives #2, #4 and #5 (see pages 9 -10), direct this effort to examining the effect of the Rules on changes in fish habitat and domestic water supplies, therefore, in-channel evaluations are needed as well.

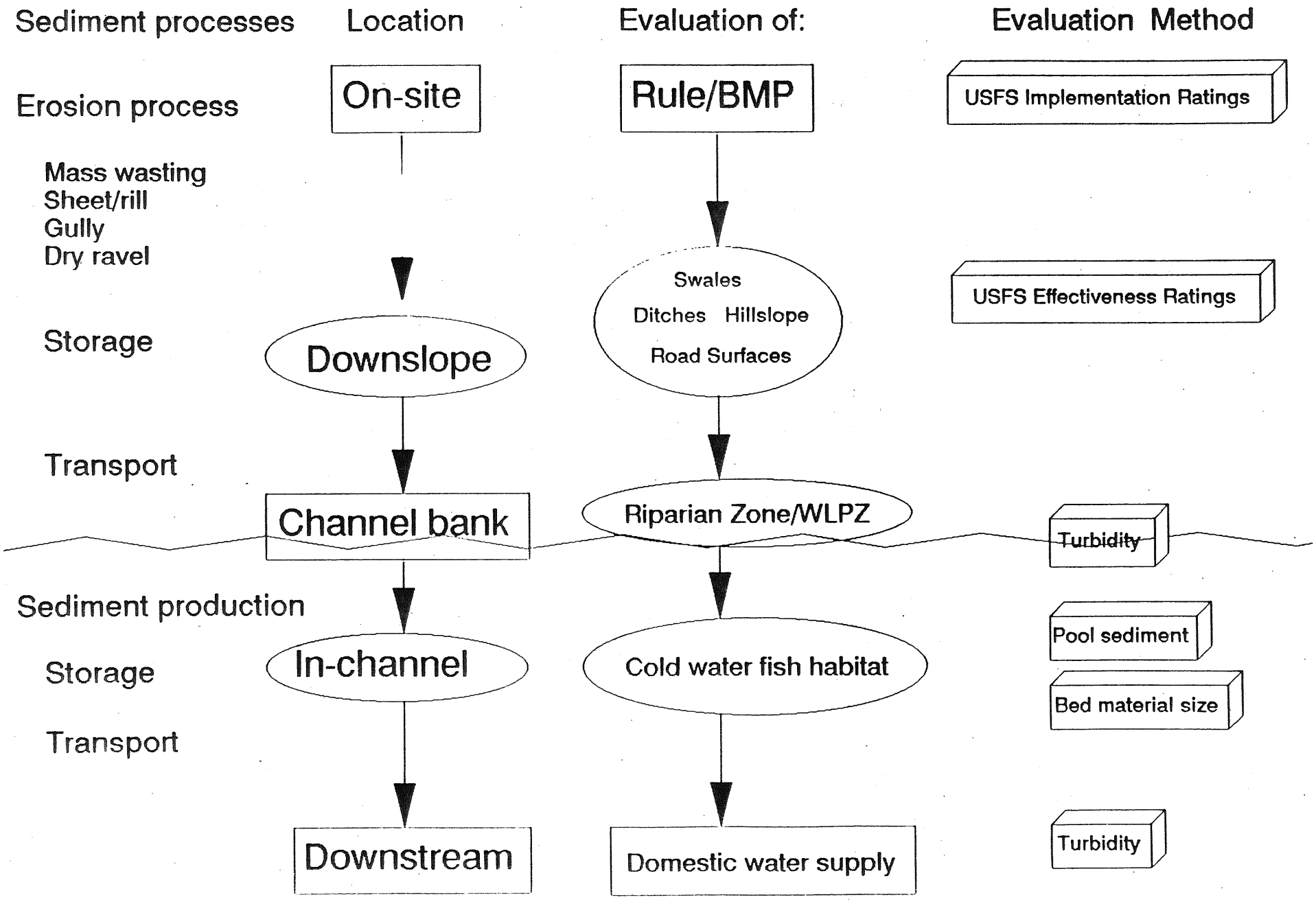
Understanding how hillslope and in-channel sediment processes behave is important in order to establish useful sediment monitoring methods. Figure 1 shows the general erosion-transport-storage processes that occur and relates them to the types of monitoring proposed for the Pilot Project, which are described in Table 1, and in Appendix B.

The precision required for the effectiveness monitoring effort is different from that required in compliance monitoring (i.e., is the water quality standard being met?) or for developing sediment budgets (i.e., how much sediment is being produced from the hillslope to the channel and delivered as sediment yield at the basin's mouth?). Qualitative assessment is adequate to answer hillslope BMP assessment questions (did the skid trail erode and deliver sediment to the channel?), while quantitative assessment is needed for most in-channel evaluations (did significant changes occur in the fine sediment levels of spawning gravels after harvesting and downstream of the harvest area?).

Hillslope Methods

Many of the methods included in the USFS BMP Evaluation Process for on-site effectiveness evaluation can be applied to the BOF's BEAP. The intent of the USFS on-site evaluations (as discussed in Part 2) is to gather representative, objective data at the site of BMP implementation. The purpose is not to develop quantitative estimates of erosion rates or the amount of sediment produced for each BMP, but to identify those practices that do not protect water quality.

Figure 1. Relationship between sediment processes and monitoring methods



The USFS method is primarily qualitative, based on visual observations and some measurements of relative erosion amounts. For example, one of the measures of the effectiveness of the skid trails practice is to rate the visual indicators of surface erosion on the skid trail. If more than 20% of the surface has rills, or rills are present that are 2 inches deep and greater than 10 feet long, then the third category/box (most severe) is checked. Combined with other on-site evidence of ground disturbance, rutting, sediment deposition from waterbars, and sediment delivery to the channel, an overall evaluation is made of skid trails for that site.

Standard forms are used by the USFS (see Appendix C) to evaluate both implementation and effectiveness. Certain changes will need to be made to the content of these forms to make them applicable to BOF rules/BMPs. The forms will need to be changed to relate the Rules to the practices applied in the field and to further relate on-site effects to the resources-at-risk for a wide variety of sites. Similar types of BOF rules/BMPs will be grouped together for evaluation on one form.

Tracking the visual evidence of sediment transport from a particular BOF rule site into the stream channel is the purpose of the hillslope monitoring procedures. In contrast, in-channel techniques measure relative changes in stream habitat quality before and after harvest, and upstream and downstream of the THP site.

In-Channel Methods

Parameter Selection

For instream monitoring, most of the methods used are well described in the recent EPA monitoring handbook (MacDonald et al. 1991). Parameter selection should focus on parameters that provide specific, quantitative (if possible) information on factors which limit the beneficial uses of cold water fish and domestic water supply. As described in Part 1, critical factors for fish are spawning and rearing habitat which are related to measured factors such as sedimentation, high temperatures, and instream cover. Excessive turbidity and reservoir sedimentation are the primary concerns for those domestic water supplies located downstream of timber harvesting areas.

One suggested tool to aid in the selection of the wide array of possible parameters is the PArameter Selection System for Streams in Forested Areas (PASSSFA), which is an "expert system" (MacDonald and Carmichael, 1991). As a supplement to EPA's monitoring guidelines (MacDonald et al, 1991), PASSSFA's computer analyses relate management activity (i.e., forest harvest; road building and maintenance) to effects on beneficial uses and allows selection of monitoring constraints (i.e., access, equipment costs, frequency, collection time, cost of analysis).

PASSSFA provides a ranking of recommended water quality parameters based on associated confidence factors (from 65 to 100). A higher number indicates a greater likelihood that a parameter will be useful to monitor the effects of a particular management activity on the selected beneficial use. Application of this system to four combinations of activity and use, and two levels of monitoring intensity is described in Appendix A.

Where To Monitor

Not every THP or harvested watershed can be monitored, either in the pilot project or in the long-term program. Logistics and cost prohibit such an undertaking. If a representative sample is taken, universal monitoring is not really necessary. Deciding where to perform monitoring involves two factors: (1) the appropriate selection of THP sites; and (2) the selection of locations within the THP site to monitor.

Selection of THPs

One of the lessons learned from the 208 Team Report was that standard forest practices as stated in the FPRs work provide adequate protection (with a few exceptions) for quality and beneficial uses of water except where sensitive site conditions exist or where sensitive physical or biological resources are at risk. These types of areas will need to be sampled in both the pilot project and the long-term program. Some low risk sites will also need to be evaluated, however, to ensure that the FPRs function well at this end of the spectrum and to provide some measure of the occurrence of sensitive sites. The THP selection process should provide for both hillslope and in-stream channel sampling locations, and provide sites for measurement of selected monitoring parameters.

Data Management and Analysis

Recommendation 9. ***Specific data management requirements need to be developed with the ongoing involvement of the MSG.***

The existing CDF THP database should be reviewed for its usefulness in conducting the monitoring program and for providing other management information. For the pilot program, the MSG will coordinate the development of a monitoring database and analysis procedures that meet the objectives of the BEAP program and the needs of CDF, the agencies, and other interests. The basic framework should include:

a. Develop and use a computer database that is accessible to personal computers to store and sort implementation and effectiveness data, including both the qualitative rankings and quantitative measurements.

b. Link data analysis with photo documentation points (see Magill, 1989).

c. Present outputs in tabular and graphical formats to aid in analysis, where appropriate.

d. Create a database and analysis procedures that can provide trend analysis for the long-term monitoring program.

Part 5. The Long-Term Monitoring Program

Lessons To Be Learned from Pilot Study

The ultimate goal of the BEAP is to establish a continuing monitoring program that will evaluate the effectiveness of current and future FPRs and BMPs. The Pilot Project will test logistics and monitoring techniques to determine the fiscal resources, number of teams, suitability of monitoring techniques, and database needs of the longer-term program. The differences between the technical aspects of the Pilot Project and the longer-term monitoring program are described below.

The Pilot Program will not address the critical institutional questions that are fundamental to the program. These questions can only be resolved by the involved agencies prior to initiating long-term activities, and are outlined in the concluding section.

Who Will Do the Long-Term Monitoring?

Recommendations from both the 208 Report and the BEAC Report are clear about the composition needed of monitoring program teams. The long-term BEAP should be performed by teams composed of personnel from the State agencies discussed in Part 2 and Part 4. The number of teams needed for the long-term BEAP will be based on the results of the Pilot Project which will track the travel time and effort involved in visiting the THP sites as well as the time needed to conduct monitoring evaluations per site. Ultimately, the number of teams and staff needed for the long-term program will be subject to the availability of agency resources.

For the long-term program, it will be critical for the MSG and the involved agencies to develop institutional arrangements that specify: a) agency roles; b) personnel commitments; and c) financial support for the program. To ensure objectivity and public acceptance of the monitoring results, CDF should coordinate the effort with other agencies and organizations.

How Monitoring Should Be Done

Methods identified by the Pilot Project will by used in the long-term monitoring program (see Appendix B for more detail). In addition, the science of monitoring is evolving. The long term monitoring program will be modified as needed to incorporate advances in science.

When Will Monitoring Be Done

Since the pilot project is only short-term in nature, the long-term program design will need to include decisions about the frequency and duration for monitoring each parameter. Both short and long-term monitoring sites should be established. The short-term sites (1-5 years) are needed only for those practices with the potential for immediate effects, such as the effect of WLPZ rules on stream temperature. Long-term monitoring sites (5-15 years) should be used to evaluate the effects of stress from at least one significant storm event, such as a 25 or 50 year storm, on those practices (culverts, or clear-cutting) and sites (e.g., slope stability in steep unstable watersheds with new roads) which may be vulnerable to such events .

Where Will Monitoring Occur

Selection of Sites Within a Watershed

THPs within watersheds should be selected for the long-term program based on a stratified random sampling approach. This sampling design is similar to that used in the 208 Study and also recommended in the BEAC Report. The Pilot Project will not test the use of stratified random sampling because the number of sites to be evaluated is too small. The pilot will, however, identify the database needs to facilitate stratified random sampling procedures for the long term program.

The objective of using a stratified random sampling procedure is to include a sufficient number of THP sites on different landscapes and at different levels of water quality risk for evaluation of forest practice rules across a wide range of conditions. It is essential that the relation between the sample strata and the population as a whole be either unbiased or have a defined bias so that results of sample analyses can be used to determine overall population impacts.

Factors to use in stratifying sampling sites, include:

- Hillslope conditions:
  - High risk of mass wasting (see Durgin et al, 1989).
  - Sites with highly erodible soils, such as decomposed granitic soils.
  - Erosion Hazard Rating on the THP (for sheet and rill erosion).
- Instream conditions:
  - Class I stream (3rd order or smaller) located within or adjacent to THP (an estimated 60% of all THPs have Class I or II streams within boundaries).
  - Domestic water supply identified on the THP or potentially affected downstream.
- CDF Ranger unit.

Selection of Candidate Watersheds

Stratified random sampling procedures are used to select THPs within a watershed, however, this approach does not deal with the larger issue of selecting which watersheds should be assessed over the long-term. Evaluating only randomly selected THPs does not provide a framework for understanding, in the long-term, the effectiveness of BMP program in a given watershed. Watersheds have different levels of sensitivity based on inherent geologic, climatic, or biologic conditions, and may need different protective or mitigation measures. For example, special forest practices have been instituted in the Grass Valley Creek watershed in Trinity County due to its highly erodible soils. One of the goals of the long-term program should be to assess, on a watershed-by-watershed basis, whether the practices are adequate and effective to protect beneficial uses in different watershed conditions.

The proposed **'sensitive watersheds' rule** currently under consideration by the BOF (BOF, 1992) supports, and would be furthered by, a watershed approach to monitoring. Use of an overall watershed approach for the long-term program would allow for the integration of different types of data to provide a resources-at-risk analysis for a given watershed. The watershed is the logical organizing unit for data collection; it provides a foundation with which existing information and complementary program efforts of different agencies and local groups can be utilized to form a holistic picture of watershed conditions. For example, limiting factors analyses for aquatic and other species, and fish habitat typing surveys conducted by DFG, geologic information from the California Division of Mines and Geology, and highly erosive soils information from CDF can all be utilized to identify particular sensitive watersheds in the commercial timber zone.

The identification of sensitive watersheds for long-term monitoring would assist in developing priorities for future studies needed to determine the limiting factors that affect habitat and water quality in these watersheds. Selected watersheds could be used as a basis to provide direction to existing complementary programs conducted by the DFG, SWRCB and CDF, as well as to direct future research and data collection efforts.

Finally, focusing on selected watersheds would allow monitoring efforts to distinguish between 'high-risk' or keystone[1] areas and those areas within a watershed which have a lower risk of causing impacts. The fact that a relatively small portion of a watershed can be responsible for a large percentage of erosion impacts is well documented (Durgin, et al, 1988). Efforts are underway to develop better methods to predict sensitive areas within a watershed, such as CDF's "Inventory of Highly Erosive Watersheds" and "Inventory of Domestic Water Supplies" (see Part 2). These tools can be used to target the focus of monitoring efforts within selected watersheds. For example, THPs in keystone areas would be subject to more intensive monitoring (greater frequency) and would be the logical sites for long-term monitoring sites (5-15 years). Conversely, lower risk areas would be the candidate sites for short-term monitoring (1-5 years) and would be subject to less frequent data collection.

Figure 2 illustrates the watershed approach for the long-term monitoring program.

[1]This term is colloquially used to mean those physical sites or attributes having a disproportionate effect on beneficial uses.

The Watershed Approach to Monitoring

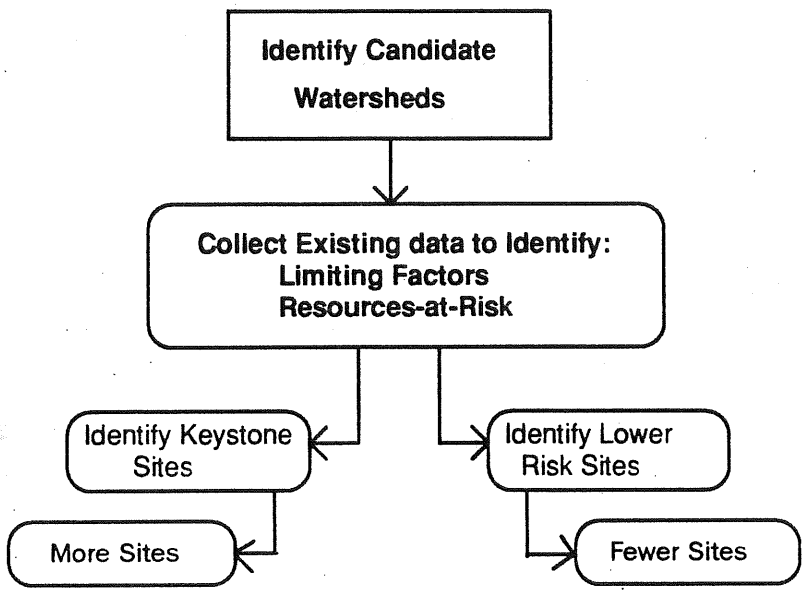


Figure 2

Factors to use in the selection of candidate watersheds include:

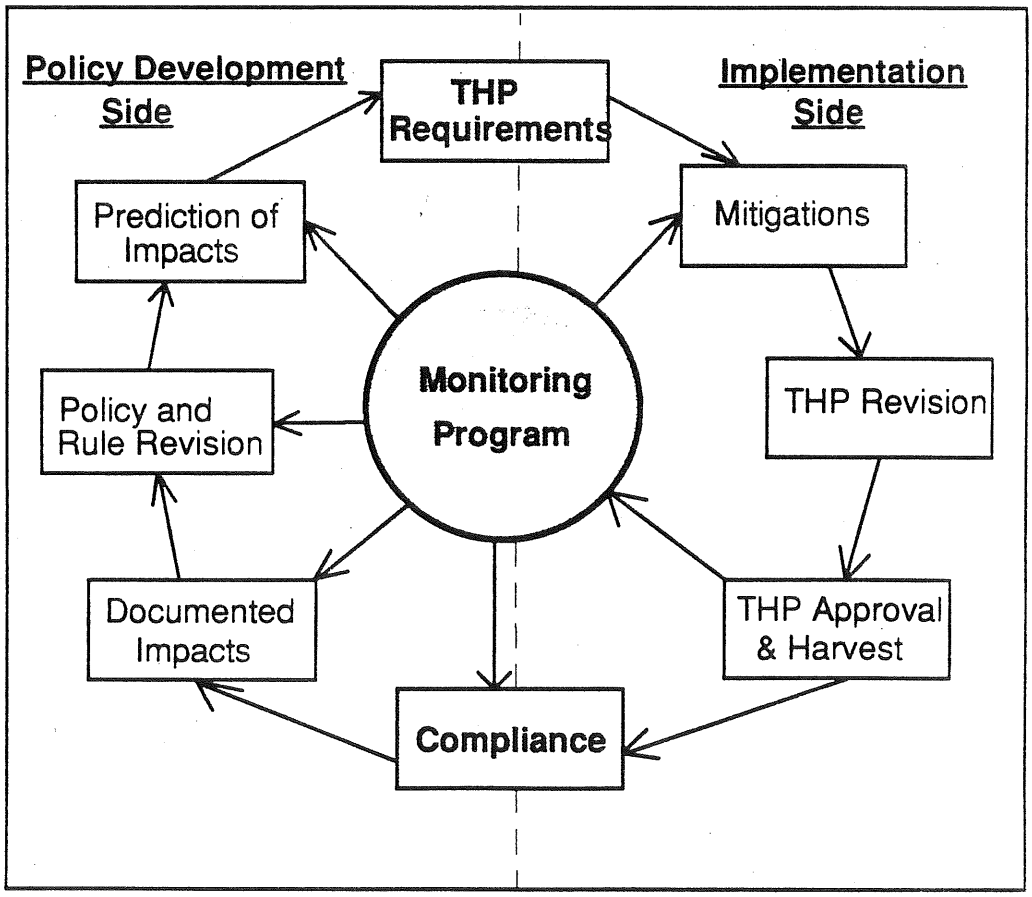
- Watersheds identified by the public in the BEAC Report (App.C).
- Watersheds nominated through the proposed Sensitive Watersheds process.
- Watersheds with sensitive aquatic species such as anadromous fish (see Appendix D).
- Availability of existing Department of Fish and Game survey information.
- Availability of existing U.S. Forest Service data in mixed ownership watersheds.

The Feedback Loop

The "208 Report observed that there was no effective feedback loop between the RPFs, review team agencies, or timber operators to provide information on the actual effects of the timber operations with which they have been involved. As a result, these participants could not readily learn from their experiences. This can lead to poor recognition of resources-at-risk and inadequate evaluation of sensitive conditions and potential impacts.

An important aspect of the long-term monitoring program must be the development of a feedback process to convey findings from these monitoring efforts. The BOF, through the Monitoring Study Group, should develop and adopt such a process to ensure that important feedback is incorporated in the day-to-day aspects of the timber harvest planning and review processes. Figure 3 shows some of the areas that should be included in this feedback loop both for policy and rule development and Rule/BMP implementation.

Figure 3



Monitoring Program Feedback Process

Funding Issues and Proposed Alternatives

The MSGs' efforts thus far, together with the reports of the BEAC and the 208 Team have clearly framed the overall plan for the monitoring and assessment program. These efforts have provided detailed direction for the pilot monitoring project as well. The staffing and fiscal resources needed to weave the plan and pilot project experience into a multi-year program have not yet, however, been identified.

Just as this report to the Board of Forestry was being completed, following the latest round of MSG discussions, the Administration and Legislature became engaged in a protracted debate over the State's fiscal condition and how to structure a State budget for fiscal year 1992-93 and beyond.

The State's fiscal situation compelled Board of Forestry staff to request alternatives to the General Fund-supported monitoring and assessment program recommended by the MSG in Chapter 4. In addition to the original MSG recommendation, three new alternatives are offered for the pilot project and long-term monitoring program. Alternative 1, the MSG recommendation, assumes new monies are available from the state budget to support a pilot and long-term program; Alternative 2. assumes no new public funds for monitoring, and relies upon redirecting existing staff resources to conduct and interagency team review; Alternative 3 assumes limited public funding and staff availability, thus relying on a volunteer supported monitoring approach; and Alternative 4 recognizes that new funding sources that could be used to support the MSG recommendation may become available through pending legislation. Alternatives 2 and 3 are the less cost alternatives driven by the severe budget cutbacks discussed above. These alternatives are presented in concept form only. More complete discussion of industry and interagency participation, funding and review processes would be necessary should the alternatives be considered.

Alternatives

Alternative 1: Budget support is available for the pilot and long-term programs.

This alternative (discussed fully in Part 4, Recommendations 3 - 9) was developed by the Monitoring Study Group under the previous budget projections. It responds most completely to the concerns raised by the public, BEAC, and the MSG.

Alternative 2: Reconstitute the "208 Team" Approach

This alternative would require redirection of existing staff with the review team agencies to conduct a field review of BMP effectiveness, similar to that performed in 1986-87 (See Parts 1 and 2 below). One or more teams would be composed of agency and industry professionals in water quality, soils and geology, fish and game, and forestry.

Sampling design and assessment protocols could remain much the same as Alternative 1 (See Appendix B), or modified through team consensus to meet funding constraints. The distinction between a pilot and long-term program may need to be reconsidered, however, based on the length of time that staff could be dedicated to the task. Further discussions would be necessary concerning the use of the stratified, random sampling approach within forest districts, versus watershed-focused sampling. Sampling would necessarily be limited.

The primary benefit of this approach would be the public confidence brought to the evaluation process by the interagency mix of expertise and regulatory perspective. Whether this alternative is realistic or not, however, rests on the ability of departments to redirect staff to a major research effort in an era of already-stressed budgets and staff work loads.

Alternative 3: Develop a Self-Monitoring Approach

This approach would make use of the existing THP review process and interagency personnel, and would require active participation by the timber industry, local watershed groups, and other natural resource organizations. Parameters to be monitored and methods would remain the same as Alternative 1 (See Appendix B), as tailored by the RPF and review team to the THP. The pilot phase would test the modified USFS evaluation forms for reporting BMP effectiveness, the data analysis process, and the interagency procedures for validation (spot checking) and review. The minimum length of the pilot phase may not need to be defined at the outset, but could depend upon iterative refinement of monitoring procedures and staff review. Once procedural methods were refined, the results of the pilot phase would be brought to the MSG for discussion and recommendations concerning the structure of a long-term program. As with Alternative 1, the pilot phase would not produce statistically-supportable conclusions on the effectiveness of BMPs, but would test the workability of the self monitoring approach in terms of program design, data collection, training required by RPFs and review team staff, interagency validation and review, and data analysis.

Research Needs and Issues

As a general recommendation applicable to both current and future research and the long-term monitoring program, it is important to devise and adopt a process to guide and coordinate the activities of research organizations conducting forest and range research both within and outside CDF. This process should include setting of priorities for funding and for selection of projects, a clearinghouse for project information, and a means of disseminating information to other researchers, the forest industry and the general public. While making specific recommendations for such a process is beyond the scope of this report, a good starting point would be to review the evaluation made by the State Board of Forestry Committee on Research (1986). As the BOF moves into a climate of increasingly complex rules that require extensive scientific support and documentation, during at time when budgetary constraints mean less available research funding, it is clear that each dollar spent on research must be targeted for specific and high priority needs.

With regard to research activities specifically related to monitoring activities, the MSG suggests that a study evaluating the use of silt fences to measure sediment delivery rates and mechanisms should be given a high priority for funding.

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Glossary of Monitoring Terms

The primary purpose of the Best Management Practices Effectiveness Assessment Program (BEAP) is to develop a monitoring program. As the project title implies, the proposed monitoring program will be directed toward evaluating the effectiveness of the water quality related Forest Practice Rules as Best Management Practices as that term is defined by Section 208 of the federal Clean Water Act. It is understood that to conduct a viable effectiveness monitoring program, implementation monitoring must first be performed. To describe the differences, the following definitions of monitoring are provided below (MacDonald et al, 1991):

Trend Monitoring. Measurements are made at regular, well-spaced intervals in order to determine the long-term trend in a particular parameter (e.g., changes in flow).

Baseline Monitoring. Existing water quality conditions are characterized to establish a data base for planning or future comparisons. The intent is to capture much of the temporal variability of the constituent(s) of interest, though there is no explicit end point at which continued baseline monitoring becomes trend monitoring. Sometimes the term is used synonymously with "inventory monitoring" or "assessment monitoring".

Implementation Monitoring. This method assesses whether activities, such as Best Management Practices (BMPs), were carried out as planned. Usually this assessment is done as an administrative review and does not involve any water quality measurements.

Effectiveness Monitoring. Evaluation is made to determine whether the specified activities (e.g., BMPs) had the desired effect. The narrow definition only includes the evaluation of individual management practices, such as the spacing of water bars on skid trails, while the broader definition includes the evaluation of the total effect of an entire set of practices (see also "Project Monitoring" below).

Project Monitoring. Assessment is made of the impact of a particular activity or project, such as a timber harvest. Often this approach is done by comparing data taken upstream and downstream of a particular project, or in some cases, on a before and after basis.

Validation Monitoring. In this context, it refers to the quantitative evaluation of a proposed water quality model to predict a particular water quality parameter. The intensity and type of sampling should be consistent with the output of the model being validated.

Compliance Monitoring. Determination is made whether specified water quality criteria are being met. The criteria can be numerical or descriptive. Usually the regulations associated with individual standards specify the location, frequency, and method of measurements. An example is determining whether the water quality objective for turbidity (i.e., "shall not be increased more than 20% above naturally occurring background levels") is being met.

Appendix A

Ranking of Water Quality Parameters by Confidence Factor[1]

Parameters	Activity/		Use/			Monitoring Level		
	Harvest/ Cold Fish		Roads/ Cold Fish		Harvest/ Water.Supply		Roads/Water Supply	
	Low/ Med	High	Low/Med	High	Low/Med	High	Low/ Med	High
Riparian vegetation	95	95	80	80				
Pool parameters	90	90	90	90				
Bed material size	90	90	85	85				
Temperature	90	90	70	70	75			
Turbidty		90		90		95		95
Large woody debris	85	85	80	80				
Channel cross section	80	80	75	75				
Riparian canopy opening	80	80	80	80				
Channel width/w:d ratio	80	80	75	75				
Fish		80		80				
Macroinvertebrates		80		80				
Suspended sediment		80		80		80		85
Intergravel D.O.		80		85				
Surface vs. subsurface		75		70				
Embeddedness		75		70				
Low flows		75						
Thalweg profile	75	75	85	85				
Bank stability	70	70	75	75				
Habitat types	70	70	80	80				
Peak flows		65		70				

[1] Source: MacDonald, L. et al, (1991). PASSSFA.

Appendix B

DESCRIPTION OF PROPOSED MONITORING PARAMETERS AND METHODS

Instream Methods

Unless otherwise specified, references for each method can be found in the appropriate section of MacDonald et al (1991).

Water Temperature

Purpose: To determine whether timber harvesting activities, through removal of riparian canopy, are significantly increasing instream temperature during the sensitive rearing phase of cold water fish. Sub-lethal and lethal temperatures are of most concern to evaluate the changes in fish habitat. (Objective #3 and Specific Objective #2)

Technique: a) Submersible thermographs left instream for 1-2 months which can continuously record water temperature at selected intervals. Data can be readily downloaded to the computer for analysis. (Caldwell et al, 1992); b) Standard max-min thermometer left instream for a period of time to record only the extremes in temperature at that site.

Sites: Since research indicates that headwater streams will likely have negligible stream temperature increases, the best stream locations for assessment are those which are at least 2nd order streams and identified as Class I or Class II streams (in the BOF Rules).

- Similar stream sites upstream and downstream of the THP location, or the WLPZ area within the THP, should be monitored.
- Average stream temperatures are best obtained in turbulent reaches. Temperature probes should be placed in the central flow of the channel.

Timing: Measurements should be made in the most potentially stressful period, between mid-July and mid-September. To compare with pre-harvest temperature variations at the upstream and downstream monitoring sites, pre-harvest temperature monitoring for one season is also suggested.

Frequency: Hourly measurements at the minimum, every 15 minutes at the maximum.

Duration: Two to three years: 1st year - pre-harvest, 2nd year -during or post-harvest; 3rd year - post harvest.

Analysis: Temperature data must first be downloaded and checked for quality. Measurements should be summarized to evaluate daily peak stream temperatures and diurnal fluctuations. Comparisons should be made of before and after conditions at the upstream and downstream sites.

Equipment Costs: a) Temperature recorders (Ryan TempMentor): 1st recorder = $712 (includes interface cable and standard software; 2-4 = $652 ; 5-19 = $591. b) Max-min thermometer variable costs.

Optional Method: (a) Manual thermometer for instantaneous measurement at time of site visit (may not coincide with peak stream temperature); (b) Riparian vegetation effect on stream shading, using the Solar Pathfinder technique.

Pertinent BOF Rules to be Evaluated: WLPZ primarily.

Bed Material: Particle Size Distribution

Purpose: To detect changes in substrate composition of spawning gravels caused by increased sedimentation.

Fine sediment can plug the gravel and be detrimental to the survival of salmonid embryos by reducing oxygen flow and by physically preventing the emergence of hatched fry.

Technique: A. Sampler to be used is a shovel (20 cm wide, 24 cm long) for most sites (Grost & Hubert, 1991); B. At other sites, sampler to be used is an excavated-core style such as a McNeil sampler (15 cm diameter, 22 cm long).

Transects are placed at even distances along the riffle/run area perpendicular to the flow. Samples are taken at evenly spaced points along the transect according to approved technique (Grost & Hubert, 1991). Samples are placed into a bag for drying and sieving in the lab. Sieves will be a series of 10 Tyler USA standard sieves with mesh openings of 50, 25, 12.5, 9.5, 6.3, 3.4, 1.7, and 0.85 mm.

Sites: A. Shovel can be used for lower gradient spawning habitat reaches with substrates consisting mainly of materials smaller than 10 cm in diameter, less than 40 cm deep, and with water velocities less than 80 cm/s.

B. McNeil sample can be used for similar sites but can better accommodate larger material (up to 14.5 cm diameter),

Sampling sites would be located using the paired-station approach, one station upstream (control) and one downstream (treated) of the THP area on the largest order stream and as close together as possible to minimize confounding site differences.

This technique should not to be used in steep headwater streams, streams with a clay substrate, or very low gradient streams.

Timing: During lowest flow period in August or September and before the beginning of spawning.

Frequency: Once per year for first three years; then only after a 25 year or greater storm event.

Duration: Year 1: Pre-logging conditions; through Year ___(at least one year following a 25 year storm event.

Sample Size: Depends on the stream size, substrate variability, and desired statistical significance. Estimated range is from 5 (2nd order stream) to 25 (5th order) samples per site.

Analysis: Results of sieving should provide dry weights (grams) by size class, including 95% confidence intervals. Characterization of the bed material should include: a) percent fines by size class; b) geometric mean diameter. Comparison of paired stations should be performed with tables and bar graphs.

Optional Methods: a) Embeddedness - for surface layer only; b) Surface vs. Subsurface particle size distribution - more field work needed (to be evaluated in North Coast RWQCB study).

Pool Parameters

Purpose: To detect changes in fine sediment deposits in pools upstream and downstream of the THP project site and indirectly indicate quality of pool habitat for cold water fish.

Technique: Apply the method of Lisle and Hilton (1991), which measures fine sediment volume in pools by probing the depth of deposits with a marked metal rod.

Sites: In a lower gradient reach of 10-15 clearly definable pools upstream of THP site and in another reach of 10-15 pools downstream, as close as possible to the THP boundary and with no intervening large tributaries or sources of sediment within each reach. As small as 2nd order streams can be evaluated. Transects (5-8) are placed at equal distance across each pool. Water depth and fines thickness is measured at a total of 30-60 locations in the pool, with more closely spaced measurements over distance deposits of fines.

Timing: During low flow conditions.

Frequency: Annually for first 3 years after harvest; every 2 years after that or in the season immediately following a major storm event, such as a 20 year event.

Sample Size: Lisle recommends 15 pools minimum per reach, but ideal sample size has not been analyzed and will depend on local variability.

Analysis: Compute the residual pool volume and fines volume within the residual pool. The fraction of pool volume filled with fines (V^*) equals the fines volume divided by the sum of fines volume and residual pool volume. A software program is available to perform these calculations. The weighted average value of V^* is used to characterize the entire reach. Comparisons of upstream and downstream stations can help reveal sediment sources and evaluate their magnitude and extent, such as by constructing graphs of V^* X distance downstream.

Equipment Costs: Less than $20 for steel bar; transect tape.

Optional Method: a) Channel cross-section; b) Thalweg profile.

Large Woody Debris

Purpose: To determine the amount of wood below the waterline at bankfull discharge that exceeds a minimum dimension. Large Woody Debris (LWD) is one of the most important source of habitat and cover for fish populations in streams. It is often the most important structural agent forming pools in small streams.

Technique: Measure the amount of LWD in a 50 meter reach and compare the value with other streams. Measure the volume of all pieces of debris >10 cm (~4 inches) in diameter that lie within the bankfull channel boundaries. The formula for computing the volume of stream section is:

$$Vol = \frac{\pi(D_1^2 + D_2^2)L}{8} m^3$$

where D_1 and D_2 are diameters of each end of the piece, and L is the length. The mass is computed by multiplying by a density of 400 kg/m^3. Debris loading is expressed as the volume (or mass) of wood per channel area (bankful width x length of channel sampled).

Sites: Second to third order watersheds should be sampled.

Timing: During the low summer flow period is easiest.

Frequency: Once, in the short term.

Duration: To observe significant changes, duration of sampling would have to be decades.

Sample size: Sample at least 2 - 5 per cent of the channel length with systematic sampling scheme to allow an estimate of standard error to be calculated.

Analysis: Compare the computed debris loading values to those reported in the literature.

Equipment Costs: 100 meter cloth tape, tape measure.

Riparian vegetation

Purpose: To determine if the riparian vegetation has been significantly altered by timber operations. Parameters commonly measured include vegetation type, vegetation cover, and vegetation density. For our purposes, emphasis will be placed on canopy cover/density.

Technique: Forest cover density can be assessed by using a spherical densiometer, which uses a point sampling technique to determine the amount of clean sky in the hemisphere centered over the observer. The percentage of solar radiation blocked by vegetation and topography can be determined simply with a Solar Pathfinder. Both techniques produces data useful for assessing changes in the riparian canopy over time, or for predicting the effect of riparian canopy removed on stream temperatures.

Sites: Second to third order watersheds should be sampled.

Timing: Easiest in the low flow summer period.

Frequency: Prior to logging operations and again after logging.

Duration: Up to 5 years after logging.

Sample size: Locate a sampling station every 100 feet.

Analysis: Determine mean canopy cover from the sample points taken.

Equipment costs: Spherical densiometer is about $100; Solar Pathfinder with steel case is about $150.

Hillslope Methods

U.S. Forest Service Effectiveness Ratings

Purpose: To provide an on-site evaluation of soil erosion (sheet and rill, gully, and mass wasting) problems directly related to forest practices/BMPs, which can also help link upslope sediment sources with instream sediment conditions.

Technique: Follow procedures described in the USFS's BMP Evaluation Program User's Guide (1992), except where not applicable to BOF/CDF experience. Adaptations will need to be identified and made to these procedures, which can later be published in a BOF Program user's guide.

Visual observation of erosion is performed by monitoring team during runoff events, ideally, and should be used in combination with upstream/downstream turbidity measurements to determine whether sediment is reaching stream. Road-related problems can be observed by driving the roads, if winter access is possible, while other rules will need to be observed by walking. Effectiveness ratings will be recorded on newly developed, standardized field forms, to be based on those used by the USFS in California (USFS, 1992) and the 208 Team (CDF, 1987); and

- In addition, photographs are to be taken of: a) erosion problems or potential erosion problems related to specific practices (e.g., landing failure or new road prism), particularly to track the path of transport and deposition; or (b) a particular site using an identified photopoint, such as for measurement of the amount of bare soil on a cut slope which can be compared with later evaluations. Standard methods for taking 35 mm color slides in the field should be used, including same size of lens and film type, for comparability (Magill, 1989).

Sites: Both the site of the Rule/BMP as well as downslope are to be examined. High risk site conditions for surface (sheet/rill) erosion (e.g., high to extreme EHR; slopes > 50%; decomposed granitic and other non-cohesive soils) and high risk practices should be targeted for the most intensive observations within the THP area.

Timing: Ideally, observations should be done during runoff events, particularly the first ones following initiation or completion of the THP. At the minimum, field observations will follow immediately after a runoff event before evidence of sediment movement can become obscured.

Frequency: Mimimum of three storm events per season. Intent is to observe the THP site under enough stressful (erosion-causing) conditions that practices can be adequately evaluated. Storm runoff events should be rated from data at the nearest stream gage station. After the initial three years, the frequency of monitoring could be reduced to evaluate only large event conditions (e.g., 25 year storms or larger).

Duration: Year 1 - 1st season following initiation or completion of THP, through Year ___, to ensure adequate sampling during the sediment production period.

Sample Size: Both random and non-random sampling procedures may be required, as described for On-Site Evaluations in USFS User's Guide.

Analysis: All results are stored in a relational computer database developed in ORACLE. A Database User's Guide was also prepared for the USFS Program, which will also need adaptation.

Optional Methods: 1. Silt fences - good visual and semi-quantitative tool but specific site must be carefully selected to be useful; potential as a monitoring tool to be evaluated in a separate CDF/BOF funded project in 1992-1993.

2. Erosion pins or bridges - for documenting local slope denudation and changes in surface micro-elevation; requires careful sampling design. 3. Erosion troughs - require frequent emptying and careful placement and sampling design.

Specific Monitoring References

Caldwell, J., Doughty, K., and K. Sullivan. 1992. Evaluation of downstream temperature effects of Type 4/5 waters (small headwater streams). Prepared for Timber/Fish/Wildlife Program Washington State.

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Lisle, T. and S. Hilton. 1991. Fine sediment in pools: an index of how sediment is affecting a stream channel. FHR Currents No.6 R-5 Fish Habitat Relationship Tech. Bulletin, US Forest Service, Six Rivers National Forest. 6 p.

MacDonald, L., Smart, A., and R. Wissmar. 1991. Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska. U.S.E.P.A., Seattle. 166 p.

Magill, A. 1989. Monitoring environmental change with color slides. Gen.Tech. Rep. PSW-117. US Forest Service-Pacific Southwest Station. Berkeley, 55 p.

U.S. Forest Service, Pacific Southwest Region. 1992. Investigating water quality in the Pacific Southwest Region: Best Management Practices Evaluation Program - User's Guide. Region 5. San Francisco, 158 p.

Van de Water, R. 1988. Monitoring plan for water quality, soil, and fish habitat effects of Salmon Complex fire recovery activities. Klamath National Forest, Salmon River Ranger District. Etna, CA. 18 p.

Appendix C

Example of USFS Best Management Practices Evaluation Form

Form T01: Streamside Management Zones
(BMP 1.8, 1.19, 1.22)

ID#: _____

Selection Code: _____

Reviewer(s) _____ Title(s) _____ Date _____ Forest _____ District _____ T _____ R _____ S _____

Project _____ Unit # _____ Year Activity Occurred _____ Rock Type _____ Stream _____

SMZ Rx: _____ Activity Status _____ NFS Watershed _____

IMPLEMENTATION

	Rating
1) Was SMZ clearly identified on the ground?	_____
2) SMZ width is as specified?	_____
3) Treatment of SMZ is as prescribed?	_____
4) Mechanized equipment restricted from SMZ during timber harvest except at approved crossings?	_____
5) Logging slash in SMZ treated by means other than mechanized equipment?	_____

1 = Exceeds contract/project requirements
2 = Meets contract/project requirements
3 = Minor departure from contract/project requirements
4 = Major departure from contract/project requirements
Rate as NA if criteria not applicable at this site

If any rating is "3" or "4", complete the following:

Problem occurred in which phase(s) of the project: ☐ Site Evaluation ☐ Plan Prescription ☐ EA ☐ Contract ☐ Layout ☐ Administration ☐ Post Sale

Comments on causes and corrective actions:

EFFECTIVENESS

1) Groundcover (Objective:____%*)	☐ No disturbance or meets or exceeds objective	☐ Groundcover ≥ 80% of objective	☐ Groundcover < 80% of objective
2) Canopy cover (Objective:____%*)	☐ No disturbance or meets or exceeds objective	☐ Canopy cover ≥ 90% of objective	☐ Canopy cover < 90% of objective
3) Disturbance to streambanks	☐ None evident	☐ Disturbance is less than 5% of channel length	☐ Activities have disturbed more than 5% of channel length
4) Sediment to channel	☐ Evidence of sediment movement to SMZ	☐ Erosion/sediment movement into SMZ but no sediment to channel	☐ Evidence that sediment has entered channel

*Use project, LMP or Forest Objective. If prescription is "no disturbance", enter "NO".

If poor effectiveness is evident, comment on:
(1) Possible causes *(e.g. site sensitivity, major storm event, etc.)*.

(2) The degree and duration of impacts to beneficial uses of water.

Appendix D

Salmon and Steelhead Stocks at Risk of Extinction in California Streams[1]

Chinook Salmon

Winter Race

1. Sacramento River, T (U.S.), E (CA),1,4.

Spring/Summer Race

1. Sacramento River (& tributaries) (spring race), B,1,2,4.

2. Klamath River (spring race), A,1,2.

3. Smith River (spring race),A,1,2.

4. Yuba River (spring race),B,1,2,4.

Fall Race

1. Shasta River, A,1,4.

2. Scott River, C,1,4.

3. San Joaquin River, C,1,2,4.

4. Consumnes River, C,1,4.

Coho Salmon

1. California small coastal streams north of San Francisco,B,1.

2. California small coastal streams south of San Francisco,A,1.

3. Klamath River, C,1,4.

Steelhead Trout

Winter Race

1. Malibu Creek, A,1.

2. Santa Clara River, A,1,4.

3. Ventura River, A,1.

4. Santa Ynez River, A,1.

5. Little Sur River, C,1.

6. Big Sur River, C,1.

7. Carmel River, A,1.

8. Salinas River, B,1.

9. Pajaro River, A,1.

10. South San Francisco Bay tributaries, A,1.

11. Sacramento River, A,1,4.

12. Napa River, A,1.

Summer Race

1. Eel River, B,1,2.

2. Mad River, A, 1,2.

3. Redwood Creek A,1,2.

4. Klamath River, B,1,4.

5. Smith River, A,2.

Sea-Run Cutthroat Trout

1. California coastal streams, B,1.

[1] From pages 8-10 in: Nehlsen, W., Williams, J. and J. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21 (American Fisheries Society).

Code: A = High risk; B = Moderate risk; C = Of special concern.

Numbers indicate the nature of the threat as described below:

1. The present or threatened destruction, modification, or curtailment of its habitat or range. In additon to habitat damage, this category includes mainstream passage and flow problems, and predation during reservior passage or residence.

2. Overutilization for commercial, recreational, scientific, or educational purposes. This category includes overharvest in mixed-stock fisheries.

3. Disease.

4. Other natural or manmade factors affecting its continued existence (hybridization, introduction of exotic or translocated species, predation not primarily associated with mainstream passage and flow problems, and competition). This category includes negative interactions with hatchery fish, such as hybridization, competition, and disease. Also included here are poor ocean survival conditions.

NOTE: Not all affected by Forest Practices.