

## LAWS AND PROGRAMS FOR CONTROLLING NONPOINT SOURCE POLLUTION IN FOREST AREAS<sup>1</sup>

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**ABSTRACT:** Recent federal legislation strengthened nonpoint source pollution regulations and helped to support and standardize pollution control efforts. A comprehensive review of current state and federal programs for forest areas reveals a substantial increase in agency water quality protection activities. These new efforts emphasize monitoring to assess the use and effectiveness of best management practices (BMPs). Recent monitoring reveals that BMP use is increasing and that such use typically maintains water quality within standards. However, information is generally lacking about the cost effectiveness of BMP programs. Carefully designed and executed monitoring is the key to better specification of BMPs and more cost effective water quality protection.

**(KEY TERMS:** water quality; nonpoint source pollution; water law; watershed management; forestry; best management practices.)

### INTRODUCTION

Since passage of the Federal Water Pollution Control Act of 1972 (33 U.S.C. 1251-1376), considerable progress has been made in controlling point sources of water pollution, allowing more emphasis to be placed on nonpoint source pollution. Although agricultural lands are the major source of nonpoint source pollution (EPA, 1990), forests are also an important concern, especially in areas of the United States with valuable and sensitive fisheries.

The laws and programs designed to control nonpoint source pollution have changed considerably in the past few years. Federal legislation has provided more specific guidance to states, and states have acted on their own to increase protection of water quality. Some of the legislation and programs focus on forests, while others apply more generally to agricultural land and other sources of nonpoint source pollution. We provide an up-to-date summary of the major

federal laws and federal and state programs that affect nonpoint source pollution on forests and associated rangelands, and discuss the implementation, efficacy, and cost effectiveness of best management practices.

### FEDERAL LAWS AFFECTING NONPOINT SOURCE POLLUTION FROM FORESTS

Federal laws influencing water quality protection on forests can be broadly separated into two groups: general resource management laws that have some bearing on water quality and specific water quality laws. Much of the general land and resource management legislation, with the exception of the National Environmental Policy Act of 1969 (42 U.S.C. 4321-4370), applies only to federal lands and vests authority with federal agencies, while the specific water quality laws apply across all ownerships and vest authority with the states. [For more detail on federal laws affecting nonpoint source pollution from national forest lands, see Wilkinson and Anderson (1985), Anderson (1987), and Whitman (1989).]

#### *General Resource Management Legislation*

The Forest Service's Organic Act of 1897 states, "No national forest shall be established, except to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the

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United States" (16 U.S.C. 475). It is not entirely clear what "favorable conditions of water flows" was intended to mean, but conditions at the time the Bill was passed suggest that it included avoiding both floods and serious erosion and sedimentation. Thus, far from being a subsidiary purpose, water quality and associated watershed protection were key objectives of national forest reservation.

The next highly significant law affecting national forest management was the Multiple Use, Sustained Yield Act of 1960 (MUSYA). MUSYA codified long-standing Forest Service management policies, specifying that national forests were to be administered for "outdoor recreation, range, timber, watershed, and wildlife and fish purposes" (16 U.S.C. 528). The MUSYA also required that production of products and services should not impair "the productivity of the land" (16 U.S.C. 531). While again emphasizing the importance of watershed protection, the Act provided no specific direction on how watersheds or water quality were to be protected.

It was not until the late 1960s that general resource management legislation imposed major new environmental protection requirements on public land agencies. The National Environmental Policy Act of 1969 (NEPA) required environmental impact statements or environmental assessments for major management actions, essentially forcing consideration and disclosure of impacts, the consideration of which had previously been left to the discretion of resource professionals. NEPA required a significant increase in the documentation of potential environmental impacts. Although the required programmatic documents have often been too general to allow analysis and prediction of potential water quality violations in a particular area, they have helped to identify areas of concern that need to be tracked as management plans become more specific.

Major public land management legislation was passed in the 1970s. The National Forest Management Act of 1976 (NFMA) requires resource management plans for national forests, and also contains prescriptive provisions requiring that the forest plans consider environmental effects, including water quality. The Act prohibits timber harvesting that fails to ensure that "soil, slope, or other watershed conditions will not be irreversibly damaged" [16 U.S.C. 1604(g)(3)(E)(i)]. Furthermore, the Forest Service must provide protection "for streams, stream banks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperature, blockages of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat" [16 U.S.C. 1604(g)(3)(E)(iii)].

The Federal Land Policy and Management Act of 1976 (FLPMA) applies to all federal land, but its main effect was to provide for Bureau of Land Management land what the MUSYA and the NFMA had provided for national forests. FLPMA requires planning for multiple uses while ensuring long-term sustainability. The Act mentioned the "water resource" and concern for "habitat for fish" [43 U.S.C. 1701 (a)(8)] among its environmental quality provisions.

While NFMA and FLPMA placed considerable procedural restrictions on federal land management, the acts, like earlier legislation, did not impose specific constraints regarding water quality. Prohibitions against "irreversibly damaged" watershed conditions and "seriously and adversely affected" water conditions, like the MUSYA prohibition on "impairment of the productivity of the land," provide a real indication of concern and a general direction for managers, but they are not specific enough to enable clear tests of accountability regarding water quality protection. Nevertheless, these Acts have had a profound impact on land and water management, principally through their requirements for more thorough documentation, disclosure, and public review of proposed management practices.

#### *Specific Water Quality Legislation*

Federal water quality legislation, with periodic amendments of gradually increasing specificity, has provided the guidelines for watershed and water quality protection that the general resource management legislation lacks, and has also extended water quality protection to state and private land. The 1972 amendments to the Federal Water Pollution Control Act (with its subsequent amendments now commonly referred to as the Clean Water Act) established a significant federal presence in water quality control. [The Federal Water Pollution Control Act (PL 80-845) was originally passed in 1948; this Act focused on the need for research, provided loans for municipal treatment works, and encouraged resolution of interstate pollution disputes, but had little direct impact on water quality. Other pre-1972 laws, which emphasized point sources and which were essentially replaced in 1972, included the Federal Water Pollution Control Act of 1956 (PL 84-660) and its 1961 amendments (PL 87-88), the Water Quality Act of 1965 (PL 89-234), and the Clean Water Restoration Act of 1966 (PL 89-753).] The 1972 Act imposed limits on point source discharges, required the states to implement water quality standards, and subsidized construction of public treatment facilities. Further, the act optimistically called for attainment of fishable and swimmable waters by 1983 and the elimination of

all point source discharges of pollutants into navigable waters by 1985.

Point source emissions were the major emphasis of the 1972 Act, but Section 208 of the Act specifically addressed nonpoint source pollution and designated silvicultural and livestock grazing activities as sources of nonpoint sources of pollution. Section 208 required states to adopt an "area wide waste treatment management planning process" that was applicable to "all wastes generated within the area" [33 U.S.C. 1288(b)(1)(A)]. The area wide plans were to include "a process to identify . . . silviculturally related nonpoint sources of pollution" and to set forth "procedures and methods (including land use requirements) to control to the extent feasible such sources" [33 U.S.C. 1288(b)(2)(F)]. The state and local plans were subject to approval by the Environmental Protection Agency (EPA). Federal land management agencies were subject to all requirements of duly promulgated state water quality laws and standards, to the extent that such standards were applied to all nongovernmental entities (33 U.S.C. 1323). Also of importance to forestry was Section 404, which addressed water pollution associated with deposit of dredged and fill material. Unlike the Section 208 nonpoint source pollution controls, regulation of these sources was primarily a federal function.

Although the EPA initially emphasized the more pressing and tractable problems of point source pollution, it also suspected early on that, as substantial control of point sources was realized, water quality degradation from nonpoint sources would "emerge as the major barrier to achievement of the [1972] Act's 1983 water quality goals" (EPA, 1974). EPA instituted a number of activities to implement nonpoint source provisions of the 1972 Act, including promulgation in 1974 of a "Suggested State Forest Practices Act" (Agee, 1975). The suggested act adopted a regulatory approach to pollution control, requiring state approval of a forest management plan before work could begin that would include the practices to be used to protect water quality, and allowing for penalties to be assessed for violations of the act. After a series of meetings around the U.S. in 1975 with interested parties, many of whom opposed a regulatory approach (Popovich, 1975), the EPA withdrew its suggested act, acquiescing to the possibility of voluntary state nonpoint source pollution control programs for forest areas that emphasized education, technical assistance, and perhaps cost sharing.

In 1976, some financial assistance for the development of 208 plans was awarded to the states, yet implementation of Section 208 plans remained a gradual process, as states and localities adapted to the new goals and the developing federal-state-local working relationship.

The Clean Water Act of 1977 amended the water quality legislation by, among other things, increasing control of toxic pollutants and authorizing a program of grants to help cover the costs to rural land owners of implementing "best management practices" (33 U.S.C. 1288) to control nonpoint source pollution. EPA regulations define best management practices (BMPs) as: "those methods, measures, or practices to prevent or reduce water pollution and include but are not limited to structural and nonstructural controls, and operation and maintenance procedures. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. Economic, institutional, and technical factors shall be considered in developing BMPs" [40 C.F.R. 35.1521-(4)(c)(1) (1984)]. Earlier definitions are found in Bailey and Waddell (1979) and U.S. Forest Service (1980). Lynch *et al.* (1985) lists examples of silviculture BMPs and Moore *et al.* (1979) and Chaney *et al.* (1990) list examples of grazing BMPs. Not all states use the term "best management practices" (BMPs); for example, Vermont uses "acceptable management practice," Connecticut uses "guidelines and suggestions," and California uses "forest practice rules."

Also, in 1977, the EPA formally informed states that they could elect either regulatory or nonregulatory programs for reducing nonpoint source discharges. Although the EPA retained authority to not approve the states' area wide plans unless the state was given at least the authority to require adoption of land management practices, this possibility became recognized as an "empty threat" (Goldfarb, 1984:188). The 1977 amendments also exempted "normal" silvicultural activities including road construction, when accomplished in accordance with approved BMPs, from the requirement of obtaining a Section 404 (dredge and fill) permit.

The Water Quality Act of 1987 further amended federal water quality legislation, appropriating new funds and establishing in Section 319 new requirements for states to develop and implement programs for controlling nonpoint sources of pollution (33 U.S.C. 1329). Section 208 previously required states to identify sources of nonpoint source pollution and to prepare plans to control such pollution, but it did not require that sources be related to specific bodies of water. This allowed states, if they wished, to maintain only a vague link between cause and effect, a lack of specificity that may have hindered plan implementation (resulting in the conclusion by Sax *et al.* (1991: 947) that "valuable in theory, Section 208 is toothless"). Section 319 encouraged implementation by requiring (1) detailed water quality plans that identified water bodies not meeting water quality standards, (2) identification of categories of nonpoint

sources or particular nonpoint sources responsible for violation of water quality standards in those water bodies, and (3) identification of BMPs to control them. Section 319 also detailed the process that the EPA was to use to either approve or disapprove the states' reports and management programs, although it lacked firm criteria for determining whether a proposed management plan was acceptable. States with programs approved by the EPA could receive matching grants to facilitate implementation of the programs. In 1989, Congress appropriated \$40 million for fiscal year 1990, of which \$34.8 million was awarded to the states. Congress appropriated \$51 million for fiscal year 1991 (EPA, 1992, Table 2).

Federal encouragement of water quality protection was again strengthened with the Coastal Zone Act Reauthorization Amendments of 1990. These amendments to the Coastal Zone Management Act of 1972 direct the EPA and the National Oceanic and Atmospheric Administration (NOAA) to prepare "guidance for specifying management measures for sources of nonpoint pollution in coastal waters" and direct the coastal states to submit a program for approval by EPA and NOAA within 30 months of publication of the guidance (16 U.S.C. 1455b).

The guidance is to include (1) a description of each "management measure" and the activities or locations for which each measure may be suitable, (2) identification of individual pollutants or categories of pollutants that may be controlled by the measures, and (3) quantitative estimates of the pollution reduction effects and costs of the measures, where "management measure" means an "economically achievable" measure for control of pollutants (16 U.S.C. 1455b). The 1990 Amendments do not clarify what was meant by "economically achievable." [A 126-page draft for forestry by EPA titled "Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Pursuant to Sec. 6217(g) of CZMA Amendments of 1990, Chapter 3: Management Measures for Forestry," was completed on April 27, 1992.]

According to the CZMA amendments, the state programs are to (1) identify coastal zone boundaries, (2) identify land uses that may cause degradation of coastal waters and management measures necessary to achieve and maintain water quality standards, (3) identify means the state will use to "exert control over" land and water uses, and (4) describe the organizational structure proposed to implement the program (16 U.S.C. 1451). The states are apparently free to use a regulatory or voluntary program, so long as the program is successful in meeting the water quality standards. Management of federal lands in or out of a coastal zone that affects the coastal zone waters must conform to the state program. Matching grants

are available to states for developing and administering their programs. Failure to submit an approvable program may lead to withholding of up to 30 percent of the grant funds available under both Section 306 of the CZMA and Section 319 of the CWA.

There is some confusion about how the CZMA amendments change the procedure already in place in response to the Water Quality Act amendments of 1987. The CZMA amendments explain merely that the state programs "shall serve as an update and expansion of the State nonpoint source management program developed under Section 319 . . . as the program under that section relates to land and water affecting coastal waters" (16 U.S.C. 1455b). However, the CZMA amendments go further in encouraging plan implementation with language requiring that standards are met, coupled with the threat of withdrawing funds that are made available to facilitate the implementation. The ultimate effect of this encouragement may be small unless the funds are substantial; in the absence of significant monetary inducements, the major effect of the CZMA amendments is likely to be the visibility they bring to the nonpoint source pollution issue.

#### STATE NONPOINT SOURCE POLLUTION CONTROL PROGRAMS

In the mid-1970s when implementation of the nonpoint source pollution provisions of the Federal Water Pollution Control Water Act of 1972 began to take effect, some states with existing programs submitted those programs to meet the new federal requirements, while others developed new approaches. Except for a few states with large commercial forest areas and recognized forest water quality problems, early state nonpoint source programs focused on agricultural lands, where pollution problems were far more serious than on forest lands. Only gradually did other states institute measures to protect water quality in forest areas.

Continuing societal concern about nonpoint source pollution, and the Water Quality Act of 1987 and CZMA of 1990, encouraged more proactive state efforts to protect water quality on forest lands. In the past four years, several states adopted BMPs for forest lands and many new states with programs increased their efforts to have their BMPs understood and used. In addition, some states, through property taxes or assessments on forestry operations, now provide cost-share funds, and others are establishing penalties for noncompliance with BMPs, especially where that noncompliance results in significant water quality degradation. In Table 1 and the following

paragraphs we briefly summarize, as of Spring 1992, state approaches for controlling nonpoint source

pollution from forest lands. The table is based largely on phone interviews with state personnel.

TABLE 1. State Approaches to Control of Nonpoint Source Pollution on Forest Lands, as of Spring 1992.<sup>a</sup>

State	Type of Program <sup>b</sup>		State Funded Financial Incentives <sup>c</sup>	Implementation Monitoring on State and Private Land <sup>d</sup>	Effectiveness Monitoring <sup>e</sup>
	Silviculture	Grazing			
<b>Southeast</b>					
Alabama	V	-	-	F(1991, 6-8/county)	-
Arkansas	V	-	-	F (1991, ?)	-
Florida	V,R	-	-	F (1991, 128)	F
Georgia	V	-	-	F (1991, 345)	F
Kentucky	V	V	-	C	-
Louisiana	V	-	-	F (1991, >100)	-
Mississippi	V	-	-	A (1991, ~100)	A
North Carolina	R	-	-	C (1991, 246)	-
South Carolina	V	-	-	F (1991, ~100)	B
Tennessee	V	V	-	F (1991, ?)	F
Virginia	V	-	-	F (1991, 1000)	F
West Virginia	R	-	C	F (1991, ~240)	-
<b>Northeast</b>					
Connecticut	V	-	-	F (1991, 89-90)	-
Delaware	R	-	-	A	-
Maine	V	R	-	P,C	O
Maryland	R	-	T,C	-	-
Massachusetts	V,R	-	-	F (1991, ~600)	F
New Hampshire	V,R	-	-	P	F
New Jersey	V	-	T	A (1991, ~575)	-
New York	V,R	-	-	PA (1991, ~1700)	PA
Pennsylvania	V	-	-	-	-
Rhode Island	R	-	-	F (1991, ?)	O
Vermont	R	-	-	C,A	F
<b>Midwest</b>					
Iowa	-	V	T,C	-	-
Indiana	V	-	T	-	-
Illinois	V	-	T,C	-	-
Michigan	V	-	-	-	-
Minnesota	V	-	C	F (1991, 48)	-
Missouri	V	-	-	A	C
Ohio	V	-	-	C	C
Wisconsin	V	-	T	-	-
<b>Great Plains</b>					
Kansas	-	-	-	-	-
Nebraska	-	-	T	C	C
North Dakota	-	-	-	-	-
Oklahoma	V	-	-	P	-
South Dakota	-	-	-	C	-
Texas	V	-	-	F (1992, 162)	F
<b>Rocky Mountains</b>					
Colorado	V	-	T	-	-
Idaho	R,R	V	T	F (1991, 40), A	C,PFA
Montana	V,R	-	-	F (1990, 44), C,A	F,B
Nevada	R	-	-	F (1991, 5)	-
Utah	-	-	-	-	-
Wyoming	-	-	-	-	-
<b>Northwest</b>					
Alaska	R	-	-	F (1991, >50)	F
Oregon	R	-	-	P (1989, 5204)	F
Washington	R	-	-	F (1991, 191)	F

TABLE 1. State Approaches to Control of Nonpoint Source Pollution on Forest Lands, as of Spring 1992 (cont'd.).<sup>a</sup>

State	Type of Program <sup>b</sup>		State Funded Financial Incentives <sup>c</sup>	Implementation Monitoring on State and Private Land <sup>d</sup>	Effectiveness Monitoring <sup>e</sup>
	Silviculture	Grazing			
Southwest					
Arizona	—	—	—	—	O
California	R	—	—	F (1991, >2000)	F
New Mexico	R	—	—	A (1991, 30)	—
Hawaii	—	—	—	—	—

<sup>a</sup> Personnel from forestry and/or environmental agencies in each state were interviewed by phone in April of 1992 to produce a draft of the table. Each state's responses were then sent by mail in May to the interviewees for verification, and the table was corrected based on any responses we received. Note that earlier summaries of state legislation and programs, some of which included only some of the states, were provided by NCASI (1983), Cabbage *et al.* (1987), Guldin (1989, Appendix C), and Essig (1991).

<sup>b</sup> V = Voluntary program of state approved BMPs.

R = Regulatory program of state approved BMPs, fines can be assessed for noncompliance.

<sup>c</sup> T = Tax incentive.

C = Cost sharing.

<sup>d</sup> F = Formal periodic post-hoc survey of all or randomly selected sites meeting certain criteria for selection (date of most recent survey and number of sites, where available).

P = Post-hoc inspection of sites selected by field foresters (not a formal random sample).

C = Inspection of complaints and other obvious problem sites.

A = Inspection of selected sites when activities are in progress (date of most recent survey and number of sites, where available).

<sup>e</sup> F = Formal periodic post-hoc qualitative survey of carefully selected sites.

P = Post-hoc qualitative inspection of selected sites.

C = Qualitative inspection of complaints or other problem sites.

A = Qualitative inspection of most activities in progress.

B = Periodic water quality monitoring of streams draining selected forested sites.

O = Occasional or limited site-specific water quality monitoring.

### Type of Program

State approaches for controlling nonpoint source pollution from forest lands can be broadly categorized as regulatory or voluntary. Regulatory programs impose requirements on land management and allow assessment of fines and other penalties for noncompliance. States with regulatory programs usually rely on inspection of management activities while the activities are in progress, as well as follow-up inspections, to improve compliance with BMPs and to determine whether penalties are to be assessed. Regulatory states may also require approval of harvest or road construction plans that include water quality protection measures before field work begins. States with voluntary programs emphasize education and training (BMP manuals, seminars, mailings, and personal contacts) and onsite inspection where requested, and do not assess fines for noncompliance with BMP guidelines. Increasingly, states with voluntary programs are performing formal compliance surveys to judge the effectiveness of the voluntary approach. On forest land across the 50 states, 23 have voluntary

programs, 13 have regulatory programs, an additional 5 use a combination of voluntary and regulatory measures, and 9 lack a formal program (Table 1).

In the Southeast, all states have forestry plans, and two states have grazing management plans, most of which employ voluntary BMPs to be implemented through training and educational programs (Table 1). Florida, North Carolina, and West Virginia require the use of BMPs for harvest-related activities — Florida in three of its five Water Management Districts (see Lickwar *et al.*, 1990), North Carolina following the state's Sedimentation Pollution Control Act, and West Virginia following its 1992 Logging Sediment Control Act.

In contrast to the Southeastern states where voluntary programs prevail, no single program type dominates among the 11 Northeastern states. For silvicultural activities, four states have regulatory programs, four have voluntary programs, and 3 have a combination of the two approaches (Table 1). Of the three states with combinations, two (Massachusetts and New Hampshire) have regulatory programs of BMPs for riparian zones and voluntary programs for

nonriparian forest sites, while New York has a regulatory program for state-owned lands and a voluntary program for private lands. On state lands in New York, a performance bond is held on larger sales to ensure proper application of BMPs. Maine has a program affecting grazing (under the jurisdiction of the state's Department of Agriculture).

Nine of the 14 states in the Midwest and Great Plains regions have voluntary programs of state-approved BMPs for forest lands, and one other state (Kansas) has BMPs under consideration (Table 1). Several of these states have relatively few forested areas, which are usually associated with farms and ranches, and thus have been under less pressure than other states to institute formal forestry BMP programs. Some states have relied on federal regulations (for example, most of the forests in South Dakota are federally owned, and federal regulations have generally been considered adequate for protection of water quality). Only Iowa has a program of grazing BMPs, although Kansas is considering formulation of them for riparian areas.

Four of the six Rocky Mountain states have nonpoint source pollution programs for forest lands (Table 1). Colorado's program is voluntary, while Montana's is regulatory for riparian areas and voluntary elsewhere. Idaho and Nevada have regulatory programs, with Lake Tahoe Basin BMPs being more restrictive than those applying to other parts of Nevada. Idaho also has a voluntary program of grazing BMPs.

All three Pacific Northwest states have regulations for control of nonpoint sources of pollution from forest practices (Table 1). In Alaska, the 1981 Forest Resources and Practices Act requires notification prior to harvesting operations, and advises use of BMPs. Alaska's program was strengthened with 1991 legislation, and more strict regulation is likely to result. In Washington, Forest Practice Rules and Regulations (pursuant to the 1974 Forest Practice Act) provide standards governing road construction, harvesting, site preparation, use of chemicals, and reforestation. Written applications prior to operations are classed into one of five categories, with each category receiving different levels of evaluation. The Oregon Forest Practices Act of 1971 covers road construction, harvesting, site preparation, use of chemicals, and reforestation.

In the Southwest, California and New Mexico have regulatory programs, Hawaii relies on strict land use planning requirements rather than water quality BMPs, and Arizona is considering adoption of voluntary silvicultural and grazing BMPs (Table 1). California's thorough regulatory program involves a combination of legislation, administrative regulation,

licensing of professional foresters and timber operators, and active enforcement (Yee, 1987). Nearly every timber harvest in California must include a timber harvest plan that receives an interdisciplinary review. Once a permit is granted, the Department of Forestry has enforcement responsibilities to ensure compliance with a wide range of regulations (including water protection). The application of BMPs proceeds in four phases: feasibility, site-specific assessment, application of BMPs, and monitoring. This elaborate process was estimated to increase the stumpage cost by about 5 to 10 percent (Skaugset, 1987).

In addition to state programs, many local ordinances have been passed by counties, townships, and municipalities. Martus *et al.* (1993) recently identified 522 local ordinances in 24 states that regulate forestry activities in the U.S., with 68 percent of them in Northeastern states and 27 percent in Southern states. Local ordinances are less common in the West, where comprehensive state-level laws are more common. About three-quarters of the ordinances were enacted in the past 10 years, and nearly half are less than five years old.

### *Financial Incentives*

Eleven states offer financial inducements, in the form of cost sharing or tax incentives, to private forest owners who adopt BMPs or carry out other activities that will have a positive effect on water quality (Table 1). In the Southeast, Virginia has a cost-sharing plan for agricultural BMPs that can apply in woodland areas. Two northeastern states, Maryland and New Jersey, offer tax incentives for use of forest management BMPs, and Maryland has a state-funded cost-sharing program encouraging reforestation. In the Midwest, Illinois has a cost-sharing program encouraging use of forestry BMPs (funded from a tax on forestry activities); Minnesota has a program emphasizing protection of riparian areas from damage by livestock; Indiana and Illinois offer tax incentives for use of BMPs in woodland or forest areas; Iowa offers tax incentives for protection of at least two acres of woodland of sufficient stand density, plus cost sharing for tree planting and stand improvement; and Wisconsin offers tax incentives for maintenance of woodlands through a formal management plan. In the Great Plains, Nebraska offers tax incentives for maintenance of woodland areas. Of the six Rocky Mountain states, two states offer tax incentives, Colorado for tree planting and management and Idaho for maintenance of forest lands.

Four federally funded programs currently provide cost-share funds and technical assistance for forestry

activities on forest or agricultural land that may have a positive effect on water quality. The Agricultural Conservation Program, begun in 1936, supports a series of agricultural conservation practices emphasizing water quality and other environmental concerns and including such practices as tree planting, stand improvement, and animal exclusions in riparian areas; over 7 million acres have been planted with trees so far, mainly in the southern states. The Conservation Reserve Program, established in 1985 and expected to end in 1995, funds retiring of highly erodible farm land through establishment of permanent cover; over 2.3 million acres have been planted with trees in 41 states, with 92 percent in the southern states. (Also, over 20 million acres have been planted in grass.) The Forestry Incentive Program, established in 1974 and slated to end in 1995, funds timber production activities, some of which (e.g., tree planting) may enhance water quality; over 3.9 million acres have benefitted so far in 49 states, with 70 percent in the southern states. Finally, the Stewardship Incentive Program, which began disbursing funds in 1992, supports a number of environmental protection activities, including streambank stabilization, riparian buffer zones, and protection of native vegetation. As of the spring of 1992, about half of the states reported using SIP funds, others were in the process of requesting them. The Agricultural Stabilization and Conservation Service administers the first three of these programs, but forestry aspects of the programs are facilitated by the U.S. Forest Service in cooperation with state personnel. The Stewardship Incentive Program is administered by the U.S. Forest Service, but the funds are disbursed with the assistance of the Agricultural Stabilization and Conservation Service. In addition to these four cost share programs, the Federal Income Tax Reforestation Incentive program provides credits for tree planting.

State or federal assistance may be conditional on the landowner filing a management plan for conducting timber or grazing operations. Most states will revoke tax incentives or cost-share funds if the BMPs are not implemented. In addition, a few states are now inspecting private lands on a regular basis to ensure that the long-term objectives (e.g., maintenance of stand densities) of the management plan are fulfilled.

### *Implementation Monitoring*

BMPs must of course be used to be effective. States use different procedures for encouraging and checking on compliance with their nonpoint source pollution programs on forest lands. Table 1 lists the approaches currently used by each of the states to monitor BMP

implementation on state and private land. Twenty states reported that they now perform formal post-hoc surveys of all or randomly selected recently managed (e.g., harvested) sites. While some states, such as Florida, have been conducting formal surveys for over ten years, many of the 20 states have only recently begun to formally measure the degree of BMP use. In addition to states performing formal surveys, five states reported doing post-hoc inspections of miscellaneous sites selected by field foresters, and seven states reported performing inspections based on complaints or other knowledge of problems. Finally, eight states, most with regulatory programs, reported that agency personnel visit some or all sites when land disturbance activities are in progress to both encourage and monitor compliance. In all, 36 states reported using some procedures for monitoring compliance, with some of these using more than one procedure.

Some states use a combination of monitoring procedures; for example, it is not uncommon for agency personnel to visit sites while activities are in progress on state land, but perform post-hoc inspections on selected private land sites (as in New York), or to use different procedures for voluntary and regulatory BMPs (as in Montana). Some states (e.g., Arizona) restrict their monitoring to state lands, while most visit private lands as well.

In addition to the BMP monitoring efforts listed in Table 1, BMP monitoring occurs where a contract between the state and a private party requires BMP use. This occurs in two circumstances, where land owners benefit from cost-sharing or tax-incentive plans (e.g., Indiana, Illinois, Iowa, Arizona, and Colorado), and where some contracts for harvest on state land require use of BMPs even though the state lacks a formal BMP program (e.g., Wyoming, Colorado).

States performing formal surveys of recently disturbed sites use a variety of procedures. First, different criteria are used for selecting the sites to be inspected. Often the sample is stratified according to land ownership (state, industry, private, and, in some cases, federal) and land characteristic (e.g., land form, soil type, vegetation type). Often the sample emphasizes sites more likely to cause water quality problems, such as sites closer to streams or lakes, on steeper slopes, and on more erodible soils. The population of potential sites may originally be determined by viewing aerial photos, reviewing permit records, or relying on the knowledge of agency personnel. Second, the time interval for surveys differs. Surveys may occur annually (as in Virginia), biennially (as in Florida; see Conner *et al.*, 1989), or on some longer or unspecified interval. Third, the evaluators differ. In some states, one multidisciplinary team visits each sample site (as the recent effort in South Carolina),

while, in others, the local (e.g., county) forester is usually the only evaluator (as in Virginia). In other states, different multidisciplinary teams cover different regions of the state (as in Montana). It is common to include conservation, industry, and academic members on the team along with agency personnel. The more sites included in the survey, the fewer persons are likely to visit each site and the more likely it is that different persons visit different sites. Fourth, a variety of field response forms are used (see NCASI, 1988, for some examples), often employing rating schemes for each of the set of relevant BMPs. Different forms result in different ways of measuring and summarizing compliance. Fifth, the number of sites differs, varying from under 50 to several thousand (see Table 1). Sixth, states check on their own, unique, set of suggested or required BMPs. Finally, states differ markedly in the detail that they provide in the survey reports, varying from the very informative to the cursory.

For all the foregoing seven reasons, the results of different states' compliance surveys are not directly comparable. With this in mind, it is nevertheless instructive to summarize results for reports we were able to obtain. Most states reported overall (across all ownerships and BMPs) compliance of at least 85 percent, and usually above 90 percent. However, compliance differed by ownership and type of BMP. In general, compliance tends to be lower for private than public or industry land, and lower for small private landowners than large private landowners. States differ in which BMPs are more, and less, often complied with, although roads and skid trails (probably the principal source of sedimentation problems in forestry) tend to receive lower than average compliance levels. For example, in Georgia, compliance was 96 percent for reforestation BMPs, but only 69 percent for road BMPs (Georgia Forestry Commission, 1991); in Virginia, compliance was 98 percent for site preparation BMPs and 84 percent for skid trail BMPs (Virginia Department of Forestry, 1991); in Vermont, compliance was above 75 percent for log landing location BMPs and below 20 percent for road and skid trail waterbar BMPs (Brynn and Clausen, 1991); and in South Carolina, compliance was 89 percent for log deck BMPs and 52 percent for streamside management zone BMPs (Hook *et al.*, 1991). In states with well-established regulatory programs, such as Oregon and Washington, the most common problems were failure to properly fill out reports or notify state officials; recent compliance with field practices tended to be at least 95 percent (Oregon Department of Forestry, 1990; TFW Field Implementation Committee, 1991).

The trend among the states is towards a more concerted implementation monitoring effort. There has

recently been a dramatic increase in the number of states periodically performing formal surveys of BMP compliance, and formal surveys of randomly selected sites now appears to be the preferred approach. Encouraging results from such surveys are now generally considered to be necessary justification for not switching from a voluntary to a regulatory nonpoint source pollution control program.

### *Effectiveness Monitoring*

Effectiveness of BMPs implemented onsite can basically be monitored in two ways: qualitatively by trained professionals during onsite inspection, or by quantitative measurement. Qualitative checking can be accomplished informally, but a formal survey of randomly selected sites, perhaps in concert with a compliance survey, is the preferred method. Quantitative measurement can include downstream water quality sampling, bedload monitoring, and biological monitoring, as well as on-land monitoring of soil movement. Careful quantitative measurement is preferable to qualitative judgments, but its high cost often limits such measurement to a few carefully selected sites.

Table 1 lists the approaches currently used in forest areas by each of the states. Thirteen states reported that they now perform formal periodic post-hoc qualitative surveys of BMP effectiveness at selected sites. Formal surveys are more common in states with regulatory BMP programs. In addition, seven other states reported performing qualitative effectiveness inspections, usually in response to complaints or in the course of other site inspections. Only five states reported doing quantitative measurement (usually water quality sampling) to evaluate BMP effectiveness, two on a periodic basis (e.g., Montana performs long-term monitoring at eight stations) and three on a more limited basis (e.g., Maine focuses its efforts on one large sensitive watershed). In all, 22 states reported performing some type of effectiveness monitoring. Both the difficulty of adequately measuring effectiveness with qualitative methods and the high costs of performing sufficient quantitative monitoring to evaluate BMP effectiveness contribute to the lack of state efforts in this arena. Note that some states (e.g., Arkansas) perform some onsite inspection for soil movement, but not for water quality per se.

The assessments of BMP effectiveness that we reviewed suggest that when BMPs are applied, they are generally effective. Consider these examples: the Georgia Forestry Commission (1991:23) concluded that "current BMPs appear to be sufficient in protecting water quality when implemented;" the Texas Forest Service (1992:21) concluded that "shortcomings

in BMP effectiveness . . . arose not from poor BMP specification, but from poor implementation;" in Idaho, Colla (1992) concluded that "when rules/BMPs are implemented they are effective in minimizing impacts to beneficial uses" (see also Harvey *et al.*, 1988); in California, the SWRCB (1987:S-4) concluded that "noncompliance [with forest practice rules] was the single most important impediment to achievement of adequate resource protection;" and in Washington, the TFW Field Implementation Committee (1991) found that only 1 percent of the BMP applications resulted in damage or potential damage to the public resource.

It should be mentioned that detailed studies have also investigated BMP effectiveness. Consider two examples:

(1) At the Leading Ridge experimental watershed in Pennsylvania, BMP implementation in the harvesting operation generally kept suspended sediment concentrations and water temperature increases at low levels. For example, during the first year following harvest, suspended sediment averaged only 5.9 mg/L for the treatment watershed compared with 1.7 mg/L for the control watershed, and stream temperature increase was about 0.6°C (Lynch *et al.*, 1985).

(2) In the Six Rivers National Forest in California, a ten-year study found that BMP implementation allowed a 50 percent reduction in harvest-related land slides, an 85 percent reduction in road-related slides, and a drop in the percent of fine materials in stream bottoms from 20-30 percent to about 13-18 percent (Knopp *et al.*, 1987).

#### FEDERAL LAND MANAGEMENT AGENCY NONPOINT SOURCE POLLUTION CONTROL EFFORTS

Federal agencies must comply with watershed protection provisions of federal land management legislation and with the Clean Water Act. According to the Clean Water Act, federal lands are to comply with state water quality laws and standards, to the same extent as any nongovernmental entity. Under Section 319 of the 1987 Amendments to the Clean Water Act, states are to identify federal actions that are inconsistent with state water quality objectives.

Although states may monitor BMP use and effectiveness on federal land (e.g., in Montana, see Schultz, 1990), they typically rely on federal agencies to monitor on federal lands, thereby focusing scarce state resources on state and private lands. The principal federal land management agencies with lands subject to management-caused disturbance are the

Forest Service and the Bureau of Land Management (BLM). In several states, these agencies have been named the Designated Management Agency to carry out state nonpoint source pollution programs on the land they manage. Some states also now have memoranda of understanding with the agencies requiring that they report BMP monitoring results to the states. Additional states are likely to establish formal arrangements with these federal agencies.

There has been considerable recent activity by both agencies to respond to Clean Water Act goals. For example, the Forest Service worked with the EPA to develop a nonpoint source management strategy to comply with the 1987 Water Quality Act. This strategy includes "a process for determining site specific BMPs designed to protect identified beneficial uses, monitoring to ensure implementation of identified practices, monitoring to ensure that practices conform to expectations, and adjustment of practices where necessary" (letter from George Leonard, Associate Chief, U.S. Forest Service, to the regional foresters, February 24, 1988). The letter goes on to stress that "it is imperative that the Forest Service work cooperatively with the States" and that "all Regions need to ensure that the Forest Service Nonpoint Source Policy is being implemented, that it is successful in meeting water quality protection objectives, and that States are involved in our evaluation and program adjustment decisions."

The Forest Service is divided into nine administrative regions that each contain several national forests, each of which contain several districts. Most of these regions have formal BMP monitoring plans. The two regions that have all or nearly all of their forest area in only one state (the Pacific Southwest and Alaska Regions) employ a uniform monitoring methodology to all national forest areas within the region (for an example, see U.S. Forest Service, 1992). Other regions with adopted plans employ a uniform methodology to a subset of the forests within the region (usually to those forests within states that require BMP monitoring). The variation in state approaches to water quality protection makes uniform region-wide monitoring plans less likely in multi-state regions. Whether or not a regional plan exists, regional personnel assist national forests in developing forest-level monitoring plans.

The BLM is divided into 12 state offices, 11 for the western states and one for the eastern states, each of which contain several districts. Most of the state offices now have an adopted plan for responding to the states' section 319 directions. In some states, BMP monitoring plans are developed by personnel in individual districts for the district as a whole or for special "resource management areas." Two state offices, Colorado and Utah, cooperate with multi-

agency interdisciplinary teams that monitor land use activities on federal lands. Like the Forest Service approach, the new BLM strategy emphasizes an iterative process of designing, applying, monitoring, and evaluating nonpoint control practices. Such practices would typically be included in the activity plan prescribing the harvest or other disturbance (personal communication, Eric Janes, BLM Service Center, Denver, 1993).

Like the regulatory states, federal agencies tend to inspect forest management sites while activities are in progress to ensure that prescribed BMPs are being implemented and other contract stipulations are followed. These site visits during land management activities have been seen by some as precluding the need for extensive post-hoc inspection of the sites, allowing post-hoc monitoring to focus on problem sites or a set of sites informally chosen by land managers. However, the role of formal monitoring, as a check on management actions and as a way of learning about physical and ecological processes, is currently being emphasized by the federal agencies (e.g., U.S. Forest Service, 1993). More formal post-hoc monitoring of randomly selected sites by employees not directly involved in management of the disturbance activities would probably contribute to BMP monitoring goals.

## DISCUSSION

The many additions to state and federal agency water quality protection programs and procedures that have occurred in the past few years suggest that water quality protection on forest lands is being taken more seriously, and that protection on rangelands is at least beginning to receive some attention. Continued societal concern about water quality, reflected and enhanced by water quality legislation since 1987, has no doubt contributed to these efforts.

Among the state and federal agencies, there seems to be quite general agreement that specifying BMPs is the most practical approach to meeting water quality standards on forest lands. How those BMPs will be specified is a complex matter, especially if an attempt is made to select the most cost-effective BMPs (i.e., those that will be least expensive to the land owner).

Specifying BMPs to reach water quality standards in a cost-effective manner requires an understanding of the complex relations between land disturbance and downstream water quality, as well as of the costs of alternative practices. The complexity arises in part from the difficulty of distinguishing among the individual upstream causes of water quality degradation (a formidable task for "nonpoint" source pollution) and of separating natural from management-caused

water quality degradation in the context of variable weather events. Monitoring water quality is essential to understand the relations between land disturbance and water quality. By observing the effect of climatic, biologic, and geomorphic processes on water quality downstream of disturbed and undisturbed areas, scientists and land managers gradually improve their understanding of these relations. This improved understanding can then be used to reassess BMP guidelines to reach water quality goals more cost-effectively. This iterative process of BMP specification, use, monitoring, and then fine-tuning of BMP specifications for future applications is the key to cost-effective BMP use and effective water quality protection, and relies heavily on gradually improved understanding of the effect of site-specific land management controls on downstream water quality.

Some have called for sufficiently extensive monitoring programs that compliance with water quality directives could be judged directly in terms of meeting water quality standards rather than in terms of application of required BMPs. With achievement of water quality standards as the criterion, landowners would then be free to choose the most cost-effective practices on a site-by-site basis to assure meeting prescribed water quality standards for the larger watershed in which the sites are found. However, this idealized approach would only be workable with sufficient water quality monitoring to isolate the specific land area sources of a problem and to determine whether the water quality degradation would have happened even in the absence of the land disturbance. Providing such detailed information would require continuous, long-term monitoring of both treatment and control sites at many points along the stream network. Applying a comprehensive monitoring program like this over the many areas subject to harvesting and heavy grazing would be very complex and costly. Another problem is that the water quality impacts of land disturbances may not occur until extreme weather conditions develop, perhaps several years after the disturbance. The practical solution has been to prescribe land management practices (i.e., BMPs) that careful studies and professional judgment indicate will control nonpoint source pollution to within standards in most cases, and then to reassess BMP guidelines as new information becomes available. Although the goal of the water quality program is to keep water quality within the standards, the immediate objective of the program becomes the implementation of prescribed BMPs.

Water quality standards are cost-effective when they are met accurately, by neither overconstraining nor underconstraining land management. The cost of over-constraining land management is in the waste of resources and consequent loss of income on the part of

the landowners. The potential cost of underconstraining land management is in the effect of poor water quality on aquatic organisms and downstream water users, plus the costs of loss of site productivity with erosion.

Common procedures for checking BMP compliance may tend to limit the cost-effectiveness with which water quality standards are met. Compliance and effectiveness surveys usually focus on whether or not the goal was met, not on the accuracy with which the goal was met. Exceeding the standard tends to be regarded as a bonus of BMP use, without regard to the cost of implementation. Where BMP implementation is costly and exceedance of the standard is not of comparable value to the cost of exceedance, monitoring effectiveness of BMPs should measure for over- and underachievement, so that future BMP requirements could be adjusted up or down to allow more cost-effective future achievement of the water quality standards.

The cost-effectiveness with which BMPs meet water quality standards also depends on how well the BMPs were chosen for a given condition. BMPs that are tailored to site-specific conditions are more likely to efficiently reach their stated goals. Because the professional expertise to carefully select BMPs is costly, BMPs are often specified for large geographical areas (such as counties or multi-county regions), although nonpoint source pollution at specific sites within the larger area may be more inexpensively controlled with one set of BMPs than another. This is not the fault of the BMP approach – rather, it is a matter of how BMPs are specified. The more carefully they are specified for a given site, the more efficiently water quality standards will be met.

Costs to the landowner are not the only costs of BMP implementation. Specification of site-specific BMPs by a trained professional and periodic adjustment of BMP guidelines, both based on careful water quality monitoring studies, to more accurately attain the water quality goals, are costly measures. These costs must be compared with the costs of overconstraining land management practices to determine the most efficient level of professional assistance needed in carrying out a BMP program. However, as a general rule, the availability of well-qualified personnel at the field level is probably the most cost-effective approach to meeting water quality standards.

Overall, our survey indicates that compliance with BMPs is generally high and gradually improving, and that water quality is usually within standards where BMPs are implemented. Although those states that have performed formal surveys of BMP implementation may tend to be those that have taken a more proactive stance in explaining the practices to forest

managers and operators and in promulgating their use, the trend is obviously towards more widespread use of formal monitoring efforts among states and federal agencies.

Nevertheless, cases of noncompliance persist (especially for road and skid trail BMPs), and water quality problems are often associated with such noncompliance. Because the bulk, if not all, of the onsite costs of BMP implementation are born by the landowner, while the benefits typically accrue to aquatic organisms and downstream water users, noncompliance may sometimes seem to landowners as an attractive alternative, especially in voluntary states. Compliance and effectiveness monitoring must therefore be an ongoing activity, and replacement of voluntary with regulatory programs must remain a realistic possibility.

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