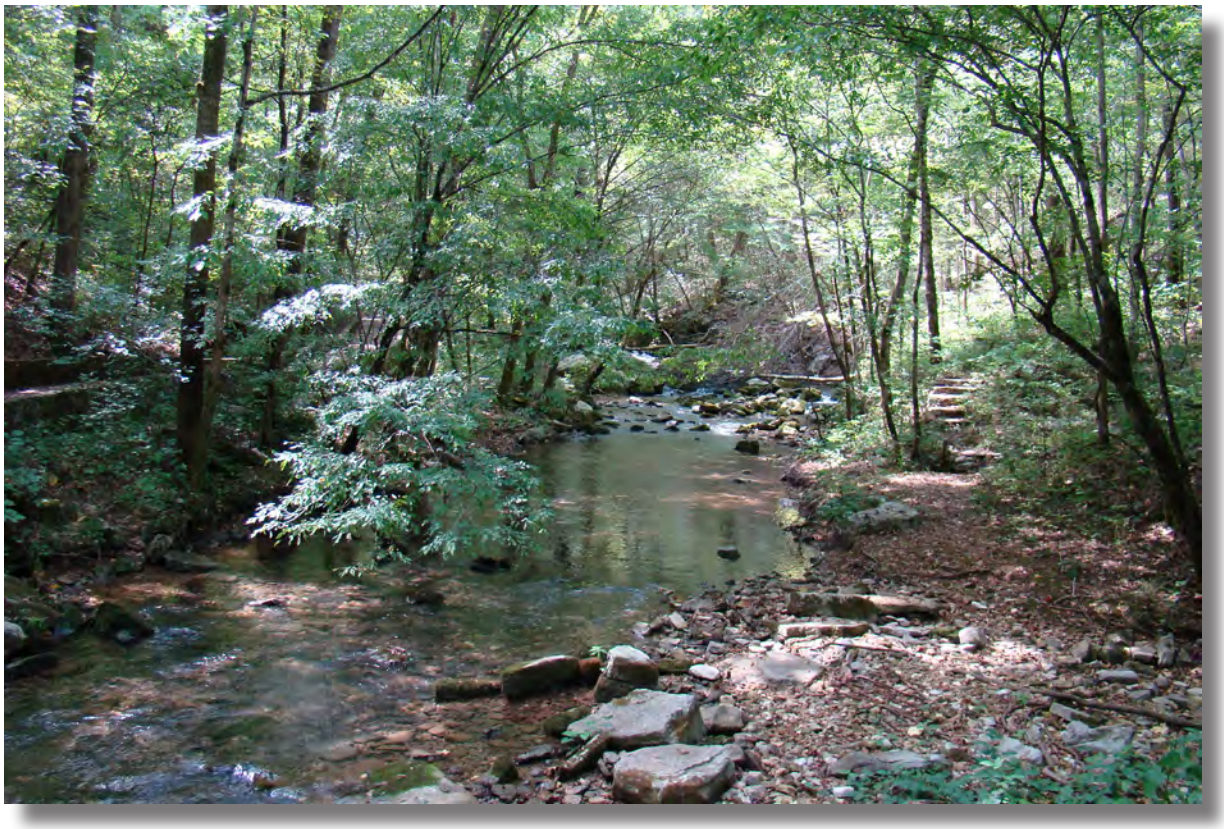
Voluntary Implementation of Forestry Best Management Practices for Water Quality Protection in Arkansas

Results of the 2010-2011 BMP Implementation Survey



Arkansas Forestry Commission — October 2011

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Results of the 2010-2011 BMP Implementation Survey

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Executive Summary

The Arkansas Forestry Commission (AFC) surveyed the implementation of voluntary forestry Best Management Practices (BMPs) on 241 sites totaling 23,297 acres. These sites were randomly selected from a pool of 1,099 candidate sites representing silvicultural operations that occurred statewide between May 2009 and March 2010.

The BMP implementation rate on the sites monitored was 89 percent. In general, implementation was highest on public and forest industry sites and lowest on private non-industrial sites. Federal tracts averaged 97 percent; state sites averaged 87 percent; industrial sites averaged 95 percent; corporate sites averaged 90 percent; and private non-industrial forest landowners (PNIFLO) averaged 83 percent. Statistically, there was no difference between federal and industry scores. The corporate and PNIFLO ownership classes were significantly different from each other and from the federal and industry scores. Due to the small sample size, it was not possible to determine if the state ownership class differed significantly from any of the other classes. AFC District scores range from 91 percent in Districts 2, 6, and 9, to 83 percent in District 8. However, there was not a significant difference between the District scores. Lastly, a separate analysis on the Poison Springs State Forest resulted in a BMP implementation rate of 96 percent.

Implementation rate by four regions:

- Delta - 86 percent
- Ozark - 89 percent
- Ouachita - 90 percent
- Gulf Costal Plain or Southwest - 89 percent

Implementation rate by Arkansas Forestry Commission Districts:

- District 1 - 88 percent
- District 2 - 91 percent
- District 3 - 86 percent
- District 4 - 87 percent
- District 5 - 90 percent
- District 6 - 91 percent
- District 7 - 89 percent
- District 8 - 83 percent
- District 9 - 91 percent

Implementation rate by BMP category:

- Harvesting - 95 percent
- Regeneration - 95 percent
- Roads - 86 percent
- Streamside Management Zones (SMZ) - 82 percent

Common deficiencies in BMP implementation noted during the survey were:

- Absence of an effective SMZ;
- Mechanical site preparation disturbing the ephemeral stream channels;
- Lack of water bars on skid trails, fire lanes, and inactive roads;
- Inadequate stabilization of stream crossings (road and skid trail); and
- Poor utilization of seeding and mulch to stabilize loose soil.

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Background and Objectives

The 1972 Clean Water Act required states to establish a program to encourage implementation of Best Management Practices (BMPs) to control non-point sources of pollution. In the state of Arkansas, the Arkansas Forestry Commission (AFC) is the lead agency responsible for the Forestry BMP Program.

The BMP Program relies on the voluntary implementation of BMPs based on the training and education of forest landowners and users. When BMP guidelines were first developed in the early 1970s, initial education and training efforts were based on data obtained from soil loss monitoring, and from information gathered while investigating complaints related to silvicultural activity.

Besides the creation of a Forestry BMP Program to address non-point source pollution related to forest management, the reauthorization of the Clean Water Act in 1987 additionally required states to develop methods for determining the effectiveness of their BMP guidelines.

In 1996, Arkansas adopted the BMP implementation survey procedures developed by the Southern Group of State Foresters to address this requirement. Titled *Silviculture Best Management Practices Implementation Monitoring, a Framework for State Forestry Agencies,* this document provided a framework for monitoring BMP implementation that is statistically sound, objective, technically feasible, and consistent with BMP program efforts in all 13 southern states.

Objectives of the implementation monitoring program include:

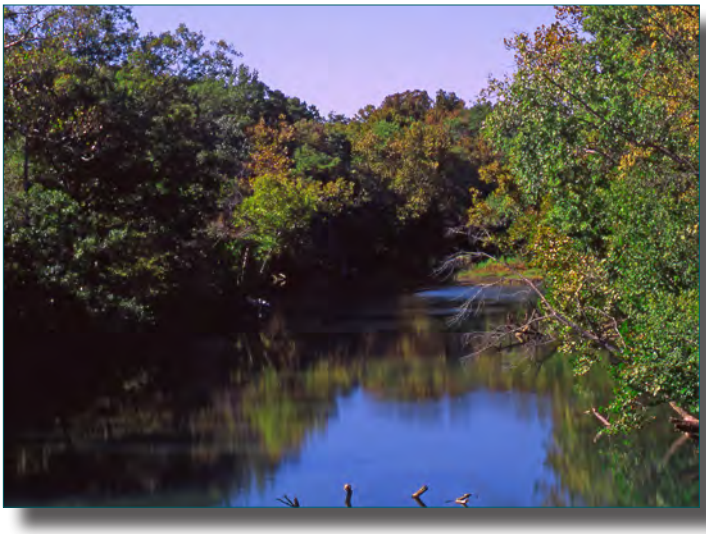
1. Measuring, documenting, and reporting the statewide extent of implementation of forestry BMPs.

2. Evaluating the general effectiveness of BMPs as applied operationally in the field.

3. Determining the need and direction of forest BMP education and outreach programs.

This report documents findings of the seventh BMP implementation survey, which was performed from May 2010 until July 2011.

The AFC completed and published its first implementation report in 1998, the second in 1999, the third in 2001, the fourth in 2004, the fifth in 2007, and the sixth in 2008.



Survey Methods

The seventh survey was conducted according to the publication *Silviculture Best Management Practices Implementation Monitoring, a Framework for State Forestry Agencies,* adopted in 1996.

Site Selection

To determine the rate of BMP implementation, sites of recent forestry activity that could be evaluated for BMP implementation had to be identified. To reduce bias in site selection, a pool of candidate tracts was first identified via aerial surveillance. While flying a pre-defined grid pattern, the location of tracts with recent forestry operations was recorded using a Digital Aerial Sketchmap System (DASM) (Figure 1).

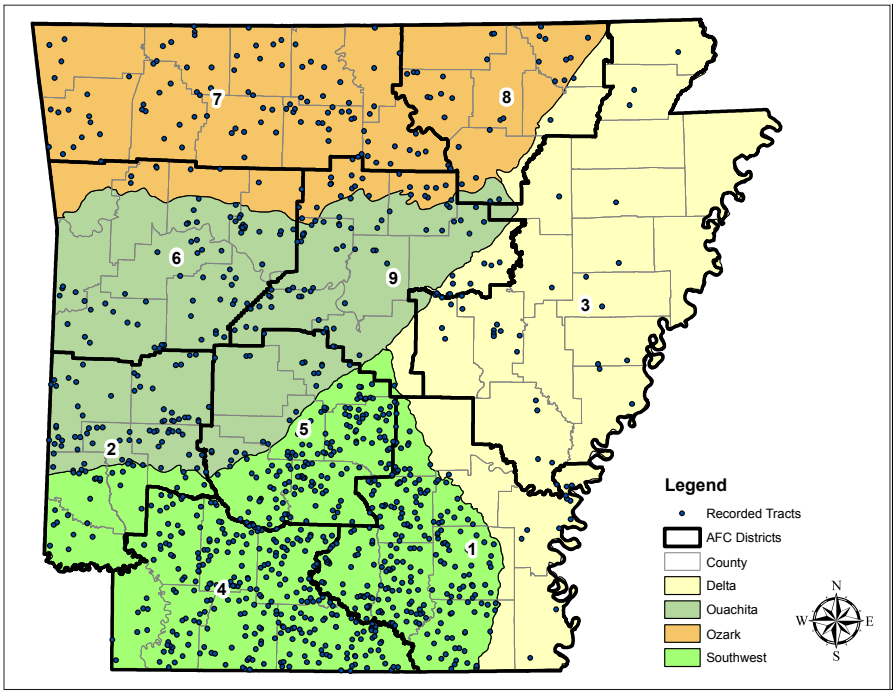


Figure 1: *Distribution of candidate sites identified during aerial surveillance*

Once a pool of candidate tracts was identified, a random sample of sites was selected for further evaluation. The distribution of these sites was based on timber severance tax records (see Appendix, page 25). AFC personnel contacted the landowners to gain access and determine the suitability of the site for this survey. Landowners were divided into five groups: Federal, State, Corporate, Industry, and Private Non-industrial Forestland Owners (PNIFLO). Only those sites representing typical silvicultural operations, and not conversions to other land uses, were considered for this survey. Recent final harvest tracts (< 1 year old) were preferred, as they reflected maximum potential for soil erosion. Statistical analysis from previous surveys indicated that a sample size of 200 sites would yield results within a 95 percent confidence level. Of the 1,099 harvested sites initially identified, 241 tracts were eventually surveyed for BMP implementation (Figure 2).

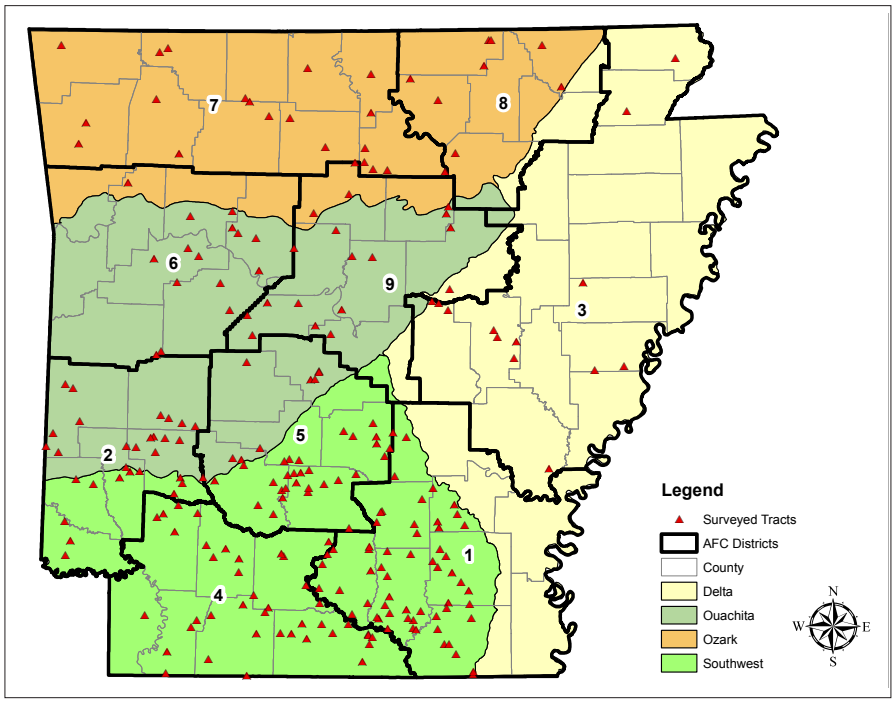


Figure 2: *Distribution of harvest sites included in the survey*

Site Monitoring and Analysis

All site evaluations were completed by the BMP Forester and the BMP Specialist. Given the number of tracts to be monitored, it was necessary for more than one person to conduct the BMP assessments.

Survey Methods

Overall control of the survey, and an acceptable level of consistency, was achieved by limiting the number of observers and using experienced personnel.

The monitoring questionnaire used during the site evaluations was revised prior to the Sixth BMP Implementation Survey to reflect state BMP guidelines adopted in March 2002. The questionnaire consists of 67 questions based on four BMP categories: Streamside Management Zones (SMZs), Roads, Harvesting, and Regeneration.

All questions were taken directly from the revised BMP book and referenced with applicable section and sub-section numbers as noted in the book. Each question was worded so that a positive answer was recorded with a "Yes," while a departure from BMP recommendations received a "No" response. Answers for questions that did not apply were indicated by "NA." Each question also included a determination of significant risk. A significant risk is a situation or set of conditions that has resulted in, or very likely will result in, the significant and measurable degradation of water quality.

Based on the results of the site evaluation, a final score was given to each tract. The score identifies the percentage of BMPs that are in place and effective compared to all the BMPs recommended for a particular site by the approved guidelines. Compiling data from all tracts allowed analysis of statewide BMP implementation. Analysis of BMP implementation based on BMP category, tract ownership, state physiographic region, and AFC District was also conducted. In keeping with previous surveys, statistical analysis of the data consisted of a completely randomized design analysis of variance; a Least Significant Difference (LSD) pairwise comparison was used to test for significant differences between categories at a 5 percent probability level.

Besides the site examination, a separate survey was used to determine if differences in BMP implementation exist on sites owned by PINFLOs based on the landowner's familiarity of basic timber sale practices and recommendations. Multiple t-tests were used to determine statistical significance of differences in the mean score of each question.

Overall BMP Implementation

The overall statewide rate of forestry BMP implementation was 89 percent (Table 1). Statewide, implementation of forestry BMPs related to harvesting and regeneration practices scored highest with a rate of 95 percent (Figure 3). Implementation of forestry BMPs related to roads scored 86 percent, while SMZ BMP implementation scored 82 percent. Harvesting and Regeneration BMP implementation was significantly higher than Road and SMZ implementation, and there was a significant difference between the Road and SMZ categories.

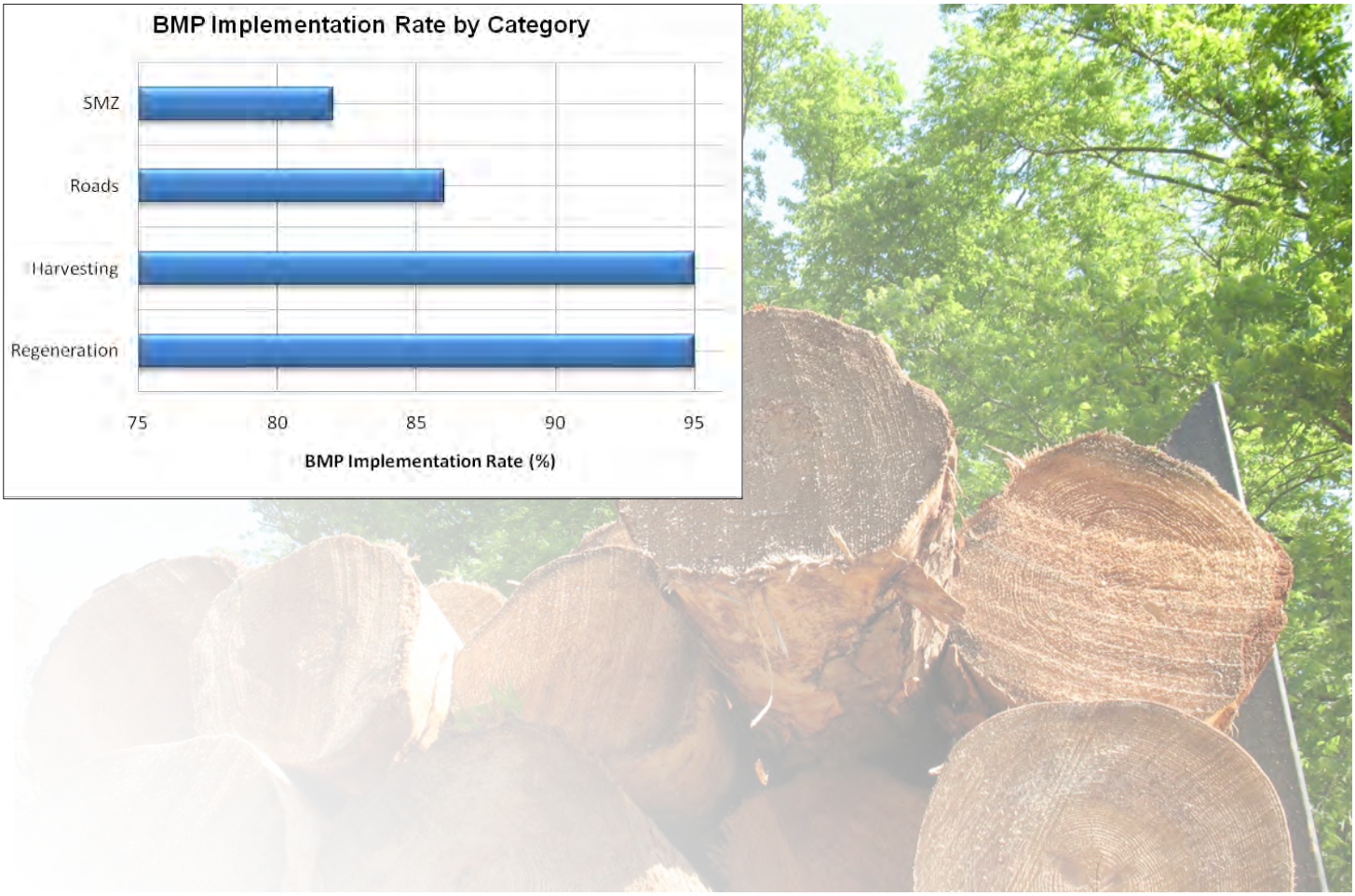
These results follow the typical pattern observed in previous surveys. However, while the overall implementation rate has remained in the upper 80th percentile for the last three surveys, the statewide rate of 89 percent represents a statistically significant 3 percent increase from the previous survey.

Table 1: *Overall BMP implementation summary*

Category	Number of Tracts	Implementation Percent	Margin of Error	Statistical Significance*
Streamside Management Zones	182	82.13	3.58	c
Roads	175	85.65	2.38	b
Harvesting	241	95.23	1.16	a
Regeneration	57	95.20	2.58	a
Overall Implementation Rate	**241**	**88.69**	**1.49**	

** Implementation percents having a difference significance letter are significantly different at the 5 percent probability level.*

Figure 3: *BMP implementation rate by BMP category*



Streamside Management Zones

SMZs are areas of forestland adjacent to non-ephemeral streams and lakes where forest management activities are limited to ensure water quality protection. While some harvesting within a SMZ is permissible, its primary function is to serve as a buffer between a stream channel and the more intensive forest management activities occurring outside the SMZ. Harvesting activities that do take place within the SMZ should be conducted in such a manner that minimizes the disturbance.

In this survey, the proper implementation of BMPs for SMZs was the lowest-scoring category in the state. Historically, SMZs have been the lowest-scoring category overall. Given the direct protection that SMZs provide for streams and prevalence of forestry activities where streams are present on site (SMZ protection was applicable on 76 percent of all sites monitored), it is important to identify deficiencies in SMZ implementation.

The state BMP recommendations for SMZs focus

Table 2: *Streamside Management Zone survey results*

Streamside Management Zone BMPs	Number of Tracts	Implementation Percent	Sig. Risk
2.11. Minimum SMZ width (35') present for SMZs bordered by land with less than 7 percent slope?	171	79.53	--
2.12. Minimum SMZ width (50') present for SMZs bordered by land with slopes 7-20 percent?	32	93.75	--
2.13. Minimum SMZ width (80') present for SMZs bordered by land with slopes > 20 percent?	2	100.00	--
2.14a. Basal area of residual trees in SMZ meet guidelines?	165	68.48	--
2.14b. Spacing of SMZ overstory trees meet guidelines?	152	80.26	--
2.16. SMZ trees removed in a manner that minimizes disturbance to the forest floor, exposure of mineral soil, or reduction of stream bank stability?	121	95.04	--
2.18. Absence of significant logging debris in stream channel?	170	81.76	2
2.19. Absence of toxic and hazardous materials such as fuels, lubricants, and solvents in SMZs?	171	100.00	--
2.23. Mechanical site preparation did not disrupt the ephemeral stream channel?	29	51.72	--
2.31. SMZ provided between braided stream channels as well as the prescribed SMZ width adjacent to the most exterior channels?	19	94.74	--
2.41. Appropriate SMZ provided for lakes and ponds?	11	81.82	--
2.51. Trees growing directly on the bank or overhanging a water body were not cut?	159	79.87	--
2.52. Mineral soil not exposed by prescribed fire?	4	100.00	--
2.53. SMZ is free of log decks?	174	100.00	--
2.55. Cave entrances and sinkholes free of logging debris?	1	100.00	--
6.12. Boundaries of all SMZs defined where site preparation occurred?	126	66.67	--
Streamside Management Zone Implementation Rate	**182**	**82.13**	**2**

on two main areas: 1) they characterize the forest structure that should be retained during a harvest to ensure a properly functioning SMZ, and 2) they identify and discourage activities that could compromise one or more of the protective qualities of a SMZ. Therefore, in the survey there are questions that address the appropriate width and structure of the SMZ (questions 2.11-2.14b, 2.31 & 2.41), and questions concerning poor practices occurring in the SMZ, such as the removal of bank trees or excessive woody debris being left in the stream channel (questions 2.16-2.23, 2.51-6.12). Field experience seems to indicate that those tracts with an appropriate SMZ in terms of width and structure typically have fewer problems concerning the poor practices occurring within the SMZ.

Of the 16 BMP questions on the survey concerning SMZs, half were implemented over 90 percent of the time, while the other half were implemented 82 percent or less of the time (Table 2). The areas of greatest concern are:

- Failure to leave adequate SMZ on slopes <7 percent;
- Failure to leave adequate SMZ for lakes or ponds;
- Failure to meet basal area target for residual trees;
- Spacing of overstory trees did not meet guidelines;
- Significant logging debris left in stream channel;
- Bank trees were removed;
- SMZ boundaries poorly defined before site preparation; and
- Ephemeral stream channels disrupted by mechanical site preparation.

Where BMPs were not implemented correctly, there was likely no SMZ left, or one that was ineffective because of failure to meet width, basal area, or spacing guidelines. It follows that where the structural requirements for an SMZ are disregarded, there is also the likelihood that the effort will not be made to leave bank trees or to fell trees in a manner that minimizes the amount of woody debris being deposited in the stream. It should also be noted that of the 31 sites

that had significant amounts of woody debris present in the stream channel, two were substantial enough to be deemed a significant risk to water quality. Excessive woody debris can constrict the stream flow, leading to scour and possible flooding. Additionally, the breakdown of the woody debris can also lower dissolved oxygen levels, thereby impairing aquatic fauna.

The fact that the lowest scores for the SMZ category deal with site preparation activities is also of interest. Having a well-defined SMZ assists site preparation contractors by making the limits of mechanical or chemical applications easily recognizable. The poor score for question 6.12 is likely due to a lack of a proper SMZ being left during the harvest operation. The BMP with the lowest implementation, question 2.23, is similarly related to what forest cover is left during the harvest. Ephemeral streams are not required to have a designated SMZ, although an intact forest floor and retaining lower lying vegetation is recommended. Therefore, following a harvest, there is often no indication of the presence of an ephemeral stream that is recognizable to a site preparation contractor. Sub-soiling (ripping) or bedding through ephemeral stream channels will likely alter the hydrology of the tract and increase the chance of sediment transport into connected non-ephemeral streams.

BMP Survey Results

Roads

As indicated previously, approximately 86 percent of the BMPs for Roads were implemented properly on the 175 tracts where applicable. There was a significant difference in the rate of implementation between Road BMPs and SMZ BMPs, and both categories scored significantly lower than Harvesting and Regeneration BMPs.

The road network used in forestry operations has the greatest potential of negatively impacting water quality if proper BMPs are not employed. This potential for impairment exists because the dirt or gravel roads commonly used to access timber serve as a constant source of sediment, which can be transported directly into a stream channel, most notably at stream crossings. To diminish the risk of impairment due to forest roads, the applicable BMPs focus on three broad areas: 1) proper planning, 2) practices to be followed during the harvest, and 3) close out procedures used to minimize the long-term effects on the road on water quality.

Table 3: *Forest road survey results*

Road BMPs	No. of Tracts	Implementation Percent	Sig. Risk
3.12. Roads located to avoid or minimize stream crossings?	158	98.73	--
3.13. Streams were crossed at right angles?	94	97.87	--
3.14 Where topography permitted, roads were located along the contour and along the crest of long ridges?	160	98.75	--
3.25. Side cast or fill material placed above the ordinary high water mark of any stream, except where necessary to stabilize stream crossings?	49	77.55	1
3.27. Seeding and mulching were employed in a timely manner to reduce erosion?	33	27.27	--
3.36a. Water turnouts, broad-based dips or rolling dips in-stalled before a stream crossing to direct road runoff water into undisturbed areas of the SMZ?	78	67.95	3
3.36b. Roads, with the exception of stream crossings, located outside the SMZ?	134	97.76	--
3.42. Erodible areas, where natural vegetation is not sufficient to stabilize the soil, re-vegetated or stabilized?	41	21.95	--
3.48. Where needed, roadbed reshaped and all drainage systems opened when all forestry activities were completed?	117	66.67	--
3.52. On roads, temporary crossing structures removed and stream banks stabilized and restored after use?	16	81.25	--
3.53. Permanent stream crossings used bridges, culverts, shelf rock fords, geoweb, concrete slabs or other materials?	61	80.33	--
3.54. Low water ford banks are stable and stream bottoms are hard?	49	83.67	--
3.55. Except at stream crossings, equipment kept out of streambeds?	114	98.25	--
3.56. Are concrete slabs installed and functioning properly?	6	100.00	--
3.61. Broad-based dips present were needed?	99	98.99	--
12.10. Broad-based dips properly constructed?	97	97.94	--
3.71. Rolling dips present where needed?	60	76.67	--
12.20. Rolling dips properly constructed?	49	89.80	--
3.83. Wing ditches present where needed?	90	83.33	--
12.30. Wing ditches constructed and functioning properly?	80	91.25	--
3.85. Wing ditches not feeding directly into adjacent drainage, gullies, or channels?	75	97.33	--
3.90. Culverts present where needed?	64	75.00	--
3.92. Culverts installed properly?	53	98.11	--
12.40. Appropriate culvert size used?	52	100.00	--
3.97. Where needed, aggregate or other suitable material used on approaches to fords, bridges, and culvert crossings?	60	60.00	2
13.10. Water bars present as specified on inactive roads?	52	65.38	--
4.13. Water bars installed and functioning properly?	37	67.57	--
4.14. Sufficient distance left between outflow discharge of water bar and stream to allow “sediment fallout?”	25	80.00	--
Roads Implementation Rate	**175**	**85.65**	**6**

BMP Survey Results

In this category, the rate of implementation for 18 of the 28 questions scored at or above 80 percent. Of the remaining 10 questions, three scored in the 70th percentile, five scored in the 60th percentile, and two scored in the 20th percentile (Table 3). The areas of greatest concern are:

- Seeding and vegetative cover not used in a timely manner to stabilize erodible soil;
- Water and sediment diversion structures not implemented or ineffective;
- Poor stream crossings; and
- Failure to follow all close out procedures upon completion of the harvest.

The BMP with the lowest score (20th percentile) was the use of seeding and mulching to stabilize erodible soil. While the use of vegetative cover does depend on season and weather conditions, it is the least expensive and most effective BMP to stabilize soil and minimize erosion. Implementing vegetative cover when possible is strongly encouraged.

The other areas of concern were failure to properly install water and sediment diversion structures such as rolling dips and water bars when applicable, failure to re-shape the roadbed and open drainage systems following a harvest, and inadequate stream crossings. The failure to properly close out forest roads and the failure to install rolling dips and water bars as needed is likely due in large part to the cost and accessibility of the proper equipment and the lack of expertise required to implement these BMPs. Besides the cost associated with road work, and the lack of technical ability, there may also be a failure to recognize that these devises can be effectively designed without hindering future use and access.

Of more direct concern to water quality, however, is the rate of implementation of BMPs for stream crossings. For example, of those tracts with stream crossings, unnecessary fill material was left in the stream channel on 22 percent of the sites; culverts were not used where needed on 25 percent of the sites; no water turnouts or dips were installed before a crossing on 32 percent of the sites; and the approaches to the stream crossing were not armored on 40 percent of the sites. To further illustrate the importance of stream crossings, the failure to follow specific BMPs for proper crossings led to six findings of significant risk to water quality. Because the crossing is a direct point of entry for sediment into a stream channel, implementation of BMPs specific to stream crossings is critical for the protection of water quality.

Harvesting

The process of skidding cut logs to a log landing, and the high-traffic volume on and around the landing itself, are two major sources of soil exposure that occur during a harvest operation. Understandably, a potential threat to water quality exists when these activities take place near a stream channel. BMPs developed to address the harvest operation, therefore, stress the importance of planning when deciding the location of log landings and skid trails. As with roads, the greatest potential threat to water quality during the harvest operation occurs at stream crossings on skid trails. Whenever possible, skid trail stream crossings should be avoided and the number of log landings minimized.

This survey indicates that overall, as in the past, logging contractors do a good job adhering to the BMP recommendations for harvesting; statewide, the implementation rate for harvesting BMPs was 95 percent (Table 4). For this category, eight of the 12 BMP recommendations were implemented more than 95 percent of the time. These BMPs deal primarily with the location of skid trails and log landings. Two other BMPs—installing frequent rolling dips on skid trails with grades over 30 percent and not using soil as a fill material at skid trial crossings—had implementation rates in the 80th percentile.

While most BMPs were followed, however, there are areas that need to be addressed. The primary area of concern is with the failure to properly stabilize skid trails following the harvest. Either temporary fill material was not removed from skid trail stream crossings or the stream banks were not adequately stabilized after the harvest on 51 percent of the tracts monitored. Likewise, water bars were not constructed on skid trails on 49 percent of the tracts evaluated. The failure to properly close out skid trails following the harvest led to five determinations of significant risks to water quality. The sixth determination of significant risk in this category was the result of a poorly placed log landing.

Table 4: *Harvesting survey results*

Harvesting BMPs	Number of Tracts	Implementation Percent	Sig. Risk
5.17. Are water bars constructed on skid trails per specifications in Table 13.1 & Figure 13.1, page 46?	51	49.02	1
4.23. Are the size and number of log landings minimized?	241	98.76	--
5.24. Are landings located away from SMZs on firm level ground?	225	98.22	--
5.25. Are landings located on dry sites so natural drainage disperses water onto the forest floor but not into a stream?	238	98.74	1
5.41. When skidding, where contours followed to the greatest extent possible?	155	99.35	--
5.43. Skid trails on slopes have occasional breaks in grade or logging slash that disperses water?	100	96.00	--
5.44. At skid trail stream crossings, soil not used as a temporary fill material when water was in the stream?	64	84.38	--
5.47. On skid trails temporary fill material removed from stream beds and stream banks stabilized?	59	50.85	4
5.48. No skid trails in stream channels?	195	97.95	--
5.52. Was skid trail construction minimized at grades greater than 30 percent?	34	100.00	--
5.53. On grades greater than 30 percent, were frequent rolling dips installed?	25	88.00	--
5.62. Litter, such as oil cans, grease containers, crankcase oil filters, old tires, and used fluids absent from the site?	241	96.68	--
Harvesting Implementation Rate	**241**	**95.23**	**6**

Regeneration

Regeneration BMPs address potential threats to water quality that arise from intensive site preparation and reforestation activities. Where intensive management is recommended, typically a combination of prescribed fire, herbicide applications, mechanical site preparation, and reforestation practices are used to establish a new stand. Besides possible chemical contamination from herbicide applications, the use of heavy equipment and fire to prepare and reforest a tract can create a situation where sediment is introduced into a water body. Thus, the BMP recommendations for regeneration activities address the application of herbicides, proper fire management and fire lane construction, and the operation of heavy equipment.

As with the Harvesting category, the rate of BMP implementation for the Regeneration category was 95 percent. Thus, it appears that the majority of BMP recommendations are being properly implemented by site preparation contractors on a regular basis. Of the 11 BMP recommendations, nine had rates of implementation greater than 90 percent (Table 5). The two remaining BMP recommendations scored much lower and need to be examined further. Where applicable, only 50 percent of the tracts had fire lanes that were constructed by hand within a SMZ. While it is an uncommon practice to have fire lanes within a SMZ, soil disturbance within an SMZ should be minimized whenever possible.

The second BMP of concern was the failure to install water bars on fire lanes with slopes >5 percent and on approaches to streams or roads. Only 45 percent of the tracts monitored followed this recommendation. Because fire lanes often follow property or stand boundaries rather than the contour of the land, it is possible that fire lanes may have steeper slopes than skid trails or access roads on the same tract.

Due to the potential for steeper slopes and the higher potential for erosion, the use of properly constructed water bars is critical to stabilizing the exposed soil and decreasing the chance of water quality impairment.

Table 5: *Regeneration survey results*

Regeneration BMPs	Number of Tracts	Implementation Percent	Sig. Risk
6.15. Has intensive site preparation been avoided on soils the NRCS has identified as highly erodible?	17	100.00	--
6.16. Existing water control devices (i.e. culverts, wing ditches) not damaged?	35	91.43	--
6.17. Heavy equipment operations avoided in wet soil conditions?	35	100.00	--
6.18. Did Intensive site preparation follow the contours of the land?	34	100.00	--
7.11. Forest chemicals apparently excluded from SMZs?	19	100.00	--
8.11. Machine planting follows the contour of the land?	12	100.00	--
8.13. No evidence of machine planting equipment crossing or turning around in roads, road ditches, and wing ditches?	16	93.75	--
10.12a. Fire lines installed parallel to streams and not plowed through the SMZ?	21	100.00	--
10.12b. Fire lines within the SMZ constructed by hand?	4	50.00	--
10.13. On final harvest cuts, when slopes of the site exceed 20 percent, individual fire strips do not exceed 300 feet in width between ignition and burnout?	1	100.00	--
10.34. On slopes exceeding 5 percent, and at approaches to streams and roads, were water bars installed in fire lines according to the BMP recommendations for skid trails?	11	45.45	--
Regeneration Implementation Rate	**57**	**95.20**	**--**

Implementation by Physiographic Region

Besides determining the statewide BMP implementation rate, there was a desire to examine if BMP utilization varied within the state's different physiographic regions. While Arkansas can be divided into several regions, for the purpose of this survey the state was partitioned into four areas: Delta, Ouachita, Ozark, and Gulf Coastal Plain or Southwest (Figures 1 and 2). Fourteen tracts were in the Delta; 42 tracts and 33 tracts represented the Ouachita and Ozark regions, respectively (Figure 4). The majority, 152 tracts, were located in the Southwest region. While the Ouachita region had the highest level of BMP implementation (Figure 5), there was no significant difference between the BMP scores of any of the regions (Table 6).

Figure 4: *Distribution of sites by region*

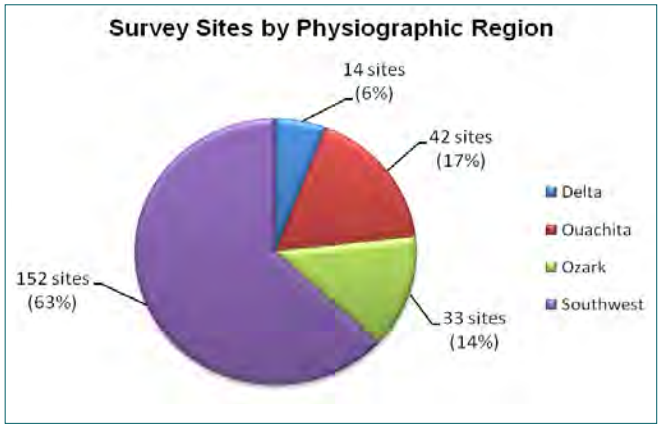
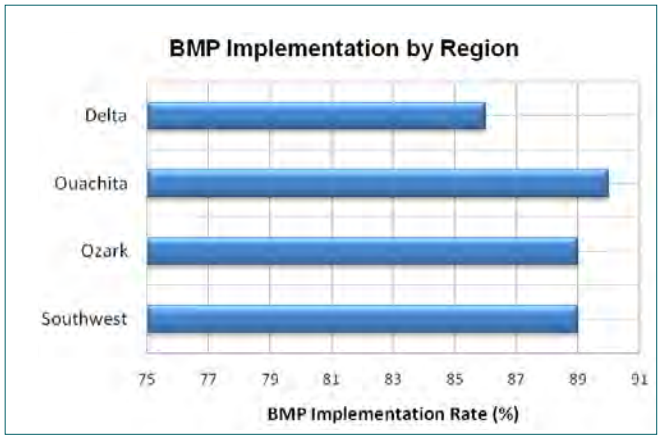


Figure 5: *Implementation rate by region*



The Delta region is actually a combination of two land forms: the Mississippi Alluvial Plain and the loess highlands known as Crowley's Ridge. Aside from Crowley's Ridge, the topography is generally flat, with numerous waterways. The dominate land use is agriculture, with forestry having little presence. There is some federal and state forestland ownership in the St. Francis National Forest and several wildlife management refuges. Within the Delta region, SMZs had the lowest rate of BMPs (68 percent), while harvesting BMPs had the highest score (94 percent) (Table 7). While the difference appears to be statistically different, caution should be used when interpreting these figures due to the number of tracts evaluated and the margin of error reported.

The Ouachita region is mountainous, though the terrain is not as steep or rugged as the Ozark Highlands. Pine is the predominant timber type and, as a result, there is a large forest industry presence. There is also a federal presence with the Ouachita National Forest. Of the tracts surveyed in the region, 40 percent were owned by forest industry while 14 percent were federally owned. BMP implementation mirrored statewide trends, with the highest and lowest scores being in the Harvesting (96 percent) and SMZ (86 percent) categories, respectively (Table 8).

The Ozark Highlands, found in the northern portion of the state, is characterized by its moderate-to-steep terrain, and an oak-hickory, upland hardwood, forest type. While heavily forested, the region is not a major timber producer. Private ownership dominates; 72 percent of the tracts surveyed were privately owned. However, there is a large federal presence with the Ozark National Forest. BMP implementation trends within the region did not differ from those seen statewide. SMZ implementation, however, did appear to be significantly lower than the BMP score for harvesting (Table 9).

The dominate timber-producing region in the state is in the Southwest. Consequently, this is where a majority of the tracts examined in the survey (63 percent) were found. Because it is the most productive timber region, there is a sizable presence of forest industry and timberland investment groups. The plurality of tracts evaluated was industrially owned (36 percent), while 35 percent were privately owned, and 29 percent were corporately owned. BMP implementation rates parallel the trend seen statewide, with Harvesting and Regeneration having significantly higher scores than the Road and SMZ scores (Table 10).

Table 6: *Implementation rate by physiographic region*

Region	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
Delta	14	2,456	85.83	5.42	a
Ouachita	42	5,109	90.30	3.43	a
Ozark	33	2,677	88.62	2.88	a
Southwest	152	13,055	88.52	2.01	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 7: *Delta Region*

Category	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
SMZs	9	1,816	68.36	20.02	b
Roads	10	2,352	89.08	9.14	a
Harvesting	14	2,456	94.28	4.49	a
Regeneration	--	--	--	--	

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 8: *Ouachita Region*

Category	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
SMZs	40	4,333	85.69	7.89	b
Roads	40	5,000	89.39	4.40	ab
Harvesting	42	5,109	95.82	2.94	a
Regeneration	20	3,550	95.67	3.46	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 9: *Ozark Region*

Category	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
SMZs	21	1,734	82.68	6.65	b
Roads	20	1,672	88.63	6.25	ab
Harvesting	33	2,677	92.42	2.55	a
Regeneration	4	200	85.42	17.18	ab

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 10: *Southwest Region*

Category	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
SMZs	119	10,881	82.02	4.63	b
Roads	105	10,643	80.00	3.23	b
Harvesting	152	13,055	95.68	1.50	a
Regeneration	32	2,517	95.99	3.40	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Implementation by Ownership

Ownership was divided into five categories for the survey: federal, state, industry, corporate, and private non-industrial forestland owners (PNIFLO). Previous surveys did not differentiate between corporate and industrial ownership. However, with an increased presence of non-traditional forestland owners purchasing lands formerly held by industry, the categories were split to allow for individual analysis. Industrial ownership was classified as those entities that owned forestland and had some kind of processing facility in the state. The corporate category included timber investment management organizations (TIMOs) and other similar entities.

Figure 6: *Distribution of sites by ownership class*

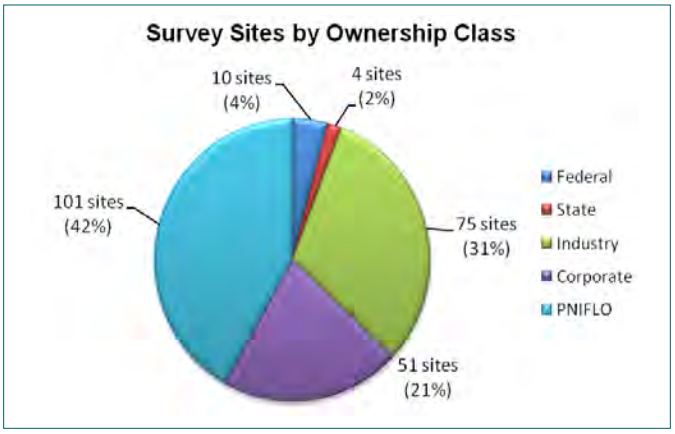
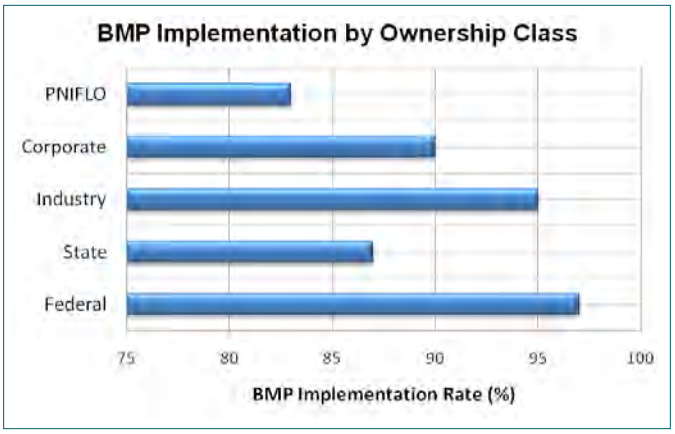


Figure 7: *Implementation rate by ownership class*



Of the 241 tracts evaluated for this survey, 101 (42 percent) were owned by PNIFLOs, 75 (31 percent) were owned by industry, 51 (21 percent) were corporate ownership, 10 (4 percent) were federal ownership, and four tracts (2 percent) were owned by state agencies (Figure 6). The number of privately owned versus publicly owned tracts sampled reflects the management objectives and priorities of the two groups. Federal tracts had the highest implementation rate of 97 percent, while PNIFLO had the lowest rate of implementation at 83 percent (Figure 7). The implementation rate for each ownership classification, and significant difference, is shown in Table 11.

Federal

Federal ownership consisted of tracts on the St. Francis, Ouachita, and Ozark National Forests. Ten tracts, comprising approximately 785 acres, were evaluated for BMP implementation, representing approximately 4 percent of all tracts surveyed.

Federal ownership historically has had the highest rate of BMP implementation, and that has continued in this survey. The federal score of 97 percent represents a significantly higher score than that found on corporate or PNIFLO ownerships, but not on industry ownerships. Overall, federal tracts scored highest on SMZs (100 percent), and lowest on Road BMPs (94 percent) (Table 12). All the tracts examined were thinning operations or selective harvests, thus there was no site preparation or reforestation activities present.

State

Because of the relatively small number of timber harvests on state land, this ownership was not well represented in the survey. Only four harvest operations were evaluated, comprising approximately 890 acres, with an overall BMP implementation rate of 87 percent. Because of the small sample size, there was not a significant difference between this ownership class and the other four ownership classes. Likewise there was insufficient data to determine the implementation rate of the different BMP categories within the state ownership class. The implementation rate for state ownership was reported to be 93 percent in the last survey; however, that rate was based on an even smaller sample size of two tracts and should not interpreted as a true representation of BMP utilization on state property.

Industry

Seventy-five tracts—31 percent of all tracts surveyed—were classified as industrial ownership with a BMP implementation rate of 95 percent. While

Implementation by Ownership

there was no significant difference between the industry and federal ownership classes, the industry ownership was significantly higher than the corporate and PNIFLO ownership classes. Overall, implementation of BMPs for Harvesting scored highest at 99 percent (Table 13). While it appears that the implementation rate for Road BMPs was lower than the SMZ score, there is no statistical difference between the two categories.

Corporate

Fifty-one tracts, comprising approximately 4,437 acres, were evaluated within the corporate ownership class. The BMP implementation rate for this ownership class was 90 percent—statistically lower than the Federal and Industry scores and statistically higher than the PNIFLO score. As for the implementation rates for the four BMP categories, Harvesting BMPs scored highest with 97 percent, Regeneration scored 95 percent, Roads scored 86 percent, and SMZs scored 86 percent (Table 14). While the Regeneration score is inconclusive due to the low number of tracts observed, the trend within the corporate ownership class mirrors the trend for BMP implementation by category statewide.

PNIFLO

The majority of tracts evaluated in this survey fell into the PNIFLO class. Comprising 101 tracts (42 percent of all tracts) and approximately 8,369 acres, the BMP implementation rate for the class was 83 percent. This implementation score was significantly lower than the rate of BMP implementation witnessed on federal, industry, and corporate tracts. For BMP categories, the implementation rates within the PNIFLO ownership class were lower in every category when compared to the other ownership classes. As seen in the other classes is, however, the same trend of relatively high implementation rates for BMPs associated with harvesting and regeneration activities, and lower rates for SMZs and forest roads. Although Road BMPs only had an implementation rate of 79 percent, this was still significantly higher than the score of 70 percent for SMZs (Table 15).

Table 11: *Implementation by Ownership Class*

Ownership	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
Federal	10	785	97.23	2.07	a
State	4	890	87.20	12.87	abc
Industry	75	8,816	94.59	1.33	a
Corporate	51	4,437	89.78	2.95	b
PNIFLO	101	8,369	82.96	2.58	c

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 12: *Federal Implementation by BMP Category*

Category	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
SMZs	6	288	100.00	0.00	a
Roads	10	785	94.21	5.89	a
Harvesting	10	785	98.89	2.22	a
Regeneration	0	--	--	--	--

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 13: *Industrial Implementation by BMP Category*

Category	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
SMZs	60	7,546	93.65	4.32	bc
Roads	65	8,339	89.74	3.24	c
Harvesting	75	8,816	98.56	1.03	a
Regeneration	32	4,656	96.09	3.08	ab

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 14: *Corporate Implementation by BMP Category*

Category	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
SMZs	42	3,570	85.51	6.44	b
Roads	34	3,475	86.03	4.86	b
Harvesting	51	4,437	96.91	2.14	a
Regeneration	5	447	95.00	10.00	ab

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 15: *PNIFLO Implementation by BMP Category*

Category	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
SMZs	72	7,020	69.95	5.81	c
Roads	62	6,178	79.49	4.59	b
Harvesting	101	8,369	91.56	2.20	a
Regeneration	20	1,164	93.83	5.03	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

PNIFLO Questionnaire

Historically, PNIFLOs have had the lowest BMP implementation rates. Given that PNIFLOs own approximately 60 percent of the forestland in the state, poor BMP implementation by this ownership increases the potential for impaired water quality due to forestry activity. The survey data reinforces this point. Of the 14 significant risks to water quality that were identified in the survey, 12 were on PNIFLO ownerships. The average BMP implementation rate for those 12 tracts was 62 percent.

In an effort to improve PNIFLO BMP implementation rates, and to shape future educational efforts to these private landowners, the previous survey started polling landowners to gauge their understanding of BMPs and basic timber sale practices. This PNIFLO questionnaire was included in this survey; the questions and results are below.

Question 1 – Was landowner familiar with AFC BMP Guidelines?

Of the 73 landowners who responded to this question, only 33 (47 percent) reported being familiar with AFC BMP Guidelines. This illustrates the lack of basic knowledge about BMPs and the need for education. It does not appear that being familiar with the guidelines alone is enough to significantly improve BMP implementation rates; there was not a significant difference in implementation rates between the two groups (Table 16).

Question 2 – Did the landowner require a written contract for the sale or activity?

The majority (79 percent) of landowners required a written contract for forestry operations. Having a sales contract, however, does not improve the likelihood of greater BMP implementation (Table 17).

Question 3 – If written contract required, were BMPs required?

Of the 58 landowners who required written contracts for forestry operations, 39 (67 percent) required BMPs to be implemented as part of the contract. While the implementation rate was slightly higher for those tracts where BMP language was included in the contract, the difference between the two groups was not statistically significant (Table 18). While unexpected, this result may be due to the sample size of the survey. Another possibility is that there is either little oversight for BMP implementation by the contractors or that the contractors are not knowledgeable of all AFC BMP recommendations.

Question 4 - Was registered forester involved in the sale or activity?

The majority of landowners (58 percent) indicated that a registered forester was involved in the sale or activity. Surprisingly, the involvement of a professional forester did not appear to improve the rate of BMP implementation (Table 19). This same finding was noted in the previous survey as well. While the majority of participants in AFC-led BMP training have been logging contractors or company foresters, this result indicates that more training efforts need to target consulting foresters, procurement foresters, and timber buyers.

Question 5 – Was the landowner a member of a professional forestry organization?

Only 42 percent of the landowners indicated that they were members of a professional forestry organization. Interestingly, landowners who were members of forestry organizations had significantly higher BMP implementation rates than those who were not (Table 20). A possible explanation is that landowners who do belong to such organizations are more knowledgeable of forestry practices and more willing to monitor harvests. Additionally, these landowners may belong

to a forest certification program where BMP implementation is a requirement.

Question 6 – Was the logging contractor an Arkansas Pro Logger? The majority of landowners (81 percent) responded that an Arkansas Pro Logger was involved in the harvest. Arkansas Pro Loggers have had BMP training by AFC personnel; thus, there is the expectation that they would have a higher BMP score than contractors who have not had the training. There was not, however, a significant difference in BMP implementation between the two groups (Table 21). One explanation for this result is that logging contractors who attended BMP training several years ago may not have received any information on the topic since that time. Also, a contractor may have a Pro Logger on staff, but not with every crew.

Table 16: *Question 1 – Was landowner familiar with AFC BMP Guidelines?*

	Number	Acres	Implementation Percent	Margin of Error	Statistical Significance*
Yes	33	2,733	83.76	4.66	a
No	40	3,708	81.80	4.41	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 17: *Question 2 – Did the landowner require a written contract for the sale or activity?*

	Number	Acres	Implementation Percent	Margin of Error	Statistical Significance*
Yes	58	5,726	83.04	3.71	a
No	15	715	81.33	6.10	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 18: *Question 3 – If written contract required, were BMPs required?*

	Number	Acres	Implementation Percent	Margin of Error	Statistical Significance*
Yes	39	3,322	84.40	4.62	a
No	19	2,404	80.25	6.18	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 19: *Question 4 - Was registered forester involved in the sale or activity?*

	Number	Acres	Implementation Percent	Margin of Error	Statistical Significance*
Yes	42	3,405	83.95	4.39	a
No	31	3,036	80.97	4.60	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 20: *Question 5 – Was the landowner a member of a professional forestry organization?*

	Number	Acres	Implementation Percent	Margin of Error	Statistical Significance*
Yes	31	2,350	86.69	4.73	a
No	42	4,091	79.73	4.12	b

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Table 21: *Question 6 – Was the logging contractor an Arkansas Pro Logger?*

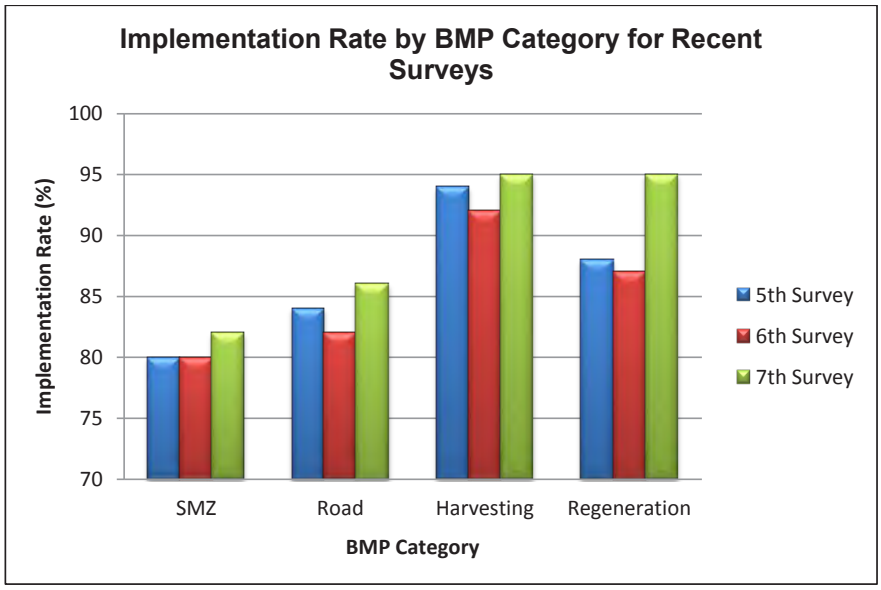
	Number	Acres	Implementation Percent	Margin of Error	Statistical Significance*
Yes	54	4,084	82.90	3.94	a
No	13	1,198	81.83	6.62	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Historical vs. Current BMP Implementation

With a statewide BMP implementation rate of 89 percent, the results of this report are in keeping with the previous surveys taken since the adoption of the new BMP guidelines for Arkansas in 2002. The statewide rate of BMP utilization has remained in the mid- to upper- 80th percentile since the fifth survey conducted in 2005-2006, the earliest survey for which results are comparable. This latest survey, however, does indicate that the rate of BMP implementation rose significantly to 89 percent from 86 percent as reported in the sixth survey of 2007-2008.

Figure 8: *Implementation Rate by BMP Category for Recent Surveys*



Several factors may have contributed to this increase in BMP implementation, all of which should be considered carefully. A potential factor could be that the results of the sixth survey might have been an anomaly. The BMP score for the sixth survey was a decrease of 2 percent from the fifth survey, which had an implementation rate of 88 percent. A possible reason for this is that the extraordinary rainfall that marked the monitoring period may have negatively influenced the survey scores.

Another factor that possibly contributed to the significant rise in implementation rates is the continued push by the forest industry toward forest certification. A key requirement to obtain certified status is to be in compliance with state BMP guidelines. As certification continues to be a driving force in the industry, the expectation is that BMP implementation rates will likely—at a minimum—maintain current levels or improve.

Related to the improvements made by the forest industry, one last possible contributing factor is the landowner composition. Given the relatively low scores of the PNIFLOs, it is reasonable to expect the BMP implementation rate to decrease as the PNIFLO class composes a larger percentage of the survey. In the sixth survey, industrial tracts and PNIFLO tracts comprised 50 percent and 45 percent of all tracts evaluated, respectively. The percent of industry tracts examined increased to 52 percent (industry and corporate classes combined), while the percent of PNIFLOs decreased to 42 percent in this survey.

There are two main reasons why a smaller proportion of PNIFLOs may be included in the survey. First, the present economic conditions could have depressed the number of PNIFLOs choosing to conduct timber sales. Secondly, this is the only ownership class where permission to conduct the survey is occasionally denied. Discarding tracts because of denial of access may not accurately reflect the composition of forestry activity in a particular area.

When looking at the trends for BMP categories over recent surveys, the most remarkable feature is the dramatic increase in BMP implementation for site preparation and regeneration activities. There has been a steady rise in the implementation score, to the point where Regeneration BMPs scores are now comparable with those are harvesting activities (Figure 8).

While the number of tracts monitored for regeneration BMPs is less than those of the other categories (24 percent of all tracts in this survey), the improvement in Regeneration BMPs is likely having a positive effect on the statewide score. One possible explanation for this increase is again tied to the improvements made by the industrial and corporate ownership associated with forest certification. Of the tracts surveyed with site preparation and regeneration activities, 65 percent were owned by these two classes; PNIFLOs owned the remaining 35 percent.

Conclusion

The use of BMPs is an effective means of reducing potential impairments to water quality that result from forestry practices. Tasked with the objective of decreasing the impact of forestry-related, non-point source pollution, the AFC BMP Program uses this biennial BMP Implementation Survey to identify trends in BMPs use statewide. More importantly, the survey gives the AFC the ability to spot deficiencies in BMP implementation and address problem areas with targeted education and training.

The results of this survey indicate that, on average, approximately 89 percent of all BMPs recommended by the Arkansas BMP guidelines are implemented on timber sales in the state. This rate of implementation represents a small increase over previous surveys, but remains within the trend of scores in the mid- to upper 80th percentile. In terms of the rate of implementation by BMP category, this survey reflects the same trends of previous surveys: BMPs for harvesting and regeneration activities had higher implementation rates than those for SMZs and Roads, with SMZs having the lowest score.

Likewise, the trends for ownership class were comparable with past surveys: federal ownership had the highest rates of BMP implementation, followed by industry, corporate, and PNIFLOs (Table 22) (Figure 9). Due to the relatively few harvests on state property, it is difficult determine an accurate implementation rate.

One new aspect of this survey was the addition of the corporate ownership class. This class was added as an acknowledgement that changing ownership patterns may result in changing management practices. There was a significant difference between the implementation rate of industry and corporate ownerships, and separating the categories resulted in a large increase in the industrial BMP score as compared to previous surveys (Figure 9). The corporate ownership class alone was slightly better than the old "industry" class from the last survey. If the industry and corporate tracts had not been separated in this survey, the result would still be substantially better than that reported previously. This finding indicates that the new industry classification made actual improvement from the last survey. As noted earlier, this improvement is likely due to the continued effects of forest certification programs.

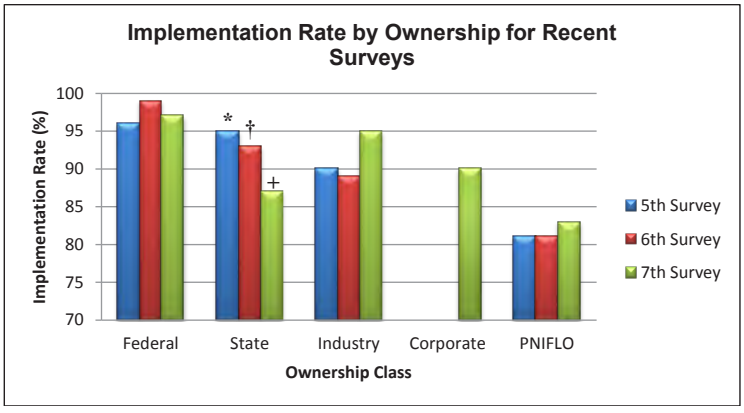
Another trend demonstrated in this survey was that locality was not as important for indicating BMP implementation as other factors, such as ownership class. There were no significant differences in the BMP rates recorded in the four regions examined.

Table 22: *Implementation Rate by Ownership and Year*

Survey Year	Land Ownership Category				
	Federal	Corporate	Industrial	PNIFLO	State
2010-2011	97 percent	90 percent	95 percent	83 percent	87 percent
2007-2008	99 percent	--	89 percent	81 percent	93 percent
2005-2006	96 percent	--	90 percent	81 percent	95 percent*
2002-2003	99 percent	--	93 percent	80 percent	96 percent
2000-2001	96 percent	--	88 percent	74 percent	92 percent
1998-1999	96 percent	--	87 percent	75 percent	82 percent
1996-1997	99 percent	--	89 percent	81 percent	89 percent

** Separate analysis from other Ownership.*

Figure 9: *Implementation Rate by Ownership for Recent Surveys*



* Separate analysis not part of the original survey
† Sample size n = 2
+ Sample size n = 4

Conclusion

Besides examining the four broad physiographic regions, the nine AFC districts were also considered. As with the larger regions, there were no significant differences in implementation rates among the districts (Table 23). While significant differences might be expected due to characteristics in terrain and the presence of an active forest industry, a possible explanation relates to the harvest method used. While final harvests were targeted for the survey, few final harvests are conducted in the Ozark Highlands region, for example, or on the National Forests. Therefore, partial harvests or thinnings were identified to increase the pool of candidate tracts in some areas. Typically, partial harvests or thinning operations are less likely to score as low as a final harvest since some overstory canopy is retained.

Table 23: *AFC District Implementation by BMP Category*

District	Number of Tracts	Acres	Implementation Percent	Margin of Error	Statistical Significance*
District 1	59	4,631	87.50	3.47	a
District 2	30	3,493	90.94	4.92	a
District 3	13	2,416	86.39	5.73	a
District 4	40	3,870	87.34	3.62	a
District 5	38	2,800	90.25	3.67	a
District 6	15	1,108	90.53	6.49	a
District 7	20	1,534	89.22	3.67	a
District 8	8	853	83.04	5.27	a
District 9	18	2,592	90.58	3.01	a

** Implementation percents having a different significance letter are significantly different at the 5 percent probability level.*

Besides the trends noted above, the survey also highlights some important deficiencies in BMP implementation. In the assessment of each BMP category, the specific BMP guidelines with the lowest scores were highlighted. Many, if not most, of these points of concern have been stressed in prior surveys, yet they remain problematic. There continues to be a significant number of streams that are not being adequately protected with an SMZ; when a buffer is left, its effectiveness is sometimes compromised by poor harvest practices within the SMZ. Where no SMZ is left at all, in some cases the error is due to the improper stream classification. Many contractors understand the need to buffer a constantly flowing stream, but erroneously identify intermittent, non-ephemeral streams as ephemeral streams. Lastly, ephemeral drains are not receiving adequate protection during site preparation activities.

As was indicated in the last survey, many of the areas of concern in the remaining categories—Roads, Harvesting, and Regeneration—could be improved by a placing a greater emphasis on BMPs used to close out a tract upon completion of the silvicultural practice. For example, common problems cited in these categories include failing to close out roads, skid trails and fire lanes with water bars, rolling dips or other sediment control devices. Also, stream crossings for both roads and skid trails need improvement. Efforts should be made to ensure that all temporary fill is removed from skid trail crossing and that the banks and approaches to the crossing are stabilized. Similarly, for road crossings, the approaches should be armored, with the last diversion mechanism on the approaches being placed outside of the SMZ; any fill material needs to be placed above the high water mark.

Lastly, a primary goal should be improving the BMP implementation rate in the PNIFLO category. It appears from the PNIFLO Questionnaire, that the general level of knowledge of BMPs and their importance needs to be improved. But, as indicated in the questionnaire, improving landowners' familiarity with BMPs alone will likely do little to increase the rate of BMP implementation. Rather, there should be a multifaceted approach of improving landowners' general knowledge, while at the same time, encouraging them to seek membership in a forestry organization that may offer assistance when conducting a timber sale. Training for logging contractors and foresters should continue to address the problems highlighted in this survey, while a new focus should fall on foresters who work directly with the PNIFLO ownership class.

Poison Springs State Forest

Although a BMP implementation rate could not be ascertained for all state lands, a separate investigation was conducted to determine the use of BMPs on the Poison Springs State Forest. The State Forest—which consists of approximately 21,439 acres in Ouachita and Nevada Counties—is used as a demonstration forest to showcase good forest management practices, among other uses.

In this analysis, all timber sales on the State Forest that were completed within one year were surveyed using the same monitoring form employed in the statewide survey. In all, twelve timber sales were surveyed; the rate of BMP implementation was documented to be 96 percent.

Although this implementation rate cannot be reported as an average implementation rate for the state, it does provide a meaningful benchmark for the AFC to meet or exceed with all future timber sales. It also can serve as useful standard for other state agencies that practice some form of forestland management on their own lands.

Appendix

Wood Harvest and Distribution of Implementation Survey Sites
Based on 2009 Severance Tax records

County	Tons	Tracts Monitored
Arkansas	68,814.00	1
Ashley	823,051.22	9
Baxter	21,045.39	2
Benton	18,989.24	1
Boone	10,020.52	2
Bradley	1,196,198.17	16
Calhoun	686,723.14	10
Carroll	5,904.29	2
Chicot	34,553.04	0
Clark	753,524.91	10
Clay	1,872.57	1
Cleburne	127,351.97	2
Cleveland	609,082.01	6
Columbia	530,431.53	6
Conway	132,183.98	2
Craighead	5,553.90	0
Crawford	2,560.85	0
Crittenden	5,180.32	0
Cross	3,222.31	0
Dallas	811,316.99	11
Desha	129,719.35	0
Drew	779,282.38	9
Faulkner	37,233.35	3
Franklin	47,985.07	1
Fulton	1,266.67	3
Garland	248,984.74	1
Grant	618,252.09	7
Greene	8,824.94	1
Hempstead	336,520.28	5
Hot Spring	460,113.41	5
Howard	323,853.80	5
Independence	143,205.25	1
Izard	61,950.31	2
Jackson	539.42	0
Jefferson	210,334.44	3
Johnson	112,502.47	2
Lafayette	248,702.46	4
Lawrence	6,717.60	0

County	Tons	Tracts Monitored
Lee	36,043.68	2
Lincoln	393,803.50	6
Little River	218,165.37	3
Logan	131,947.22	3
Lonoke	11,032.28	3
Madison	113,235.30	2
Marion	25,537.46	1
Miller	120,679.95	1
Mississippi	0.00	0
Monroe	13,891.43	0
Montgomery	60,092.07	4
Nevada	522,094.63	5
Newton	68,647.41	1
Ouachita	530,163.67	7
Perry	348,675.75	4
Phillips	34,303.92	0
Pike	619,046.28	10
Poinsett	566.03	0
Polk	384,627.89	6
Pope	236,382.00	4
Prairie	39,251.02	4
Pulaski	89,333.48	2
Randolph	11,441.53	2
St. Francis	18,681.29	1
Saline	348,722.22	4
Scott	163,840.89	2
Searcy	139,674.44	2
Sebastain	16,702.43	0
Sevier	223,218.64	2
Sharp	87,750.25	0
Stone	107,787.97	5
Union	1,096,076.88	12
Van Buren	256,150.62	3
Washington	12,740.92	2
White	185,673.40	2
Woodruff	4,364.13	0
Yell	231,037.12	3
TOTAL	**16,524,951.45**	**241**

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