3B: Streamside Management Areas

Management Measure for Streamside Management Areas

Establish and maintain a streamside management area along surface waters, which is sufficiently wide and which includes a sufficient number of canopy species to buffer against detrimental changes in the temperature regime of the water body, to provide bank stability, and to withstand wind damage. Manage the SMA in such a way as to protect against soil disturbance in the SMA and delivery to the stream of sediments and nutrients generated by forestry activities, including harvesting. Manage the SMA canopy species to provide a sustainable source of large woody debris needed for in-stream channel structure and aquatic species habitat.

Management Measure Description

Streamside management areas (SMAs), also commonly referred to as streamside management zones or riparian management areas or zones, are areas of riparian vegetation along streams that receive special management attention because of their value in protecting water quality and habitat. Riparian vegetation is highly beneficial to water quality and aquatic habitat. Riparian areas reduce runoff and trap sediment from upslope areas and may reduce nutrients in runoff (Belt et al., 1992). Canopy species shade surface waters, moderating water temperature and providing detritus that serves as an energy source for streams. Trees in riparian areas are a source of large woody debris (LWD) to surface waters. Riparian areas provide important habitat for aquatic organisms and terrestrial species.

The width of SMAs is determined in one of two ways: (1) a fixed minimum width is recommended or prescribed, or (2) a variable width is determined based on site conditions such as slope (Phillips et al., 2000) (Figure 3-5). SMAs need to be of sufficient width to protect the adjacent water body. A minimum width of 35 to 50 feet is generally recommended for SMAs to be effective. Areas such as intermittent channels, ephemeral channels, and depressions need to be given special consideration when determining SMA boundaries. Channels should be disturbed as little as possible to maximize the effectiveness of an SMA, as disturbance in and adjacent to a SMA can contribute considerably to pollutant runoff volumes. SMAs also need to be able to withstand wind damage or blowdown. For example, a single rank of canopy trees is not likely to withstand blowdown and maintain the functions of an SMA.

Table 3-2 presents North Carolina's recommendations for SMA widths for various types of water bodies dependent on adjacent upland slope. Maine's recommended filter strip widths are dependent on the land slope between the road and the water body (Table 3-3). SMA widths might vary along a stream's course and on opposite sides of the same stream. SMA width is measured along the ground from the streambank on each side of the stream and not from the centerline of the watercourse (Georgia Forestry Commission, 1999).

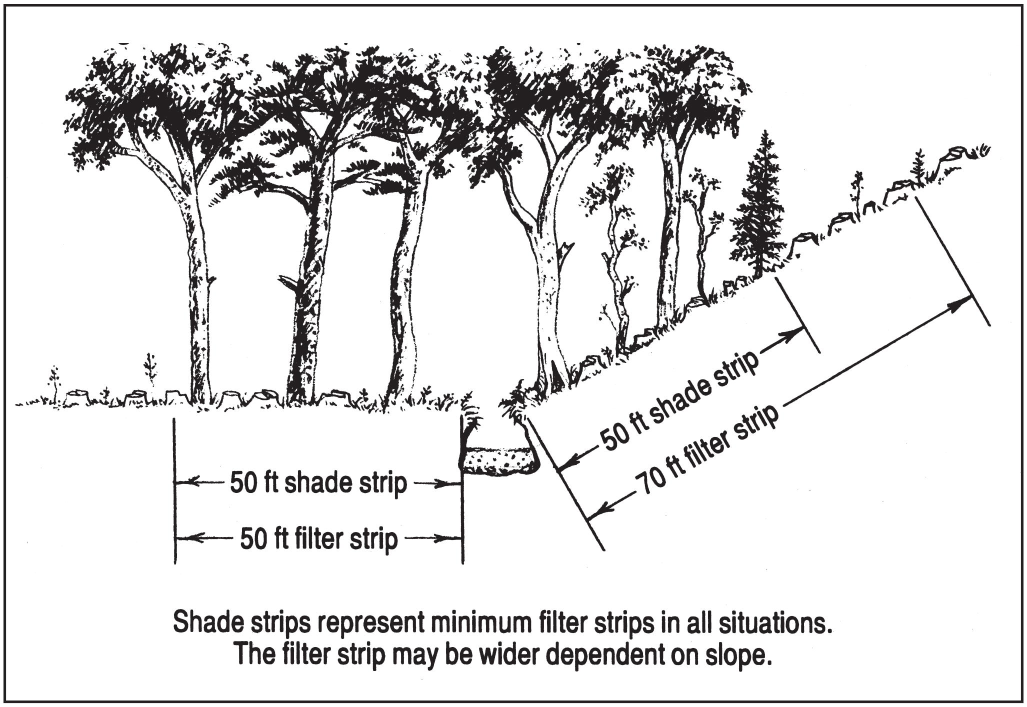

Figure 3-5. Calculation of slope—an important step in determining SMA width (Georgia Forestry Commission, 1999).

Table 3-2. Recommended Minimum SMZ Widths (North Carolina Division of Forest Resources, 1989)

Type of Stream or Water Body	Percent Slope of Adjacent Lands				
	0–5	6–10	11–20	21–45	46+
	SMZ Width Each Side (feet)				
Intermittent	50	50	50	50	50
Perennial	50	50	50	50	50
Perennial trout waters	50	66	75	100	125
Public water supplies (Streams and reservoirs)	50	100	150	150	200

Table 3-3. Recommendations for Filter Strip Widths (Maine Forest Service, 1991)

Slope of Land (%)	Width of Strip (ft along ground)
0	25
10	45
20	65
30	85
40	105
50	125
60	145
70	165

A sufficient number of large trees in an SMA provide for bank stability and a sustainable source of large woody debris. LWD consists of naturally occurring dead and downed woody materials, not to be confused with logging slash or debris. Trees to be maintained or managed in the SMA can provide large woody debris to the stream at a rate that maintains beneficial uses associated with fish habitat and stream structure. Woody debris is added at the site and downstream at a rate that is sustainable over a long time period.

A sufficient number of canopy species are maintained in an SMA also to provide shading to the stream water surface to prevent changes in the temperature regime of the water body and to prevent harmful temperature- or sunlight-related effects on the aquatic biota. If the existing shading conditions for the water body prior to activity are known to be less than optimal for the stream, SMAs can be managed to increase shading of the water body.

Lakeside management areas, or LMAs—the lake and pond equivalent of SMAs—should also be left around lakes and ponds on harvest sites (Minnesota Forest Resources Council, 1999; Wisconsin Department of Natural Resources, 2003). The width of LMAs varies depending on site conditions, as do the recommended widths of SMAs. Topography, hydrology, size of water body, size of adjacent harvest area, harvest method, forest management objectives (e.g., timber production, wildlife), whether the water body contains sensitive fish species, and tree species composition all influence the size and leave-tree recommendations for LMAs.

Generally, LMAs should be as wide as SMAs, or generally between 50 and 100 feet wide, though where sensitive fish species are present in the water body, a wider LMA—up to 200 feet—may be necessary to fully protect water quality.

Other considerations for timber harvesting near lakes and ponds include ensuring that some trees are left on all areas surrounding water bodies all the way to the top of the adjacent slope, and using an extended rotation period within LMAs (as should be done for SMAs) to minimize soil and riparian area disturbance.

To preserve SMA integrity for water quality protection, some states limit the type of harvesting, timing of operations, amount harvested, or reforestation methods used in them. SMAs are managed to use only harvest and forestry methods that prevent soil disturbance in the SMA. Additional operational considerations for SMAs are addressed in subsequent management measures. Practices for SMA applications to wetlands are described in the *Wetlands Forest Management Measure* (Chapter 3, section J).

Benefits of Streamside Management Areas

The effectiveness of SMAs in regulating water temperature depends on the interrelationship between vegetative and stream characteristics. Specifying leave tree and stream shade quantities is an effective way to prevent detrimental temperature changes. An example of a leave tree specification might be Leave trees that provide midsummer and midday shade to the water surface, and preferably a quantity of trees that provide a minimum of 50 percent of the summer midday shade. Shade cover is preferably left distributed evenly within the SMA. If a threat of blowdown exists, leave trees may be clumped and clustered as long as sufficient shade at the reach scale is provided.

Lynch and others (1985) studied the effectiveness of SMAs in controlling suspended sediment and turbidity levels (Table 3-4). A combination of practices were applied,

Table 3-4. Storm Water Suspended Sediment Delivery for Treatments (Pennsylvania) (Lynch et al., 1985)

Water Year and Treatment	Annual Average Suspended Sediment in mg/L (Range)
1977	
Forested control	1.7 (0.2–8.6)
Clear-cut-herbicide	10.4 (2.3–30.5)
Commercial clear-cut with BMPs[a]	5.9 (0.3–20.9)
1978	
Forested control	5.1 (0.3–33.5)
Clear-cut-herbicide	— [b](1.8–38.0)
Commercial clear-cut with BMPs[a]	9.3 (0.2–76.0)

[a]Buffer strips, skidding in streams prohibited, slash disposal away from streams, skid trail and road layout away from streams.
[b]Data not available

including SMAs and prohibitions on skidding, slash disposal, and roads located in or near streams. Average storm water-suspended sediment and turbidity levels in the area without these practices were very high compared to those of the control and SMA/BMP sites. Table 3-5 presents data on how effective different cutting practices and buffer strips are in preventing debris from entering the stream channel (Froehlich, 1973).

Hall and others (1987) studied the effectiveness of SMAs in protecting streams from temperature increases, large increases in sediment load, and reduced dissolved oxygen (Table 3-6). The value of SMAs for protecting streams from water temperature changes is clear from the 30 ºF maximum daily increase in stream temperature observed during the study. The study also showed that not leaving a SMA can cause sediment increases streams, and more recent research has demonstrated that SMAs might be effective in

Table 3-5. Average Changes in Total Coarse and Fine Debris of a Stream Channel After Harvesting (Oregon) (Froehlich, 1973)

Cutting Practice	Natural Debris	Material Added in Felling	% Increase
	(tons per hundred feet of channel)		
Conventional tree-felling	8.1	47	570
Cable-assisted directional felling	16	14	112
Conventional tree-felling with buffer strip[a]	12	1.3	14

[a]Buffer strips ranged from 20 to 130 feet wide for different channel segments.

Table 3-6. Comparison of Effects of Two Methods of Harvesting on Water Quality (Oregon) (Hall et al., 1987)

Watershed	Method	Streamflow	Water Temperature	Sediment	Dissolved Oxygen
Deer Creek	Patch cut with buffer strips (750 acres)	No increase in peak flow	No change	Increases for one year due to periodic road failure	No change
Needle Branch	Clearcut with no stream protection (175 acres)	Small increases	Large changes, daily maximum increase by 30 °F, returning to pre-log temp. within 7 years	Five-fold increase during first winter, returning to near normal the fourth year after harvest	Reduced by logging slash to near zero in some reaches; returned to normal when slash removed

intercepting overland flow and some sediment it contains, but not in intercepting sediment contained in channelized flow (Belt et al., 1992; Keim and Schoenholtz, 1999). Keim and Schoenholtz (1999), in a study on highly erodible soils in Mississippi, found that the primary means by which SMAs reduce sediment delivery to streams is by preventing soil disturbance next to the stream and not by intercepting sediment from upland sources. Finally, the study demonstrated the effect that logging slash placed in streams has in depleting dissolved oxygen as it decomposes.

Hartman and others (1987) compared the physical changes associated with logging using three streamside treatments—leaving a variable-width strip of vegetation along a stream (least intensive); clear cutting to the margin of a stream, but with virtually no instream disturbance (intensive); and clear-cutting to the stream bank with some yarding near the stream and pulling merchantable timber from the stream (most intensive). They performed their study to observe the effect of different SMAs on the supply of woody debris. The volume and stability of large woody debris decreased immediately in the most intensive treatment area, decreased a few years after logging in the careful logging area, and remained stable where streamside trees and other vegetation remained.

The costs associated with SMAs vary according to site conditions. SMAs can be more difficult to lay out on rough terrain or along a stream or river that meanders a lot due to the need to adjust the SMA width appropriately. Also, harvesters or landowners take into account the value of merchantable timber left unharvested because of SMA restrictions. No single SMA width or layout is preferable for all sites in terms of cost. Dykstra and Froelich (1976a) concluded in one study that a 55-foot buffer strip was the least costly on a million-board-foot (mfb) basis, but they cautioned that cost is not the only factor to consider when deciding what type of stream protection to use (Table 3-7).

There are several research papers that focus on the costs of SMA implementation. Lickwar (1989) examined the costs of SMAs as determined by varying slope steepness (Table 3-8) in different regions in the Southeast and compared them to road construction and revegetation practice costs. He found that SMAs are the least expensive practice, in general, and that their cost is approximately the same regardless of slope. The costs associated with use of alternative buffer and filter strips were also analyzed in an Oregon study (Olsen, 1987) (Table 3-9). In that study, increasing the SMA width from 35 feet on each side of a stream to 50 feet reduced the value per acre by $75 (discounted cost) to $103 (undiscounted cost), or an approximate 2 percent increase in harvesting cost per acre (from $3,163 discounted to $5,163 undiscounted). Doubling the SMA width from

Table 3-7. Average Estimated Logging and Stream Protection Costs per MBF (Oregon) (Dykstra and Froehlich, 1976a)

Cutting Practice	Total Cost		Volume Foregone
	Average	Range	
Conventional felling	$70.98	$62.74–85.74	None
Cable-assisted directional felling (1.43% breakage saved within 200-foot stream)	$74.62	$61.19–89.49	—
Cable-assisted felling (10% breakage saved)	$70.59	$56.00–85.42	—
Buffer strip (55 feet wide)	$66.86	$56.84–79.55	0 - 6 percent
Buffer strip (150 feet wide)	$77.78	$69.70–86.74	6 - 17 percent

Note: All costs updated to 1998 dollars.
[a]Cost estimates for each of 10 areas studied by Dykstra and Froehlich were averaged for this table.

Table 3-8. Cost Estimates (and Cost as a Percent of Gross Revenues) for Streamside Management Areas (Lickwar, 1989)

Practice Component	Steep Sites[a]	Moderate Sites[b]	Flat Sites[c]
Streamside Management Zones	$2,958 (0.52%)	$3,441 (0.51%)	$3,363 (0.26%)

Note: All costs updated to 1998 dollars.
[a] Based on a 1,148-acre forest and gross harvest revenues of $573,485. Slopes average over 9 percent.
[b] Based on a 1,104-acre forest and gross harvest revenues of $678,947. Slopes ranged from 4 percent to 8 percent.
[c] Based on a 1,832-acre forest and gross harvest revenues of $1,290,641. Slopes ranged from 0 percent to 3 percent.

Table 3-9. Cost Effects of Three Alternative Buffer Strips (Oregon): Case Study Results with 640-acre Base (36 mbf/acre) (Olsen, 1987)

	Scenario		
	I	II	III
Average buffer width (feet on each side)	35	50	70
Percent conifers removed	100	60	25
Percent reclassified Class II streams[a]	0	20	80
Harvesting restrictions	Current	New	New
Road Construction			
New miles	2.09	2.14	3.06
Road and landing acres	10.9	11.1	15.9
Cost total (1000's)	$96.00	$102.00	$197.00
Cost/acre	$149.00	$160.00	$307.00
Harvesting Activities[b]			
mmbf harvested	22.681	22.265	20.277
Acres harvested	638.3	635.5	633.1
Cost total (1000's)	$3,104.00	$3,101.00	$2,842.00
Cost/acre	$4,841.00	$4,835.00	$4,432.00
Cost/mbf	$136.87	$139.26	$140.17
Inaccessible Area and Volume			
Percent area in buffers	1.3	3.9	14.0
mmbf left in buffers	0.000	0.313	2.214
Acres unloggable	1.44	4.32	6.72
mmbf lost to roads and landings	0.202	0.205	0.295
Undiscounted Costs (1000's)			
Road cost	$96.00	$102.00	$197.00
Harvesting cost	$3,104.00	$3,101.00	$2,842.00
Value of volume foregone[c]	$38.00	$101.00	$413.00
Total	$3,238.00	$3,304.00	$3,451.00
Cost/acre	$5,060.00	$5,163.00	$5,393.00
Reduced dollar value/acre	—	$103.00	$323.00
Discounted Costs			
Cost with 4% discount rate (1000's)	$2,023.00	$2,071.00	$2,195.00
Cost/acre	$3,162.00	$3,237.00	$3,431.00
Reduced value/acre	—	$75.00	$269.00

Note: mmbf = millon board feet; mbf = thousand board feet.
1986 dollars.
[a] Generally, only Class I streams are buffered.
[b] Includes felling, landing construction and setup, yarding, loading, and hauling.
[c] Volume foregone x net revenue ($150/mbf).

35 to 70 feet on each side of a stream reduced the dollar value per acre by approximately 3 times, adding approximately 8 percent to the discounted harvesting costs.

According to the Vermont Agency of Natural Resources, adequately sized SMAs are the best means to protect water quality (VANR, 1998). The agency conducted habitat assessments and bioassessments on stream segments above and below harvest sites and before and after harvesting and determined that SMAs are particularly important for protecting small headwater streams and ephemeral stream channels. The Virginia Department of Forestry also monitored BMP implementation and effectiveness and determined that although improvement was needed in meeting minimum standards of implementation, properly implemented SMAs (together with stream crossings and preharvest plans) are crucial to protecting water quality.

The Oregon Department of Forestry similarly found that application of a riparian rule (passed in 1987) results in stream protection that generally maintains pre-operation vegetative conditions.

Where SMAs were found to be ineffective or less effective than possible, the Virginia Department of Forestry discovered that in some cases this was the result of careless timber harvesting in the SMAs, a lack of adequately sized SMAs on adjacent intermittent streams, or gaps in SMAs caused by cutting in them.

Of course, BMPs are effective only when properly designed and constructed. In general, poor BMP effectiveness can be attributed to one or more of the following:

- A lack of time or willingness to plan timber harvests carefully before cutting begins.
- A lack of skill in or knowledge of designing effective BMPs.
- A lack of equipment needed to implement BMPs effectively.
- The belief that BMPs are not an integral part of the timber harvesting process and can be engineered and fitted to a logging site after timber harvesting has been completed.
- A lack of timely implementation and maintenance of BMPs.

Best Management Practices

◆ *Minimize disturbances that would expose the mineral soil of the SMA forest floor. Do not operate skidders or other heavy machinery in the SMA.*

◆ *Locate all landings, portable sawmills, and roads outside the SMA.*

◆ *Restrict mechanical site preparation in the SMA, and encourage natural revegetation, seeding, and hand planting.*

◆ *Limit pesticide and fertilizer usage in the SMA. Establish buffers for pesticide application for all flowing streams.*

◆ *Directionally fell trees away from streams to prevent excessive quantities of logging slash and organic debris from entering the water body. Remove slash and debris unless consultation with a fisheries biologist indicates that it should be left in the stream for large woody debris.*

There is no “correct” amount of organic debris that streams should have. Streams have natural amounts of organic debris (e.g., fallen leaves, twigs, limbs, and trees), but the amount varies with season, tree falls, storms, and so forth. Aquatic organisms are adapted to the annual (and longer) range of the quantities of organic debris in the stream. As discussed in Chapter 2, large woody debris, or LWD, alters sediment and water routing and, thereby, affects channel morphology, provides structure and complexity to aquatic and terrestrial organism habitats, and is a source of nutrients for aquatic organisms. Periodic variations in the influx of sediment and LWD also contribute to habitat heterogeneity that is reflected in diverse aquatic communities. When areas upslope from a stream are changed enough that the quantity of organic debris that reaches a stream is significantly changed (i.e., so much that it is too little or too much for the stream's dynamics and the aquatic organisms), it can be detrimental to the aquatic system and be considered a water quality problem. Removing trees from near the stream edge, harvesting older trees on upslope areas, and burning that removes forest floor litter could all reduce inputs of organic debris to the aquatic system and adversely affect stream ecology.

Retaining SMAs along streams is one step to take to ensure that the streams are provided with sufficient inputs of organic debris. Leaving slash and other logging debris in a stream could exceed the natural high limit of organic debris inputs for the stream's ecology and adversely affecting the stream. Removing felled material from streams on a site where changes have occurred that will reduce inputs of organic debris in the future could leave the stream with less organic debris than the stream ecology is adapted to. Maintaining stream water quality—which includes habitat diversity for aquatic life support—does not necessarily imply reducing inputs of woody debris to a stream, therefore, but rather means not altering the aquatic system to a degree in either direction (too much or too little) that stream ecology is adversely affected. A fisheries biologist will be able to help with decisions on what sizes and quantities of woody debris, if any, should be left in a stream to mimic natural conditions. Table 3-10 compares the goals of two types of LWD projects. Further information on the role and importance of LWD in streams and on placing LWD in streams can be obtained from the U.S. Army Corps of Engineers' Ecosystem Management and Restoration Research Program (EMRRP). A paper issued under the program, *Streambank habitat enhancement with large woody debris* (Fischenich and Morrow, 2000), can be found on the Web at http://el.erdc.usace.army.mil/elpubs/pdf/sr13.pdf.

◆ *Apply harvesting restrictions in the SMA to maintain its integrity.*

Vegetation, including trees, should be left in the SMA to achieve the desired objective for the area, such as maintain shading and bank stability and to provide adequate woody debris to create habitat diversity and provide nutrients to surface waters. This provision for leaving residual trees might be specified in various ways. For example, the Maine Forestry Service specifies that no more than 40 percent of the total volume of timber 6 inches diameter breast height (DBH) and greater be removed in a 10-year period, and that the trees removed be reasonably distributed within the SMA. Florida recommends leaving a volume equal to or exceeding one-half the volume of a fully stocked stand. The number of residual trees varies inversely with their average diameter. A shading specification that is independent of the volume of timber might be necessary for streams where temperature changes could alter aquatic habitat.

Table 3-10. Goals of Two Main Types of LWD Projects (Fischenich and Morrow, 2000)

	Category 1	Category 2
LWD Project Goals	Improve habitat by increasing LWD quantities in a stream	Alter flows to improve aquatic habitat