Chapter 16

# Best Management Practices for Riparian Areas

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*"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is not when it tends otherwise."*

Aldo Leopold — A Sand County Almanac

Forest streams, lakes, and other water bodies create unique conditions along their margins that control and influence transfers of energy, nutrients, and sediments between 'aquatic and terrestrial systems. These riparian areas are among the most critical features of the landscape because they contain a rich diversity of plants and animals and help to maintain water quality and terrestrial and aquatic habitats (Hunter 1990; Gregory et al. 1991). These fragile areas are easily disturbed, and caution is needed whenever forest management occurs within them. Riparian areas are often linear features of variable width that have high edge-to-area ratios but generally occupy only a small part of the landscape. However, the linear nature of riparian areas means that resource managers and loggers, either through active management or the need to gain access to a site, will invariably come into contact with these features. Therefore, the proper management tools are needed to maintain the functions of riparian areas and minimize disturbance to the terrestrial and aquatic systems.

Best Management Practices (BMPs) are developed to prevent or minimize the adverse impacts of forestry activities on water quality while permitting the intended forest management activities to occur. They serve as the cornerstone for most state water quality protection programs ( NCASI 1994; Phillips 1995; Stuart 1996). Possibly the earliest effort to establish BMP guidelines was the "Criteria for Managing the National Forests in the Appalachians" (1971) by Regions 8 and 9 of the USDA Forest Service. The development of BMP programs has been a collaborative effort among state agencies and organizations (both public and private) and federal agencies to identify practices that reflect the particular physiographic, economic, technical and political considerations of each state. Monitoring has shown nationally that compliance with BMPs is relatively high (Hook et al. 1991; Adams and Hook 1993, 1994; Henson 1995, 1996; and Carraway et al. 1998). However, by definition, BMPs were designed to protect water quality, not the other functions and values of riparian areas. We need to move beyond BMPs based solely on water quality to address these additional functions and values.

All state BMP programs recognize the importance of retaining some form of riparian management zone (RMZ) with management options that minimize impacts to the water resource (Vermont Department of Forest, Parks, and Recreation 1987; Kentucky Division of Forestry 1998; Maryland DNR 1992; Alabama Forestry Commission 1993; Florida 1993; Tennessee Division of Forestry 1993; South Carolina Forestry Commission 1994; Georgia Forestry Commission 1995; Kittredge, and Parker 1995; Minnesota DNR 1995; Wisconsin DNR 1995; Cassidy, Aron, and Trembly 1996; Virginia Department of Forestry 1997; and North Carolina DENR 1998). Achieving BMP compliance in these areas generally requires greater care, reduced physical intrusion (e.g., skid trails, roads, equipment) into the riparian management zone, and often reduced levels of harvest (e.g., thinning, uneven-aged management) or no harvest at all. It also requires preharvest planning that considers the landowner's management objectives. The BMPs discussed in this chapter pertain to lands where silvicultural or other forest management activities are planned and conducted. This chapter will describe the management issues of concern, water bodies that are addressed by traditional BMPs, RMZ options, and approaches to the development of RMZ guidelines that move beyond BMPs and address issues other than the protection of water quality.

## Management Issues of Concern

Any forest management activity adjacent to or intruding into the riparian area has the potential to negatively impact water quality, terrestrial and aquatic habitat, and other riparian functions and values. These activities include timber harvesting, mechanical site preparation, pesticide application, prescribed burning, fire line clearing, insect and disease control, road construction and maintenance, and recreational development. The concern that has received the greatest attention is nonpoint source (NPS) pollution, which originates from diffuse sources across the landscape. NPS pollution contributed from any particular area may be small or insignificant, but can create water quality problems when combined across the landscape. Nationally, forests occupy approximately one-third of the land base, but forest management is credited with contributing only 1 to 5% of NPS pollution in assessed waters of the United States (U.S. GAO 1991; Kochenderfer et al. 1997). Because forests can help decrease NPS pollution, groups of trees are sometimes planted adjacent to waterbodies where agriculture is the predominant land use (NRCS 1996). Sediment is the principal pollutant associated with forest management operations (Pardo 1980; Golden et al. 1984). Sediment originating from the construction and use of logging roads and skid trails generally exceeds that from all other forestry activities (Megahan 1972; Patric 1976). Stream crossings are the dominant feature where roads make the major contribution of sediment to water bodies. State BMPs have traditionally been designed to reduce and trap erosion and to control subsequent sedimentation of water bodies. Research has shown that where BMPs are properly employed, significantly less erosion and sedimentation occur (Black and Clark 1958; Hewlett and Douglass 1968; Swift 1984a, 1984b, 1986; Kochenderfer and Helvey 1987; Burroughs and King 1989; Briggs et al. 1998). Other sources of NPS pollution that are of concern include fertilizers, pesticides, fuels and lubricants, organic matter and nutrient leaching, and thermal impacts from removal of vegetative cover.

Forest management activities can also impact other riparian functions and values such as cultural resources (e.g., logging camps, cemeteries, burial mounds, artifacts); streamflow and water quantity; forest soil productivity; terrestrial and aquatic habitat type, structure (e.g., inputs of coarse woody debris), and amount; bank stability; recreation; aesthetics; and rare, threatened, and endangered species. Forest management activities can have multiple impacts on the resource if BMPs or other forest practice guidelines are not followed (Table 16.1).

Table 16.1 Potential impacts to riparian areas from forest management activities

| | | | | | | Habitat Type, Structure and Amount | | | |
|---|---|---|---|---|---|---|---|---|---|
| Forest Management Activity | More Erosion and Sedimentation | Chemical Pollution to Water | Slash Disposal | Temperature Increases | Soil Compaction & | Terrestrial | Aquatic | Cultural Resources | Forest Soil Productivity |
| Timber harvest | X | X | X | X | X | X | X | X | X |
| Site preparation | x | x | x | x | x | x | x | x | x |
| Pesticide use | | X | | X | | x | x | | X |
| Prescribed burning | x | x | | X | | x | x | x | x |
| Fire line construction | x | x | x | | X | | x | x | x |
| Roads | x | x | x | x | x | x | x | x | x |
| Recreation | x | x | x | x | x | x | x | x | x |

## Water Bodies Addressed

Riparian areas exist around all water bodies. The water bodies of concern for forest management include lakes, perennial streams, rivers, intermittent and ephemeral streams, vernal and autumnal pools, nonopen-water wetlands, and open water wetlands. A necessary question is whether all water bodies should be or can be practically managed to the same standard of importance in terms of riparian functions and values. When developing riparian guidelines, a decision must be made about the degree of protection given to each of these water bodies. For example, lakes, perennial streams, rivers, and open-water wetlands are likely to receive a higher standard of protection than nonopen water wetlands, intermittent or ephemeral drainages, and vernal and autumnal pools. This varying level of protection may occur due to the relative presence/absence of each type of water body within the landscape, their ease of identification (e.g., ephemeral streams and vernal and autumnal pools may be difficult to identify during dry periods or under a cover of snow), the perceived importance of each water body, and their associated functions and values.

The terminology for management within riparian areas is variable and often describes the function of the practice or identifies the type of water body. Common terms include streamside management zone, RMZ, filter strip, riparian buffer, and shade strip. A streamside management zone (SMZ) is a designated area that consists of the stream itself and an adjacent area of varying width where management that might affect water quality and aquatic habitat is modified. The SMZ is not a zone of management exclusion; instead, it is a zone of closely managed activity. Despite the name of the zone (i.e., streamside), the associated guidelines are also applied to open water bodies in many states that apply SMZs. Florida, for example, uses the SMZ acronym to mean special management zone (Florida 1993). Within the SMZ, the use of practices such as filter strips and shade strips are commonly prescribed. The RMZ performs the same functions as the SMZ but is named to be inclusive of other types of water bodies.

A buffer is a transitional area between two'different land uses that mitigates the effects of one land use on the other. A filter strip is an area of land adjacent to a water body that provides for infiltration of surface runoff and traps sediment and associated pollutants and may be a designated function for land within or around SMZs and RMZs. A key aspect of a filter strip is that rutting, compaction, and exposure of mineral soil are minimized to permit the filter strip to function. A shade strip is an area of land adjacent to a water body where sufficient timber or other vegetation is retained to provide shade that maintains temperatures within the normal range. In this chapter, RMZ will be the preferred term.

## Options in the Riparian Management Zone

Many of the BMP recommendations for operating within or adjacent to the RMZ (e.g., skid trail location, water bar spacings) are fairly consistent between states. One difference, however, is in specifications for RMZ width and harvesting restrictions. How wide should the RMZ be? Should the RMZ be a fixed width or variable width based on site conditions? How much harvesting is permitted within the RMZ?

The criteria for establishing effective RMZ widths and acceptable management restrictions within the RMZ have been heavily debated among resource professionals and the concerned public. Some will argue that the wider the RMZ, the greater the protection given to riparian functions. At some point, increasing the width of the RMZ and imposing more restrictions on management will conflict with economic considerations, the landowner's management objectives, and issues of property rights. For resource management agencies and public lands, the "wider is better" approach will likely have more appeal where economic objectives for management are not dominant. Many resource management agencies apply wider RMZs than are required by state guidelines for water quality protection to provide for "other" riparian functions and values. This does not imply that agencies are not concerned about economics or that these wide RMZs are BMPs for water quality protection, but rather that the agencies' management is or may be more encompassing than that of private landowners. However, economic considerations, particularly for private lands, may result in a minimal RMZ width. It could be difficult to convince nonindustrial private forest (NIPF) landowners to maintain a wide RMZ with many management restrictions where riparian edge is a significant portion of small tracts.

The width of the RMZ can be selected in two ways: (1) reserve a fixed width or standard width that may vary based on slope or water body type; and (2) establish a variable width based on specific site conditions (e.g., composition, age, and condition of vegetation; site geomorphology; animal and plant species present on the site; watershed-level issues; adjacent land use; sensitivity of the site to disturbance). Some examples of recommended buffer widths are given in Table 16.2. Most RMZ guidelines recommend minimum widths in the range of 50 to 100 feet.

The advantage of fixed-width RMZs is that they are easily applied and monitored for compliance. Applying a fixed-width RMZ does not require a knowledge of ecological principles. Therefore, they may be more easily applied without management assistance. A disadvantage of fixed-width RMZs is that they are based on a narrow set of site conditions that may not commonly exist. Compliance monitoring of the implementation or application of fixed-width RMZs, while easily accomplished, does not indicate protection of riparian functions. A fixed distance may result in a RMZ that is not wide enough to protect these functions. In other cases, it may be more than what is needed to protect them. However, applying a minimum fixed width may protect some of these functions. An argument for fixed-width RMZs for NIPF landowners is that we are currently reaching a relatively small

Table 16.2 Examples of RMZ widths and harvest restrictions

| State | Water Type | RMZ Width-ft. | RMZ Harvest Restrictions |
|---|---|---|---|
| Maryland (1992) | Perrenial streams and wetlands | 50-250 w/ slope % | Maintain 60 sq. ft. BA/ac. Even distribution. |
| Wisconsin (1995) | Lakes and nav. streams | 100 | O-50 - no harvest<br>50-100 - maintain 60 sq. ft. BA/ac. |
| | Nav. Int. streams | 35 | Maintain 60 sq. ft. BA/ac. Even dist. |
| North Carolina (1998) | All water bodies (critical areas) | 50-250 w/ slope % (75-300 w/ slope %) | Selection harvest up to 25% of existing canopy |
| | Ephem. streams | | Same, no bare ground |
| | Intmit. streams | | Same, and < 41% bare ground |
| | Peren. streams | | Same, and < 21% bare ground |
| New Jersey (1995) | Open water, incl. intermit. streams | 25-165 w/slope % & erosion hazard | Any harvest system can be used if the integrity of the soil surface is maintained. |
| Pennsylvania (1993) | Streams, lakes, ponds, wetlands | 25-165 rds, lndngs<br>50-165 harvest area | Maintain 50% BA. RMZ width double in municipal watersheds |
| Vermont (1987) | P. strms & lakes | 50-l 1 0+ w/ slope % | Light thinning or selection harvest |
| Ohio (1992) | Shade strips (peren. streams) | 25 | No cut or light cut |
| | Filter strips (water courses) | 25-250 w/ slope % | Selection harvest. RMZ double in municipal watersheds |
| Florida (1993) | Peren. streams | 35-200 | Selection harvest. |
| | Interm. streams | 35-300 | Maintain integrity of soil surface |
| | Lakes, sinkholes | 35 | Selection harvest. |
| Minnesota (1999) | Trout waters | 150-200 | Maintain 60-80 sq. ft. BA/ac. |
| | Nontrout waters Even age mgt. | 50- 100 w/ stream width or lake size | Maintain 25-80 sq. ft. BA/ac. |
| | Nontrout waters Uneven age mgt. | 50-200 w/ stream width or lake size | Maintain 80 sq. ft. BA/ac. |
| | Filter strips (p.& i. strms, lks, o.w. wetlands, ponds) | 50-150 w/ slope % | Maintain integrity of forest floor (also around seeps and springs) |

percentage of these landowners with professional assistance (Gathman et al. 1992), and most of the landowners and loggers are not likely to have the expertise to evaluate the site-specific conditions and determine the appropriate width of the RMZ. However, the percentage of landowners receiving technical assistance may be increasing due to education and incentive programs, such as the Stewardship Incentives Program. When that technical assistance is used, BMP compliance will likely increase (Henson 1996).

Compared to fixed-width RMZs, variable-width RMZs are more apt to be applied on public and private industrial lands. Making the right decision about width requires trained judgment. Larger ownerships maintain technical staff who can evaluate the specific site conditions and identify the appropriate width of the RMZ. Variable-width RMZs allow flexible management decisions based on ecological and landscape principles, specific site conditions, intensity of adjacent land use, and the need to maintain and protect identified functions. Making the decision will likely require site visits that collect detailed information about the site and surrounding landscape. This means that deciding on the RMZ width will be more costly and time consuming. However, this approach will likely provide more protection to water quality and other functions of the RMZ.

Once the RMZ is defined, the management activities within the RMZ, such as harvesting levels, are considered. Harvesting in the RMZ can be conducted so as to leave the residual basal area scattered uniformly across the RMZ or harvest so that a higher proportion of the uncut trees are left adjacent to the water body. Whatever the harvesting regime, residual trees must be windfirm to resist blowdown and maintain functions of the RMZ. The bulk of protection for water quality, aquatic habitat, and riparian functions occurs closest to the water body and diminishes with increasing distance from the water body. The trees closest to the water body will provide large woody debris for both terrestrial and aquatic habitats, promote bank stability, provide shade, maintain water temperatures within the normal range, provide detritus to the water body, and address some recreational and aesthetic concerns. The outer portion of the RMZ may be more suited to addressing terrestrial biodiversity issues while providing additional protection to the inner zone (e.g., windfirmness). This management approach is embodied in the USDA Natural Resources Conservation Services buffer strip interim conservation practice standard for the Conservation Reserve Program (USDA NRCS 1996). Because the different types of water bodies have both overlapping and differing functions and values, RMZ guidelines may vary by type of water body.

Tree orientation is another consideration for harvesting within the RMZ. Within one mature tree length of the water body, retain trees leaning towards the water body because they will eventually fall into it and provide large woody debris for aquatic habitat niches. Trees leaning away from the water body are preferred for harvest. However, one reason not to remove all of trees leaning away from the water body is that they will also provide terrestrial biodiversity habitat once they fall down. In addition, maintaining a mixture of conifers and deciduous species in a multi-layered canopy is desirable for the maintenance of plant and animal diversity.

Determination of RMZ widths and forest management restrictions is influenced by economic considerations. Ability to harvest riparian species with economic value is necessary to encourage continued landowner commitment to maintaining these areas. For the landowner and logger, there are real costs associated with BMP implementation in riparian areas. Some of these costs include opportunity costs of not harvesting, reduced stumpage payments due to increased harvesting costs, or the added expense of installing a particular type of stream crossing or culvert (Ellefson and Miles 1985; Dissmeyer and Foster 1987; Lickwar et al. 1991). Recognizing that guidelines may affect operating costs and efficiency, guidelines need to be flexible enough to protect water quality and other riparian functions while providing for an economically viable operation. There are also indirect costs to agencies and organizations associated with implementing various programs (e.g., technical assistance, education-extension, monitoring compliance, regulatory enforcement). For NIPF land, incentive programs need to encourage compliance with BMP recommendations and other practices within RMZs. These programs can include tax incentives, financial incentives (cost sharing), educational-extension programs, technical assistance, voluntary guidelines that provide flexibility, and some form of regulation.

While it is relatively easy to identify and quantify BMP implementation costs, few studies have tried to quantify benefits. Many benefits may accrue to society as a whole or to individual groups within society (e.g., hunters, bird watchers), off-site or in the future, and some benefits may be associated with species that do not have a current market value. Also, it is difficult to develop appropriate production and price relationships for many of the benefits. This lack of information about BMP benefits makes it difficult to conduct complete economic analyses of riparian management zones.

# Best Management Practices

Before land management activities begin within a RMZ, the landowner or manager needs to identify their management objectives for the area within the RMZ. Once these objectives have been identified, the landowner or manager should plan their BMPs. Planning is, in itself, a Best Management Practice and is probably the most important BMP. It is an opportunity to identify site-specific needs, landscape-level concerns, potential problems, conflicts, and to select mitigating activities that prevent impacts, modify the intensity of impacts, or improve pre-existing poor conditions. Because the RMZ is identified as a zone of special concern, it is important to consider where and how much disturbance is appropriate, the size of the RMZ, the location and type of mitigating practices, and the best season for the activity. Planning helps to identify the risks and costs of management activity in the RMZ. If possible, the RMZ should be visited to identify sensitive areas such as stream crossings; special vegetation or animal habitats; cultural resources; sensitive habitats, troublesome topography, soils, or geology; and potential sources and routing of sediment. During the visit, existing disturbances such as old roads can be identified so that planning may include appropriate remedial activities or future use if existing sites are properly located and stabilized.

BMPs specific to the RMZ fit into three categories: those that limit disturbance, those that exclude pollutants, and guidelines for river and stream crossings. State BMP guidelines exclude or control activities that disturb the soil such as roads, skid trails, log landings, boat landings and other recreation sites, site preparation, and fire and fire lines. Some guidelines exclude the use of machinery such as tractors or skidders, requiring the logger to pull logs by cable from equipment set outside the RMZ. Other guidelines limit the number, size, or location of trees that may be cut in order to reserve trees for shade strips, aesthetic view protection, or coarse woody debris.

BMPs are designed to mitigate or prevent adverse impacts due to sediment movement, water temperature shifts, changes in streamflow, input of chemicals, organic debris, solid waste disposal, and habitat alteration. Where soil is disturbed and erosion occurs, fine soil particles can be deposited as mud in water bodies or transported as suspended sediment in turbid waters. Larger particles add to the bedload volume and may fill stream channels and reduce lake volume. Excess sediment reduces water quality and covers the normal substrate of water bodies.

Reduction of vegetation density in the RMZ can lead to increases in summer water temperatures and possible reductions in winter temperatures, thus altering the habitat for aquatic organisms (Swift 1983). Temperature change is directly related to the location and amount of vegetation removed (Kochenderfer et al. 1997). Where reducing the density of forest cover increases soil moisture storage, nonstorm stream flow rates can increase (Swank et al. 1988). Road drainage will add to stormflow volume if there is a direct surface connection with the stream system or if the drainage becomes part of the subsurface stormflow.

Most pollution control BMPs focus on techniques to exclude sediment from the water body. These include controlling erosion at its source, trapping sediment in natural or constructed barriers, dispersing storm water and its suspended sediment away from the water body, and avoiding or controlling situations that initiate debris slides. Various guidelines cover methods of draining storm water from a roadway such as waterbars on closed roads, broad-based dips, the sloping or shaping of roadbeds, and ditch line drainage. Guidelines protect water quality by recommending against the disposal of storm water into the water body or its RMZ.

BMPs control chemical pollutants by restricting vehicle or equipment maintenance, trash disposal, and pesticide application and equipment servicing within the RMZ. Chemicals used in the RMZ may move to and pollute the water body. They include spilled fuels and lubricants from vehicles and earthmoving or logging equipment, residues washed off pavements, and pesticides and fertilizers carried by wind drift or storm waters. Trash and solid waste disposal in the RMZ also may pollute the subsurface and surface water. The wetter soils characteristic of riparian areas increase the probability of spills impacting subsurface water. Excess organic debris, such as slash disposal, can add nutrients to the RMZ, which may be either beneficial or polluting.

The aquatic habitat may be physically altered by stream crossing structures, which can block the upstream migration of fish and amphibians. Undesirable practices include road locations inside the RMZ where construction has moved the channel or mined the substrate of the water body for gravel. Problem stream crossings must be identified early and remedial actions taken to eliminate or minimize their impact.

Stream and river road crossings are the major disturbances (e.g., decreased bank stability, increased erosion, and subsequent sedimentation) in the RMZ. BMP guidelines specify the culvert size and placement, and use of bridges, fords, or other type crossings. A management guideline may specify that crossings are removed when intermittent use roads are closed, effectively-disturbing the stream an additional time. Portable bridges offer a low-impact alternative for such roads. BMPs to reduce stream crossing impacts include using brush barriers below road fills, putting erosion-preventing materials and plantings on fills at crossings, covering of fills with geotextiles, using geogrids, temporary wood mats, tire mats, or wood planks to stabilize soils at crossings, and putting rock in ditch lines and fords. Stream and wetland crossing options and some of their associated impacts have been summarized (Blinn et al. 1998).

When the specific BMPs to be used in the RMZ have been identified, the landowner or resource manager should ensure that the appropriate lines are marked to identify the edge of the RMZ. They should also mark the trees to be left and identify skid trail and water crossing locations (Figure 16.1). In addition, the landowner or resource manager should include the restrictions as appropriate language in contracts and meet with the contractor and logger on site before harvest entry begins. Timber sale administration is critical to ensure that protection standards are met.

# Other Riparian Considerations for Guideline Development

As noted earlier, BMPs were designed to protect water quality. However, functions not generally covered in most BMP guidebooks are receiving increased attention including protection of cultural resources, maintenance of travel corridors and habitat structure for wildlife, maintenance of unique habitats, and maintenance of soil productivity. Some of these situations are covered by antiquities and endangered species regulations. Protection of these other functions and values should also consider landowner objectives where voluntary programs have become established. The survey and planning associated with management of the RMZ provide opportunities to identify and protect these resources. Forest management that considers these, and other issues, provides a more comprehensive approach to protecting the broad array of riparian functions and values.

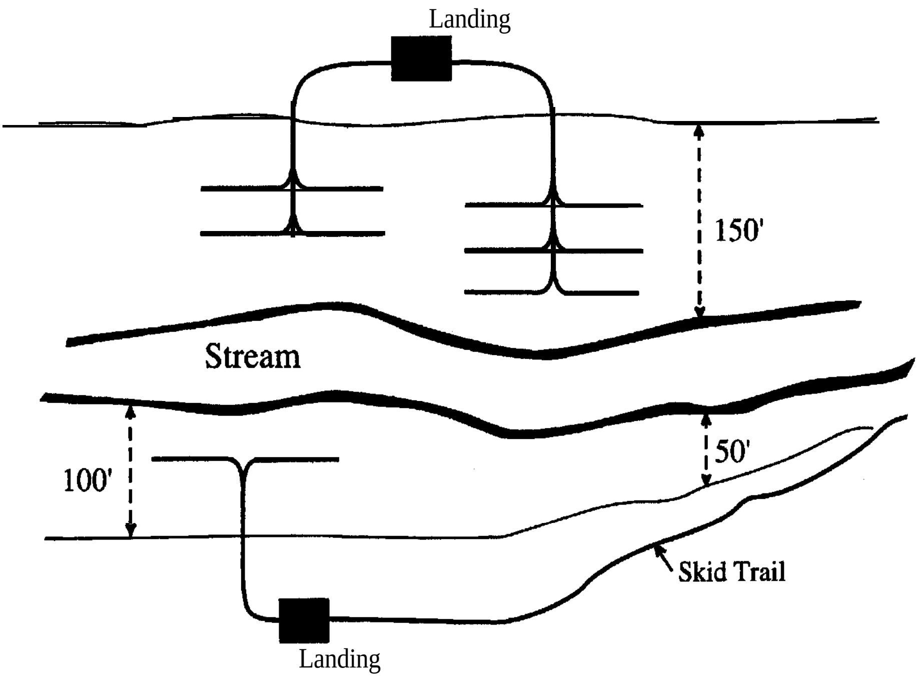



Figure 16.1 Skid trails and landings in riparian areas (Blinn and Dahlman 1995). The limit (width) of the RMZ is noted in feet from the water's edge.

Because of differences in terrain or vegetation between a riparian zone and the surrounding landscape, the RMZ may be a travel corridor for some animals, including humans. BMPs may indirectly protect these uses, but where such corridors are identified, specific practices can be created to serve that special need.

Riparian areas historically constituted much of the landscape that various cultures used (i.e., settlement location, economic activities, social activities, and spiritual activities) (Emerson 1996). Protection measures for cultural resources include excluding the land containing the cultural resources from the sale area; clearly marking the boundaries of the cultural resources when included in the sale area; keeping roads, skid trails, and landings away from the cultural resource area; and measures reducing soil disturbance in cultural resource areas.

Riparian areas have high plant diversity, both horizontally and vertically from the water's edge, which contributes to the high diversity of animals that live in these areas (Hunter 1990). However, riparian area diversity may be reduced in some situations by past land-use. Measures to protect and maintain wildlife habitat in riparian areas include use of silvicultural systems other than clearcutting, retention of mast, retention of cavity trees, retention of slash and downed logs, and retention of conifers to provide food, cover, and nesting sites. While the retention of standing and downed materials provides unique habitats for wildlife, the potential for insect and disease infestations as well as operator safety need to be considered.

Maintaining soil productivity is a key to maintaining riparian benefits on a sustainable basis. Soils within riparian areas are generally wetter than soils in adjacent upland areas. Issues of concern for soil productivity include compaction, rutting, erosion, loss of organic matter, depletion of available nutrients and nutrient reserves, and reduction of soil fauna and flora. Many of the measures in existing state BMPs protect against negative impacts to soil properties in riparian areas. Important protection measures include matching tree species to site, minimizing exposure of mineral soil in riparian areas, using harvesting techniques that promote retention of slash and debris within the riparian area, using equipment that is suited to the site and the size of the material being harvested, minimizing intrusion of equipment into riparian areas, confining equipment to designated trails, and using corduroy (e.g., logs, brush mats) or other suitable materials (e.g., geotextile with reusable wood mats, wood planks, tire mats) to construct temporary crossings on weak or wet soils (see Chapter 15).

# Approaches to BMP Development

In developing NPS pollution control programs, states need to design BMPs that respond to local needs and conditions and protect water quality; while the U.S. Environmental Protection Agency retains the responsibility for program review and oversight. State BMPs are developed and implemented through basically two approaches: voluntary or regulatory programs. Most of the states have opted for the voluntary approach, which assumes that BMPs are first developed and then promoted through education and technical assistance. Workshops, demonstration areas, and brochures are critical to program implementation (Teeter et al. 1997). Landowners are encouraged to use loggers and operators who have a working knowledge of state BMPs. In many states, BMPs are then monitored for their use (Hook et al. 1991; Adams and Hook 1993, 1994; Phillips et al. 1994; Holaday et al. 1995; Henson 1996; Carraway et al. 1998; and Adams 1998). Monitoring information is then used to modify the BMPs, to improve BMP efficacy, and to target future education efforts and technical assistance.

Many regulatory programs use mandatory controls and enforcement strategies enacted in state forest practice rules or water quality statutes (Ellefson and Miles 1985). These programs use some combination of plans, permits, and prescriptions. Harvest operations are often reviewed by the responsible state agency. Implementation of these BMPs is required based on site-specific conditions, and penalties may be levied to ensure compliance.

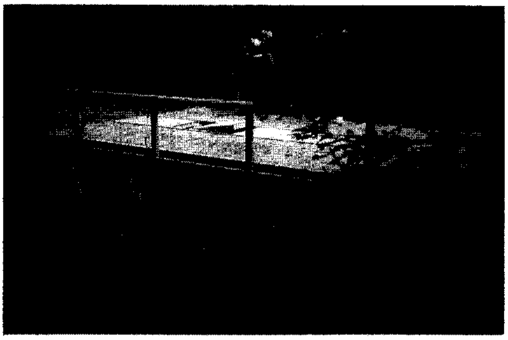
In most states, acceptable compliance is judged by the installation of a specific set of voluntary or required practices without regard to how effective the practices are in an individual case. The North Carolina program may be unique because a wide range of practices is suggested for use, but acceptable performance is judged solely on the landowner's ability to protect aquatic resources regardless of BMP methods selected (NC DENR 1998).

States have taken two basic approaches in developing guidelines and practices: (1) through an agency followed by public review and (2) through involvement of all concerned stakeholder interests, which may be followed by public review. Development of BMPs through an agency approach is problematic. These BMPs are generally strong on science but often weak on practicality and flexibility. Economics may not be considered to the degree that many land management organizations would desire. Often the time needed to develop these BMPs is relatively short compared to the long period of implementation because there will be resistance from interest groups not involved in development of the guidelines. Without stakeholder involvement in guideline development, there is little opportunity to build the trust among affected groups that is critical for effective implementation of any BMP program.

The involvement of stakeholder groups in the development of BMPs and other forest practice guidelines requires more patience and time. Once agreement is reached, however, implementation will likely be more rapid and effective since there is a greater probability that the interest groups have bought into the product produced. The BMPs or other forest practice guidelines developed by consensus are more likely to reflect a balance of science, practicality, and economics. There is also greater likelihood that trust will develop among the many stakeholders involved in BMP development, which is necessary for successful program implementation.

## Conclusion

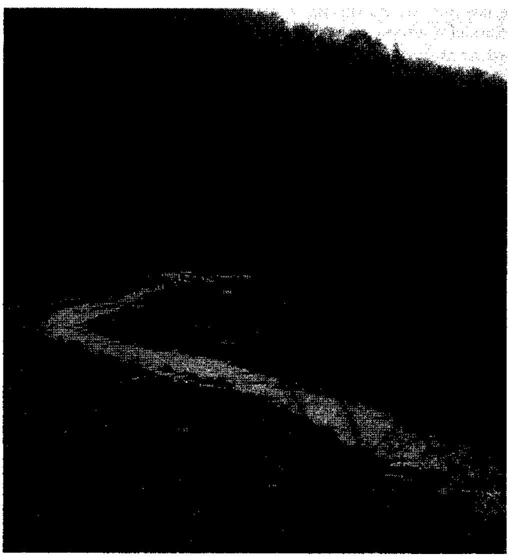
Most states have developed and published BMPs that address water quality and have begun programs to encourage and evaluate their implementation. The forestry community within each state must continue to support education efforts, technical assistance, research, and other implementation efforts to ensure improvement in the adoption and use of BMPs. At the same time, it is important that the forestry community move forward holistically in addressing other key issues to maintain its credibility in dealing with important resource concerns within the RMZ.



Sandy Verry

Water quality has long been the emphasis in forestry BMPs, like using temporary bridges to prevent sedimentation in streams, but-new BMPs include habitat considerations, like leaving legacy patches for this boreal owl.

Tom Nichols



Federal Interagency Restor. Group

Many states have adopted mining BMPs as well as forestry BMPs to prevent this type of habitat destruction where the stream is used as a road for mining access.