Water Quality Protection on National Forests in the Pacific Southwest Region: Best Management Practices Evaluation Program, 2003-2007

USDA Forest Service
Pacific Southwest Region
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Executive Summary

The USDA Forest Service Pacific Southwest Region (USFS) Best Management Practices Evaluation Program (BMPEP) included 2,861 randomly-selected onsite evaluations of Best Management Practice (BMP) implementation and effectiveness between 2003 and 2007. For the 5-year reporting period, 86% of Best Management Practices (BMPs) were rated as implemented and 89% were rated as effective. Among implemented BMPs, 93% were rated effective.

Of the 2,861 on-site evaluations used for this report, 98% indicated no significant adverse impacts on water quality. Only 8% of the onsite evaluations indicated any measurable potential or actual adverse impacts on water quality.

Many of the BMPs rated as ineffective were ineffective owing to lack of implementation rather than shortcomings in the BMPs. Improved implementation of BMPs is the single most useful step that can be taken to improve water-quality protection on national forests in California.

Several BMPs were not highly effective even when implemented, and can be revised to improve protection of water quality. These include BMPs for developed recreation sites, road stream crossings, and water source development.

Several BMPs have been 95 to 100% effective when implemented, including almost all BMPs for timber harvests, vegetation management, and prescribed fire. Given the documented performance of these BMPs, effectiveness monitoring of these protocols can be reduced in the future in order to focus on areas where improvement is needed.

BMP implementation and effectiveness have improved slightly in comparison to results for 1992 to 2002 (Staab, 2004), and the number of BMPEP evaluations has increased. BMP implementation on national forests in California was within the range of results reported in previous studies on private lands in the western United States.

Measures planned to improve protection of water quality on national forest system lands in the Pacific Southwest Region include implementation checklists for all projects with ground disturbance, annual reviews of national forest watershed staffing, revision of selected BMPs that have relatively low effectiveness when implemented, modification of the BMPEP scoring procedures, and adoption of a new regional water-quality monitoring program.

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Introduction

California depends on water produced in forested watersheds. Almost all forest management activities have potential to affect water quality. The implementation of appropriate forest management measures is therefore critical to protection of the state's water resources.

The national forests in California were established under the Organic Act of 1897, which states that a primary purpose of the national forests is to "secure favorable conditions of water flows." All national forests in California are managed by the USDA Forest Service (USFS). The USFS Pacific Southwest Region (Region 5) manages roughly 20,000,000 acres (fig. 1) in 18 national forests that produce about 45% of the state's water. Results for small areas of the state within the Siskiyou and Humboldt-Toiyabe National Forests are not included in this report because these forests are administered by other USFS regions.

Figure 1: Locations of national forests within the Pacific Southwest Region in California.

The federal Clean Water Act gives the authority to regulate water-quality protection to the states. In California, this authority rests with the State Water Resources Control Board and 9 Regional Water Quality Control Boards. In 1981, the State Water Resources Control Board entered into a management agency agreement (MAA) with the USFS that designated the USFS as the water-quality management agency for national forest lands in California. This agreement obligates the USFS to incorporate Best Management

Practices (BMPs) for protection of water quality into land and resource management activities and to monitor their implementation and effectiveness, which has been accomplished since 1992 using the BMP Evaluation Program (BMPEP; USFS, 2000; USFS, 2002). Although changes in state law have affected the status of the MAA, it remains in effect. A strategy to modify the agreement is currently being negotiated.

This report presents the results of the BMPEP for the national forests in the Pacific Southwest Region for 2003 to 2007. Onsite evaluations are the foundation of the BMPEP and are therefore the focus of this report. This report temporally extends the analysis of BMPEP monitoring results for 1992 to 2002 (Staab, 2004).

BMP effectiveness can be affected by weather conditions. BMPs that are adequate for mild or moderate rainfall, snowmelt, and runoff conditions may not be appropriate for more extreme conditions. A general evaluation of hydrologic stress during the 2003 to 2007 reporting period can be made based on streamflow records published by the U.S. Geological Survey (http://ca.water.usgs.gov). Streamflow stations with long, but variable, periods of record were used to compare unregulated annual peak streamflows during the 5 years of the 2003 to 2007 reporting period with the highest annual peak flows for the periods of record. Seven stations were selected throughout the state to represent the areas included within the national forest system (Table 1a). Results are shown in Table 1b. Annual peak streamflows at the 7 stations during 2003 to 2007 ranged from 0% to 100% of the period-of-record maximums. In general, peak flows were high during 2006 (3 to 100% of maximum flows) and low in 2007 (0 to 29% of maximum flows). These results indicate that the 2003 to 2007 reporting period was not extreme in terms of precipitation or runoff, but represents a reasonably wide range of conditions that can be considered a "fair test" of BMP effectiveness.

Table 1a: U.S. Geological Survey streamgages used to represent hydrologic conditions on national forests during the 2003 to 2007 study period

Station number	Stream	National forests	Period of record (POR)	POR peak streamflow (cfs)	POR water year
11532500	Smith River	Six Rivers, Klamath, Mendocino	1932-2007	228,000	1965
11402000	Spanish Creek	Modoc, Lassen, Plumas	1934-2007	22,100	1997
11427700	Duncan Canyon	Tahoe, Eldorado, Stanislaus	1961-2007	3,650	1965
10336780	Trout Creek	LTBMU	1961-2007	615	2006
11189500	South Fork Kern R.	Sierra, Sequoia, Inyo	1914-2007	28,700	1967
11143000	Big Sur River	Los Padres	1951-2007	10,700	1978
11015000	Sweetwater River	Angeles, San Bernardino, Cleveland	1957-2007	3,890	1967

Table 1b: Annual peak streamflows during water years 2003 to 2007 at selected USGS streamflow gaging stations, expressed as percentages of the maximum recorded peak streamflows during the station periods of record (http://ca.water.usgs.gov)

Station number	Stream	%, 2003	%, 2004	%, 2005	%, 2006	%, 2007
11532500	Smith River	26	36	38	53	29
11402000	Spanish Creek	19	30	18	57	12
11427700	Duncan Canyon	15	15	32	85	23
10336780	Trout Creek	23	9	32	100	10
11189500	South Fork Kern R.	23	1	7	6	0
11143000	Big Sur River	33	17	22	39	6
11015000	Sweetwater River	1	22	75	3	0
Average		20	19	32	49	12

Objectives

The objectives of this report are to:

1. Summarize onsite evaluations of BMP implementation and effectiveness.
2. Summarize observations of adverse effects on water quality from BMP evaluations.
3. Identify BMPs that can be improved to benefit water quality.
4. Identify BMPs that are highly effective in protecting water quality.
5. Compare results to other recent BMP monitoring studies in California
6. Describe a new BMPEP scoring protocol scheduled for implementation in 2010.
7. Present recommendations for improving BMP implementation and effectiveness.

Methods

Onsite evaluations are used to assess both BMP implementation and effectiveness. Implementation evaluations determine the extent to which planned water quality protection measures were actually put in place on project sites. Effectiveness evaluations determine the extent to which the practices met their water-quality protection objectives.

There are 29 onsite evaluation protocols used to assess the implementation and effectiveness of most of the 96 individual BMPs, or groups of closely related BMPs. BMPEP protocols for major categories of land and resource management activities are summarized in Table 2. A more detailed list of protocols and associated BMPs is provided in Appendix A. References in this report to BMP implementation and effectiveness results for the 29 onsite evaluation protocols refer to the groups of BMPs evaluated by each protocol, rather than individual BMPs. Additional details can be found in *Investigating Water Quality in the Pacific Southwest Region, Best Management Practices Evaluation Program (BMPEP) User's Guide* (USFS, 2002) and *Water Quality Management for National Forest System Lands in California* (USFS, 2000; http://www.fs.fed.us/r5/publications/).

Onsite evaluation protocols are applied to both randomly and non-randomly selected project sites. The numbers of random evaluations to be completed each year are assigned to the national forests by the regional office, based on: 1) the relative importance of the BMP in protecting water quality in the Region; and 2) the management activities most common on the individual Forest (for example, range management on the Modoc National Forest, recreation on the Angeles National Forest). Forests supplement these randomly selected sites with additional sites based on local monitoring needs, such as those prescribed in environmental compliance (NEPA) documents. Although all data collected with onsite evaluations are entered into the regional BMPEP data base, only data from onsite evaluations made at randomly selected sites are presented in this report.

Table 2- BMPEP Onsite Evaluation Protocols and associated BMP's for major categories of land and resource management activities on national forest system lands in California

Land and resource management activity	BMPEP protocols (USFS, 2002)	BMPs (USFS, 2000)
Timber	T01 to T07	1-8, 1-10, 1-11, 1-12, 1-13, 1-14, 1-15, 1-16, 1-17, 1-18, 1-19, 1-20, 1-21, 1-22, 1-25, 5-3
Roads (Engineering)	E08 to E20	2-1 to 2-5, 2-7 to 2-12, 2-14, 2-16 to 2-27
Recreation	R22, R23, and R30	4-4 to 4-6, 4-9, 4-10
Grazing (Range)	G24	8-1 to 8-3
Fuels (Prescribed fire)	F25	6-2 and 6-3
Mining	M26 and M27	3-1 to 3-3, 2-18
Vegetation Management	V28 and V29	5-1, 5-2, 5-4 to 5-6

Procedures for onsite evaluations vary greatly, but the overall approach for each onsite evaluation is consistent. For BMP implementation, evaluators are asked a variety of specific questions intended to determine whether the project was executed on the ground, as planned and described in project documents. A range of possible scores is allocated to each question, depending on its relative importance and the degree to which particular requirements are met (whether the project exceeds, meets, departs slightly, or departs substantially from requirements). Scores for all implementation questions are then summed and compared to a predetermined threshold (inference point) to conclude whether the applicable BMPs were implemented. BMP effectiveness is determined based on indirect measures of water quality protection, including observations (for example, evidence of sediment delivery to channels) and quantitative measurements (for example, amount of ground cover, percent of stream

shade). A scoring system similar to that used for BMP implementation is used to determine BMP effectiveness. All evaluations are scored automatically after entry into the regional BMPEP data base. Therefore, field evaluators do not necessarily know whether BMPs will be considered implemented or effective at the time of the onsite evaluation.

This scoring approach results in a 2 x 2 matrix, in which BMPs are placed into 1 of 4 categories: implemented and effective, implemented, but not effective, not implemented, but effective, not implemented and not effective. Evaluations rated as not implemented but effective indicate that under the conditions prevailing between the project activity and the effectiveness monitoring, the prescribed BMPs were not necessary to protect water quality.

BMPEP monitoring is conducted at the hillslope scale and does not include direct monitoring of beneficial uses in streams. BMPs scored as "ineffective" therefore represent potential, rather than actual, impairment of beneficial uses by a given activity.

In addition to the implementation and effectiveness questions, field evaluators qualitatively estimate the degree, duration, and spatial extent of any existing or potential adverse water-quality impacts associated with the evaluated BMPs (the evaluations do not distinguish between existing and potential impacts, and references to adverse water-quality effects in this report apply to both actual and potential impacts). Each protocol includes guidelines for rating activities in 1 of 3 categories corresponding to insignificant (unmeasurable), minor, and significant levels of adverse impacts. If adverse impacts are noted, the impacts are classified into 1 of 3 duration levels (less than 5 days, more than 5 days but less than one season, and more than one season) and 1 of 3 spatial extent levels (hillslope scale, stream reach scale, and drainage basin scale).

BMPEP implementation and effectiveness scoring problems may affect results for several protocols included in this report. These problems, as well as steps underway to correct them, are discussed in detail in Appendix B. This report uses results as they were stored in the regional BMPEP data base as of June 28, 2008, with the exception of Table 6, which uses data retrieved on September 18, 2008. The field evaluations of adverse water-quality effects (degree, duration, and spatial extent) are independent of the scoring protocols and are therefore useful as indicators of BMP performance for all protocols regardless of scoring procedures.

Results and Discussion

A total of 2,861 onsite evaluations were conducted in the Pacific Southwest Region during fiscal years 2003 to 2007 using 29 monitoring protocols (Tables 3 and 4). The average number of evaluations per year during the 2003 to 2007 period was 572, which is a significant increase from the average of 357 evaluations per year for the 1992 to 2002 period (Staab, 2004).

Based on implementation and effectiveness scores for the evaluations, each onsite evaluation was classified into 1 of 4 categories, as described above. The total number of BMPs considered implemented is the sum of the "implemented and effective" and "implemented, but not effective" evaluations. The total number of BMPs considered effective is the sum of

the "implemented and effective" and "not implemented, but effective" evaluations. BMPs were considered to be effective even where not implemented if no evidence of water-quality impairment was observed. Unless otherwise noted, BMPs reported as effective in this report include both implemented and non-implemented BMPs that were considered to be effective based on lack of evidence for water-quality impairment.

Of the total of 2,861 BMPs evaluated for the 29 protocols, 2,467 (86%) were rated as implemented and 2,533 (89%) were rated as effective (note that the number of evaluations reported in Table 3 sums to only 2,854 owing to slight differences between annual and study-period totals in the data base; results reported here include the entire 2,861 evaluations). Implementation ranged from 81% in 2003 to 89% in 2007 (Table 3). Effectiveness ranged from 86% in 2003 to 90% in 2007 (Table 3). Both implementation and effectiveness improved between 2003 and 2007. The generally higher peak flows experienced in 2006 (Table 1b) do not appear to have reduced BMP effectiveness for the region as a whole. Of the 2,467 BMPs that were implemented, 2,284, or 93%, were effective (Table 4).

Table 3: BMPEP evaluations conducted at national forests in the Pacific Southwest Region, 2003 to 2007

Year	Number of forests reporting results	Number of evaluations completed	% Implemented	% Effective
2003	14	597	81	86
2004	14	452	88	89
2005	11	495	88	90
2006	13	532	87	90
2007	16	778	89	90

Among individual monitoring protocols, BMP implementation ranged from 0 to 100%, with an average of 84% (Table 4). BMP effectiveness ranged from 57 to 100%, with an average of 88% (Table 4). Among implemented BMPs, effectiveness ranged from 69 to 100%, with an average of 93% (Table 4). Eight protocols (T03, T05, T06, E18, E19, F25, M27, and V28) achieved 100% effectiveness among implemented BMPs. Eight protocols (E08, E09, E13, E16, E20, G24, R22, and R23) had effectiveness less than 90% among implemented BMPs. The remaining 12 protocols had effectiveness ranging between 90 and 99% among implemented BMPs (M26 had no implemented BMPs and was therefore not included).

To better summarize the results of the BMP monitoring, protocols were grouped into 6 major land-management activities (Table 5). Among the major activities, implementation ranged from a low of 24% for mining to a high of 98% for vegetation management. Effectiveness, expressed as a percentage of the total number of BMPs evaluated, ranged from a low of 73% for recreation to a high of 98% for fuels management. Effectiveness, expressed as a percentage of implemented BMPs, ranged from 82% (recreation) to 100% (fuels management and mining).

Effectiveness of implemented BMPs was high, indicating that the BMPs are accomplishing their objective of protecting water quality. The greatest opportunities for improving protection of water quality appear to be in increased implementation, particularly for recreation and mining activities.

BMPEP results for each of the 18 national forests in the region are summarized in Table 6. BMP implementation ranged from 77 to 93%. BMP effectiveness ranged from 74 to 97%. Among implemented BMPs, effectiveness ranged from 77 to 99%.

Overall, 92% of the BMPs evaluated for this report were considered to have no potential or actual adverse impacts on water quality (Table 7). An additional 1% were considered to have insignificant adverse impacts. A total of 6% had minor adverse impacts, and only 2% had significant adverse impacts (percentages total to 101% due to rounding). The percentage of onsite evaluations associated with measurable potential or actual adverse impacts on water quality is the sum of the evaluations with minor and significant impacts, or 8% of all evaluations. The percentages of onsite evaluations reporting measurable impacts on water quality ranged from 0 to 21% among the 29 BMPEP protocols (Table 7).

Among the 2,861 onsite evaluations analyzed for this report, 98% had no significant impacts to water quality (Table 7). The difference between this percentage and the total implementation percentage of 86% indicates that for 12% of the evaluations, BMPs were not implemented as they should have been, but under prevailing conditions were not needed to protect water quality. This result does not excuse lack of implementation, but does indicate that implementation failures do not necessarily result in significant adverse impacts to water quality.

Adverse water-quality impacts that persisted for 5 or more days were reported for 6% of the onsite evaluations, and 3% of the evaluations reported impacts that extended to stream channels. The difference between the percentage of evaluations reporting impacts that extended to stream channels (3%) and the percentage of evaluations with measurable potential or actual adverse impacts (8%) indicates that most of the measurable adverse impacts were potential rather than actual.

Table 4: Implementation and effectiveness of BMPEP protocols for all national forests in the Pacific Southwest Region, 2003 to 2007

[IE, implemented and effective; NIE, not implemented but effective; INE, implemented but not effective; NINE, not implemented and not effective; IMP, implemented; EFF, effective; IMP EFF, effectiveness expressed as a percentage of implemented BMPs]

Protocol	Number of Evaluations	% IE	% NIE	% INE	% NINE	% IMP	% EFF	% IMP EFF
T01	206	91	3	4	1	96	94	95
T02	224	86	12	0	2	86	97	99
T03	45	40	49	0	11	40	89	100
T04	278	94	4	1	1	94	98	99
T05	42	93	7	0	0	93	100	100
T06	24	100	0	0	0	100	100	100
T07	33	85	6	6	3	91	91	93
E08	309	72	10	10	7	82	83	88
E09	252	77	4	12	8	89	80	86
E10	184	88	5	6	1	94	93	94
E11	173	89	5	2	3	91	94	97
E12	25	96	0	4	0	100	96	96
E13	82	63	13	18	5	82	77	78
E14	71	86	6	6	3	92	92	94
E15	35	80	3	6	11	86	83	93
E16	51	53	10	20	18	73	63	73
E17	45	82	7	2	9	84	89	97
E18	1	100	0	0	0	100	100	100
E19	6	83	17	0	0	83	100	100
E20	37	81	0	16	3	97	81	83
R22	114	50	7	23	20	73	57	69
R23	34	56	12	9	24	65	68	86
R30	120	70	19	5	6	75	89	93
G24	98	79	2	15	4	94	81	84
F25	190	87	11	0	2	87	98	100
M26	41	0	80	0	20	0	80	--
M27	13	100	0	0	0	100	100	100
V28	67	99	0	0	1	99	99	100
V29	61	90	3	7	0	97	93	93
Total	2,861							

Table 5: BMP implementation and effectives for major activities on national forests in the Pacific Southwest Region, FY 2003-2007

Activities	Protocols	BMPs Implemented (% of total)	BMPs Effective (% of total)	BMPs Effective (% of implemented)
Timber	T01 to T07	90	96	98
Roads	E08 to E20	88	85	90
Recreation	R22, R23, and R30	73	73	82
Grazing	G24	94	81	84
Fuels	F25	87	98	100
Mining	M26 and M27	24	85	100
Vegetation Management	V28 and V29	98	96	97

Table 6: BMPEP results for national forests in the Pacific Southwest Region, 2003 to 2007

National Forest	Number of BMPEP evaluations	% BMPs Implemented	% total BMPs effective	% implemented BMPs Effective
Angeles	26	85	81	77
Cleveland	32	91	81	83
Eldorado	164	91	97	99
Inyo	120	78	74	81
Klamath	242	90	96	99
Lake Tahoe Basin	208	90	87	90
Lassen	362	91	91	94
Los Padres	147	84	77	80
Mendocino	55	93	93	94
Modoc	11	91	82	90
Plumas	364	83	86	92
San Bernardino	59	80	97	98
Sequioa	204	82	86	89
Shasta-Trinity	304	82	88	97
Sierra	53	77	91	98
Six Rivers	179	85	91	95
Stanislaus	121	91	88	91
Tahoe	210	88	90	94

Results in Table 7 indicate that the protocols most likely to be associated with measurable adverse water-quality effects (percentages of BMPs with measurable effects higher than 15%) are R22 (developed recreation sites), E09 (road stream crossings), and E16 (water source development). These protocols also were found to have relatively low effectiveness when implemented (Table 4). The BMPs evaluated with these protocols are high priorities for revision.

Six protocols had no evaluations with measurable water-quality effects, and an additional 11 protocols had 5% or less of their evaluations with measurable water-quality effects (Table 7). These include all the timber harvesting BMPs except T07 (meadow protection), and all vegetation management and prescribed fire BMPs. The BMPs for these protocols can be considered highly effective at protecting water quality.

Results presented in this report can usefully be compared to previous USFS regional monitoring results to determine if BMP implementation and effectiveness have improved. For the 1992 to 2002 period, overall BMP implementation was 85%, and for implemented BMPs, overall effectiveness was 92% (Staab, 2004). Results for 2003 to 2007 presented in this report are slightly higher for both implementation (86%) and effectiveness (93% of implemented BMPs).

Results of this report can also be compared with previous studies of BMPs on privately owned forest lands in the Western states (Table 8). Results are only roughly comparable because the BMPs, evaluation procedures, and scoring procedures vary. Only implementation results are presented in Table 8 owing to substantial differences in methods for evaluating effectiveness. BMP implementation success on national forests in the Pacific Southwest Region during 2003 to 2007 was within the range of the results of these previous studies.

Recommendations

1. Increased implementation of BMPs would clearly improve the performance of the USFS in protecting water quality in California. The USFS intends to achieve improvements in implementation through the following actions:
    a. In addition to random BMPEP evaluations, the USFS will require the completion of implementation checklists for all projects on national forests in the Pacific Southwest Region that involve ground disturbance. BMP implementation checklists are part of the proposed USFS regional monitoring plan (see item 5. below and Appendix C), which will be put into effect when formally approved by the State Water Resources Control Board as part of the renegotiation of the MAA.
    b. Forest staffing will be reviewed annually by the USFS regional office and when appropriate, recommendations will be made to national forests that need additional personnel for BMP implementation review.
    c. Training in BMPEP monitoring and inter-forest BMPEP reviews will be coordinated by the USFS regional office.

d. The USFS regional office will review BMPEP protocols and forms to determine where revisions are needed so that BMP implementation language and intent is more clearly defined for evaluators. This, along with training described above, should reduce evaluator variation and error in understanding the intent of each BMP.

2. BMPs evaluated using several BMPEP protocols were found to be effective even when implemented for less than 90% of the evaluations. These protocols include 5 engineering protocols, 2 recreation protocols, and one grazing protocol. The BMPs evaluated by these protocols therefore will be reviewed and revised to improve their effectiveness after consideration of scoring problems (see item 4. below).
3. Several BMPEP protocols achieved 100% effectiveness among implemented BMPs. These included 3 timber harvest, 2 engineering, one fire, one mining, and one vegetation management protocol. The high level of effectiveness indicates that the BMPs are performing well when implemented. The USFS will reduce BMPEP effectiveness evaluation targets for these protocols to allow watershed staff to focus on higher monitoring priorities (see item 5. below).
4. The USFS will implement the Frazier scoring protocol beginning with BMPEP evaluations for 2009 (see appendix B).
5. The USFS will implement the Pacific Southwest Regional water-quality monitoring plan (appendix C) when approved by the State Water Resources Control Board as a component of the revised Management Agency Agreement.

Table 7: BMP onsite evaluations on national forests in the Pacific Southwest Region associated with measurable adverse effects on water quality, 2003 to 2007

BMPEP Protocol	% BMPs with measurable actual or potential adverse effects on water quality	% BMPs w/ effects that persisted for 5 or more days	% BMPs w/ effects that extended to a stream
T01: Streamside Management Zones (SMZs)	3	3	3
T02: Skid Trails	1	2	0
T03: Suspended Yarding	2	4	0
T04: Landings	1	1	1
T05: Timber Sale Administration	0	0	0
T06: Special Erosion Control & Revegetation	4	0	0
T07: Meadow Protection	9	9	6
E08: Road Surface, Drainage & Slope Protection	11	12	6
E09: Stream Crossings	15	14	9
E10: Road Decommissioning	2	2	0
E11: Control of Sidecast Material	5	3	2
E12: Servicing and Refueling	0	0	0
E13: In-Channel Construction Practices	6	4	7
E14: Temporary Roads	1	3	1
E15: Rip Rap Composition	6	9	3
E16: Water Source Development	18	22	16
E17: Snow Removal	0	0	2
E18: Pioneer Road Construction	0	0	0
E19: Restoration of Borrow Pits & Quarries	0	0	0
E20: Protection of Roads During Wet Periods	14	14	8
R22: Developed Recreation sites	21	22	9
R23: Location of Stock Facilities in Wilderness	9	9	0
R30: Dispersed Recreation	8	8	7
G24: Range Management	11	11	6
F25: Prescribed Fire	1	1	1
M26: Mining Operations (Locatable Minerals)	12	10	5
M27: Common Variety Minerals	0	0	0
V28: Vegetation Manipulation	1	1	1
V29: Revegetation of Surface Disturbed Areas	5	5	2
Total	8	6	3

Table 8: Implementation results from selected previous studies of BMP implementation on private forest lands in Western states

Authors	State	Study Period	Type of BMPs	% Implemented
Brandow and others, 2006	California	2001-2004	Roads	96
Brandow and others, 2006	California	2001-2004	Watercourse crossings	83
Cafferata and others, 2002	California	1996-2001	Roads	93
Cafferata and others, 2002	California	1996-2001	Skid trails	95
Cafferata and others, 2002	California	1996-2001	Landings	94
Cafferata and others, 2002	California	1996-2001	Watercourse crossings	86
Cafferata and others, 2002	California	1996-2001	Stream protection zones	98
Ice and others, 2004	Idaho	2000	Forest Practice Rules	92
Ice and others, 2004	Montana	2002	Forest Practice Rules	96
Ice and others, 2004	New Mexico	unspecified	Forest Practice Rules	75
Ice and others, 2004	Oregon	unspecified	Forest Practice rules	96
Ice and others, 2004	Wyoming	Not much	Forest Practice Rules	91

Summary

The BMP implementation and effectiveness results presented in this report indicate that the USFS Pacific Southwest Region BMP program was generally successful in protecting water quality between 2003 and 2007. The number of BMP evaluations has increased since 2002, and rates of implementation and effectiveness have improved.

Of the 2,861 on-site evaluations used for this report, 98% indicated no significant adverse impacts on water quality. Only 8% of the onsite evaluations indicated any measurable potential or actual adverse impacts on water quality.

Many of the BMPs rated as ineffective were ineffective owing to lack of implementation rather than shortcomings in the BMPs. Improved implementation of BMPs is the single most useful step that can be taken to improve water-quality protection on national forests in California.

Several BMPs were not highly effective when implemented, and can be revised to improve protection of water quality. These include some BMPs for developed recreation sites, road stream crossings, and water source development.

Several BMPs have been highly effective when implemented, including almost all BMPs for timber harvests, vegetation management, and prescribed fire. Given the documented performance of these BMPs, effectiveness monitoring of these protocols can be reduced in the future in order to focus on problems.

BMP implementation and effectiveness have improved slightly in comparison to results for 1992 to 2002 (Staab, 2004), and the number of BMPEP evaluations has increased. BMP implementation on national forests in California was within the range of results reported in previous studies on private lands in the western United States.

Measures planned to improve protection of water quality on national forest system lands in the Pacific Southwest Region include implementation checklists for all projects with ground disturbance, annual reviews of national forest watershed staffing, revision of selected BMPs that have relatively low effectiveness when implemented, modification of BMPEP scoring procedures, and adoption of a new regional water-quality monitoring program.

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APPENDIX A: BMPEP Onsite Evaluation Protocols and associated BMP's

BMPEP Onsite Evaluation Protocols	BMPs Evaluated
T01: Streamside Management Zones (SMZs)	• SMZ Designation (1-8) • Streamcourse and Aquatic Protection (1-19) • Slash Treatment in Sensitive Areas (1-22)
T02: Skid Trails	• Tractor Skidding Design (1-10) • Erosion Control on Skid Trails (1-17)
T03: Suspended Yarding	• Suspended Log Yarding in Timber Harvesting (1-11)
T04: Landings	• Log Landing Location (1-12) • Log Landing Erosion Control (1-16)
T05: Timber Sale Administration	• Erosion Prevention & Control Measures During Timber Sale Operations (1-13) • Erosion Control Structure Maintenance (1-20) • Acceptance of Timber Sale Erosion Control Measures Before Sale Closure (1-21) • Modification of Timber Sale Contract (1-25)
T06: Special Erosion Control & Revegetation	• Special Erosion Prevention Measures on Disturbed Land (1-14) • Revegetation of Areas Disturbed by Harvest Activities (1-15)
T07: Meadow Protection	• Meadow Protection During Timber Harvesting (1-18) • Slash Treatment in Sensitive Areas (1-22) • Tractor Operation Limitation in Wetlands and Meadows (5-3)
E08: Road Surface, Drainage & Slope Protection	• Erosion Control Plan (2-2) • Stabilization of Road Slope Surfaces and Spoil Disposal Areas (2-4) • Road Slope Stabilization Construction Practices (2-5) • Control of Drainage (2-7) • Construction of Stable Embankments (2-10) • Maintenance of Roads (2-22) • Road Surface Treatments to Prevent Loss of Materials (2-23)
E09: Stream Crossings	• General Guidelines for Location and Design of Roads (2-1) • Stabilization of Road Slope Surfaces and Spoil Disposal Areas (2-4) • Road Slope Stabilization Construction Practices (2-5) • Control of Road Drainage (2-7) • Construction of Stable Embankments (fills) (2-10) • Stabilization of Road Slope Surfaces and Spoil Disposal Areas (2-4)
E10: Road Decommissioning	• Obliteration or Decommissioning of Roads (2-26)
E11: Control of Sidecast Material	• Control of Sidecast Material During Construction & Maintenance (2-11)
E12: Servicing and Refueling	• Servicing and Refueling of Equipment (2-12)
E13: In-Channel Construction Practices	• Controlling in-Channel Excavation (2-14) • Diversion of Flows Around Construction Sites (2-15) • Bridge and Culvert Installation (2-17)
E14: Temporary Roads	• Stream Crossings on Temporary Roads (2-16) • Obliteration or Decommissioning of Roads (2-26)
E15: Rip Rap Composition	• Specifying Rip Rap Composition (2-20)
E16: Water Source Development	• Water Source Development Consistent with Water Quality Protection (2-21)

BMPEP Onsite Evaluation Protocols	BMPs Evaluated
E17: Snow Removal	• Snow Removal Controls to Avoid Resource Damage (2-25)
E18: Pioneer Road Construction	• Timing of Construction Activities (2-3) • Constraints Related to Pioneer Road Construction (2-8) • Timely Erosion Control Measures on Incomplete Road and Stream Crossing Projects (2-9) • Disposal of Right-of-way and Roadside Debris (2-19)
E19: Restoration of Borrow Pits & Quarries	• Regulation of Streamside Gravel Borrow Areas (2-18) • Obliteration or Decommissioning of Roads (2-26) • Restoration of Borrow Pits and Quarries (2-27)
E20: Protection of Roads During Wet Periods	• Traffic Control During Wet Periods (2-24) • Management by Closure to Use (7-7)
R22: Developed Recreation sites	• Control of Sanitation Facilities (4-4) • Control of Solid Waste Disposal (4-5) • Assuring that Organizational Camps Have Proper Sanitation and Water Supply Facilities (4-6) • Protection of Water Quality Within Developed and Dispersed Recreation Areas (4-9) • Location of Pack and Riding Stock Facilities and Use in Wilderness, Primitive, and Wilderness Study Areas (4-10)
R23: Location of Stock Facilities in Wilderness	• Location of Pack and Riding Stock Facilities and Use in Wilderness, Primitive, and Wilderness Study Areas (4-10)
G24: Range Management	• Range Analysis and Planning (8-1), Grazing Permit System (8-2), Rangeland Improvements (8-3)
F25: Prescribed Fire	• Consideration of Water Quality in Formulating Fire Prescriptions (6-2) • Protection of Water Quality from Prescribed Burning Effects (6-3)
M26: Mining Operations (Locatable Minerals)	• Water Resources Protection on Locatable Mineral Operations (3-1) • Administering Terms of BLM-Issued Permits or Leases for Mineral Exploration and Extraction on NFS Lands (3-2)
M27: Common Variety Minerals	• Administering Common Variety Mineral Removal Permits (3-3) • Regulation of Streamside Gravel Borrow Areas (2-18)
V28: Vegetation Manipulation	• Soil Disturbing Treatments on the Contour (5-1) • Slope Limitations Mechanical Equipment Operation (5-2) • Disposal of Organic Debris (5-5) • Soil Moisture Limitations for Tractor Operations (5-6)
V29: Revegetation of Surface Disturbed Areas	• Revegetation of Surface Disturbed Areas (5-4)
R30: Dispersed Recreation	• Control of Sanitation Facilities (4-4) • Control of Solid Waste Disposal (4-5) • Assuring that Organizational Camps Have Proper Sanitation and Water Supply Facilities (4-6) • Protection of Water Quality Within Developed and Dispersed Recreation Areas (4-9) • Location of Pack and Riding Stock Facilities and Use in Wilderness, Primitive, and Wilderness Study Areas (4-10)

APPENDIX B: BMPEP SCORING PROCEDURES, PROBLEMS, AND PLANNED IMPROVEMENTS

BMPEP evaluations are conducted in the field using forms specific to each protocol. Each form consists of questions for implementation and effectiveness. Questions are answered with numbers ("raw" scores) that indicate the degree to which implementation or effectiveness was achieved. Low numbers indicate successful implementation and effectiveness, while high numbers indicate poor performance. Implementation questions are usually answered with numbers ranging from 1 to 4, with a score of 2 signifying acceptable implementation. Similarly, effectiveness questions are usually answered with numbers ranging from 1 to 3, with a score of 2 indicating acceptable effectiveness (some questions are yes/no answers, see discussion below). For both implementation and effectiveness responses, scores higher than 2 indicate standards were not met, and scores of 1 indicate that standards were exceeded (meaning that BMP performance was better than expected).

After the questions are answered on the form, the answers are entered into the Regional BMPEP data base and a weighted score is assigned to each response. Weighted scores were developed by a regional team of experienced hydrologists and fisheries biologists based on the potential for effects on water quality related to each question and response. The weighted scores were designed to result in an overall evaluation score of roughly 100 for a worst-case outcome.

The evaluations are automatically scored in the BMPEP data base using the sums of the weighted scores for all responses. The determinations of implementation and effectiveness depend on comparing the sums of the weighted implementation or effectiveness scores to pre-set inference points (IPs). High scores indicate poor performance, so a sum of weighted scores that is at or above the IP is rated as "not implemented" or "ineffective." A sum below the IP is rated as "implemented" or "effective."

A weighted-score sum equivalent to a "raw" score of 2 on all questions is minimally acceptable performance, so the IPs should be roughly equal to a sum of weighted scores corresponding to "raw" scores of 2, plus 1. Poor performance on one question (score of 4), however, can be offset by superior performance on another question (score of 1), so an evaluation that included a major BMP departure could still be rated as implemented and effective. Also, because the evaluations are scored based on weighted scores, some responses affect the overall score more than others. In practice, most IPs have been set to values corresponding to the sums of the minimally successful weighted scores plus roughly 10 points, to allow for minor departures without "failing" the entire evaluation. However, documentation of the IP determination process is incomplete, and identifying the correct IP for some protocols is problematic.

Over the 17 years during which the BMPEP data base has been in use, several problems with this scoring procedure have arisen owing to changes in the BMPEP field forms and questions. Questions and weighted scores were changed or added in the data base, but the IPs were not updated to correspond to the newer scores. As a result, 2 BMPEP protocols (E15, E20) could potentially have been scored as implemented or effective when their actual performance was substandard, and 3 BMPEP protocols (T03, E13, R22) could have been

scored as not implemented or ineffective when their performance was adequate or better. The number of incorrectly scored evaluations, if any, is not known, and can be determined only by an examination of the individual evaluation forms. In addition, 3 BMPEP protocols have multiple questions in the data base that correspond to a single question on the field form, and the correct IPs cannot be determined (E10, E18, and M26).

To address these problems, a new scoring procedure was developed in 2004 by a regional BMPEP task group that included Stanislaus National Forest hydrologist Jim Frazier, Lassen National Forest Fisheries Biologist Ken Roby, and Regional Hydrologist Brian Staab. The revised procedure has since been known as the "Frazier protocol" (attached below). This protocol does not use IPs, but instead rates BMPs as successful or not based on whether individual responses indicate departures. This system is much easier to use and understand, but it was never incorporated into the BMPEP due to lack of funding. Regional funds adequate to support the change in scoring procedure were made available in 2008, and an Enterprise Team has been contracted to make the scoring procedure change.

An initial comparison of the existing pass-fail IP-based scoring system and the Frazier 3-level protocol was made using data from 2,832 evaluations made between 2003 and 2007 and retrieved in September, 2008. The Frazier protocol rated fewer evaluations as implemented and effective (Table B-1), but also fewer as not implemented and not effective (Table B-2), because the new protocol has a third possible score of "at risk" that does not count toward either implementation/effectiveness or lack of implementation/effectiveness. The existing scoring system rated 86% of the evaluations as implemented and 86% as effective. The Frazier protocol rated 81% of the evaluations as implemented and 71% as effective. The existing scoring system rated 14% of the evaluations as not implemented and 13% as not effective. The Frazier protocol rated 5% of the evaluations as not implemented and 10% as not effective. For the BMPEP protocols that had questionable scores using the IP-based system (T03, E10, E13, E15, E18, R22, M26; noted in ***bold italics*** in Tables B-1 and B-2 below), the Frazier protocol scores are considered a more reliable indicator of implementation and effectiveness.

Table B-1: BMPEP implementation and effectiveness success for 2003 to 2007 scored under the existing IP-based system and the proposed Frazier protocol

[imp; implemented; eff, effective; results in bold italics indicate BMPEP protocols with scoring problems using the IP system]

Protocol	Number of evaluations	IP scoring, % imp	IP scoring, % eff	Frazier scoring, % imp	Frazier scoring, % eff
T01	201	91	89	92	89
T02	223	86	97	91	89
T03	***45***	***89***	***40***	***89***	***87***
T04	277	94	98	93	90
T05	42	93	100	90	79
T06	24	100	100	96	92
T07	33	91	91	70	64
E08	309	82	83	75	53
E09	252	89	80	76	50
E10	***184***	***73***	***93***	***85***	***67***
E11	173	91	94	51	50
E12	25	100	96	88	80
E13	***82***	***82***	***77***	***82***	***82***
E14	35	86	83	77	69
E15	***35***	***86***	***83***	***77***	***69***
E16	51	73	63	73	86
E17	45	84	89	76	76
E18	***1***	***100***	***100***	***0***	***0***
E19	6	100	83	67	83
E20	***37***	***97***	***81***	***78***	***51***
R22	***114***	***73***	***57***	***84***	***82***
R23	34	65	68	56	32
G24	98	94	81	83	41
F25	190	87	98	81	83
M26	***41***	***0***	***59***	***73***	***54***
M27	27	100	48	74	85
V28	67	99	99	96	90
V29	61	97	93	82	74
R30	120	87	85	74	77
Average	**--**	**86**	**86**	**81**	**71**

Table B-2: BMPEP implementation and effectiveness failures for 2003 to 2007 scored under the existing IP-based system and the proposed Frazier protocol

[imp; implemented; eff, effective; results in *bold italics* indicate BMPEP protocols with scoring problems using the IP system]

Protocol	Number of evaluations	IP scoring, % not imp	IP scoring, % not eff	Frazier scoring, % not imp	Frazier scoring, % not eff
T01	201	4	6	4	3
T02	223	14	3	3	5
T03	***45***	***11***	***60***	***2***	***4***
T04	277	6	2	3	4
T05	42	7	0	0	2
T06	24	0	0	0	0
T07	33	9	9	6	3
E08	309	18	17	6	14
E09	252	11	20	5	24
E10	***184***	***27***	***7***	***4***	***7***
E11	173	9	6	8	3
E12	25	0	4	0	4
E13	***82***	***18***	***23***	***4***	***1***
E14	35	14	17	6	17
E15	***35***	***14***	***17***	***6***	***17***
E16	51	27	37	16	12
E17	45	16	11	2	4
E18	***1***	***0***	***0***	***0***	***0***
E19	6	0	17	0	0
E20	***37***	***3***	***19***	***3***	***24***
R22	***114***	***28***	***44***	***5***	***9***
R23	34	35	32	15	59
G24	98	6	19	0	28
F25	190	13	2	4	5
M26	41	100	41	7	17
M27	27	0	52	4	0
V28	67	1	1	1	3
V29	61	3	7	2	7
R30	120	13	15	8	20
Average	**--**	**14**	**13**	**5**	**10**

R5 BMPEP Scoring Rule Set

By Jim Frazier
April 13, 2004

Implementation

Pass

- All rating items are 1 or 2, and/or < ½ of rating items are 3, and none is 4 (example: if there are 5 rating items: 2 are 3's and the rest are 1 or 2)

At Risk

- ***½ of rating items are 3, and none is 4 (example: if there are 5 rating items: 3 are 3's and the rest are 1 or 2)***

Fail

- ***All rating items are 3's, or any rating item is a 4***

Effectiveness

Pass

- All rating items are in column 1, or combination of column 1 and 2 with <1/2 of the rating items in column 2

At Risk

- >= ½ of the rating items are in column 2 with no more than 1 rating item in column 3 (example: if there are 6 rating items, at least 4 are in column 2 and not more than 1 in column 3)

Fail

- 2 or more rating items are in column 3, or any rating in column 3 is a "sediment to channel" rating item

Note: Columns 1-3 as described above go from left to right on the evaluation form

APPENDIX C: DRAFT version 1.6 , USDA Forest Service Pacific Southwest Region Water Quality Monitoring Plan, September 29, 2008

A comprehensive and regionally consistent water-quality monitoring program is needed to guide water-quality protection programs on national forests in the Pacific Southwest Region. This draft plan proposes a program that is intended to meet the needs of the Region as well as the State Water Resources Control Board and the Regional Water Quality Control Boards for water-quality information. When finalized, this plan will serve as the monitoring component of the Regional Water Quality Management Plan. This version of the draft plan incorporates suggestions from the staffs of the State and North Coast Regional Boards.

Criteria

The program must include the following:

1. A scientifically valid approach to data collection and analysis.
2. Early detection of water-quality problems associated with current management activities.
3. Follow-up monitoring to ensure correction of known deficiencies and to evaluate long-term effectiveness of water-quality protection measures.
4. Conjunctive hillslope and in-channel monitoring ("nested" monitoring) to evaluate linkages between BMP effectiveness and effects on beneficial uses.
5. Evaluation of trends in beneficial uses in receiving waters downstream of forest management activities, including waters listed as impaired under section 303(d).
6. Assessments of water quality in relatively pristine reference streams for comparison with listed and potentially listed impaired waters.
7. Targeted monitoring of high-risk projects.
8. Flexibility in program scope to ensure that the program can be accomplished with available Forest Service resources.

Program Management

1. The monitoring program will be a regional program coordinated by the Regional Office and conducted by the national forest staffs.
2. Monitoring targets will be made based on regional priorities, rather than being evenly distributed among forests.
3. Annual targets for all monitoring activities will be set by the Regional Office and communicated to the State and Regional Boards. Targets will be changed as necessary to reflect changes in funding and staffing.
4. Funding to support monitoring will be allocated based on assigned targets.
5. Watershed staff will be used to conduct monitoring to the extent possible, but monitoring may also be conducted by other trained USFS personnel.

Proposed Plan

This plan will rely on existing well-documented monitoring methods. Hillslope monitoring for management activities will use Best Management Practice Evaluation Program (BMPEP, U.S. Forest Service, Pacific Southwest Region, 2001) protocols. In-channel monitoring will follow Stream Condition Inventory (SCI, U.S. Forest Service, Pacific Southwest Region, 2002) protocols.

A. Hillslope monitoring of current management activities and corrective actions

1. All projects will have administrative implementation monitoring using a "checklist" approach. This monitoring will be conducted by USFS project staff (timber, range, recreation, etc.) and will be coordinated and reviewed by the Forest Hydrologists. Administrative implementation monitoring will be the primary systematic means for early detection of potential water-quality problems, and will be completed early enough to allow corrective actions to be taken, if needed, prior to the onset of the first winter after project implementation.
2. The BMPEP, with random site selection, will continue to be the primary means of assessing the effectiveness of water-quality protection for current projects on NFS lands at the hillslope scale.
3. Effectiveness monitoring for BMPEP protocols that have consistently scored 95% or higher for 5 consecutive years at the Regional level will be reduced to allow efforts to focus on implementation, retrospective, and beneficial-use monitoring.
4. Corrective actions will be taken in response to recommendations made the previous year to address water-quality protection, and these actions will be documented in annual BMPEP reports.
5. Follow-up monitoring for sites that were not rated as fully implemented or effective the previous year will be conducted, and results will be presented in annual BMPEP reports.
6. All projects in "high risk" watersheds that are at or above thresholds of concern for cumulative watershed effects, as determined by the Equivalent Roaded Area model, or in watersheds with 303(d) listed impaired waters, will have non-random BMPEP effectiveness monitoring.
7. National forests will conduct road patrols to the extent allowed by weather, safety, and road conditions during and after major storms to detect and correct road drainage problems that could affect water quality.

B. Retrospective hillslope monitoring of past management activities

1. Sample pools will be developed for timber, engineering, and grazing projects completed in the past 5 years that were rated as effective as part of the random BMPEP monitoring.
2. Projects will be selected randomly for retrospective BMPEP effectiveness evaluations.
3. Results of retrospective monitoring will be compared to original BMPEP effectiveness scores to determine if BMPs remained effective over a period of years.

C. Representative in-channel beneficial-use monitoring

The purpose of in-channel monitoring of beneficial uses is to determine whether BMPs collectively are effective in protecting water quality at the watershed scale. Effectiveness will be assessed by monitoring trends in channel characteristics that affect beneficial uses and by comparing channel characteristics of streams downstream of intensively managed areas with those in pristine watersheds (the paired watershed approach).

Because USFS resources are limited, monitoring will be restricted to a relatively small number of sites. Therefore, monitoring sites will need to be carefully selected to represent large landscapes within the national forest system. Detecting downstream channel changes related to upstream activities is problematic (MacDonald and Coe, 2006), so monitoring sites will be located on headwaters streams. Paired monitoring sites (intensively managed and pristine) will be selected to have similar valley segment and stream reach characteristics (Bisson and others, 2006).

4. Fixed long-term locations for SCI surveys will be selected by the forest hydrologists and Regional Office in cooperation with the State and Regional Board staffs to represent areas of similar landform, geology, climate, and vegetation.
5. SCI sites will be selected to minimize variability in channel type.
6. SCI sites will be stratified based on watershed condition class (I, II, III), with approximately one-third of the selected watersheds in each condition class.
7. SCI surveys will be made near the mouth of each selected watershed at least once every 5 years and as soon as possible following major (RI>10 year) floods. Roughly 20% of the watersheds will be surveyed each year, on average.
8. If SCI results indicate adverse impacts to channels from management activities in watersheds in condition class II or III, restoration plans will be developed and implemented. Adverse impacts will be inferred by comparison with SCI results for watersheds in condition class I.
9. Non-random "nested" BMPEP evaluations for all current management activities will be conducted within the selected watersheds. Implementation and effectiveness results will be compared to SCI results.
10. For watersheds 303(d) listed for water temperature, SCI water-temperature monitoring will be conducted for at least one full snow-free season. In addition, effective shade will be monitored using Solar Pathfinders.
11. Sites will be removed from or added to the sample pool as needed by the Regional Office in consultation with the State and Regional Boards.

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