Riparian Management Practices in the United States: A Summary of State Guidelines

by

Charles R. Blinn and Michael A. Kilgore[1]

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[1]The authors are, respectively, Professor/Extension Specialist and Assistant Professor, University of Minnesota, 1530 Cleveland Ave. North, St. Paul, MN 55108. Research supported by the University of Minnesota's Department of Forest Resources, the University of Minnesota Extension Service, the Minnesota Agricultural Experiment Station under Project MN 42-042, and the Minnesota Forest Resources Council.

For more information about the Department of Forest Resources and its teaching, research, and outreach programs, contact the department at:

Department of Forest Resources
University of Minnesota
115 Green Hall
1530 Cleveland Avenue North
St. Paul MN 55108-6112

Ph: 612-624-3400
Fax: 612-625-5212
Email: fr@forestry.umn.edu

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Abstract

Individual states develop guidelines to protect and manage forest riparian resources. A review of 49 states' forest riparian guidelines (e.g., BMPs, regulations) in 2000 revealed the primary focus is to protect the quality of water adjacent to perennial and intermittent streams and lakes. In only a few states do riparian guidelines address other riparian functions and values beyond water quality protection (e.g., wildlife habitat). Riparian guidelines typically contain three basic components: minimum riparian zone width, minimum residual trees for the riparian zone, and other guidelines for modifying management practices within the riparian zone. A commonly recommended riparian management zone is 50 feet wide with 50 - 75 percent crown closure (or 50 - 75 ft^2/acre of residual basal area), although the specific guidelines in each state vary tremendously. While science cannot specify the management prescriptions needed to protect all riparian functions across every site, understanding site-specific conditions is critical to effective guideline implementation.

Riparian areas are the aquatic ecosystem as well as the boundary between aquatic and terrestrial ecosystems. Their moist and often wet soils and high water tables make them one of the most important and diverse parts of a forest ecosystem. Riparian ecosystems vary considerably between one another and internally along their length and width in terms of their physical dimension, topography, moisture regime, soils, vegetation, species abundance, and diversity. In addition to their ecological importance, they provide a range of functions with

economic and social value.

Riparian forests are one of the most widely studied and debated components of forest ecosystems. Hundreds of articles, dozens of books, and numerous bibliographies and reviews have been written on the ecology of riparian areas and their management (for example, Belt et al. 1992, Castelle et al. 1992, Castelle and Johnson 2000, Correll 1999, Koehler and Thomas 2000, Van Deventer 1992, Verry et al. 2000, Wenger 1999, and Wigington and Beschta 2000). Most of those studies have examined stream systems in the Pacific Northwest or Appalachian mountains.

As knowledge of riparian forests expands, so too have concerns about managing within these areas (Verry and Dolloff 2000). Today, resource managers and timber harvesters are being challenged to minimize adverse impacts to riparian systems when operating near water bodies. They rely on Best Management Practices (BMPs), zoning ordinances, or forest practice regulations to provide guidance for operating within these areas. Initially, most states developed forest management BMPs in response to the federal Clean Water Act of 1972. The primary focus of these BMPs was to reduce nonpoint source pollution associated with timber harvesting and forest management activities. Numerous additional federal, state, and local rules, regulations, plans, and policies have since been added to ensure adequate riparian area protection.

By 1996, 47 states had programs to promote forestry BMPs (National Association of State Foresters 1996). Those BMPs recognize the importance of establishing riparian buffer zones which are known by a wide variety of names such as riparian management zones (RMZ), riparian management areas, streamside (or special) management zones (SMZ), stream protection zones, and buffer strips. An important purpose of those buffer areas is to protect the functions

and values of the water body and its associated riparian area from the impact of site-based harvesting activities. To accomplish that objective, the guidelines provide recommendations for modifying management activities.

Although the BMPs incorporate the best available science, the base of knowledge of timber harvesting impacts on riparian systems is not extensive in some areas of the country. Therefore, program developers often must rely on knowledge and approaches from another region of the country or attempt to provide common sense recommendations to addressing issues that have been identified. The purpose of this report is to summarize the state riparian timber harvesting guidelines within the US as of the year 2000.

National Review

In February 2000, we contacted state foresters in all states and asked them to provide us with a copy of state BMPs, guidelines, or forest practice regulations regarding timber harvesting within riparian areas. We did not review the extent to which federal laws, local regulations, or zoning ordinances effect timber harvesting activities within riparian areas. Where it was not possible to obtain a copy of their guidebook, we obtained information from a website maintained by the Southern Forestry Extension Service (www.usabmp.net). That site provides links to several BMP guidebooks.

We reviewed the guidebooks and other on-line information to identify the riparian guidelines. Appropriate information from each guidebook was initially summarized into a table and key trends were identified. When we compiled the tabular summary, we made every attempt to only include information from the particular water bodies that each state defined as being a part of their RMZ, SMZ, stream protection zone, or buffer strip guidelines. If a guidebook

contained information about water bodies that were not included within their management zone definition, we excluded those additional water bodies from the summary. As an example, Minnesota has separate sections within their guidebook for riparian management zones and for wetland inclusions and seasonal ponds. As wetland inclusions and seasonal ponds are not addressed within Minnesota's guidebook definition of riparian management zones, they were excluded from the tabular summary for that state.

Focus of the Guidelines

We reviewed forest management guidelines used in 49 states (guidelines for Arizona were not available). Of the 38 guidebooks that provided a publication date, seven were published in 2000, 14 during 1997 - 1999, 11 during 1993 - 1996, and six prior to 1993. As evidence that the guideline process is evolutionary and that revisions are based on the results of monitoring and accumulated knowledge (Norman 1996), several states are in the second or third edition of their guidebook. A few indicated they are currently in the process of revising their guidelines. Only the most recent published riparian guidelines were reviewed.

In most guidebooks, the riparian guidelines are located toward the beginning of the guidebook where they often follow a planning section. The focus of riparian guidelines is often on water quality protection. Water quality issues cited include sediments, nutrients, pesticides, fuels and lubricants, organic matter, and thermal impacts. Some states noted consideration of additional riparian functions and values beyond water quality. For example, Minnesota's riparian guidelines reference a variety of functions and values such as wildlife habitat, biological diversity, and aesthetics. Although 24 states have labeled their guidelines as "Streamside Management Zone" practices, 17 of those states also address non-stream water bodies such as

wetlands, lakes, and ponds.

State riparian guidelines address a variety of different water bodies (Table 1). In order of decreasing frequency, the water bodies noted below are each identified by at least 10 states. For four of the states indicating that they have guidelines for "streams," it was assumed that those are perennial streams as no definition of "streams" was found in their guidebook.

Perennial streams (49 states)

Intermittent streams (40 states)

Lakes (including perennial lakes) (27 states)

Domestic water supplies (17 states)

Wetlands (11 states)

Ponds (11 states)

In three states, forest riparian guidelines vary based on the geographic location within the state. In addition to recognizing geographic differences, Alaska also sets different standards for state, other public, and private lands. As few states establish deminimus values (size below which there is no realistic reason to provide protection) within their guidebooks, it is assumed that all water body sizes are addressed by the guidelines. A few states with regulatory programs have both required guidelines as well as additional recommendations that go beyond the requirements.

No states limit the extent or length of a harvest area along all water bodies or the size of the harvest unit. However, Oregon has developed alternative vegetation retention prescriptions for situations where the existing streamside stand is capable of growing conifers but where conifer stocking is currently low and is unlikely to improve in a "timely manner" due to competition from hardwoods and brush. Within those areas, no more than one-half of the total

stream length within the harvest unit can be included within a "conversion block." Conversion blocks can be no more than 500 feet long and must be separated from each other by a strip that is at least 200 feet long where trees must be retained within at least 20 feet of the high water level of the stream. Within a conversion block, all trees growing in the stream or within 10 feet of the high water level of the stream and all trees leaning toward the channel within 20 feet of the high water level of large streams must be retained.

Some states have written their guidelines to both specify the recommendation as well as the associated rationale. As an example, instead of stating "Avoid harvesting streambank trees," the entire guideline states "Avoid harvesting streambank trees as such trees provide bank stability during peak runoff and offer shade which helps hold water temperature more constant." The reason for including both components within the guideline may be to make sure that guidebook users understand the purpose of each guideline which may lead to higher levels of on-the-ground implementation. A few states specify desired future conditions within the riparian area.

The authors were surprised to see that four states have guidebooks and riparian guidelines which are nearly identical. Differences in factors such as forest vegetation, topography, political and stakeholder considerations among the four states were minimal as the photographs, text, and guidelines were virtually identical within the documents.

Riparian Guideline Components

The guidelines generally contain three basic components. First, is a minimum width of the zone which is measured as the distance from the water's edge or high water mark (RMZ width recommendations). Second, is the minimum amount of residual trees remaining following

timber harvesting activities (residual tree recommendations). Third are other guidelines which are intended to modify a variety of management practices within the management zone (additional recommendations). Summary information from each of those three components is presented below, focusing on perennial streams, intermittent streams, and lakes as they are the three most prevalent water bodies addressed by riparian guidelines.

RMZ Width Recommendations

Crow et al. (2000) reported that the minimum RMZ width required to protect the riparian area depends on factors such as groundwater and flood hydrology, critical species habitat, the structural characteristics of the riparian forest, the gradients controlled by physiographic features such as slope, and the degree of contrast between the riparian area and the adjacent landscape. Because each riparian area is unique and many variables need to be considered, little scientific data exists to support the use of one specific buffer width across every site (Crow et al. 2000, Palik et al. 2000, and Todd 2000).

It has been reported that the effectiveness of riparian buffers at mitigating impacts to riparian functions increases with RMZ width and that width needs to be extended based on various on-site factors such as slope and soil infiltration rates (Belt et al. 1992, Castelle and Johnson 2000, Crow et al. 2000, Palik et al. 2000, Wenger 1999). Several studies report that most of the potential contributions of riparian vegetation to the ecological functions within a stream are realized within the first 15 to 100 feet from the stream bank. RMZ widths in that range typically provide at least 50 percent of potential effectiveness and often 75 percent or greater effectiveness at protecting various stream functions (Castelle and Johnson 2000). Wenger (1999) reported that while narrow RMZ widths are fairly effective in the short-term,

wider buffers provide greater sediment control, especially on steeper slopes, and are more effective over the long-term.

One of the greatest challenges in trying to develop RMZ width recommendations is that most scientific studies only examined one or a few widths (Wenger 1999). While studies have tended to focus on maintenance of perennial stream functions in mountainous terrain, most do not consider terrestrial habitat. As some studies compared the effectiveness of different buffer widths where no harvesting was performed within the RMZ, the actual effectiveness of the management zone might be different when harvesting does occur.

The width of an RMZ can be either: (1) a fixed-width or standard width that may vary based on slope or water body type; or (2) a variable-width that is based on specific site conditions such as composition, age, and condition of the vegetation, site geomorphology, watershed-level issues, and animal and plant species present on the site (Belt et al. 1992, Castelle and Johnson 2000, and Phillips et al. 2000). While fixed-width "one-size-fits-all" approaches are easier to apply, variable width RMZs offer greater flexibility in landscape-level protection (O'Laughlin and Belt 1995). Ilhardt et al. (2000) describe a functional approach to defining riparian areas that uses the variable-width approach. Under that approach, the extent of the riparian area is defined on-the-ground by the strength of ecosystem functions.

Our analysis of state RMZ guidelines found the fixed-width approach is most commonly applied to define RMZ width. A 50-foot minimum RMZ width from either the edge of the water body or the ordinary high-water mark is frequently recommended for perennial streams, intermittent streams, and lakes (Tables 2 - 4). Recommended widths for intermittent streams are generally lower than for perennial streams or lakes. Recommended RMZ widths tend to be highest in the West and lowest in the South. Although these regions vary in forest vegetation,

topography, and the proportion of cold water streams, part of the differences in RMZ width may be due to the processes used to develop state guidelines.

Approximately 75 percent of the states publish both minimum, base-level, fixed-width recommendations and additional values that increase the width based on: (1) water body size or slope or (2) by incorporating slope effects with water body size or soil erodibility. Some states also note that, despite their fixed-width values, the actual RMZ width should be determined during an on-site evaluation which considers factors such as size and type of water body, topography, soils, vegetative cover, and special site conditions. Landowner objectives are infrequently cited as being a modifier of RMZ width recommendations.

States vary widely in the number of slope categories that can modify the base-level RMZ width for a water body, from 2 – 11 categories, with three or four categories being most common. The maximum slope category is 100 percent. Seven of the 21 states that use slope percentage to modify the base-level RMZ width adjacent to a perennial stream establish wider guidelines once the slope exceeds 10 percent. The other two-thirds are divided equally between states that identify breakpoints below 10 percent (range of 0 - 9 percent slope) and above (range of 14 - 35 percent).

States have defined either two or three categories of water body size or soil erodibility to modify the base-level RMZ width. For most states whose guidelines increase the recommended RMZ width with stream width, a perennial stream width of 19 feet is the most common breakpoint. This breakpoint ranges from 2 to 25 feet. None of the states increase the width of the management zone with decreasing stream width. The classifications (1) “slightly erodible” and “erodible,” (2) “slightly erodible” and “severely erodible,” or (3) “low,” “moderate,” and “high” erodibility are used by three states to separate the additional effects of soil on RMZ

width.

Three states divide the fixed-width RMZ into two or three different strips or zones where the one closest to the water's edge has the most management restrictions (e.g., fewer trees can be removed, less equipment trafficking) and the outer strip or zone the least restrictions. The width of the outer zone is extended with increasing slope and soil erodibility. Other states attempt to achieve something similar by recommending that no trees are to be harvested from the bed or banks if doing so will destabilize the soil, degrade water quality, or reduce shading of the water body.

Residual Tree Recommendations

The amount of residual trees left in the RMZ after harvest is also an important component of timber harvesting guidelines. The focus on the residual tree component of an RMZ, instead of on other buffer elements such as slope or soil type, is due to the fact that vegetation is the one variable over which land managers exert the most control. Castelle and Johnson (2000) quantify the effect of forested riparian vegetation on riparian maintenance for six functions.

Rabeni and Smale (1995) and Weller et al. (1998) reported the importance of maintaining continuous vegetation within RMZs along streams. Gaps, crossings, or other breaks in vegetation within the RMZ are locations for the majority of contaminant transport to the stream, compromising the effectiveness of the system.

State guidebooks identify a variety of methods to define residual trees. Basal area (either percent of original basal area or amount of residual basal area) and crown spacing (either percent of original canopy or percent of crown closure within the residual stand) are the methods used

most frequently. Other methods include retaining a specified percent of pre-harvest shade on the water body, retaining a specified percent of original live trees, and retaining a sufficient number of trees to maintain shading of the water body.

Belt et al. (1992) express concern about prescribing residual tree recommendations based on a specified percent of pre-harvest shade because different tree species, initial canopy densities, stream widths, and reach orientations may or may not provide adequate protection. They also indicate that research does not show that the specified retention levels of pre-harvest shade, or any other pre-harvest level of shade, will assure that salmonid temperature standards are met. Similar concerns exist for methods which prescribe percentages of pre-harvest basal area or percent of original canopy. It might also be difficult to monitor the implementation of those methods post-harvest unless appropriate pre-harvest data was collected.

Many states recommend using uneven-aged management within the RMZ. Minnesota is the only state that has separate residual tree values for even- and uneven-age management with the higher values recommended for even-age management.

Minimum residual basal area values included in state riparian guidelines are generally in the range of 50 - 75 ft^2 per acre or 50 - 75 percent crown closure for perennial streams and lakes (Tables 5 - 7). Several states do not specify a minimum residual tree recommendation, leaving that determination up to the on-the-ground manager. Guidelines for perennial streams and lakes in the North and West regions are more likely not to specify residual tree recommendations. Nine states indicate that residual trees should be evenly- or well-distributed within the management zone. Perhaps noting that the number of functions contributing to riparian and aquatic ecosystem processes increases as you approach the water's edge (Ilhardt et al. 2000), several states indicate the importance of leaving more trees closer to the water's edge. This

approach, which is more commonly recommended for perennial streams and lakes, is generally accomplished by establishing a no-harvest or partial-harvest-only zone within a specified distance of the water's edge.

Residual tree recommendations for intermittent streams are either the same or lower than those for perennial streams or lakes (Tables 5 - 7). As with RMZ width, residual tree recommendations tend to be highest in the West and lowest in the South. Again, regional differences may be attributed to both the ecological and physical setting and the processes by which individual state guidelines were developed.

Additional RMZ Recommendations

Most states specify one or more additional guidelines that are designed to modify operations within the RMZ. While some of those recommendations relate to management of the non-tree vegetation, other factors are also addressed. Those guidelines may be found within the section on riparian management zones or within other guidebook sections (e.g., roads, landings, skid trails, stream crossings).

Several additional timber harvesting recommendations are included in at least 10 guidebooks (Table 8). Some of the most common additional recommendations include: maintain a filter strip to trap sediment and maintain soil infiltration rates (filter strip width generally increases with slope); minimize stream and wetland crossings; cross streams at a right angle to the channel; locate roads, skid trails, landings, and sawmills outside of the RMZ and filter strip whenever possible; establish fueling and maintenance areas outside of the RMZ whenever possible; and remove logging debris that is dropped into a water body during harvesting activities.

Fewer than 10 states have guidelines that indicate (excessive) rutting within the RMZ should be avoided; management should favor long-lived, uneven-age species; the stream or stream channel should not be used as a skid trail or road; trees on the South and West banks provide the most critical shading of water; or planning should include development and management of wildlife habitat. A few states prescribe leave tree requirements within a specified distance from the high-water mark on both sides of streams along a thousand-foot stream segment to provide large organic debris. Explicit consideration of the future forest, facilitating adequate regeneration, and maintaining the health of RMZ trees are not commonly addressed by guidelines.

Relationship of RMZ Width, Residual Tree Recommendations, and Slope

Pearson product moment correlation coefficients between RMZ width, residual tree recommendations, and slope were calculated to assess the relationship between pairs of factors. There is a relatively strong correlation between RMZ width and residual tree recommendations (0.74), indicating that states with higher RMZ widths also have higher residual tree recommendations. While the positive correlation is surprising, it is due to the differences in forest vegetation, topography, the proportion of cold water streams, and the processes used to develop guidelines between the West and the South. Those differences resulted in RMZ widths and residual basal area tree recommendations being higher in the West than in the South.

Correlations are weaker between RMZ width and slope (0.30) and between residual tree recommendations and slope (-0.27). Low correlation is not a surprise for those two comparisons given the relative breadth of RMZ width and residual tree recommendations as compared to the few slope breakouts identified. While the correlation is relatively weak, the negative

relationship between residual tree recommendations and slope is contrary to expectation. However, as is further discussed in the next section, a higher residual tree recommendation does not automatically mean greater protection to the riparian resource.

Looking Beyond the Numbers

The Minnesota Forest Resources Council (MFRC) conducted a science-based review of its riparian and seasonal pond guidelines in 2000 (Minnesota Forest Resources Council 2000). A primary purpose of the review was to assess the consistency of the guidelines with current science and knowledge from a variety of disciplines (e.g., silviculture, ecology, hydrology). Many of the points raised during the review are pertinent to other states' forest riparian guidelines (further information on many of these points can be found in Verry et al. (2000)). Findings of the MFRC's review include:

- Small to moderate changes in hydrology within the riparian area can lead to significant changes in plant species composition. As such, maintaining the hydrology of a riparian area is the most important overall consideration. Anything that alters the hydrology (e.g., skid trails, bridges, roads, soil compaction, rutting) changes the dynamics of the riparian zone.
- The importance of riparian functions increases with decreasing distance to the water. A common sense rule is to be more sensitive the closer one operates to the water body.
- Science cannot specify with certainty the RMZ width and amount of residual trees needed to protect all riparian functions. The specific width of a RMZ will vary according to the type of water body, site conditions, and specific riparian functions and values needing the most protection.

- A higher residual basal area does not automatically mean greater protection to the riparian resource. For example, a stand could have a high basal area but few trees and be less effective in protecting against sedimentation and thermal impacts than a stand with a lower basal area and lots of smaller-diameter trees and a dense shrub component.
- Residual tree recommendations often are not consistent with the silvicultural prescription needed within the RMZ. Although the residual trees may protect riparian functions in the short-term, these recommendations generally lack a long-term view of the desired future riparian forest vegetation. RMZ silvicultural prescriptions should consider multiple entries, regeneration planning, stand density regulation through thinning, and the distribution of residual vegetation to avoid overlooking the spatial and temporal scales of forest ecology and how the remaining composition and distribution affect succession.
- Because RMZ guidelines are site-based, they do not address landscape-level issues and cumulative effects. The types and intensity of land use practices (e.g., the extent of harvest, conversion to nonforested status, development) within a landscape can have a greater influence on aquatic ecosystems than specific RMZ parameters (e.g., width, amount of residual trees). The effectiveness of a particular RMZ prescription will depend on what is happening within the landscape.
- Scale issues of a harvest unit (i.e., length of harvest unit along a stream) are important. For example, the impact on fish populations could be significant if relatively few trees are left along a long stream reach.

Applying Riparian Guidelines

While riparian guidelines address a variety of riparian functions and water bodies, the

primary focus is on water quality protection adjacent to perennial and intermittent streams and lakes. A commonly recommended, base-level RMZ prescription is for a 50-foot RMZ with 50 - 75 percent crown closure (or 50 - 75 ft^2/acre of residual basal area). The base-level width would be increased if the slope adjacent to the water body exceeds 10 percent. As states revise their guidelines to incorporate new monitoring information and other knowledge, they may address additional riparian functions which could result in more stringent guidelines.

Forest riparian guidelines need to incorporate the best available science, yet recommend economically feasible and practical timber harvesting and forest management practices. Individuals responsible for developing such guidelines need research results that are relevant to the various water bodies and site conditions found within their state. With the increasing emphasis on riparian resource protection, on-the-ground managers need additional information to help them apply RMZ guidelines to a particular setting. They also need more training to understand how to evaluate site-based conditions and resource needs so they feel comfortable modifying fixed-width recommendations or implementing variable-width approaches. Field keys that help integrate the large amount of information about riparian areas into a site-based, variable-width approach for protecting and enhancing functionality during harvesting activities, combined with field training on the application of the key, could help increase the effectiveness of on-the-ground management and riparian resource protection.

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Table 1. Types of water bodies addressed by the various states' riparian guidelines and how riparian management zone (RMZ) width guidelines are modified by a) water body size, b) slope, or c) soil erodibility in the area adjoining the water body.

Type of water body	Number of states					
	One RMZ width for all site conditions	RMZ width varies by water body size[1]	RMZ width varies by slope	RMZ width varies by both water body size and slope	RMZ width varies by both slope and soil erodibility	Total
Rivers	0	0	0	4	0	4
Streams[2]	2	0	0	2	0	4
Perennial streams	13	6	18	5	3	45
Intermittent streams	12	4	19	2	3	40
Ephemeral streams	5	0	1	0	0	6
Trout streams	2	0	4	0	0	6
Anadromous streams	0	0	1	0	0	1
Wetlands	2	4	4	0	1	11
Lakes	7	4	14	0	1	26
Perennial lakes	0	0	0	0	1	1
Intermittent lakes	0	0	0	0	1	1
Ponds	2	1	5	1	2	11
Domestic water supplies	3	1	12	0	1	17
Seeps and springs	3	0	5	0	1	9
Sinkholes	0	0	1	0	0	1
Perennial sinkholes	0	0	0	0	1	1
Intermittent sinkholes	0	0	0	0	1	1
Vernal ponds	3	0	0	0	0	3
Caves	0	0	1	0	0	1

[1]While most states differentiate by width, stream order, or acreage of the water body, some also distinguish by flow rate or site index of timber adjoining the water body.
[2]While the states that have guidelines for "streams" did not define that term within their guidebook, it was assumed that, at the minimum, perennial streams are included.

Table 2. Regional summary of minimum riparian management zone (RMZ) widths for perennial streams.[1, 2]

Minimum RMZ width (ft)	Number of states and (percent by region)		
	North (20 states)	South (13 states)	West (16 states)
15	1 (5)	0	0
25	3 (15)	2 (15)	0
30	1 (5)	1 (8)	0
35	0	2 (15)	0
40	0	2 (15)	1 (6)
50	8 (40)	5 (38)	4 (25)
60	0	0	2 (13)
75	1 (5)	0	2 (13)
90	1 (5)	0	0
95	0	0	1 (6)
100	3 (15)	0	1 (6)
110	1 (5)	0	1 (6)
120	0	0	1 (6)
200	0	0	1 (6)
Site-specific	0	1 (8)	0
Not specified	1 (5)	0	2 (13)

[1]Summary includes states that have guidelines for "streams" and "perennial streams" in Table 1. Values for some states represent an average across two or more classifications of perennial streams, based on size or other criteria within each state's guidebook. Percentages for some columns may not equal 100 due to rounding.

[2]North: Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin.
South: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia.
West: Alaska, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming.

Table 3. Regional summary of minimum riparian management zone (RMZ) widths for intermittent streams.[1, 2]

Minimum RMZ width (ft)	Number of states and (percent by region)		
	North (14 states)	South (12 states)	West (14 states)
0	0	1 (8)	0
20	0	1 (8)	0
25	4 (29)	2 (17)	0
30	1 (7)	1 (8)	0
35	1 (7)	3 (25)	1 (7)
40	0	1 (8)	0
50	4 (29)	2 (17)	3 (21)
60	0	0	2 (14)
75	0	0	2 (14)
95	0	0	1 (7)
100	3 (21)	0	1 (7)
110	0	0	1 (7)
120	0	0	1 (7)
130	1 (7)	0	0
200	0	0	1 (7)
Site-specific	0	1 (8)	0
Not specified	0	0	1 (7)

[1]Values for some states represent an average across two or more classifications of intermittent streams, based on size or other criteria within each state's guidebook. Percentages for some columns may not equal 100 due to rounding.

[2]North: Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin.
South: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia.
West: Alaska, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming.

Table 4. Regional summary of minimum riparian management zone (RMZ) widths for lakes, including perennial lakes.[1, 2]

Minimum RMZ width (ft)	Number of states and (percent by region)		
	North (10 states)	South (5 states)	West (12 states)
25	2 (20)	1 (20)	0
35	1 (10)	1 (20)	0
50	3 (30)	3 (60)	3 (25)
60	0	0	2 (17)
75	0	0	3 (25)
100	3 (30)	0	1 (8)
120	1 (10)	0	1 (8)
200	0	0	1 (8)
Not specified	0	0	1 (8)

[1]Values for some states represent an average across two or more classifications of lakes, based on size or other criteria within each state's guidebook. Percentages for some columns may not equal 100 due to rounding.

[2]North: Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin.
South: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia.
West: Alaska, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming.

Table 5. Regional summary of minimum riparian management zone residual tree recommendations for perennial streams.[1, 2]

Minimum residual tree recommendation	Number of states and (percent by region)		
	North (20 states)	South (13 states)	West (16 states)
25 - 80 ft^2/acre of basal area	1 (5)	0	0
50 percent of crown closure, 50 percent of original canopy, 50 percent of original basal area, or 50 ft^2/acre of basal area	3 (15)	9 (69)	2 (13)
60 percent of crown closure or 60 ft^2/acre of basal area	4 (20)	0	0
70 percent of crown closure	1 (5)	0	0
75 percent of pre-harvest shade on stream	0	1 (8)	2 (13)
40 live conifer trees/1,000 feet along large streams[3] and 30 live conifers/1,000 feet along medium streams[3]	0	0	1 (6)
250 ft^2/acre of basal area at age 140	0	0	1 (6)
Sufficient number of trees to maintain shading	3 (15)	0	1 (6)
Avoid clearcutting	0	0	1 (6)
Landowner objectives	0	1 (8)	0
No harvesting	0	0	2 (13)
Not specified[4]	8 (40)	2 (15)	6 (38)

[1]Values for some states represent an average across two or more classifications of perennial streams, based on size or other criteria within each state's guidebook. Percentages for some columns may not equal 100 due to rounding.

[2]North: Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin.
South: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia.
West: Alaska, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming.

[3]For streams that do not have fish use, conifers must be at least 11 inches diameter at breast height (DBH) for large streams and 8 inches DBH for medium streams.

[4]Several states note that while minimum residual tree recommendations are not specified within their guidebook, it is important to retain other vegetation and/or ground cover to protect the forest floor and the stream bank in a manner which will maintain water quality.

Table 6. Regional summary of minimum riparian management zone residual tree recommendations for intermittent streams.[1, 2]

Minimum residual tree recommendation	Number of states and (percent by region)		
	North (14 states)	South (12 states)	West (14 states)
0 percent of overstory trees	0	1 (8)	0
25 ft^2/acre of basal area or 25 percent of crown closure	0	1 (8)	0
25 - 80 ft^2/acre of basal area	1 (7)	0	0
50 percent of crown closure, 50 percent of original canopy, 50 percent of original basal area, or 50 ft^2/acre of basal area	1 (7)	3 (25)	2 (14)
60 percent of crown closure or 60 ft^2/acre of basal area	4 (29)	0	0
70 percent of crown closure	1 (7)	0	0
75 percent of pre-harvest shade on stream or original forest	0	1 (8)	1 (7)
30 live conifer trees/1,000 feet along large streams[3] and 10 live conifers/1,000 feet along medium streams[3]	0	0	1 (7)
250 ft^2/acre of basal area at age 140	0	0	1 (7)
Sufficient number of trees to maintain shading	2 (14)	0	0
Avoid clearcutting	0	0	1 (7)
No harvesting	0	0	2 (14)
Not specified[4]	5 (36)	6 (50)	6 (43)

[1]Values for some states represent an average across two or more classifications of intermittent streams, based on size or other criteria within each state's guidebook. Percentages for some columns may not equal 100 due to rounding.

[2]North: Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin.
South: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia.
West: Alaska, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming.

[3]For streams that do not have fish use, conifers must be at least 11 inches diameter at breast height (DBH) for large streams and 8 inches DBH for medium streams.
[4]Several states note that while minimum residual tree recommendations are not specified within their guidebook, it is important to retain other vegetation and/or ground cover to protect the forest floor and the stream bank in a manner which will maintain water quality.

Table 7. Regional summary of minimum riparian management zone residual tree recommendations for lakes, including perennial lakes.[1, 2]

Minimum residual tree recommendation	Number of states and (percent by region)		
	North (10 states)	South (5 states)	West (12 states)
25 - 80 ft^2/acre of basal area	1 (10)	0	0
50 percent of crown closure, 50 percent of original canopy, 50 percent of original basal area, or 50 percent of original live trees	1 (10)	3(60)	2 (17)
60 ft^2/acre of basal area	3 (30)	0	0
75 percent of pre-harvest shade on lake or 75 ft^2/acre of basal area	0	1 (20)	1 (8)
250 ft^2/acre of basal area at age 140	0	0	1 (8)
Sufficient number of trees to maintain shading	2 (20)	0	0
Avoid clearcutting	0	0	1 (8)
No harvesting	0	0	1 (8)
Not specified[3]	3 (30)	1 (20)	6 (50)

[1]Values for some states represent an average across two or more classifications of lakes, based on size or other criteria within each state's guidebook. Percentages for some columns may not equal 100 due to rounding.

[2]North: Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin.
South: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia.
West: Alaska, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming.

[3]Several states note that while minimum residual tree recommendations are not specified within their guidebook, it is important to retain other vegetation and/or ground cover to protect the forest floor and the lake shoreline in a manner which will maintain water quality.

Table 8. Sample listing of some of the more frequently cited "other recommendations" for riparian management zones (RMZs) beyond width and residual vegetation recommendations.[1]

Planning guidelines
Outside boundaries of the RMZ should be well-marked before operations begin.
Maintain an adequate filter strip, which minimizes disturbance of the forest floor, exposure of mineral soil, and disturbance to other vegetation. (Some states specify a maximum amount of mineral soil exposure within a specified distance of the water's edge. Width of the filter strip is often slope dependent.)
Minimize the number of water crossings. Locate water crossings where impacts are likely to be minimal.
Where feasible, locate [new] roads outside of the RMZ and filter strip, except where necessary to cross a water body.
When road construction cannot be avoided, access roads should cross stream channels and RMZs at or near a right angle.
Where feasible, locate [new] landings and log decks, skid trails, and sawmills outside of the RMZ and filter strip.
Designate specific areas for refueling equipment, equipment storage, and equipment maintenance outside of the RMZ.
Use cable skidders when ground skidding systems are employed.
Avoid operating [skidding] equipment within the RMZ; operate ground-based equipment within the RMZ only when the ground is dry or frozen (to minimize rutting) or use appropriate light-on-the-land equipment.
Operational guidelines
Drainage structures should be used on roads and skid trails prior to their entrance into a RMZ and on approaches to water crossings to intercept and properly discharge runoff waters.
Do not move slash into or pile slash within the RMZ.
Remove any tops or other logging debris that are dropped into the water or channel.
Do not harvest trees from banks, beds, or steep slopes if it will destabilize the soil, degrade water quality, or reduce shading over the water body.
Use directional felling techniques to fell trees away from the water body, except where safety is a concern.

[1]Each guideline appears in at least 10 guidebooks. As the specific wording of each guideline varies from state to state, they are paraphrased here. Words enclosed within brackets are modifiers found in some guidebooks.