What are the implementation rates and effectiveness of BMPs in the South?

Chapter 22: Best Management Practices in the South

Bruce A. Prud'homme and John G. Greis
Southern Region, USDA Forest Service

Key Findings

- The nonpoint-source pollutant of greatest concern to forest management is sediment, which reaches stream channels primarily through erosion. Rain splash and sheet erosion account for the majority of hillslope erosion.
- Maintaining channel stability and the hydrologic character of the watershed can control stream channel erosion and maintain the sediment/stream energy relationship.
- Silviculture Best Management Practices (BMPs) are designed to reduce nonpoint-source pollution and maintain stream channel integrity so that State water-quality standards are met. Where their effectiveness has been evaluated, they have achieved that goal.
- All States have adopted silviculture BMPs and have trained landowners, loggers, and forestry practitioners.
- Twelve of 13 Southern States have measured BMP implementation since 1990, but have employed unique approaches to selecting sample sites and conducting onsite evaluations, resulting in different degrees of statistical strength and different expressions of results. Consistency among States is improving.
- Six of the 13 States have adapted their BMP implementation monitoring program to incorporate procedures contained in the voluntary regional protocol for implementation monitoring endorsed by the Southern Group of State Foresters in 1997. To date, five States have reported findings based on this approach.
- The most recent results of statewide BMP monitoring in the five States that utilize common monitoring and reporting methodologies ranged from 63- to 96-percent implementation of all applicable BMPs.
- In general, BMP implementation has been reported to be highest on public land, followed in descending order by forest industry land, corporate nonindustrial land, and private nonindustrial land.
- Several States report that forest management operations that involve advice and oversight by forestry professionals exhibit higher degrees of BMP implementation than those not having that involvement. Response by State forestry agencies to BMP violations or complaints varies widely. Six follow established, formal interagency agreements that can include referral to enforcement agencies; seven have no formal process for followup or referral, but do refer some cases to other agencies. All attempt to work with landowners to correct deficiencies prior to referral to enforcement agencies.
- The Sustainable Forestry Initiative (SFI) of the American Forest and Paper Association requires that member companies adhere to BMPs on company land. In addition, some forest products companies impose sanctions on timber producers who fail to implement BMPs when logging on other ownerships.

Introduction

Best Management Practices (BMPs) are the cornerstone of the forestry community's approach to protecting water resources during and after forest treatments, commonly referred to as management activities. Design and testing of effective BMPs requires an understanding of basic watershed functions, erosion and sedimentation processes, and interactions between these processes and aquatic resources. Implementation of effective BMPs, once designed, requires continuous education of an ever-changing population of forestry practitioners and landowners. Measuring the success of BMP programs requires regular and credible surveying of BMP implementation. This chapter addresses each of these topics independently.

Methods and Data Sources

Scientific literature provided information on erosion and sedimentation processes, BMP effectiveness, and other BMP benefits. The 13 Southern State forestry agencies provided descriptions and results of BMP implementation monitoring in their States as well as information on formal agreements between State agencies for handling suspected incidents of water pollution from forestry operations.

Results

Information on erosion and sedimentation processes and control, BMP effectiveness, and overall benefits of BMPs is presented in narrative form. BMP implementation monitoring information is reported for each State in narrative form and in table 22.1. Due to differences in methods for measuring BMP implementation, comparisons of rates among States are not made. For similar reasons the degrees of implementation achieved by regulatory versus nonregulatory programs are not compared.

Discussion and Conclusions

Erosion and Sedimentation Processes

Sedimentation of surface water is the most common nonpoint-source pollution concern related to forest management activities. Sedimentation is the end result of several processes, including erosion; sediment production, transport and deposition; and instream morphological processes. In-depth discussion of these processes can be found in Dunne and Leopold (1978), Leopold and others (1992), Knighton (1993), and Rosgen (1996). This chapter summarizes portions of those authors' work to provide background and context for the origin, purpose, and design of BMPs.

Hillslope erosion—Erosion is the wearing away of the Earth's surface by wind, water, ice, or gravity. For purposes of this chapter, sediment is the mineral or organic material that is displaced by these forces and delivered to water bodies. Sedimentation is the settlement or deposition of sediment out of the water column.

Table 22.1—Best management practice implementation monitoring program characteristics of 13 Southern States

State	BMP implem. surveys	Implem. rate[a]	Latest survey report	Formal interagency State agreem't.	Ownership classes reported	Identified BMP implem. needs	Comments
	No.	*Percent*					
AL	6	93	N/A	Yes	N/A	N/A	BMP implem. is determined by aerial survey. BMP implem. surveys are conducted, but there are no published reports as such.
AR	2	80	1999	Yes	F, FI, S, NIPF	Roads and harvesting	Southern BMP monitoring recommendations incorporated.
FL	10	96	1999	No	P, FI, NIPF	Roads and trails, and stream crossings	Risk to water quality is evaluated. Southern BMP monitoring recommendations incorporated.
GA	3	BMPs 79, assessed acres 98	1998	Yes	FI, P, NIPF	Stream crossings	Risk to water quality is evaluated. Southern BMP monitoring recommendations incorporated.
KY	1	35 were effective	N/A	No	P, FI, NIPF	N/A	BMPs made mandatory in July 2001. A BMP implem. survey was conducted, but there is no published survey report as such.
LA	4	83 qualitative, 93 quantitative	1997	No	FI, CNIF, P, NIPF	SMZs and permanent roads	As professional assistance increased, BMP implem. increased.
MS	1	87	N/A	No	N/A	N/A	A BMP imple. survey was conducted, but there is no published survey report as such. New BMP monitoring strategy is being developed.
NC	2	95	1996	Yes	P, FI, NIPF	Permanent roads, water bars on temp. roads and skid trails, and SMZ encroachment	As professional assistance increased, BMP implem. increased. Southern BMP monitoring recommendations incorporated.

continued

Table 22.1—Best management practice implementation monitoring program characteristics of 13 Southern States (continued)

State	BMP implem. surveys	Implem. rate[a]	Latest survey report	Formal interagency State agreem't.	Ownership classes reported	Identified BMP implem. needs	Comments
	No.	*Percent*					
OK	0	N/A	N/A	No	N/A	N/A	BMP monitoring program being developed.
SC	5	91.5 harvesting BMPs, 98 site prep BMPs	1997	Yes	P, FI, NIPF	Harvesting systems, SMZs and stream crossings	Risk to water quality is evaluated. Courtesy exam believed effective.
TN	2	63	1996	Yes	N/A	Stream crossings, SMZ encroachment, revegetation of disturbed areas, logging debris in streams	Risk to water quality is evaluated. Southern BMP monitoring recommendations incorporated.
TX	4	89	1999	No	F, FI, NIPF	Stream crossings, temp. roads, and skid trails	Risk to water quality is evaluated. BMP implem. increased with professional assistance, logger and landowner training, and BMP inclusion in the logging contracts. Southern BMP monitoring recommendations incorporated.
VA	10	90 partial imple., 7 full imple.	1999	No	N/A	Water control structures and vegetative cover of disturbed mineral soil	Risk to water quality is evaluated.

N/A = not applicable, F = Federal, FI = forest industry, S = State, P = private, CNIF = corporate nonindustrial, NIPF = nonindustrial private forest owners.
[a] Latest reported overall statewide.

Erosion and sedimentation are natural processes critical to developing and maintaining stream channel form and function. However, sedimentation at above geologic rates, especially fine inorganic sediment particles, can be of concern (Waters 1995).

Rain splash, sheetwash, rills, and gullies associated with overland runoff account for most hillslope erosion. Other sources include mass wasting and soil creep (Dunne and Leopold 1978). Mass wasting usually occurs on steep slopes that slide, or slump, when saturated soils weaken to the point of failing to hold in place against gravity. Soil creep occurs on more gentle slopes where soil particles move downslope very slowly. While these are naturally occurring processes, human activities can cause or accelerate them.

Rain splash erosion occurs when raindrops impact and displace exposed soil. Vegetation and litter cover on the ground absorb virtually all the kinetic energy of rainfall and prevent most rain splash erosion. Thus, protection of soil cover is an important strategy for minimizing this type of erosion.

Sheet erosion occurs when overland flow travels downslope in an irregular, sheetlike fashion. This type of erosion actually occurs as tiny streams of water moving back and forth across the slope. It can transport already detached sediment as well as dislodge soil particles. Several site characteristics including soil particle size and pore space, bulk density, and organic matter content affect sheet erosion processes by influencing soil infiltration capacity. The latter three can be directly affected by management activities.

Rill erosion occurs when sheet flow cuts small, separate channels as it moves downslope. Gullies are rills greater than 1 foot wide and 1 foot deep. Exposed soil in rills and gullies is especially vulnerable to rain splash erosion, so rills and gullies can grow rapidly. Gully erosion can be dramatic, contributing large sediment loads to streams. Nevertheless, rain splash and sheet erosion generally account for over 70 percent of total hillslope erosion (Leopold and others 1995).

Stream channel erosion processes—Channel erosion can be caused by a variety of factors. Most stream channel erosion is caused by the action of instream water (Leopold and others 1995). Water in motion exerts fluid stress, or applied stress, on the streambed and varies with velocity. When applied stress reaches the point

that bed particles begin to move, channel erosion results.

The capacity of a stream to carry sediment also increases with stream velocity. At a given flow, velocity varies within channels longitudinally and in cross section. Thus, channel erosion and sedimentation occur simultaneously. The magnitude of these processes is affected by flow rate; high flows increase channel erosion, and low flows increase sedimentation, or deposition.

Rosgen (1996) discusses stream morphology in terms of channel balance, or equilibrium. Sediment size and load vary with stream discharge and stream channel slope, and all exist in a state of dynamic equilibrium. Changes in one variable lead to adjustments by one or more of the others. For example, when sediment delivery to a channel exceeds its transport capacity, sedimentation results. Conversely, reductions in sediment supply below a minimum limit deprive streamflow of sediment, and channels can erode.

Hydrologic responses—Stream equilibrium is also sensitive to hydrologic response of watersheds, especially peak flow. The most important peak flows for channel formation are associated with bank-full events. Bank-full recurs about every 1.5 years, on average. During bank-full floods, streambed material is mobile and channels experience change.

Factors affecting peak flow include the area of impervious material, soil infiltration capacity, time of concentration, drainage density, and antecedent soil moisture. Changes in any of these factors can alter peak flows.

Channel alteration—Channel straightening effectively reduces total channel length over a given elevation change, resulting in increased stream channel slope. Increases in slope frequently increase stream velocity and can cause upstream channel erosion. The effect proceeds upstream until stream slope equilibrium is re-attained.

Constrictions at stream crossings (culverts, bridges) can increase downstream velocity (result in downstream channel scour) and decrease upstream velocity (increase sedimentation above the crossing).

Silviculture BMPs are designed to eliminate or mitigate impacts of management activities on these erosion and sedimentation processes. Natural watershed processes and flow regimes are encouraged and impacts to water quality are minimized by protecting soil cover and soil properties, minimizing channel disturbance, providing adequate road drainage to the forest floor, and designing and properly installing stream crossings.

Other Benefits of BMPs

The origin of BMPs lies in the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq), commonly referred to as the Clean Water Act (CWA). It directs States to develop programs to control nonpoint-source water pollution and to improve quality of water affected by such pollution. It directs States to identify BMPs and other measures to reduce nonpoint-source pollution loadings, and to identify programs for BMP implementation. This law is addressed in more detail in chapters 8 and 19.

Other benefits of BMPs to landowners and the public can be significant. They include improved water quality and aquatic habitat, protected site productivity, and more stable watershed yields. Streamside management zones (SMZs), for example, protect water quality, but also provide habitat for riparian-dependent species, wildlife travel corridors, sources for large woody debris to maintain stream stability and aquatic diversity, and aesthetic benefits. While these benefits exist and can be significant, the exact nature and degree of benefit depend heavily on specific site conditions and circumstances. These variables make it impractical to explicitly address ancillary BMP benefits in this chapter, other than to recognize their relevance and need for further study.

BMPs in this chapter, then, are those designed to protect the chemical, physical, and biological aspects of water quality, and their effectiveness is evaluated in this context.

Effectiveness of BMPs in Protecting Water Quality

Silvicultural activities include final timber harvest, intermediate harvests, site preparation, planting, fertilizer application, pest management, road construction and reconstruction, and fire management. Most, but not all, of these activities involve some degree of ground disturbance.

Aquatic conditions most likely to be impacted by forest treatments include water temperature, sediment and nutrient concentrations, stream channel stability, aquatic habitat quality, and toxic contamination. The purpose of silviculture BMPs is to eliminate or mitigate these effects.

Although States report that silviculture is a relatively minor contributor to stream impairment regionally, the pollutant most often associated with silviculture in State section 305(b) reports is sediment (see chapter 19). Forest roads are the greatest source of forestry-related sediment (Waters 1995, chapter 21). Thus, BMPs commonly focus on eliminating or mitigating sediment from forest roads.

Some of the relevant research and operational monitoring conducted in the South are reviewed in the next sections. Some of the cited studies are highly data intensive from instrumented watersheds, while others are less data intensive, employing upstream versus downstream observations of specified parameters. Both study types, if carefully designed and implemented, yield valuable information from which valid conclusions can be drawn.

Early research—BMPs are based on either research results, where available, or scientific principles. USDA Forest Service scientists at the Coweeta Hydrologic Research Laboratory conducted much of the research that formed the basis for BMPs in the South. Coweeta was established by the USDA Forest Service in the Appalachian Mountains of southwestern North Carolina to describe and understand the physical and biological processes that influence water as it moves through forested watersheds. Coweeta studies were and are data intensive.

Coweeta scientists conducted one of the earliest evaluations of effects of practical forest treatments on water quality in 1956 and 1957. A logging operation was conducted in the Stamp Creek drainage of the Tallulah Ranger District on the Chattahoochee National Forest (Black and Clark, no date). Specific operational standards (forerunners of BMPs) were written into the logging contract to test and demonstrate their ability to

protect water quality during commercial logging.

Logging practices and road management were designed to control runoff to the adjacent streams. Roads and landings were located away from streams; storm runoff was removed from roads and dispersed onto the forest floor via strategically located broad-based dips; roads were constructed on the contour and limited to less than 10-percent grade; road crossings of streams were minimized and culverts or bridges installed; and road approaches to streams were graveled. Trees were felled downhill and limbed and topped in place; trees were skidded tree-length uphill by cable, butt-end first; skidding was dispersed over the harvest site; and logging slash was left in place except in streams. After the sale, roads and trails were smoothed of ruts and channels, and broad-based dips were restored and maintained to divert road drainage onto the forest floor.

Sediment concentrations in Stamp Creek, monitored throughout the harvest period, averaged 5 parts per million (ppm) as compared to 4 ppm for a nearby control watershed, and 31 ppm for a watershed logged without the applied operational standards. This was one of the first demonstrations that carefully planned and executed commercial logging practices do not degrade water quality. It also demonstrated that water quality can be impacted if protection is not provided.

Other research at Coweeta demonstrated road design considerations that reduce sedimentation from forest roads (Swift 1984). In one study, two sections of an existing logging access road were reconstructed to standards designed at Coweeta. The design called for an outsloped road with no inside ditches, and broad-based dips to divert road drainage. Grades above broad-based dips were kept constant at between 5 and 7 percent, outlets from broad-based dips were directed to undisturbed forest floor, outside berms kept road drainage off fillslopes, and brush barriers were constructed at the toes of fillslopes. Several key observations resulted from this study.

- Soil loss from roadbeds was greatest during winter storms and peak logging truck traffic.
- Lower road grades had lower soil losses.
- Cut-slope erosion was reduced if debris was left undisturbed at the toe of the slope during road maintenance.
- Outsloped roads without inside ditches reduced cut-slope erosion on many light-duty roads.
- Shorter fills, greater compaction, and brush barriers at fillslope toes reduced fillslope erosion.
- Locating fills away from streams reduced direct sediment input from roads to streams.
- Gravel spread on roadbeds and grass cover on slopes minimized soil losses.
- Grass cover on cut slopes reduced winter cut-slope erosion.
- Grass cover reduced downslope movement of slumps on moistened fillslopes.
- Gravel cover reduced roadbed rutting and erosion in wet seasons.
- Minimizing road width and curve radius reduced road erosion.

In other research, Swift (1986) tested a number of regionally recommended stream buffer widths and an array of other road BMPs for sediment reduction effectiveness. His findings were:

- Grassed fillslopes reduced sediment travel distance to half of that below mulched only and bare slopes.
- Undisturbed forest floor reduced sediment travel distance to half that on a forest floor with litter consumed by prescribed fire.
- Sediment travel distance below forest roads was related to forest floor slope.
- Sediment travel distance from outsloped roads with broad-based dips was not as great as that discharged via culverts.
- Grassed fillslopes and forest floor roughness reduced sediment travel distance by more than 20 feet below forest roads, and brush barriers reduced it more.
- The presence of brush barriers essentially removed the percent slope relationship for sediment travel distance from grassed and ungrassed roadways.
- Ninety-four percent of the soil deposition distances were less than stream buffer widths recommended by the USDA Forest Service Appalachian Guide standards of 1973 for "slight erosion hazard" soils. Thus, the buffer widths were largely adequate.
- A combination of tested practices can be used to reduce the width of required buffer strips for control of sediment from roads.

Swift recommended that filter strip widths between roads and streams in the Appalachians be based on site conditions and construction and stabilization factors such as grassing slopes, out-sloping roads, broad-based dips, cross drains, brush barriers, and forest floor cover.

Examination of State BMPs reveals strong similarities to the previously mentioned practices that were tested at Coweeta. Indeed, this research has been widely used as the scientific basis for BMPs in Southern States. It also demonstrates that BMPs complement one another when employed as a system of practices.

Operational effectiveness monitoring—Several studies have been conducted in the South to test the effectiveness of State BMPs or national forest water-quality standards and guidelines. A variety of water-quality parameters has been evaluated in a variety of locations, testing the effectiveness of differing practices. All provide valuable insight into the topic and several are summarized in the following paragraphs.

Clinginpeel (1989) and Neihardt (1992) measured the effectiveness of BMPs on the Ouachita National Forest in Arkansas and Oklahoma. Clinginpeel focused on BMPs for streamside management areas (SMAs) and for road crossings at streams; Neihardt evaluated BMPs for temporary road crossings of intermittent and ephemeral streams. The measured parameters in both studies were sediment, turbidity in Jackson turbidity units (JTUs), conductivity, alkalinity, pH, nitrites, nitrates, sulfates, and chlorides. Additional parameters in Neihardt's study were total dissolved solids, hardness, turbidity in nephelometric turbidity units (NTUs), acid, and several metals.

Clinginpeel found that sulfates differed significantly above and below stream crossings, but actual differences were small (1.84 mg per liter and 1.94 mg per liter, respectively). Above and

below measurements at SMAs were statistically different for turbidity (16.1 and 19.5 JTUs, respectively) and pH (6.13 and 6.32 pH, respectively), but remained within State standards. All the other parameters were unchanged. Neihardt found that turbidity measured in JTUs was statistically different, but turbidity measured in NTUs was not.

Both investigators concluded that forestry BMPs, as implemented on the Ouachita National Forest, effectively maintained water quality within State standards.

In a separate monitoring effort, Clinginpeel (1993) evaluated the effectiveness of BMPs for silvicultural herbicide application on the Ouachita National Forest from fiscal years 1989 through 1993. Again, stormwater samples were collected above and below treated areas from streams in potentially impacted areas, and analyzed for positive readings of Garlon, Velpar, and Roundup. In all, 348 water samples were collected from 168 sites. Sixty-nine samples, or 19.8 percent, tested positive for herbicides, but all positive samples were less than one-fourth the U.S. Environmental Protection Agency (EPA) limit for the specific herbicide and the toxic limit for fish. He concluded that the BMPs tested effectively protected water quality and fisheries.

In the early 1990s the North Carolina Division of Water Quality and the USDA Forest Service examined the effectiveness of BMPs on a forest road in the Appalachians (North Carolina Division of Water Quality 1994). A long-existing road, which closely paralleled Timbered Branch and its tributaries for about 2 miles and had been a chronic source of road sediments to the stream, was retrofitted with a number of measures designed to reduce sediment loading. They included ditch outlets, sediment traps, berms, weeps, outslopes, humps, and relief culverts. Sediment reduction was assessed qualitatively, and biological monitoring was conducted on the affected streams to determine effects on aquatic species. Improvements in taxa richness and diversity in the aquatic community were attributed to the sediment reduction practices.

The Georgia Forestry Commission, under a CWA section 319 grant and with quality assurance and quality control provided by the Georgia Environmental Protection Division, monitored 1-year-old harvested sites in all physiographic regions of that State and tested for State turbidity standard violations (Green 1995). Selected sites were 90 to 100 percent compliant with forestry BMPs, and all included timber harvests and road construction. Turbidity measurements in NTUs were taken upstream and downstream monthly and immediately after runoff-generating storm events. Neither violations of State turbidity standards nor significant increases in turbidity were found.

The Florida Division of Forestry and the Florida Department of Environmental Protection conducted a biological assessment of four commercially harvested sites before and after harvest (Vowell 2001). Sites selected were on forest industry land and were scheduled for harvest as part of normal ongoing company operations. Management activities at all sites involved clearcut timber harvest, intensive mechanical site preparation, herbicide and fertilizer application, and replanting. Florida's silviculture BMPs were strictly adhered to during all operations. Upstream and downstream habitat and biological assessments were conducted before and immediately after activities were performed, and were continued for 2 years. Investigators found no statistically significant differences in parameters measured between the reference and treated sites. Hence, the authors concluded that Florida's silviculture BMPs were effective in protecting water quality, aquatic habitat, and overall stream ecosystem health.

The South Carolina Forestry Commission, in cooperation with Clemson University and the South Carolina Department of Health and Environmental Control, evaluated the effectiveness of silviculture BMPs in protecting water quality in all physiographic regions in South Carolina (Adams and others 1995). Twenty-seven harvested sites from the Coastal Plain to the mountains were selected. BMP compliance on the sites ranged from inadequate to excellent, thus bracketing the full range of potential effects. BMP effectiveness was determined by Stream Habitat Assessment (SHA) and benthic macroinvertebrate monitoring. Upstream reference sites were used for comparison. Ten sites that rated inadequate for BMP compliance experienced negative SHA impacts, but only one site experienced moderate macroinvertebrate impairment. On sites where BMP compliance was rated as adequate or excellent, SHA indicated that streams were not impacted. The study did not look at an incremental comparison in SHA or bioassessment with incremental BMP compliance. Sites either passed or failed BMP inspection. Sites that passed BMP compliance inspection scored well on the bioassessment. The authors concluded that BMP compliance inspections appeared to be a reliable and economical surrogate for monitoring BMP effectiveness in South Carolina.

Williams and others (1999) evaluated BMP effectiveness in the South Carolina Piedmont, which they considered the most sensitive physiographic province in the State. The authors studied three harvest, site preparation, and regeneration alternatives (with BMPs) for changes in flow, sediment, and nutrients, and compared results to a control watershed. They observed statistically significant increases in observed parameters in all alternatives, but all waters met State water-quality standards. Further, they demonstrated that forestry BMPs reduced sediment yield to one-tenth of that occurring without BMPs.

A report published by the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI 1992), presented numerous documented studies of buffer-strip effectiveness in protecting water quality from silvicultural impacts. It concluded that buffers are effective in reducing transported sediment and pesticides and generally effective in reducing soluble nitrogen and, to a lesser extent, phosphorus delivery to streams.

The above body of scientific literature and monitoring results consistently demonstrates that forest management practices are capable of impacting surface water quality. However, it also demonstrates that appropriate BMPs fully implemented as designed and adapted to the site effectively protect water chemistry, aquatic habitat, and aquatic biota.

BMP Implementation in Southern States

Pursuant to the CWA, each State has developed a State Water Quality Management Plan. These plans include BMPs to reduce nonpoint-source water pollution from various sources, including silviculture. State forestry agencies are typically designated by Governors as the lead agency for silviculture BMP program management. Consequently, beginning in 1978, each Southern State forestry agency, working in cooperation with other forestry experts and their State's water-quality agency, has adopted BMPs. Most have revised their BMPs since 1990.

BMP implementation is largely voluntary in Southern States, but three States (Florida, North Carolina, and Virginia) have linked BMP implementation to other State regulatory programs, making them quasi-regulatory in some circumstances, and BMP implementation became mandatory in Kentucky in July 2000. There are also 15 mandatory Federal BMPs, or conditions, required in all States for exemption of certain silvicultural activities conducted in waters of the United States. See chapter 8 for a more thorough discussion of section 404(f) of the CWA. Compliance with these Federal conditions has not been systematically monitored by any agency.

The voluntary nature of State BMP programs precludes establishing permit conditions. Lacking this mechanism, States have employed logger, forester, forest practice purveyor, and landowner education as the primary tool to achieve BMP implementation. Training has traditionally been conducted in cooperation with forest industries, forestry associations, and State agencies. Member companies of the American Forest and Paper Association are required by the SFI guidelines to meet or exceed State BMPs on company-owned forest land.

To gauge the effectiveness of their educational efforts and to target needed adjustments, State forestry agencies have sponsored or conducted surveys to measure the degree to which BMPs are being implemented. Twelve of 13 States have completed at least 1 survey since 1990. Findings are typically published in formal reports and are available from the respective State forestry agencies. Section 319 (CWA) funding has supported these efforts.

To correctly interpret monitoring results reported by States, it is essential to understand the history of implementation monitoring and how it has evolved. Implementation (compliance) monitoring of non-regulatory BMPs is unique to the forestry community. While other nonpoint-source sectors, such as agriculture, are generally unregulated in the South, the degree of compliance with BMPs for agricultural activities has not been systematically measured or reported. Therefore, survey design standards and monitoring protocols have had to evolve over the 20 years of nonpoint-source program existence. During that time, State forestry agencies have approached implementation monitoring in different ways, degrees of detail, precision, and statistical strength.

Past differences in survey design and statistical strength and metrics chosen for evaluation within and among States preclude precise reporting of State or regional progress over time. Results range from statistically valid to informative but of unknown statistical strength. Statistical approaches are noted in the individual State summaries that follow.

It is important to note that, as with sampling approaches, onsite evaluation of BMP implementation and reporting varies among States. Some provide largely qualitative judgments of overall effort; others calculate and summarize compliance with specific BMPs. These are noted in the State summaries.

States have differed in their aggressiveness toward monitoring BMP implementation, a direct reflection of State priorities and available resources. Seven States have completed more than one comprehensive statewide survey (Florida, 10; Texas, 4; Louisiana, 3; Georgia, 3; Arkansas, 2; North Carolina, 2; and Tennessee, 2). Louisiana is in the process of data analysis and report preparation of its fourth survey. South Carolina has completed four harvesting BMP and two site-preparation BMP surveys. Their current survey system is unique to the region in that it includes three visits to each surveyed site to observe status of BMPs. Alabama has surveyed implementation in differing manners since 1994, but has produced no formal survey report to date. Mississippi and Kentucky have completed one statewide survey, but neither has published a formal report to date. Pursuant to State law, Virginia monitors a percentage of the activities of which it is notified. Oklahoma is planning but has not yet surveyed BMP implementation statewide.

Ten of the States utilize State forestry agency staff to conduct surveys, but university forestry school specialists conducted the surveys in Louisiana and Kentucky. Some States have staff dedicated to water-quality management, but most depend on existing personnel.

Through the 1990s, CWA section 319 funds became readily available to State forestry agencies for BMP program management, and the aggressiveness of implementation monitoring increased. In order to improve regional similarity in survey design and onsite evaluations, the Southern Group of State Foresters (SGSF) recommended in 1997 general forestry BMP implementation monitoring procedures for voluntary use by States. To date, six States (Arkansas, Florida, Georgia, North Carolina, Tennessee, and Texas) have redesigned their programs to incorporate these recommendations.

The SGSF recommends evaluation of specific BMPs in a manner that requires the evaluator to judge whether each applicable practice was implemented properly and completely and whether a risk to water quality exists as a result of noncompliance. Rates are determined by calculating the percent of applicable BMPs fully implemented and are reported by BMP category, such as SMZs, and for the entire operation. The SGSF also recommends sampling treated sites in a systematic and predetermined manner to ensure statistical validity.

The South Carolina monitoring approach has many similarities to the SGSF recommendations, but results are reported differently. While evaluating practices onsite, much of the same data is collected as is called for by the SGSF, but implementation percentages are not reported per BMP category or for the entire operation. Rather, South Carolina reports compliance in a way that reflects the percent of those BMP categories evaluated that were both properly implemented and protected

water quality. Sites are also assigned a pass/fail rating based on whether risks to water quality are present.

Other States are either continuing their programs as previously designed or are in various stages of revision to coincide with the SGSF approach.

State implementation monitoring summaries—To compile information contained in the State summaries, written requests were made to each State forestry agency director in March 2000 for BMP implementation monitoring data. Specific information requested included monitoring design, BMP categories measured, implementation rates statewide and by physiographic province, and ownership category if available. Responses were received from all States. As noted earlier, all but one (Oklahoma) reported that they had completed at least one monitoring survey. Following is a brief synopsis of the information received.

Alabama summary—The Alabama Forestry Commission began conducting annual BMP implementation surveys in 1994 (Personal communication. 2000. Timothy C. Boyce, Alabama Forestry Commission. P.O. Box 302550, Montgomery, AL 36130-2550), and monitoring is accomplished by aerial reconnaissance only. BMP survey information is available, although there is no published survey report as such. Until recently the survey was conducted statewide, but currently the survey covers half the State each year, alternating between the north and south. The Commission records all forestry sites via aerial survey, and one site from each county is randomly selected for BMP implementation monitoring every 2 months. Selected sites must be well defined as forestry practices, be 1 year old or less, in any stage of completion (ongoing, stopped, or completed), and free from sampling bias (neither size, ownership, or access are considered). BMP categories are SMZs, stream crossings, forest roads, timber harvesting, reforestation/stand management (includes pesticides and firebreaks), and forested wetland management. The survey evaluation form includes yes or no questions under each BMP category, and at the end of the evaluation, the site is rated yes or no as to whether BMPs were adequately implemented overall. The most recent information is for the survey completed in northern Alabama in fiscal year 1998–99. The survey rated BMP implementation as adequate on 93 percent of sites inspected. Of those with streams present, 80 percent were rated as adequate for SMZs. Alabama does not report by ownership category.

Arkansas summary—The Arkansas Forestry Commission has completed two statewide BMP monitoring surveys; the most recent one was for the survey period 1998–99 (Eagle 1999). Sites were randomly selected, and permission for access was obtained. The number of sites verified was based on sample percentage estimates for projected statistical accuracy of ±5 percent, and was distributed throughout the State on the basis of 1997 timber severance tax records. Sites were harvested from 1 to 24 months before survey, and categories of BMPs were forest road construction and maintenance, harvesting, mechanical site preparation, chemical site preparation, SMZs, and harvest planning. Forest industry provided the Arkansas Forestry Commission with closed-out and site-prepared sites for monitoring. Results are reported statewide and by physiographic region and landowner category.

The overall State BMP implementation rate for the 1998–99 survey was 80 percent. Implementation was 88 percent for planning, 75 percent for roads, 77 percent for harvesting, 79 percent for mechanical site preparation, 80 percent for chemical site preparation, and 81 percent for SMZs.

In the Delta, about 7 percent of all sites were sampled, and the overall compliance rate was 85 percent. About 14 percent of the sites in the Ouachita region were visited; the overall compliance rate was about 77 percent. About 12 percent of the sites were visited in the Ozark region, and overall compliance was about 77 percent. About 67 percent of the sites were visited in the Southwest region; the overall compliance was about 80 percent.

Four landowner categories were recognized in Arkansas. The survey reported 75 percent overall implementation for private nonindustrial landowners, 87 percent for forest industry, 96 percent for national forests, and 82 percent for State land.

Florida summary—The Florida Division of Forestry began biennial silviculture BMP compliance surveys in 1981 (Vowell 2000). The most recent compliance report is for the survey completed in 1999. In all, 199 sites were monitored, the number was that estimated needed to achieve statistical significance at the 95-percent confidence level. Candidate sites must have had silvicultural treatment within the past 2 years and had some part of the site within 300 feet of a stream, lake of at least 2 acres, sinkhole, or wetland identified in the BMP manual. Sites for the survey were distributed across the State based on the level of timber harvest by county, with at least one site for each county that had any harvest activity. Most sites were selected by aerial reconnaissance from aircraft flying over randomly selected township and range lines at an altitude of 800 to 1,200 feet until the target number sites for each county was reached. If flights were not available for any county, sites were selected from the ground, assigned a number, and then drawn by lot.

Florida has 14 BMP categories: SMZs, wetlands, public lands, canals, sinkholes, forest roads, stream crossings, timber harvesting, site preparation, fire line construction, pesticide/fertilizer, waste disposal, wet-weather operations, and emergency conditions. Multiple questions answerable by yes, no, or N/A were evaluated under each category in the survey form, so the total number of actual silviculture practices evaluated on the 199 sites was 4,997. The yes and no answers were tallied, and the percent compliance, exclusive of the N/A answers, was calculated for each site. The survey determined that BMP compliance ranged by category from 91 to 100 percent. The statewide compliance rate was 96 percent in all BMP categories. Of the survey sites, 8 percent were on public land, 37 percent were on industry land, and 55 percent were on private nonindustrial land. Statewide compliance rates for the ownership categories were 99, 97, and 96 percent, respectively.

Included in Florida's BMP survey is the opportunity to note whether significant risk to water quality exists on the evaluated site. The 1997 survey found 0.16 percent of the evaluated practices on all sites monitored posed significant risk to water quality. All of the conditions leading to a significant

risk were corrected per the division of forestry recommendations.

Georgia summary—The Georgia Forestry Commission has completed its third BMP implementation survey (Green 2001). The latest survey is the first that conforms to the BMP monitoring protocol endorsed by the SGSF in 1997. The survey was conducted from fall 1997 through summer 1998 on 386 sites selected from across the State in a stratified random sample. All sites experienced some kind of silvicultural treatment in the preceding 2 years, and represented all land ownership categories in all geographic and physiographic provinces. By ownership, 72 percent of the sites were nonindustrial private, 26 percent were forest industry, and 2 percent were public. By physiographic province, about 6.5 percent were in the mountains, 34.5 percent were in the Piedmont, 19 percent were in the upper Coastal Plain, and 40 percent were in the lower Coastal Plain. BMPs were judged as in compliance (yes), not in compliance (no), or not applicable (N/A) under several BMP categories, and a percent compliance was calculated for each category, for the site as a whole and for the State. A judgment was made for each BMP not properly implemented, or found to have failed, as to whether a significant risk to water quality resulted. Results were also expressed in acres, miles of road and streams, and number of stream crossings in full compliance for each BMP category, for the site as a whole, and for the State overall. A total of 6,690 individual BMPs were evaluated over about 43,118 acres.

Percent implementation was calculated in two ways. The number of acres on which BMPs were properly implemented was calculated for each BMP category, and the number of applicable BMPs properly implemented was calculated. Therefore, BMP implementation was reported as a percentage by acres and a percentage by BMP. Categories for BMPs and respective compliance ratings were SMZs (80.9 percent), stream crossings (58.8 percent), main haul roads (76.6 percent), timber harvesting (87.3 percent), mechanical site preparation (96. percent), chemical applications (99.3 percent), control burning (61.5 percent), and artificial regene-ration (93.4 percent). Statewide BMP implementation compliance was estimated at 78.7 percent for all BMP categories in all land ownerships and all physiographic regions. Statewide compliance on the number of acres assessed was 98.2 percent. By land ownership, BMP compliance by acres assessed and BMPs implemented, was 97.4 and 75.4 percent on private nonindustrial, 99.1 and 86.3 percent on forest industry land, and 99.4 and 84 percent on all public land, respectively.

Of particular concern to the Georgia Forestry Commission were stream crossings. However, the commission noted that many of the out-of-compliance stream crossings existed before silvicultural treatments were conducted and were not specifically related to forestry operations. Future surveys will include only treatments specifically related to the forestry activities.

Kentucky summary—The Kentucky Division of Forestry BMP monitoring program estimates BMP effectiveness at mitigating nonpoint-source runoff (Stringer 1997b). The University of Kentucky conducted a BMP survey from September 1995 to April 1997 (Stringer 1997a). The BMP categories monitored included SMZs, roads, trails, landings, and stream crossings.

A total of 100 timber harvest sites were located for systematic sampling from the three physiographic regions of the State. The three regions are area 1 (Jackson Purchase, Western Coal Field, Pennroyal), area 2 (Inner and Outer Bluegrass and the Knobs), and area 3 (Appalachian Plateau and Cumberland Mountains).

Of the 100 sites monitored, evaluators determined that only 80 needed active BMPs. Those 80 were evaluated for BMP implementation.

Monitoring indicated that of those 80 monitored sites, 35 percent had BMPs that were effective, 12.5 percent had BMPs that were partially effective, 10 percent had BMPs that were not effective, and 42.5 percent had no BMPs. In other words, more than half (52.5 percent) of the 80 sites either had no BMPs or the BMPs were ineffective, and less than half (47.5 percent) had BMPs that were effective or partially effective.

Area 2 had the highest incidence of BMPs not used or not effective (59 percent), and area 3 was evenly split (43.2 percent) between "BMPs not used or not effective" and "BMPs effective or active BMP use not needed."

Nonindustrial private land had slightly less implementation and effectiveness of BMPs than the other landowner categories. On a scale of 1 to 5 (1 is worst and 5 is best), public ownerships rated about 4.5 for BMP use and effectiveness, forest industry rated about 3.75 to 4, and nonindustrial private land ownership rated about 3.

Louisiana summary—The Louisiana Department of Agriculture and Forestry has conducted four BMP implementation surveys (1991, 1994, 1997, and 2000). The most recent published report was for the 1997 survey (Hughes and Feduccia 1999), and the 2000 survey was not published in time for inclusion in this Assessment. The number of survey sites necessary to determine with 95-percent confidence if forestry BMP implementation in Louisiana was at least 80 percent in 1997 was estimated at 256; 266 individual sites were actually surveyed. Sample sites were randomly selected by aerial observation, regardless of ownership, and the number of sites in each parish was based on 1996 timber harvest volume. Land ownership categories were forest industry, corporate nonforest industry, nonindustrial private, and public (Federal, State, and local governments). The geographic regions were Delta, northwest, southeast, and southwest.

Categories for BMPs were SMZs, road construction, timber harvest, site preparation and reforestation, and fire line construction. The survey form showed the number of specific BMPs in each category that were assessed. Implementation of BMPs was noted as exceeds, full implementation, minor departure, needed but not applied, and no action required. Exceeds, full implementation, and minor departure were categorized as implemented; needed but not applied was considered not implemented.

Each survey site was given both an overall qualitative and quantitative implementation rating. The qualitative rating was in answer to the yes or no question, "Do you feel there was adequate BMP implementation on

this site?" The quantitative rating was calculated as the percentage of implemented BMP guidelines on the site.

The overall statewide qualitative implementation rate was 83 percent, and the statewide quantitative implementation rate was 93 percent. Quantitative geographic implementation rates were 93 percent in the Delta, 94 percent in the northwest, 92 percent in the southeast, and 96 percent in the southwest. Quantitative implementation rates by ownership category were 97 percent for forest industry, 95 percent for corporate nonforest industry, 91 percent for nonindustrial forest, and 93 percent for public. Qualitative rates were not reported for geographic or landowner categories.

Mississippi summary—The Mississippi Forestry Commission conducted a forestry BMP implementation survey in 1994, although there is no published implementation monitoring report (Personal communication. 2000. Michael Sampson, Mississippi Forestry Commission, Suite 3000, 301 Bldg., Jackson, MS 39201). Fifteen tracts harvested during 1993 were randomly selected from among all landowner categories from each of Mississippi's 82 counties, for a total of 1,230 tracts sampled. The survey estimated statewide BMP implementation at 87 percent. The commission recommended corrective measures on the surveyed sites needing BMPs. A new BMP monitoring strategy is being developed.

North Carolina summary—The North Carolina Division of Forest Resources has instituted voluntary BMPs to ensure that the nine mandatory Forest Practice Guidelines (FPGs) related to water quality are met by forest management operations in the State (White 1992). Mandatory FPGs are required for exemption of forestry operations from the Sediment Pollution Control Act passed in the early 1970s. The FPGs are performance standards that must be complied with, while BMPs are the more specific on-the-ground activities that, when applied, should result in maintaining compliance with the FPGs.

The division conducted forestry BMP surveys in 1995 and 1996 (Hensen 1996) and is in the process of completing a 2000 survey. Two hundred timber harvest and 23 site-preparation sites, most of which were harvested between spring 1995 and spring 1996, were selected for the 1996 survey. Tracts had to have potential for affecting some water body, and were randomly selected and distributed throughout the State based on each county's timber production. BMP categories were permanent roads, skid trails and temporary roads, SMZs, landings, and site preparation. Each category had a number of questions to be answered as yes, no, or N/A, and each site received an overall rating of no effort, poor, fair, good, or excellent. Landowner categories were public, industrial, and nonindustrial private. There was no physiographic or geographic stratification in the survey, but there was a slope category broken into three slope ranges: (1) flat (0 to 5 percent), (2) hilly (6 to 25 percent), and (3) steep (less than 25 percent).

Overall statewide BMP implementation was rated at 95 percent as either good or excellent. Public land was rated at 100 percent, industry land at 90 percent, and nonindustrial land at 76 percent. There was no discernable BMP implementation pattern based on slope.

Oklahoma summary—Oklahoma is in the process of conducting its first comprehensive forestry BMP implementation survey. (Personal communication. 2000. Kurt Atkinson, Oklahoma Department of Agriculture, Forestry Services, 2800 N. Lincoln Blvd., Oklahoma City, OK 73105).

South Carolina summary—The South Carolina Forestry Commission conducted BMP compliance surveys for timber harvesting in 1990, 1991, and 1994 (Jones 2000). A site-preparation BMP monitoring survey was conducted in 1996. The BMP monitoring report published in February 2000 presents findings of the harvesting and site-preparation BMP survey begun in 1997.

In 1997, 200 recently harvested sites were located through aerial survey across South Carolina for BMP compliance evaluation. Sites were distributed in proportion to timber harvests in each county relative to the whole State. Three visits were made to each site: one after harvest for compliance with harvest BMPs, one after site preparation for compliance with site-preparation BMPs, and a third visit 2 years after harvest. The final visit examined site stabilization, BMP effectiveness, species and regeneration method used, and any ongoing erosion from silvicultural activities.

BMP implementation is scored in the site evaluations, but the findings are reported in the percent of BMPs determined acceptable for protecting water quality. To be acceptable, no water quality should be measurably impaired by the activity. Harvesting BMP ratings were 98.6 percent acceptable for road systems, 86.7 percent acceptable for road stream crossings, 83.7 percent acceptable for SMZs, and 89.0 percent acceptable for logging systems. Statewide and overall, 91.5 percent of harvesting BMP categories were rated as acceptable.

Site-preparation category ratings were 95.9 percent acceptable for mechanical treatments, 100 percent acceptable for herbicide applications, and 100 percent acceptable for prescribed burning. No sites had minor drainage activities to be evaluated in this survey. Statewide and overall, 98.0 percent of site-preparation BMPs were rated acceptable. Visual observations of ground cover during the second and third visits indicated that naturally occurring vegetation generally stabilized harvested areas after one growing season, even in high-traffic areas and where mechanical site preparation occurred.

Findings by landowner categories were nonindustrial private with under 1,000 acres 87 percent acceptable BMPs, nonindustrial private with over 1,000 acres 94 percent, forest industry 98 percent, and public 100 percent.

There was no physiographic reporting in the 1997 survey, but 11 sites with inadequate harvest system BMPs were noted in the Piedmont and 6 in the Coastal Plain.

Tennessee summary—The Tennessee Forestry Division reported two forestry BMP surveys, one conducted in 1993 and one in 1996 (Tennessee Department of Agriculture Forestry Division 1996). The survey form and protocol were modified in 1995, so results of the two surveys are not entirely comparable. In the second survey, 200 timber harvest and associated road construction sites were evaluated in all physiographic regions. One hundred seventy-nine sites were randomly selected, and 21 sites were investigated in response to water-quality complaints. Monitoring was

conducted within 6 months after all activities were completed. Sites selected randomly were not reported separately from those visited due to complaints, so the overall results are not completely unbiased. During the survey, investigators noted instances where water pollution occurred or was likely to occur due to lack of BMPs or improper use of BMPs. In such instances, the operator or landowner was contacted and advised of necessary corrective action.

Examiners noted whether guidelines under each BMP category were implemented or whether the BMP was not applicable to that site. Responses were summed to determine the BMP implementation rates for the forestry practices and the operation as a whole. From the 200 sites evaluated, there was a total of 1,787 individual BMP observations. Ratings for BMP categories were roads 59.5 percent compliance, SMZs 70.5 percent compliance, stream crossings 59.8 percent compliance, timber harvesting 47.6 percent compliance, and waste disposal 87.0 percent compliance. Only one site had been mechanically prepared, and all BMPs were implemented on that site. There were no observations in either the tree planting or fire line construction categories.

The overall statewide BMP compliance rate for the 1996 survey was 62.9 percent for all sites visited, the randomly chosen ones and those visited in response to water-quality complaints. Monitoring results were not broken out by landowner group or physiographic province.

Texas summary—The Texas Forest Service conducted forestry BMP surveys in 1992, 1996, 1998, and 2000 (Carraway and others 2000). Texas revised its survey form and protocol in 1998 to incorporate the protocol of the SGSF.

The most recent survey was conducted between June 1998 and August 1999. A number of yes, no, or N/A assessment questions were evaluated under the various BMP categories. An evaluation of significant risk was added for each assessment question. The purpose was to assess whether failure to properly implement a specific BMP posed significant risk to water quality. The yes and no answers were summed, and an overall site compliance rating was calculated.

One hundred fifty timber harvest sites were randomly selected for investigation by aerial reconnaissance and from knowledge of harvest activities gathered from Texas Forest Service personnel. The sites were distributed among the counties based on estimated annual timber harvest. Sample sites were located without regard to ownership or proximity to water.

Results are reported by BMP category, ownership, and type of operation. BMP categories and overall compliance rates reported were permanent roads 94.1 percent, skid trails/temporary roads 77.5 percent, stream crossings 66.7 percent, SMZs 86.0 percent, site preparation 96.2 percent, landings 98.8 percent, and wetlands, 86.7 percent. Overall State compliance for all categories was 88.6 percent.

Compliance by ownership category was Forest Service 97.9 percent, forest industry 94.2 percent, and nonindustrial private 81.2 percent. Compliance by type of operation was clearcut 85 percent, partial cut 93 percent, thinning 92 percent, and site preparation only 93 percent.

In general, as terrain steepness increased, compliance decreased. Also, the Texas Forest Service reported for the first time a statistically significant increase in BMP compliance when:

- A forester was involved in the timber sale.
- The logging contractor attended the BMP training workshop.
- The landowner was familiar with BMPs.
- There were BMPs in the timber-sale or site-preparation contract.

Virginia summary—Virginia State law requires notification of Virginia Department of Forestry within 3 days of initiating timber harvest (Personal communication. 2000. Samuel Austin, Department of Forestry, Fontaine Research Park, 900 Natural Resources Drive, P.O. Box 3758, Charlottesville, VA 22903-0758). Semiannually, the department randomly selects 30 timber harvests from this database for BMP audits. Monitoring categories are stream crossings, water control structures, seeded areas, SMZs, trail/road grade, rutting, gravel/mats, oil spill/trash, and other. To be in full compliance, 100 percent of applicable BMPs at the audit site have to be 100 percent-implemented and meet 100 percent of the technical specifications of the BMP manual. Measured in this way, compliance has ranged from 16 percent in 1991 to 7 percent in June 1999. Effort to implement BMPs was noted on 90 percent of the sites visited. The field evaluator indicated that 90 percent of the sites were experiencing no related water-quality impacts, but 38 percent exhibited potential for impact.

The above summary of State reports illustrates the variety of BMP monitoring approaches and levels of monitoring effort employed by Southern State forestry agencies over the past 20 years. This reflects the priority placed on BMP implementation monitoring by States, as well as human and financial resource constraints.

The summary also demonstrates the difficulty of discerning actual rates of compliance with specific BMPs. Many on-the-ground determinations of BMP implementation are qualitative by design, adding to the difficulty of comparing or reproducing results. It is also noteworthy that most State surveys are conducted after on-the-ground activities have ceased. Thus, it is possible that water-quality impacts could occur but stabilize prior to the site being evaluated.

Given the nature and limitations of the reported data, three notable characteristics emerge. First, BMPs are being implemented in all States across the South. Rates of implementation reported by five States that use comparable monitoring methodology range from 63 to 96 percent of all applicable BMPs. These States are located throughout the South in a variety of physiographic areas. Second, implementation of BMPs tends to be highest on public land, followed in descending order by forest industry, corporate nonindustrial, and private nonindustrial forest land. Third, forest management operations that involve advice and oversight by forestry professionals exhibit higher BMP implementation rates than operations not having that involvement.

On the whole, the State forestry agencies report increasing BMP implementation over time. They credit this improvement to ongoing efforts to educate those involved in forestry about BMPs and the benefits of BMPs, technical assistance, changing

legislation in some States, increasing partnerships with forest industry, and increasing efforts of forest industry (including industry-imposed sanctions on noncomplying timber producers) to improve BMP implementation.

These findings indicate that current approaches to achieving BMP implementation are having positive results, particularly on large ownerships. The challenge remains large and persistent, however, to achieve equal success on nonindustrial private tracts, given that they are owned by almost 5 million individuals (chapters 14 and 16), and a relatively small percentage of these individuals typically receive professional forestry assistance prior to treating their land (chapter 10).

Regulatory Versus Nonregulatory Approaches

Traditionally, water-quality management agencies have depended on regulatory approaches to control point source (discreet conveyance) discharges into State waters. Regulatory processes vary, but typically include establishment of permit conditions, permit application and review, and compliance monitoring. Monitoring is conducted in different ways, ranging from self-monitoring and reporting to site inspections by the regulating agency. This approach provides regulating agencies the opportunity to review plans in advance, encourage or require modifications in order to meet conditions of the regulation, and closely track compliance throughout an activity. Depending on individual statutes, these opportunities might or might not apply to forest management activities if regulatory approaches were to be employed in the South.

As noted, regulatory approaches were developed for and have long been employed to control point-source discharges. Forest management practices are considered nonpoint-pollution sources. The CWA stipulated that nonpoint-source pollution control is to be accomplished through BMPs identified by each State. Though BMP implementation is not mandatory under the CWA, States have the option of developing and implementing regulatory approaches for that purpose.

In all States in the South, BMP programs are administered by State forestry agencies, whose regulatory authorities, with some exceptions, are limited to fire management. Some States require BMP implementation to meet the terms of other State wetlands or sediment control laws or regulations, but none require permit application, review, and issuance prior to forest treatments. Likewise, BMP compliance monitoring is not required.

Several factors have been used to compare and contrast regulatory and nonregulatory approaches to preventing nonpoint pollution from forest management sources. These include cost to landowners, program costs to the State, level of compliance, and degrees of water-quality protection.

Hawks and others (1993) compared Maryland's regulatory with Virginia's nonregulatory program. According to these authors, neither approach was clearly superior to the other in achieving BMP compliance or protecting water quality. Both States were reasonably effective in obtaining BMP implementation. Maryland's regulatory approach was more costly to landowners and to the State.

Another comparison of programs by NCASI (1994) compared and modeled economic and noneconomic costs and benefits of existing and hypothetical regulatory scenarios in Virginia and the State of Washington. The authors concluded that the modeled regulatory program and the most aggressive nonregulatory program scenario would result in nearly equal water-quality benefits. They projected that regulatory program costs would be nearly double those of the nonregulatory program.

Regardless of the approach employed or its actual or perceived advantages, the common goal of both is to achieve protection of water quality. To this end, all Southern States utilize preventive practices (BMPs) and employ followup actions when water-quality degradation is noted or complaints are received. While followup procedures associated with State regulatory programs are not explicitly discussed in this Assessment, formal followup procedures employed by States for forestry BMPs are described here.

Following are State-by-State summaries of current procedures in place to respond to noncompliance or complaints. They are based on information received from State forestry agencies.

Alabama—Alabama has a nonregulatory BMP program (Personal communication. 2000. Timothy C. Boyce, Alabama Forestry Commission. P.O. Box 302550, Montgomery, AL 36130-2550). Through cooperative agreement, the Alabama Division of Environment refers suspected water-quality complaints due to forestry to the forestry commission. A forester visits the area to determine if a forestry-related water-quality problem exists, or could develop, due to lack of or inadequately implemented forestry BMPs. If that situation exists, the responsible party is contacted and provided recommendations for corrective action. A followup visit is made, and if corrective action is not taken, the problem is referred back to the division of environment for appropriate enforcement. The number of BMP complaints acted on by the forestry commission in 1998, 1999, and 2000 were 17, 17, and 42, respectively.

Arkansas—Arkansas has a nonregulatory BMP program (Personal communication. 2000. Dennis M. Eagle, Arkansas Forestry Commission, P.O. Box 10, Greenbrier, AR 72058–0010). The Arkansas Forestry Commission has the lead role for supervising the silvicultural portion of the nonpoint-source water pollution control program. The Arkansas Division of Environmental Quality (DEQ) has regulatory water pollution control authority in Arkansas, and a formal memorandum of understanding exists between the forestry commission and DEQ. Complaints or violations of water quality suspected to be due to forestry are first referred to the forestry commission, which works with the landowner and operator to rectify any identified cause(s) of pollution. If the landowner or operator fails to correct the cause, the incident is referred back to the DEQ, which has authority to institute civil action and assess fines of up to $10,000 per day. The forestry commission estimates acting on about four such complaints or cases per year from 1998 through 2000.

Florida—Florida has a nonregulatory BMP program, but State permits are required for forest roads, stream and wetland crossings, ditching, and borrow pits (Vowell 2000). As part of its BMP monitoring program, the division

assesses risk from noncompliance with specific BMPs. When it is determined that a BMP has not been implemented properly, an assessment of "significant risk" is made. Significant risk exists when a situation presents imminent and substantial danger to designated beneficial uses of State waters. In these cases, the division recommends corrective measures to be taken by the landowner. Although no formal memorandum of understanding exists between the division of forestry and the department of environmental protection, if recommended action is not taken, the landowner is referred to the appropriate regulatory authority. This has occurred an estimated six times from 1998 through 2000.

Georgia—Georgia has a non-regulatory forestry BMP program. Incidents of suspected forestry-related water pollution are first referred to the Georgia Forestry Commission, which investigates the site (Personal communication. 2000. Frank Green, Georgia Forestry Commission, P.O. Box 819,Macon, GA 31202-3480). If a water-quality problem is attributable to forest practices, corrective measures are recommended to the operator or landowner. If recommendations are implemented and the problem is corrected, no further action is taken. If the recommendations are not taken and the problem persists, incidents are referred to the Georgia Environmental Protection Division for enforcement action. This has occurred five times between 1998 and 2000.

Additionally, the Georgia Forestry Commission submits a regular report of water-quality violators to the forest industry members of the SFI, who individually can stop accepting wood from those producers at their mills. The SFI mills that receive wood from producers on that list contact those producers and tell them they are at risk of not having their wood accepted at their gates.

Likewise, the State Board of Registered Foresters in Georgia has adopted a system for imposing sanctions against registered professional foresters for BMP noncompliance (Personal communication. 2001. Frank Green, Georgia Forestry Commission, P.O. Box 819, Macon, GA 31202-3480). In cases of BMP noncompliance, registered professional foresters may face penalties including consent agreement, fines, license suspension, license probation, and public reprimand.

Kentucky—Kentucky instituted a new regulatory timber harvesting BMP program on July 15, 2000 (Personal communication. 2000. Larry Lowe, Department of Natural Resources, Division of Forestry, 627 Comanche Trail, Frankfort, KY 40601). Loggers are required to use appropriate BMPs, and a Kentucky Master Logger (a logger who has completed the logger-training program of the Kentucky Division of Forestry) must be on site and in charge of any commercial logging operation. The division visits and inspects logging operations for compliance. Noncompliance results in a written warning to the logger describing what is out of compliance and what needs to be accomplished to bring the operation into compliance. If the written warning fails to bring corrective action, an informal conference is held with the logger. Failing correction, a notice of violation is issued, and, as a last step, a special order is issued. The special order provides for shutting down a portion of the operation until compliance is achieved. Where noncompliance is serious enough to pose a significant threat to water quality, an emergency order can be issued which will shut down the entire operation without going through the first three steps. If these steps for attaining BMP compliance fail, the division of forestry can initiate administrative hearings, fines, or court actions. Prior to this program, the division of forestry reports that they referred several silviculture-related water-quality cases to the division of water, but their exact number and resolution status are unknown.

Louisiana—Louisiana has a non-regulatory BMP program. Louisiana has no formal process in which suspected forestry-related water-pollution cases are handled separately from any other suspected nonpoint-source pollution problem (Personal communication. 2000. Don Feduccia, Louisiana Department of Agriculture and Forestry, Office of Forestry, P.O. Box 1628, Baton Rouge, LA 70821-1628). When the Louisiana Department of Agriculture and Forestry is called out on a site with suspected forestry water-quality violations, it may make suggestions for BMPs that may be missing or inadequate. No formal departmental process exists for dealing with specific forestry operations suspected of causing water pollution, nor does any formal agreement for addressing such occurrences exist between the department of agriculture and forestry and any other State agency.

Mississippi—Mississippi has a nonregulatory forestry BMP program (Personal communication. 2000. Michael Sampson, Mississippi Forestry Commission, Suite 3000, 301 Bldg., Jackson, MS 39201). In cases of BMP noncompliance, the commission makes recommendations to correct the problems. No formal interagency agreement exists for referrals.

North Carolina—North Carolina has a set of mandatory FPGs, which are performance standards specified for various forest management categories, but has voluntary forestry BMPs designed to ensure attainment of the FPGs (White 1992). The North Carolina legislature passed the Sediment Pollution Control Act, which requires a site plan for land-disturbing activities and is enforceable by the division of land resources. The act initially exempted forestry, but in 1989 it was amended to exempt forestry only so long as forestry activities are conducted in accordance with FPGs.

In cases of citizen complaints or other reported incidents of guideline noncompliance, a division of forest resources representative visits the suspected sites and recommends remedial action with a timetable to the operator. If the responsible operator cannot be found, the recommendation is given to the landowner. If recommendations are not implemented and a water-quality problem(s) continues, the incident is referred to the department of land resources, the division of water quality, or the division of forest resources law enforcement staff for action. Activity can be stopped and a fine of $1,000 levied, a sediment plan required within 30 days of disturbance, specific cleanup measures required, and a $500 per day fine levied if cleanup is not accomplished. The site is monitored until cleanup is finished.

Since 1990, over 26,000 guideline evaluations have been conducted, about 1,900 notices of noncompliance have been issued, and approximately

100 cases referred for enforcement to other State agencies (27 since 1998). Cases resolved without the need for punitive action have not been formally tracked.

Oklahoma—Oklahoma has a nonregulatory forestry BMP program (Personal communication. 2000. Kurt Atkinson, Oklahoma Department of Agriculture, Forestry Services, 2800 N. Lincoln Blvd., Oklahoma City, OK 73105). Suspected forestry-related water-quality violations are inspected by forestry services, and any necessary corrective action is recommended. If the operator or landowner does not take the recommended action and a water-quality violation persists, the incident is referred to the DEQ for necessary enforcement action. There is no formal interagency agreement for referrals of this kind. In addition, some major forest industries in Oklahoma accept wood at their gates only from loggers who have completed master logger training, which includes a module on forestry BMPs.

South Carolina—South Carolina has a nonregulatory silviculture BMP program with regulatory backup provided by the South Carolina Department of Health and Environmental Control (DHEC). A formal memorandum of understanding between the South Carolina Forestry Commission (SCFC) and DHEC defines the role of each agency in preventing or correcting water-quality impacts from forestry operations. The DHEC refers all forestry-related water-quality complaints to SCFC for investigation. The forestry commission recommends corrective actions to the landowner and forestry operator, where noted problems can be resolved. Sites on which SCFC recommendations are not implemented within 30 days are referred back to DHEC for enforcement action.

Additionally, SCFC has developed a Courtesy Exam Program, unique in the Southern States, as a proactive means to encourage proper BMP implementation (Jones 2000). In this program, active forestry operations are located through weekly aerial reconnaissance of major drainages; through voluntary prior notification by foresters, loggers, or site-preparation contractors; through complaints from the public; through the DHEC; and through other sources. Permission is secured from landowners to visit individual sites, the operators are contacted, and BMP foresters inspect the sites for BMP compliance. Written recommendations based on the site visits and BMP manuals are provided to the landowners and contractors, and the BMP foresters make followup visits after project completion to see if BMPs were followed and if related water-quality problems occurred.

Monthly courtesy exam summaries are provided to DHEC and made available to others upon written request. Summaries include a list of operators who failed to implement BMPs and may have created unresolved water-quality problems. Individual forest products companies have used this information to take corrective actions that they deem necessary. Actions have included refusal of wood at the mill, mandatory State monitoring, and additional training requirements (Personal communication. 2001. Tim Adams, South Carolina Forestry Commission, P.O. Box 21707, Columbia, SC 29221). The courtesy exam program is credited for achieving high rates of BMP implementation in South Carolina. In 1999, for example, BMP compliance was 99 percent on sites that underwent a courtesy exam.

Tennessee—Tennessee has a nonregulatory BMP program (Personal communication. 2000. David Arnold, Department of Agriculture, Forestry Division, Box 40627, Nashville, TN 37204). In incidents of suspected water pollution due to forestry, investigators from the department of agriculture are called in to assess the sites and recommend any necessary corrective measures. If, after reasonable efforts by that department, an operator or landowner fails to cooperate or comply with recommendations, the department of environment and conservation may take appropriate enforcement action. During 1998 to 2000, 126 cases were referred by the division of forestry.

The Tennessee State Legislature passed House Bill 2846 in 2000, which gives stop-work authority to the Commissioner of Environment and Conservation. When water pollution occurs because an operator fails to use forestry BMPs, the commissioner, after consultation with the department of agriculture, may issue a stop-work order, and shall at the same time notify the landowner that a stop-work order has been issued. The operator must then cease part of or all activities contributing to the pollution. The order will remain in effect until the operator implements the forestry division's recommended BMPs that eliminate and prevent further pollution from forestry activities at that site. Any operator who receives a stop-work order must, for the next 2 years, notify in writing the Commissioner of Agriculture and the Commissioner of Environment and Conservation at least 10 days prior to beginning any silvicultural activity. Information must include the names of the landowner and operator, the location of and acreage of proposed silvicultural activity, and the beginning and expected ending dates of silvicultural activities.

Texas—Texas has a nonregulatory BMP program (Personal communication. 2000. Burl Carraway, Texas Forest Service, Best Management Practices, P.O. Box 310, Lufkin, TX 75902-0310). There is no formal State interagency agreement by which BMP noncompliance is addressed. However, there is a State coordinating committee consisting of all regulatory agencies (Texas Natural Resources Conservation Council, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency) and the forestry community (Texas Forest Service, Texas Soil and Water Conservation Board, Texas Forestry Association, Texas Loggers Council, forestry consultants, Texas Parks and Wildlife Department, forest industry, and others). In cases of reported or discovered BMP noncompliance, or nonpoint-source water pollution from forestry operations, the coordinating committee provides advice for recommended BMPs and seeks cooperation of the logger and/or landowner. Texas has a "bad actor" provision in its water-quality law that allows pursuit of a repeat offender, but it rarely, if ever, has been used with respect to silviculture. The Texas forest industries that subscribe to the SFI have taken it upon themselves to audit timber producers supplying their mills, and producers found in noncompliance with BMPs are counseled to improve BMP implementation. Those who do not comply with Texas-recommended BMPs are not permitted to deliver wood at these mills. This

arrangement is believed to be producing an improving trend in BMP implementation in Texas, but there are many small timber industry mills that do not subscribe to the SFI.

Virginia—Virginia has a non-regulatory BMP program, but it does have mandatory harvest notification no later than 3 working days after the initiation of harvest operations (Personal communication. 2000. Matt Poirot, Department of Forestry, Fontaine Research Park, 900 Natural Resources Drive, P.O. Box 3758, Charlottesville, VA 22903-0758). Further, the Silvicultural Water Quality Law, effective June 1, 1993, authorizes the Virginia Department of Forestry to require corrective measures for silvicultural operations causing, or with potential to cause, sedimentation of State waters. In cases where the department enforces this law, the first step is issuance of a notice of required action, which is an informal description of what needs to be done to correct the problem. If that fails to bring resolution, an informal conference is held with the operator. The next step could be issuance of a special order, which details proof of sediment pollution and contains a step-by-step prescription of necessary corrective measures with a schedule for work. If the operator fails to comply with the special order, a formal hearing is held to determine if the special order was violated. Finally, civil fines of up to $5,000 per day can be assessed. This authority also includes issuance of stop-work orders. Formal actions taken by the department of forestry in 1998, 1999, and 2000 total 199, 272, and 540, respectively. The increase in 2000 is attributed to addition of compliance monitoring staff.

Other forestry-specific State laws include the Chesapeake Bay Preservation Act and local land use tax rules. These acts and rules exempt forestry from certain requirements, or exempt forest land from certain taxes, provided that BMPs are implemented and verified by the department of forests. Monitoring of BMPs for compliance with the Silvicultural Water Quality Law is done coincidentally on about 240 randomly selected tracts per year through quarterly administrative review in the six department regions, and through the semiannual BMP implementation and effectiveness monitoring survey.

Analysis of this topic leads to several broad observations:

- The nonregulatory approach utilized in Southern States over the past 20 years to protect forest water resources is nontraditional, unique, and still evolving. Its dependence on practitioner education, direct landowner assistance, and systematic monitoring of program effectiveness has gained momentum and widespread acceptance in the forestry community.
- The silviculture BMPs recommended by Southern States are grounded in science or are based on scientific principles. While there are differences among States in specific individual BMPs applied on the ground (SMZ widths, for instance), consistency among States is generally strong and continues to increase. While not tested for effectiveness in every State or ecological region, studies conducted to date have found BMPs effective at maintaining State water quality within applicable standards. Additional scientific validation of BMP design will serve to refine their application to fit site-specific conditions.
- Success of the nonregulatory approach requires continual education efforts targeted at the ever-changing groups and individuals who own and treat the South's forests.
- Documenting the effectiveness of these approaches and their efficacy in protecting water resources is complex, costly, and still evolving. Southern States vary widely in their methodologies and commitment of resources for BMP monitoring.

Needs for Additional Research

- Additional documentation of the scientific basis for BMPs and studies of BMP effectiveness are needed to evaluate them in representative ecological provinces in the South. Key topical areas should include stream crossings, SMZ harvesting options, and overall SMZ management. Chemical, physical, and biological water-quality parameters and stream channel stability indices should be documented for different stream types.
- Reasons that landowners comply or do not comply with BMPs are not well understood. Additional information of this kind would be useful for targeting outreach efforts and adjusting State programs.
- Resource benefits provided by BMPs other than water-quality protection should be studied and documented. This information would be useful for encouraging landowner acceptance and could identify needed modifications in BMPs. Landowner understanding of the full range of benefits derived through BMPs, in addition to water quality, may increase landowner commitment to BMPs.
- Effects of nontimber uses of forests, such as off-road vehicle use and equestrian crossings, are not well documented, but are potentially significant. Effects of these uses may be similar to those of roads and skid trails (concentrated traffic in small, potentially high-impact areas). Science-based BMPs could be tailored for these and other common forest uses.
- Economic costs and benefits of BMPs to landowners are not well understood, and should be documented.

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The southern forest resource assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States. Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire. Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits that they provide.

Keywords: Conservation, forest sustainability, integrated assessment.