Voluntary Implementation of Forestry Best Management Practices in East Texas

Results from Round 9 of
BMP Implementation Monitoring

TEXAS A&M FOREST SERVICE
A Member of the Texas A&M University System

December 2015

Voluntary Implementation of Forestry Best Management Practices in East Texas

Results from Round 9 of BMP Implementation Monitoring
2013-2015

by

Hughes Simpson, Program Coordinator
Todd Thomas, Water Resources Forester
Donna Work, Biologist

TEXAS A&M FOREST SERVICE
Sustainable Forestry
Water Resources Program

Prepared in Cooperation With the
Texas State Soil and Water Conservation Board
and
U.S. Environmental Protection Agency

This report was financed in part (60%) by a 319(h) grant from the U.S. Environmental Protection Agency through the Texas State Soil and Water Conservation Board.

EXECUTIVE SUMMARY

A Best Management Practices (BMP) monitoring program evaluated the level of implementation of voluntary forestry BMPs in East Texas. A total of 150 randomly selected sites on which silvicultural activities occurred were evaluated. These sites were monitored between July 12, 2013, and October 28, 2015, and are believed to be a representative sample of the forestry activities that occurred in East Texas during that time.

Overall BMP implementation on the monitored sites was 94.0%. In general, implementation was highest on sites under public ownership. These National Forest sites had an overall implementation of 100%. Corporate lands (commercial landowners that do not have wood processing facilities) scored 94.5% overall, while family forest owners scored 93.0%. For the first time since the program began, no sites were monitored on industrial forestland as a result of the land divestiture that began in 2005.

Implementation with BMPs was statistically higher when:

- the logging contractor had attended formal BMP training
- a forester was involved in the sale or activity
- BMPs were included in the timber sale contract

Implementation was generally lowest on sites when:

- a forester was not involved in the sale or activity
- BMPs were not included in the timber sale contract
- the logger had not attended the BMP workshop

Deficiencies noted during the evaluations included:

- adequately draining and stabilizing temporary roads with appropriate structures
- stabilizing stream crossings on temporary roads
- controlling soil movement during site preparation

Improvements from previous rounds included increases in:

- reduction in total significant risks to water quality
- overall BMP implementation on family forest ownership
- overall BMP implementation on stream crossings, especially with regards to using correct crossings and removal of temporary crossings
- maintaining adequate width and residual density in streamside management zones

TABLE OF CONTENTS

BACKGROUND AND OBJECTIVES

The Clean Water Act (CWA), as reauthorized in 1987, called for states to establish a program for development and implementation of Best Management Practices (BMP) to reduce nonpoint source (NPS) water pollution. The Act also required states to develop methods for determining "BMP effectiveness," including a measure of BMP implementation.

The Texas Silvicultural Nonpoint Source Pollution Prevention Project, funded by a Fiscal Year 2012 CWA Section 319(h) grant from the Environmental Protection Agency (EPA) through the Texas State Soil and Water Conservation Board (TSSWCB), requires that a monitoring program be instituted to document the level of voluntary BMP implementation and effectiveness of BMPs in reducing NPS pollution from silvicultural activities. Objectives of the monitoring program are to:

1) Measure the degree of BMP implementation by forest landowners, silvicultural contractors, forest industry, and government agencies.

2) Evaluate the effectiveness of BMPs as applied in the field and identify any weaknesses in the BMP guidelines.

This report documents the findings of BMP implementation monitoring for 150 sites evaluated between July 12, 2013, and October 28, 2015, and represents the ninth round conducted by Texas A&M Forest Service. Previous surveys were published in October 1992, March 1996, April 1998, September 2000, November 2002, October 2005, December 2008, and December 2011. These reports can be viewed online at http://tfsweb.tamu.edu/water.

DISTRIBUTION AND SELECTION OF IMPLEMENTATION MONITORING SITES

To obtain a valid estimate of overall implementation of forestry Best Management Practices, monitoring sites were distributed throughout East Texas and among all forestland ownership categories. Sites were believed to be representative of all silvicultural activities occurring across East Texas. The distribution of monitoring sites was based on the estimated annual timber harvest for each county as reported in the Texas A&M Forest Service publication *Texas Forest Resource Harvest Trends 2011*, and the average annual removals of growing stock by ownership class, as reported in a June 2013 query of the Forest Inventory EVALIdator web-application version 1.5.1.05. See Table 1.

In order to obtain a sample of recently conducted silvicultural operations for implementation monitoring, satellite imagery was used at several points throughout the monitoring period, each time focusing on a different area in East Texas. The detection process utilized the shortwave infrared band of Landsat images, which is correlated to

vegetation moisture. Large increases in shortwave infrared reflectance between two dates indicate silvicultural activity, so monitoring sites in a given period were identified by subtracting the shortwave infrared reflectance at the beginning of the period from the reflectance at the end of the period and mapping the difference. Over 540 operations were identified across East Texas, from which 150 sites were randomly selected to be monitored for this survey, using the distribution parameters outlined above.

Table 1. Distribution of Implementation Monitoring Sites by County.

County	Number of Sites Monitored
Anderson	3
Angelina	8
Bowie	4
Cass	7
Cherokee	6
Gregg	1
Hardin	7
Harrison	3
Henderson	1
Houston	4
Jasper	13
Liberty	5
Marion	3
Montgomery	2
Morris	1
Nacogdoches	7
Newton	10
Orange	2
Panola	6
Polk	8
Red River	2
Rusk	2
Sabine	6
San Augustine	6
San Jacinto	1
Shelby	5
Smith	3
Titus	1
Trinity	7
Tyler	11
Upshur	2
Walker	2
Wood	1
Total	**150**

QUALITY CONTROL

To eliminate bias, implementation monitoring sites were randomly selected from a pool of recent silvicultural operations identified through satellite imagery detection. All monitoring evaluations were conducted by one or a combination of two trained foresters assigned to the TFS Water Resources Program. Using only program employees as inspectors provided greater accuracy and quality control. At the beginning of the monitoring project, as well as periodically throughout the survey, inspectors jointly evaluated sites to ensure consistency. All monitoring data was collected in accordance with a Quality Assurance Project Plan, approved by TSSWCB and EPA.

MONITORING CHECKLIST

The monitoring checklist that was used in Round 9 was also used for the previous five surveys, a period dating back to 1999. This objective, 45-question form follows the *BMP Implementation Monitoring Framework*, a guidance document approved by the Southern Group of State Foresters to promote consistency among the southern states when conducting BMP implementation monitoring. The form is found in the Appendix.

The monitoring form evaluates BMPs for seven different categories: Permanent Roads, Temporary Roads/Skid Trails, Stream Crossings, Streamside Management Zones, Site Preparation, Landings, and Wetlands. Each question is worded so that a positive response is answered with a "Yes," while a negative response, indicating a departure from BMP recommendations, is answered "No." Questions that are not applicable to the site are answered "NA." Questions answered "No" are also evaluated to determine if a "significant risk" to water quality exists. A significant risk is an existing on-the-ground condition resulting from failure to correctly implement BMPs that, if left unmitigated, has already or will likely result in an adverse change in the chemical, physical, or biological condition of a water body. Such change may or may not violate water quality standards. Follow up questions are answered, when applicable or known, to determine trends associated with BMP implementation. A comments section at the end of the form provides additional information related to BMP implementation on the site.

Each site was scored with a value representing percent implementation. This score was computed by dividing the number of questions receiving a yes answer by the total number of applicable questions [Y/(Y+N)]. A qualitative assessment was also included in which sites were rated as *No Effort, Poor, Fair, Good,* or *Excellent*.

Site evaluations were entered into a database for storage and analysis. These data were also imported into a Geographic Information System (GIS) for further analysis and spatial representation.

INSPECTION CONTACTS

Landowners were contacted prior to inspecting the site so that permission for entry onto the property could be obtained. During this initial contact, the inspector explained the program, recorded information regarding the operation, and invited the landowner and his/her representative to join him on site during the evaluation. Sites were resampled if the landowner denied access. In nearly all cases on corporate and public forestland, a professional forester accompanied the inspector. Landowners, logging contractors, foresters, and timber buyers (where applicable and identifiable) were provided a copy of the completed checklist, along with a cover letter explaining the Water Resources program and instructions on interpreting the form.

RESULTS

Between July 12, 2013, and October 28, 2015, TFS Water Resources foresters evaluated BMP implementation on 150 sites, totaling 16,500 acres, throughout 33 counties in East Texas. These sites are spatially represented by ownership category in Figure 1. Tabulated results for each question on the BMP implementation monitoring checklist are located in the Appendix.

SITE CHARACTERISTICS

Eighty-one of the 150 sites (54%) were on family forest lands. Sixty-four sites (43%) were owned by corporate landowners. Five sites (3%) were on public lands.

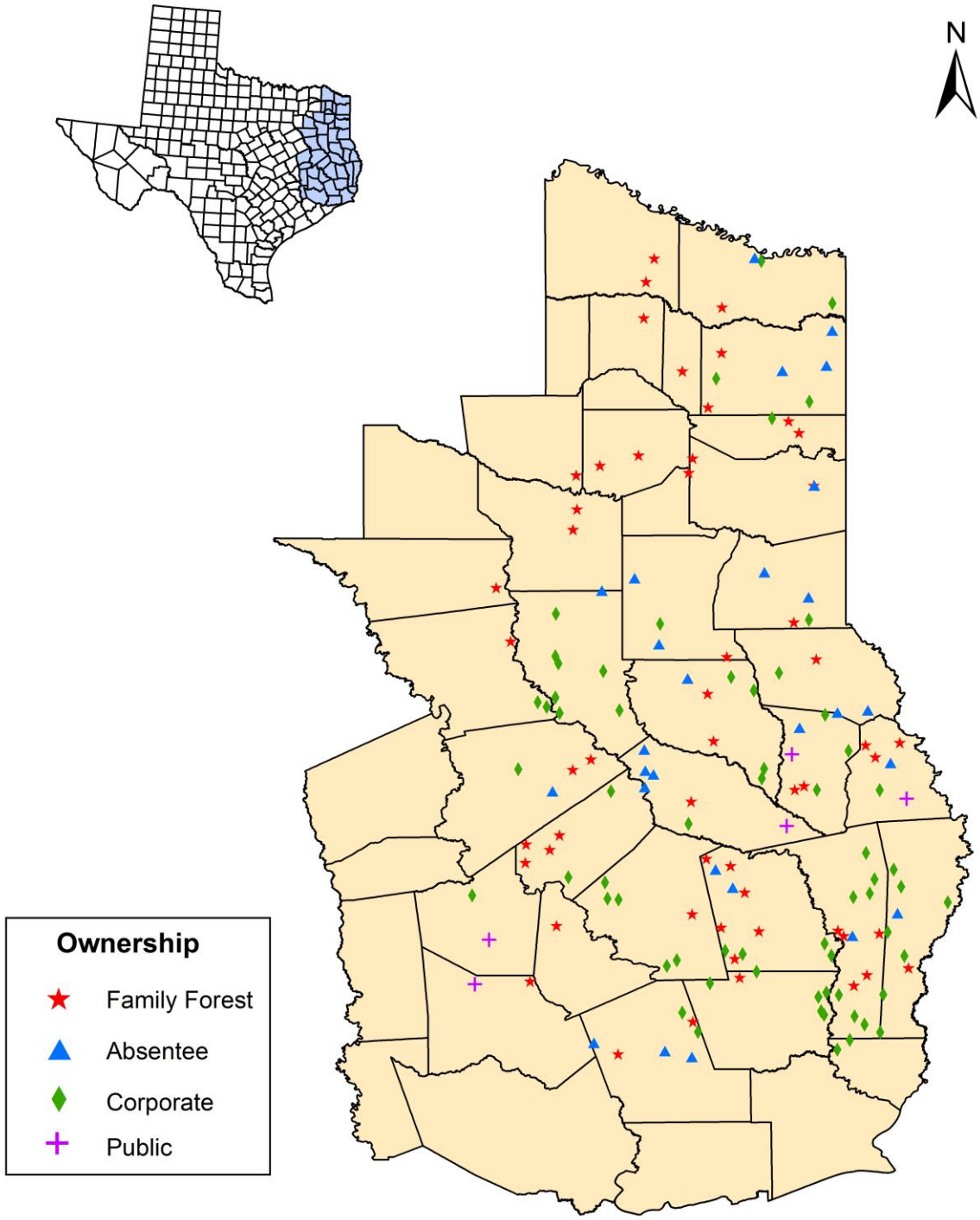
The majority of sites (49%) were monitored after a regeneration harvest, which included 73 clearcuts. Forty-one site preparation and/or plantings, and 36 thinning operations were evaluated. In 51 cases, the site preparation was evaluated as an element of the preceding timber harvest operation (10) or succeeding planting operation (41).

Professional foresters were involved in planning and/or administering the silvicultural operation on 148 (99%) of the sites. Private consultants were involved on 74 of the sites. On 69 sites, the forester was employed by corporations, while U.S. Forest Service foresters were involved on 5 sites.

Terrain classification was observed on the site and general soil erodibility was determined from the Natural Resources Conservation Service (NRCS) Soil Survey, if available, or estimated by the forester in the field. Ninety sites (60%) were on flat terrain. Thirty-eight sites (25%) were on hilly terrain and 22 (15%) were on steep terrain. Eighty-eight sites (59%) were on soils with low erodibility, 56 sites (37%) on medium erodibility soils, and 6 (4%) were on high erodibility soils.

Of the 150 sites, 118 contained either a perennial (23) or intermittent (57) stream or both (38). A permanent water body was found within 1,600 feet of 128 sites (85%).

Figure 1. Site Locations by Ownership Category.



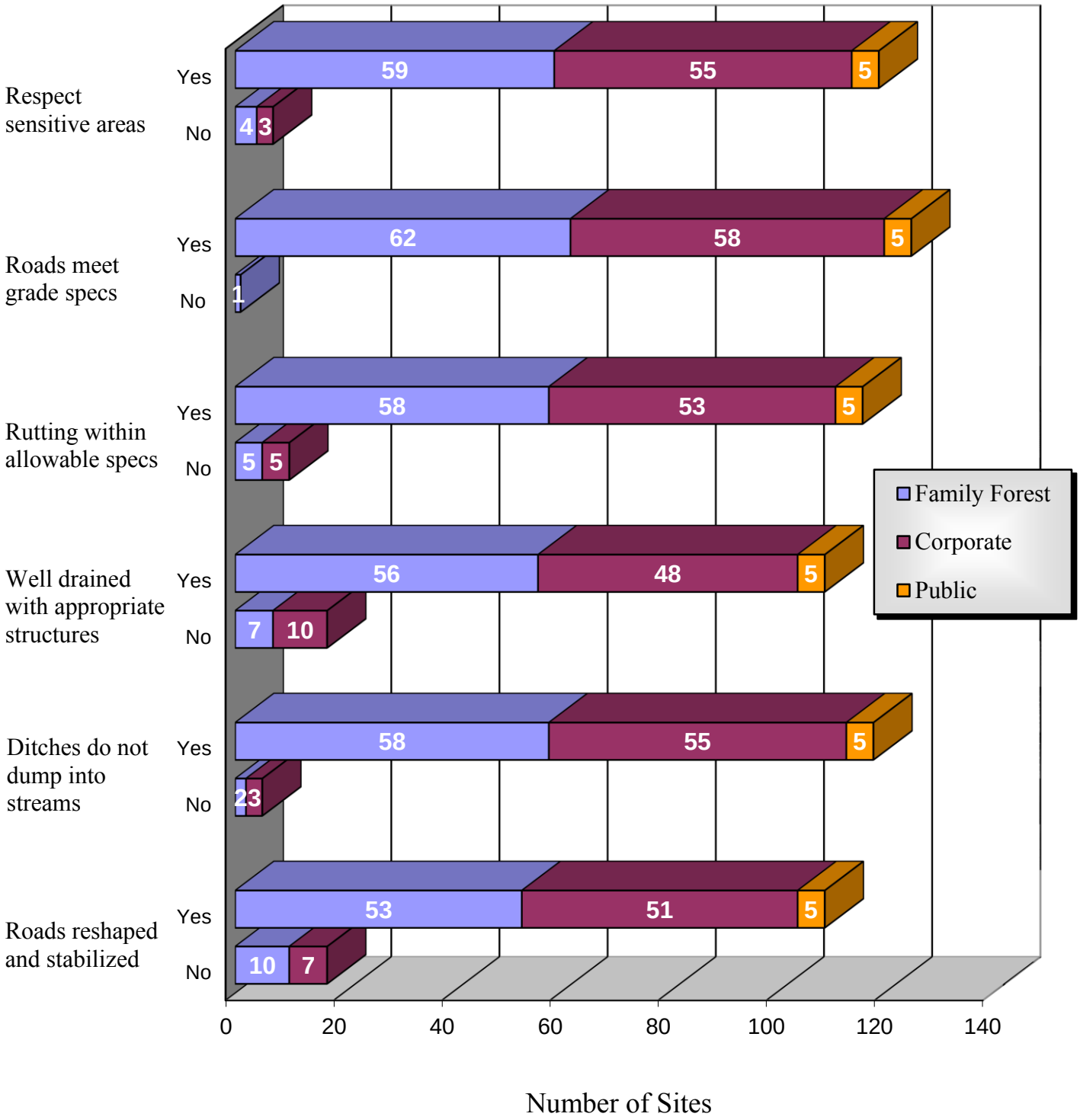
PERMANENT ROADS

Permanent roads were evaluated for BMP implementation when they were used in the forestry operation. Permanent roads in the forestry context are generally graded dirt roads that are used for year-round access. County roads were not included in the monitoring, as they are not under the management control of the landowner. Permanent roads were applicable on 126 of the 150 sites. The percent implementation for permanent roads was 92.4% with no significant risks. Within this category, the lowest scores (86.5%) were for roads being well drained with appropriate structures and roads reshaped and stabilized. The highest score was for roads meeting grade specifications (99.2%). See Table 2. Figure 2 breaks down the numbers of sites into ownership type.

Table 2. Implementation of BMPs Relating to Permanent Roads.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Respect sensitive areas	119	7	24	94.4	0	4.1
Roads meet grade specifications	125	1	24	99.2	0	1.6
Rutting within allowable specs	116	10	24	92.1	0	4.8
Well drained with appropriate structures	109	17	24	86.5	0	6.1
Ditches do not dump into streams	118	5	27	95.9	0	3.6
Roads reshaped and stabilized	109	17	24	86.5	0	6.1
Overall	**696**	**57**	**147**	**92.4**	**0**	**1.9**

Figure 2. BMP Implementation on Permanent Roads by Ownership Type.



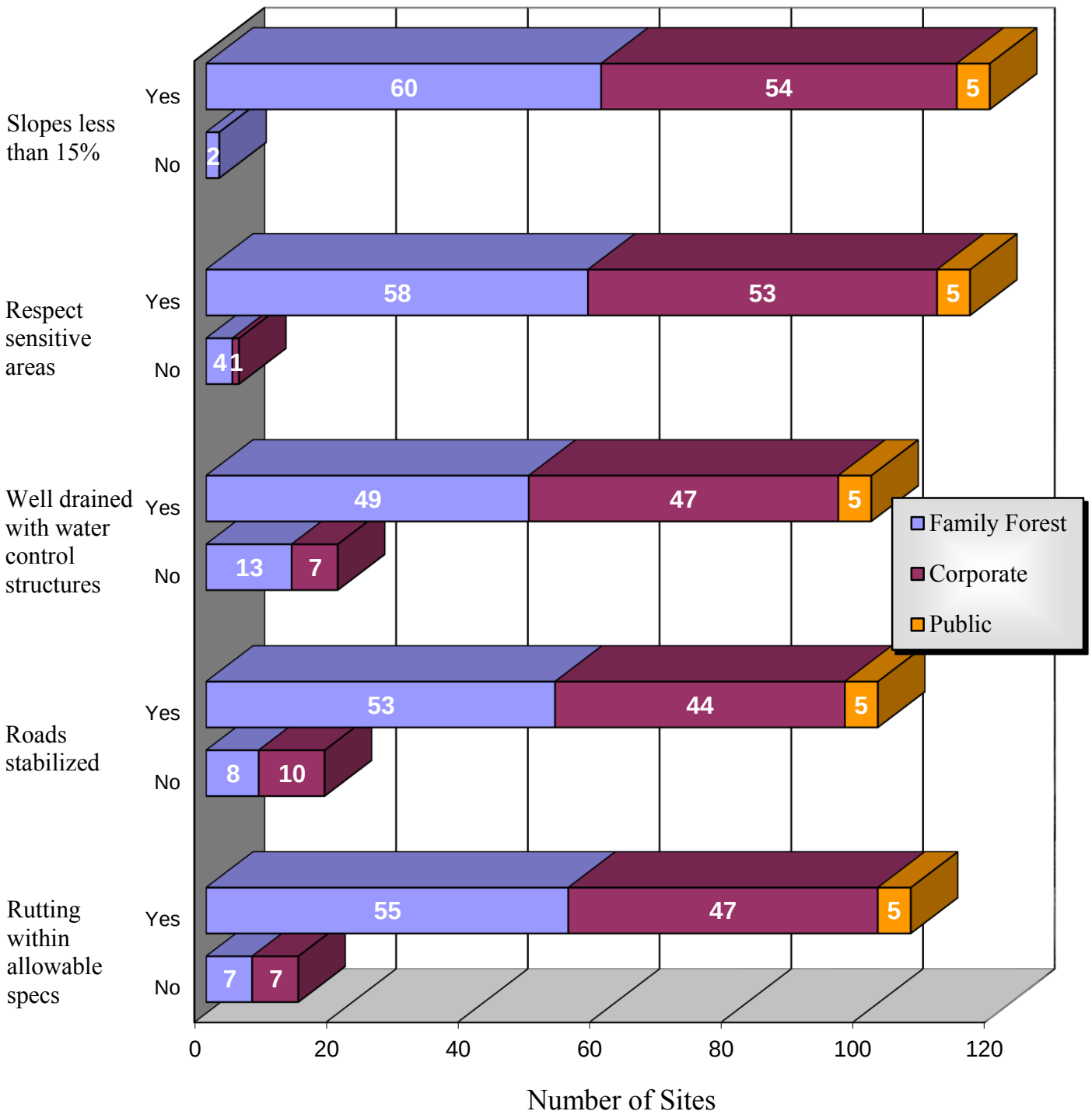
SKID TRAILS AND TEMPORARY ROADS

Skid trails and temporary roads were evaluated on 121 of the 150 monitoring sites. Skid trails are routes through the logging area in which logs are skidded or dragged to a central loading point called a "deck," "landing," or "set." Temporary roads are not designed to carry traffic long-term and are usually retired, closed, or reforested after the harvest activity. The percent implementation for temporary roads was 90.2% with no significant risks. Within this category, the lowest implementation score was for roads being well drained with appropriate water control structures (83.5%). The highest score (98.3%) was for roads meeting grade specifications. See Table 3 and Figure 3.

Table 3. Implementation of BMPs Relating to Skid Trails and Temporary Roads.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Slopes less than 15%	119	2	29	98.3	0	2.4
Respect sensitive areas	116	5	29	95.9	0	3.6
Well drained with water control structures	101	20	29	83.5	0	6.8
Roads stabilized	102	18	30	85.0	0	6.5
Rutting within allowable specifications	107	14	29	88.4	0	5.8
Overall	**545**	**59**	**146**	**90.2**	**0**	**2.4**

Figure 3. BMP Implementation on Skid Trails/Temporary Roads by Ownership Type.



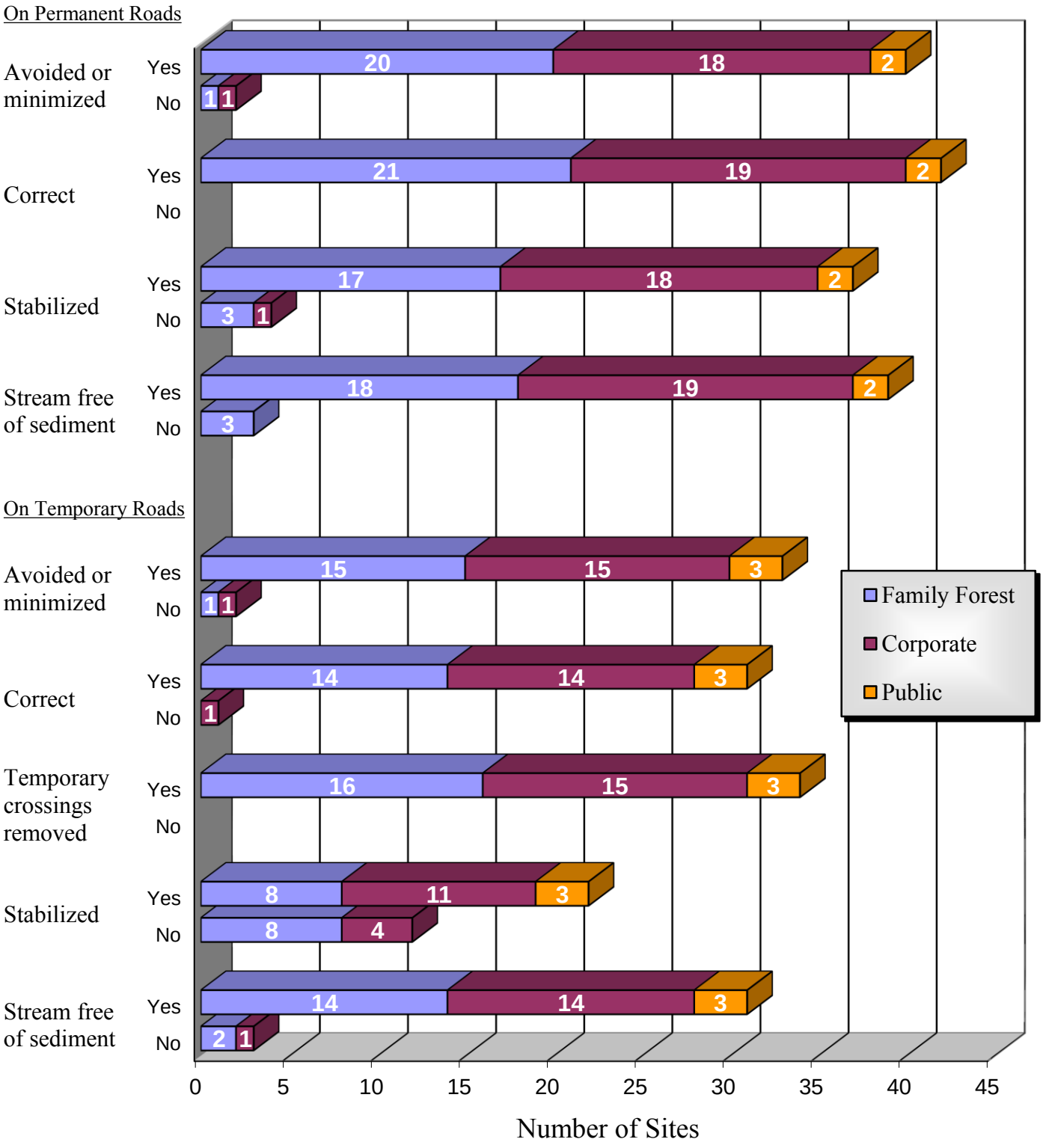
STREAM CROSSINGS

Stream crossings were evaluated on 51 sites. Sixteen sites had crossings on permanent roads only, 9 had crossings on temporary roads only, and 26 had crossings on both permanent and temporary roads. The percent implementation for stream crossings was 92.0% with no significant risks. Within this category, the lowest implementation score for stream crossings on both permanent and temporary roads was stabilization of crossings (90.2% on permanent roads, 64.7% on temporary roads). The highest implementation on permanent roads was for correctness (100%); for temporary roads, it was for removing temporary crossings (100%). See Table 4 and Figure 4.

Table 4. Implementation of BMPs Relating to Stream Crossings.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Permanent Roads						
Avoided or minimized	40	2	108	95.2	0	6.6
Correct	42	0	108	100	0	-
Stabilized	37	4	109	90.2	0	9.3
Stream free of sediment	39	3	108	92.8	0	8.0
Permanent Roads Total	*158*	*9*	*433*	*94.6*	*0*	*3.5*
Temporary Roads						
Avoided or minimized	33	2	115	94.3	0	7.8
Correct	31	1	118	96.9	0	6.1
Temporary crossings removed	34	0	116	100	0	-
Stabilized	22	12	116	64.7	0	16.4
Stream free of sediment	31	3	116	91.2	0	9.7
Temporary Roads Total	*151*	*18*	*581*	*89.3*	*0*	*4.8*
Overall	**309**	**27**	**1,014**	**92.0**	**0**	**3.0**

Figure 4. BMP Implementation on Stream Crossings by Ownership Type.



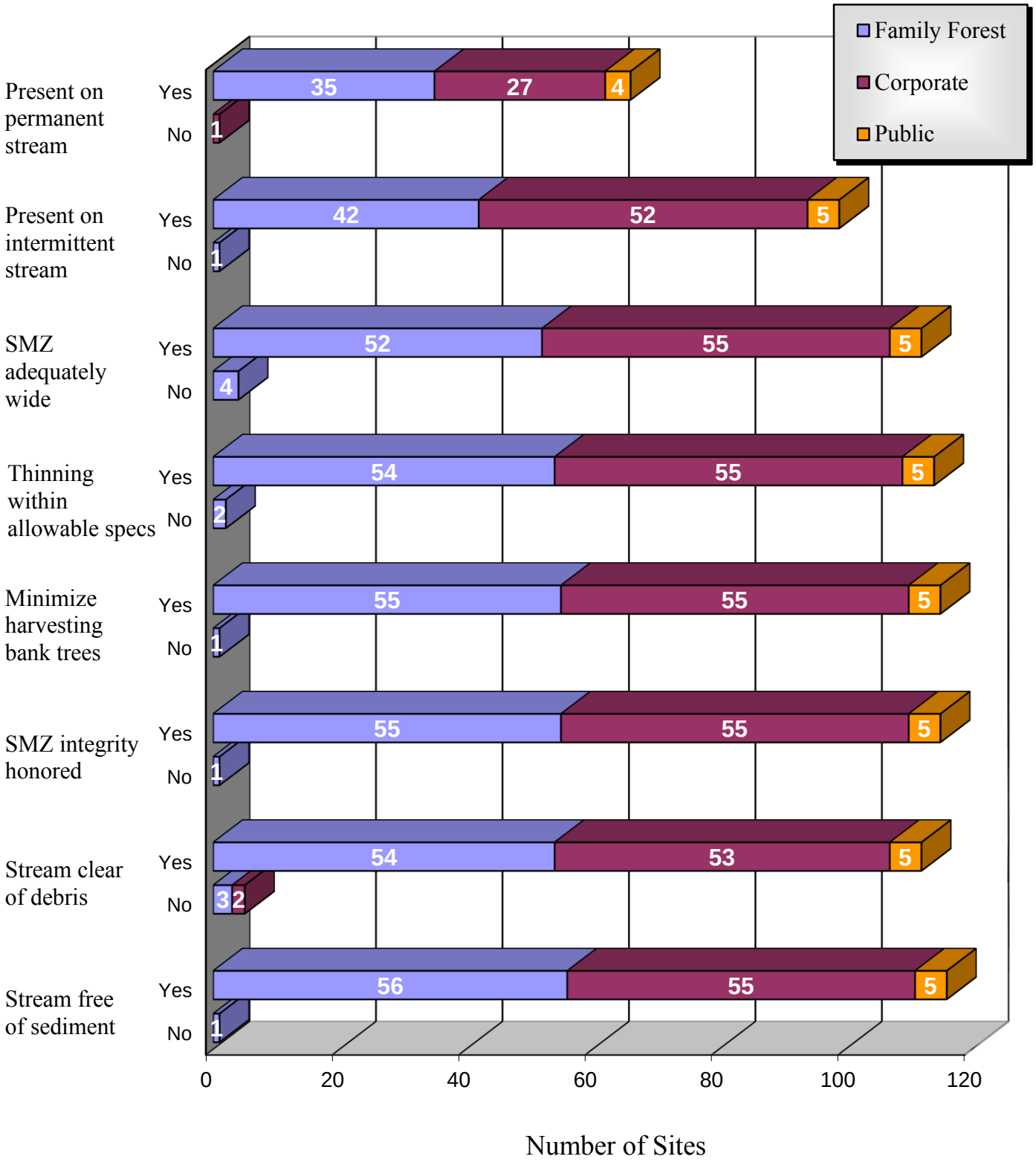
STREAMSIDE MANAGEMENT ZONES

Streamside management zones (SMZs) are recommended on all perennial and intermittent streams. All sites with either a perennial or intermittent stream were evaluated for the presence and adequacy of SMZs. Streams were present on 118 of the 150 sites. Of these 118 sites, 23 had perennial streams only, 57 had intermittent streams only, and 38 had both perennial and intermittent streams. The percent implementation for SMZs was 98.2% with no significant risks. Within this category, the lowest implementation was for stream clear of debris (95.7%), while the highest scores were for stream free of sediment, SMZ integrity honored, and minimize harvesting bank trees (99.1%). See Table 5 and Figure 5.

Table 5. Implementation of BMPs Relating to SMZs.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Present on perennial stream	66	1	83	98.5	0	3.0
Present on intermittent stream	99	1	50	99.0	0	2.0
SMZ adequately wide	112	4	34	96.6	0	3.4
Thinning within specifications	114	2	34	98.3	0	2.4
Minimize harvesting bank trees	115	1	34	99.1	0	1.8
SMZ integrity honored	115	1	34	99.1	0	1.8
Stream clear of debris	112	5	33	95.7	0	3.8
Stream free of sediment	116	1	33	99.1	0	1.7
Overall	**849**	**16**	**335**	**98.2**	**0**	**0.9**

Figure 5. BMP Implementation on Streamside Management Zones by Ownership Type.



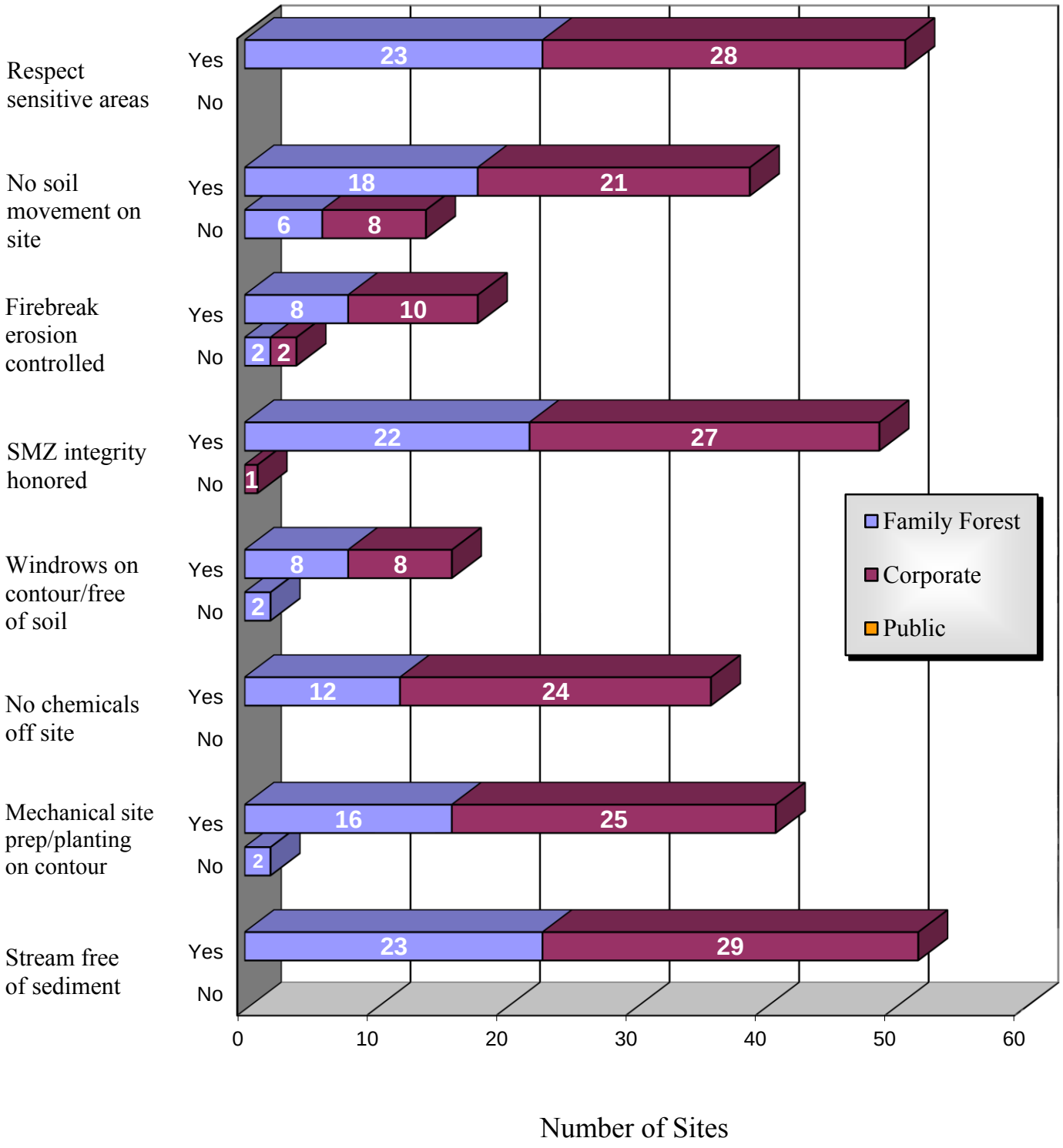
SITE PREPARATION

Fifty-two sites were evaluated for implementation of site preparation BMPs. A variety of site preparation techniques were evaluated, including some combination of herbicide, shearing, piling, subsoiling, bedding, burning, and planting. Six sites involved application of herbicide only. The implementation for site preparation was 92.6% with two significant risks noted. Within this category, two areas were found to have fully implemented BMPs (100%) - no chemicals off site and stream free of sediment. The lowest implementation score was for no soil movement on site (73.6%). See Table 6 and Figure 6.

Table 6. Implementation of BMPs Relating to Site Preparation.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Respect sensitive areas	51	1	98	98.1	0	3.8
No soil movement on site	39	14	97	73.6	1	12.1
Firebreak erosion controlled	18	4	128	81.8	0	16.4
SMZ integrity honored	49	1	100	98.0	1	4.0
Windrows on contour/free of soil	16	2	132	88.9	0	14.8
No chemicals off site	36	0	114	100	0	-
Mechanical site prep/ planting on contour	41	2	107	95.3	0	6.4
Stream free of sediment	52	0	98	100	0	-
Overall	**302**	**24**	**874**	**92.6**	**2**	**3.0**

Figure 6. BMP Implementation on Site Preparation by Ownership Type.



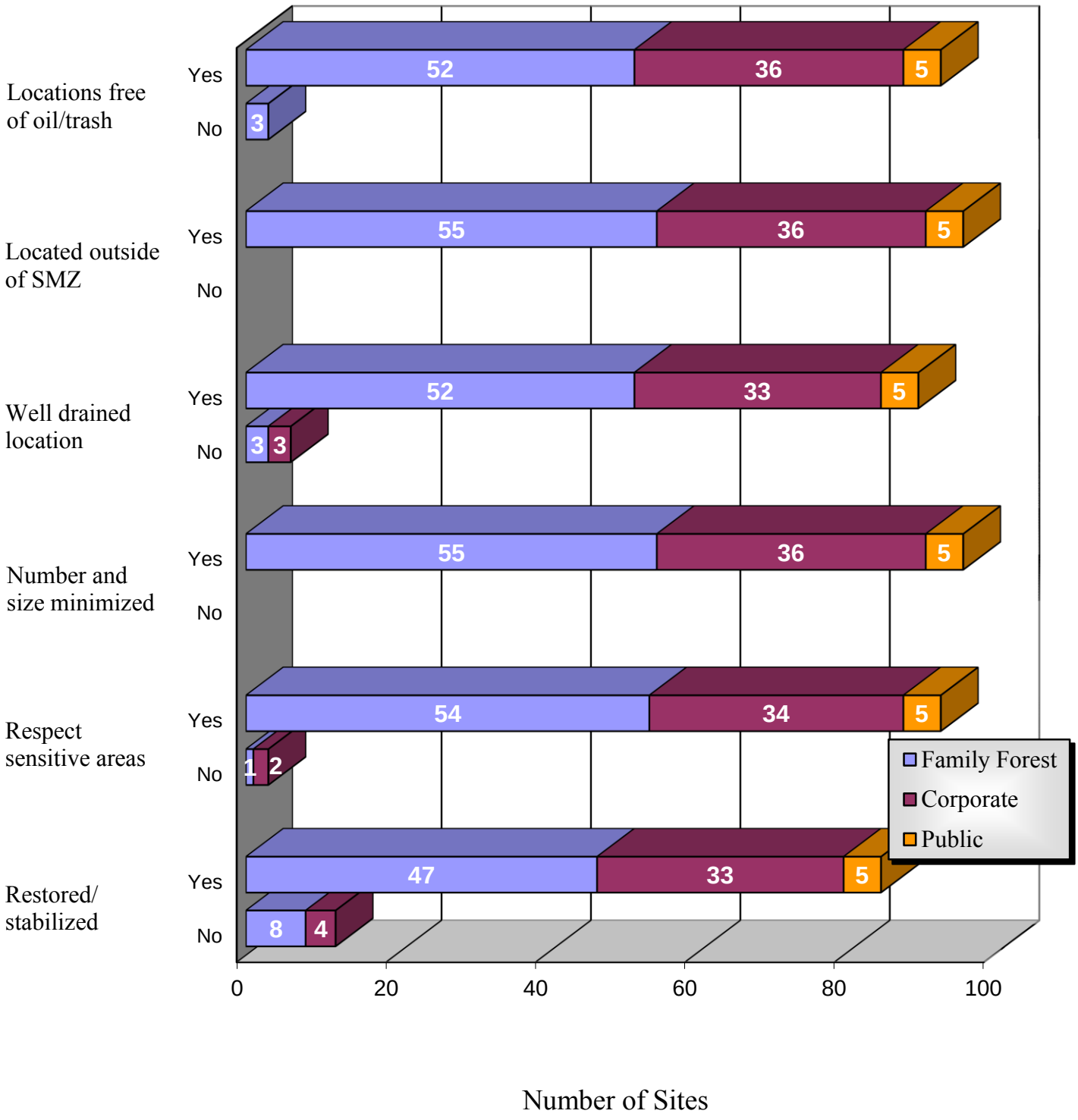
LANDINGS

Landings, sometimes called "decks" or "sets," are areas where logs are gathered, delimbed, bucked, and loaded onto trucks. Landings were evaluated on 96 sites with an overall implementation of 95.8% with no significant risks. Within this category, two areas were found to have fully implemented BMPs (100%) - located outside of SMZ and number and size minimized. The lowest implementation score was for landings being restored/stabilized (87.6%). See Table 7 and Figure 7.

Table 7. Implementation of BMPs Relating to Landings.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Location free of oil/trash	93	3	54	96.9	0	3.5
Located outside of SMZ	96	0	54	100	0	-
Well drained location	90	6	54	93.8	0	4.9
Number and size minimized	96	0	54	100	0	-
Respect sensitive areas	93	3	54	96.9	0	3.5
Restored/stabilized	85	12	53	87.6	0	6.7
Overall	**553**	**24**	**323**	**95.8**	**0**	**1.7**

Figure 7. BMP Implementation on Landings by Ownership Type.



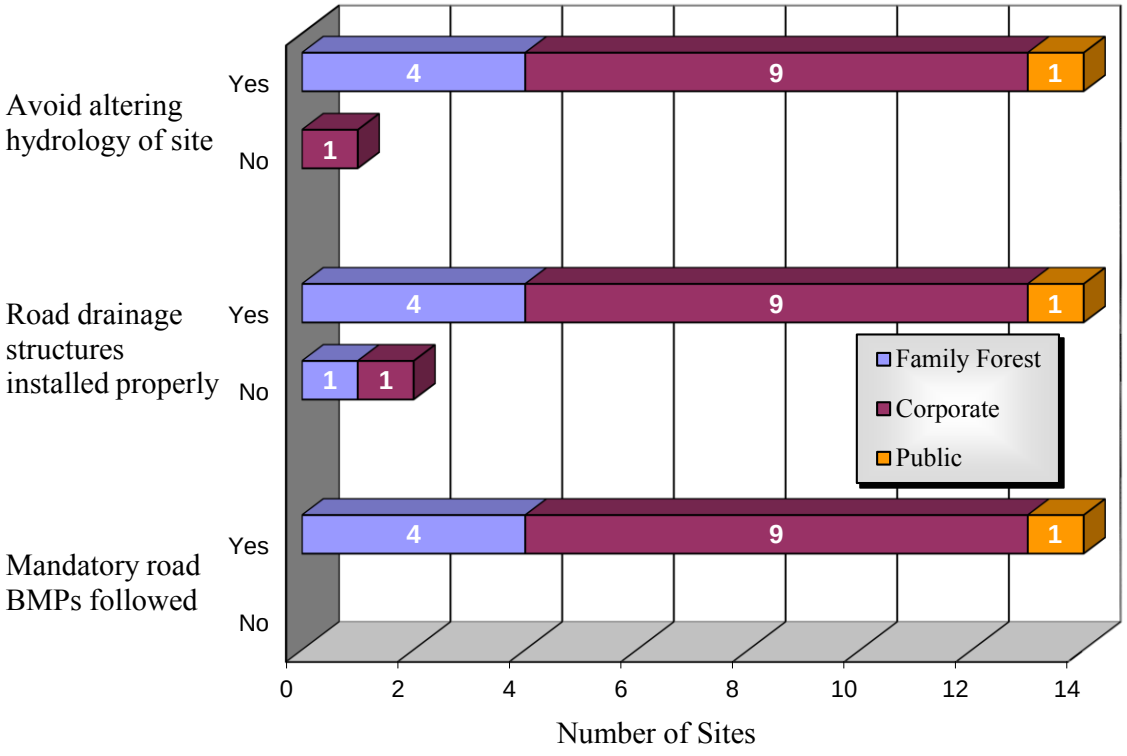
WETLANDS

Sixteen sites had wetland or "wetland like" areas – not necessarily jurisdictional wetlands. These sites had an overall implementation of 93.3%. No significant risks were noted and all mandatory road BMPs for wetlands were followed. See Table 8 and Figure 8.

Table 8. Implementation of BMPs Relating to Wetlands.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Avoid altering hydrology of site	14	1	135	93.3	0	12.9
Road drainage structures installed properly	14	2	134	87.5	0	16.5
Mandatory road BMPs followed	14	0	136	100	0	-
Overall	**42**	**3**	**405**	**93.3**	**0**	**7.4**

Figure 8. BMP Implementation on Wetlands by Ownership Type.



OVERALL BMP IMPLEMENTATION

To illustrate the range of the overall implementation scores, Figures 9 and 10 separate the results into five categories: 60-70%, 71-80%, 81-90%, 91-95%, and 96-100%. Figure 9 spatially illustrates implementation across all ownership types. Figure 10 demonstrates the distribution of sites by implementation score class and ownership type.

IMPLEMENTATION BY SITE CHARACTERISTICS

Ownership

BMP implementation varied by ownership type. The public ownership category fared best, with an overall implementation of 100% and no significant risks on five sites.

The 64 sites managed by corporate entities had an overall implementation rate of 94.5% with one significant risk.

Family forest owners had an implementation rating of 93.2% with one significant risk on 81 sites.

Type of Activity

Three types of silvicultural activities were monitored: regeneration harvests, thinning, and site preparation. Two sites were evaluated for site preparation only; nine were planting only; and 30 were site preparation and planting. Eleven of the regeneration harvest sites were evaluated along with planting and/or site preparation. See Table 9.

Table 9. Overall BMP Implementation by Type of Operation.

Type of Operation	BMP Implementation
Regeneration harvest (clearcut)	93.4%
Thinning	95.9%
Site preparation and/or planting	93.3%

Figure 9: Overall Implementation Scores Across all Ownerships and Monitoring Criteria.

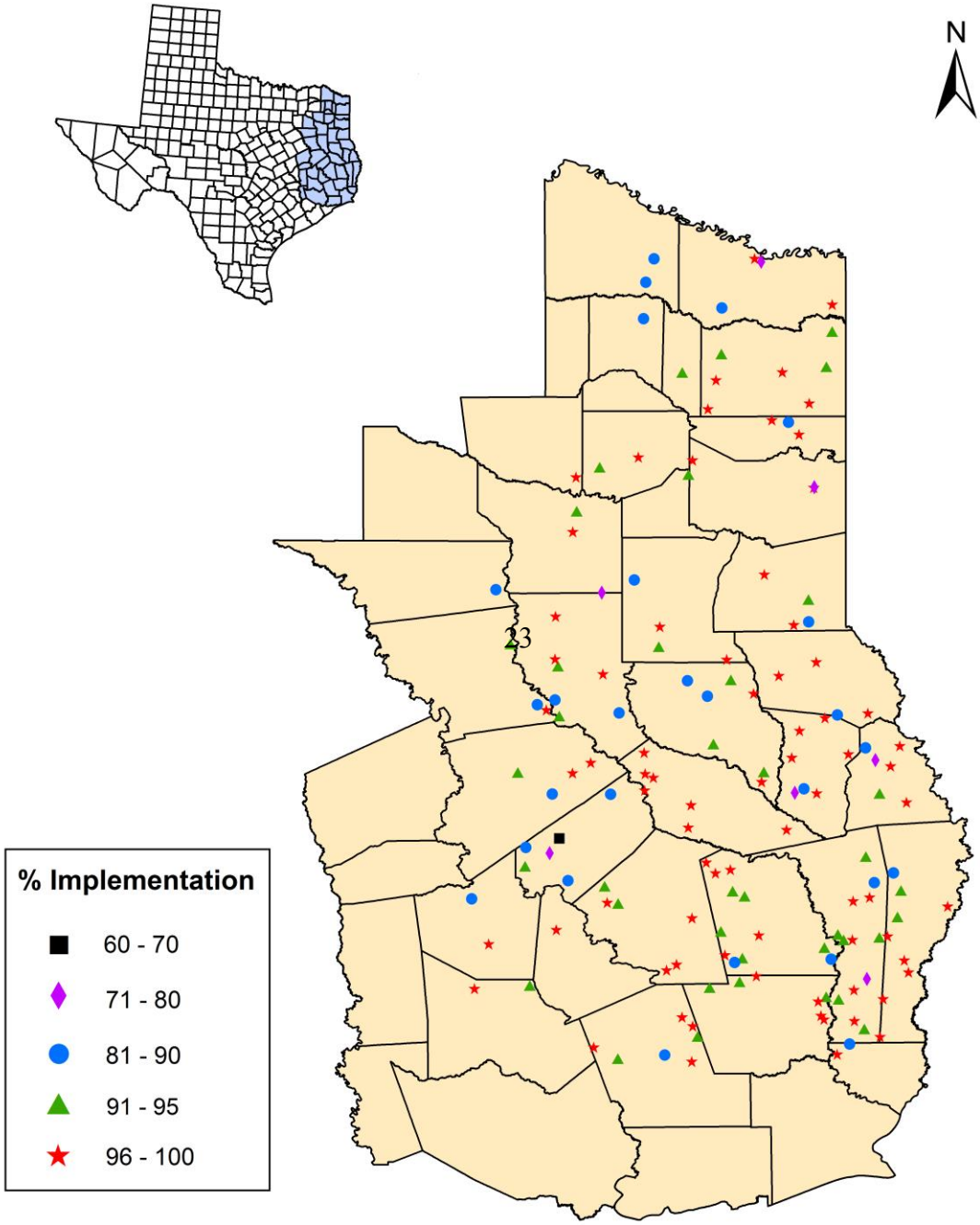
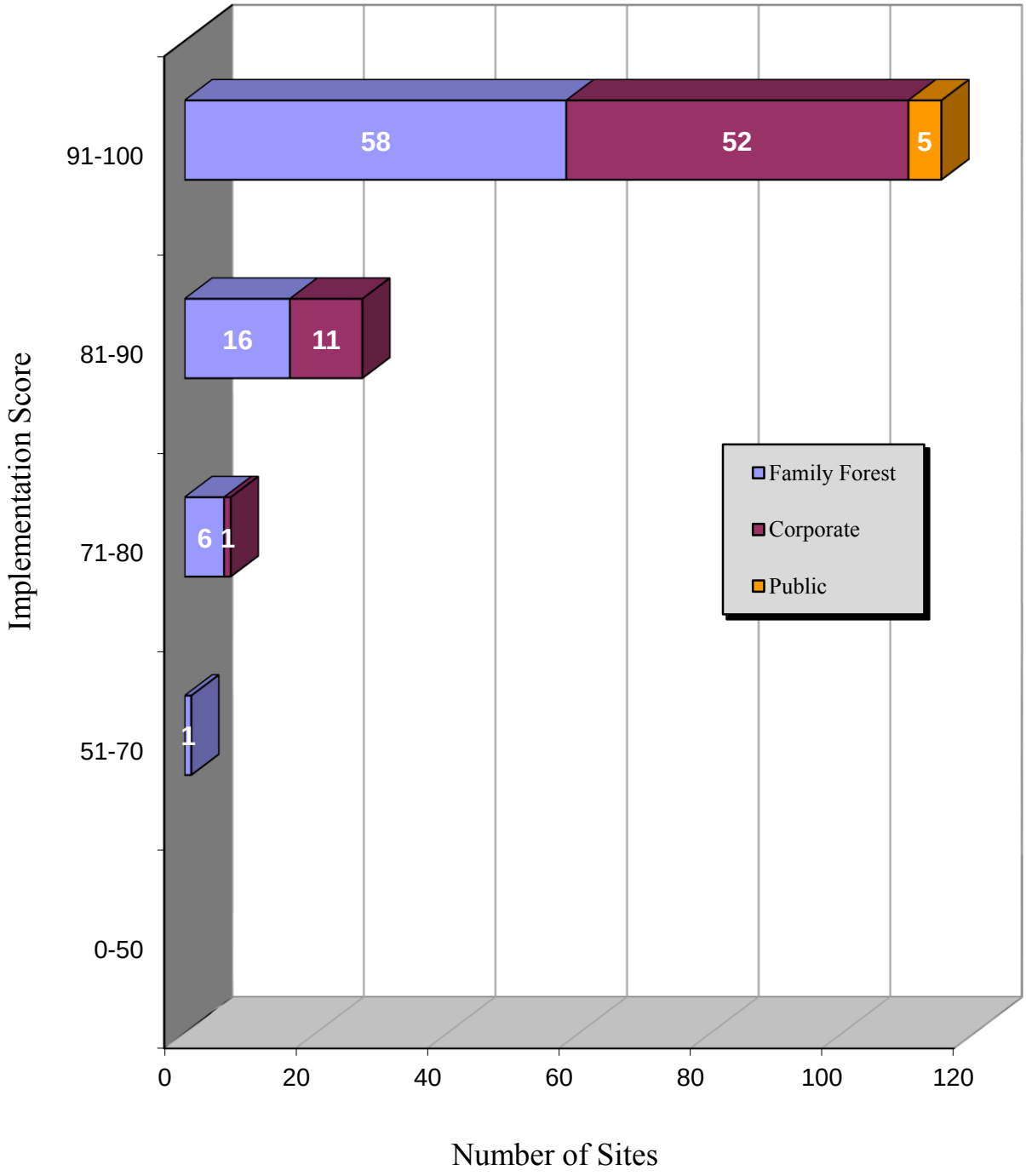


Figure 10. Overall Implementation Scores by Number of Sites and Ownership.



Region

East Texas was divided into two regions, North and South, for easy comparison of BMP implementation rates. The line was drawn along the northern boundary of Leon, Houston, Angelina, San Augustine, and Sabine Counties. Eighty-nine sites were monitored in the southern region and had an implementation rating of 94.5%, while 61 sites were monitored in the northern region with an implementation rating of 93.1%. The higher BMP implementation in Southeast Texas is expected due to the high concentration of corporate and public ownership; flatter topography; and less erodible soils.

Terrain

Monitoring sites were classified as *Flat*, *Hilly*, or *Steep*. BMP implementation on the 90 flat sites was 93.3% with one significant risk; 95.1% with one significant risk on the 38 hilly sites; and 94.8% with no significant risks on the 22 steep sites.

Erodibility

Monitoring sites were identified as having *Low*, *Medium*, or *High* soil erodibility. BMP implementation was 93.9% with one significant risk on a total of 88 low erodibility sites; 93.8% with no significant risks on 56 medium erodibility sites; and 96.7% with one significant risk on 6 high erodibility sites.

Distance to Permanent Water

Distance to the nearest permanent waterbody was determined for each monitoring site. BMP implementation on 90 sites with permanent water less than 300 feet away was 93.4% with one significant risk. BMP implementation was 93.4% with no significant risks on 23 sites with permanent water 300 to 800 feet away; 94.6% with one significant risk on 15 sites with permanent water 800 to 1600 feet away; and 96.5% with no significant risks on the 22 sites in which permanent water was greater than 1,600 feet away.

River Basin

Monitoring sites were located in the following river basins: Cypress, Neches, Red, Sabine, San Jacinto, Sulphur, and Trinity. BMP implementation was highest in the San Jacinto River Basin (95.0%, 1 site) and lowest in the Red River Basin (87.5%, 2 sites). See Table 10 and Figure 11.

Hydrologic Unit Code (Watershed)

Monitoring sites were also assessed by their eight digit hydrologic unit code (HUC). One HUC (12040101) had an implementation score of 100%. Seventeen of the 20 watersheds (85%) scored over 90%. The lowest rated watershed had a BMP implementation rating of 87.5% (11140106). It should be noted that only two sites were monitored within this watershed. See Table 11 and Figure 12.

Table 10. BMP Implementation by River Basin.

River Basin	Number of Sites	% Implementation	Significant Risks
Cypress	13	94.8	0
Neches	75	94.4	1
Red	2	87.5	0
Sabine	34	94.5	0
San Jacinto	1	95.0	0
Sulphur	8	91.4	0
Trinity	17	92.0	1

Table 11. BMP Implementation by 8-digit Hydrologic Unit Code.

Hydrologic Unit Code	Number of Sites	% Implementation	Significant Risks
11140106	2	87.5	0
11140302	6	91.2	0
11140303	2	92.0	0
11140305	2	89.2	0
11140306	7	95.6	0
11140307	4	96.1	0
12010002	15	93.3	0
12010004	5	96.0	0
12010005	16	95.0	0
12020001	5	91.2	0
12020002	17	95.5	1
12020003	16	94.7	0
12020004	7	94.3	0
12020005	16	93.4	0
12020006	10	95.9	1
12020007	5	96.1	0
12030002	1	91.7	0
12030202	10	88.9	0
12040101	2	100	0
12040103	2	93.9	0

Proximity to 303 (d) Listed Stream Segments

The proximity of BMP monitoring sites to 303(d) listed (impaired) stream segments was analyzed using GIS. Eighteen sites were identified to be within one mile of a listed stream segment and had an implementation rating of 94.2%. It should be noted that BMP implementation was higher near these listed waters than the overall BMP implementation for all monitored sites. Forest operations provided greater water quality protection near these sensitive areas.

Figure 11. Site Location by River Basin.

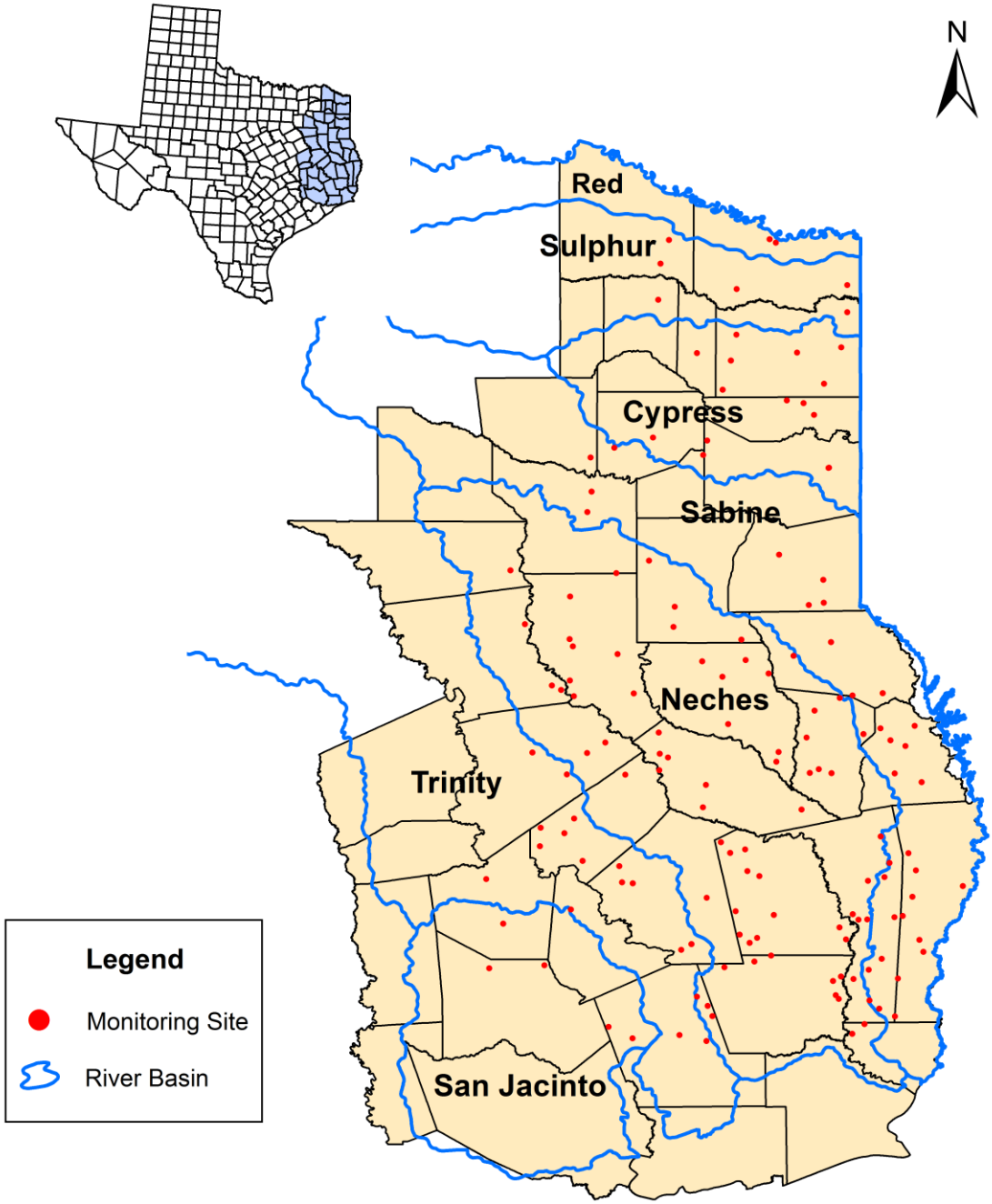
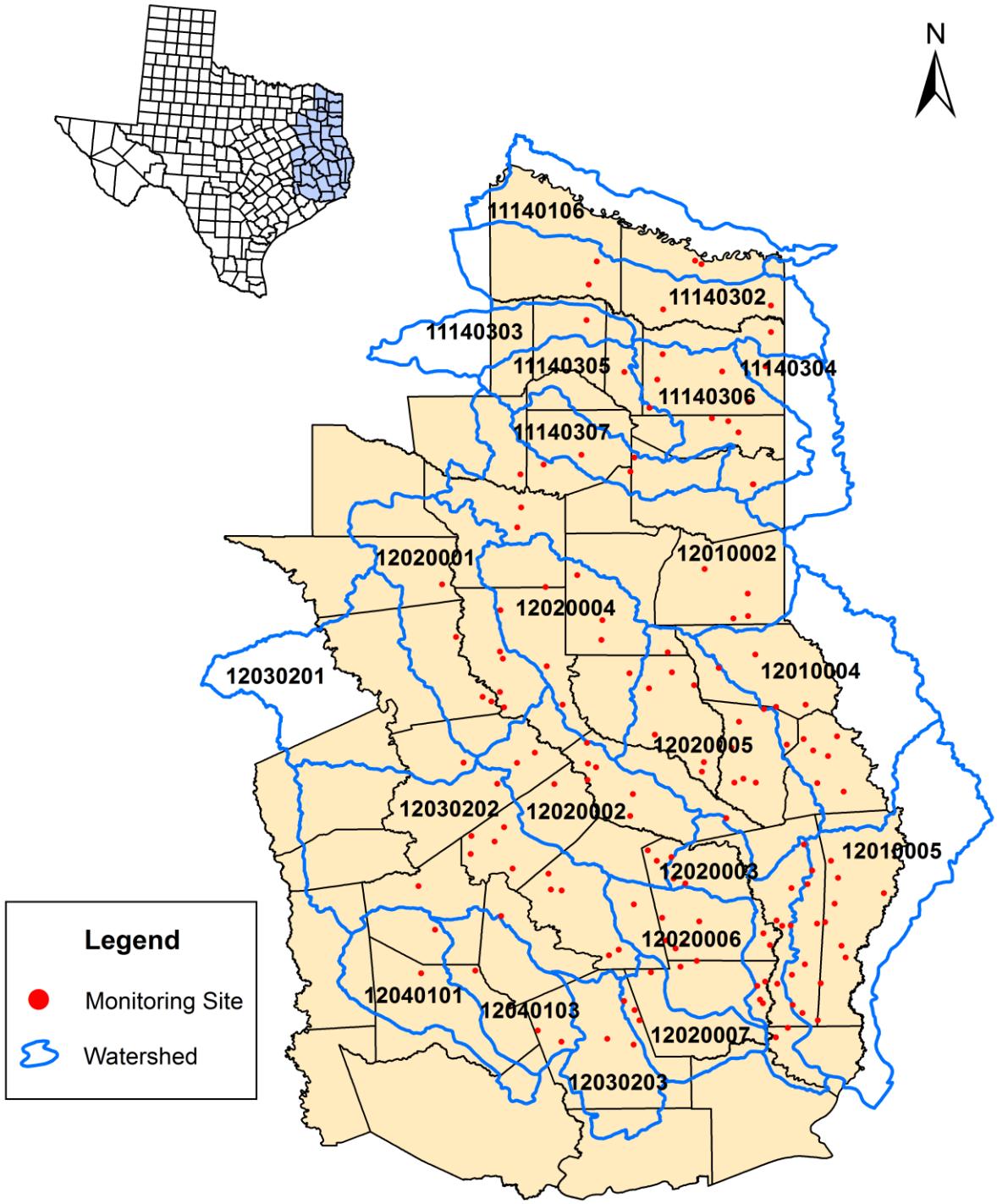


Figure 12. Site Location by Hydrologic Unit Code (Watershed).



STATISTICAL ANALYSIS

Statistical tests were performed to provide further information about the accuracy of the data collected. BMP trend analyses were also performed on certain categories to determine statistical significance. By understanding trends where lower BMP implementation occurred, Texas A&M Forest Service can develop outreach efforts that target these areas for improvement.

STATISTICAL TESTS

Margin of Error

The margin of error expresses the maximum likely difference observed between the sample mean and the true population mean with 95% probability. It is an important statistical calculation that was performed on all individual BMPs (i.e., SMZs present on perennial streams) using the respective percent implementation and total number of applicable questions. The formula used to calculate the margin of error is outlined below. See Tables 2 – 8.

$$m = 2\sqrt{\frac{P(100-P)}{n}}$$

Where m = margin of error for a single BMP
P = the percent implementation for a single BMP
n = the number of sites on which the BMP was evaluated

Confidence Interval

The 95% confidence interval is a tool that statisticians use to demonstrate their confidence in the measured mean of a sample. It provides a range for which they are 95% confident (i.e., 19 times out of 20) that the actual mean will be found. To calculate the confidence interval, the mean, variance, standard deviation, standard error, and margin of error must also be calculated. The formula used to calculate the confidence interval is listed below. For Round 9, the 95% confidence interval for the overall BMP implementation across all sites was (92.9, 95.0).

95% CI = Mean ± Margin of Error

STATISTICAL SIGNIFICANCE OF BMP TRENDS

Statistical analyses were performed on the following categories:

- Forester Involved in Sale or Activity
- Logging Contractor Attended BMP Training
- Landowner Familiar with BMPs
- BMPs Included in the Timber Sale Contract
- Timber Delivered to SFI® Mill
- Landowner Has a Forest Management Plan

Since the data was not normally distributed, a non-parametric test (Wilcoxon) was performed. To determine statistical significance, the resulting *P* value was compared to the level of significance. The *P* value is the probability of observing a value of the test statistic as contradictory (or more) to the null hypothesis as the computed value of the test statistic. In these tests, a 0.05 (5%) level of significance was used. For the two implementation ratings to be significantly different, the *P* value must be lower than the level of significance. The implementation ratings for the "yes" and the "no" answers were calculated to be significantly different in three of the categories. See Table 12.

Table 12. Results of Statistical Tests Determining Statistically Significant Differences.

	% Implementation		Non Parametric	Level of	Statistically
	Yes	No	*P* value	Significance	Different?
Forester Involved	94.2	76.7	0.019	0.05	YES
Logger Trained	94.6	86.0	0.033	0.05	YES
Landowner Familiar	94.2	89.6	0.478	0.05	NO
BMPs in Contract	94.2	76.7	0.019	0.05	YES
SFI® Mill	94.4	89.6	0.153	0.05	NO
Management Plan	94.3	86.1	0.057	0.05	NO

Forester Involved in the Sale or Activity

BMP implementation was higher when a professional forester was involved in the sale or activity. One hundred forty-eight sites were identified as having a professional forester involved and had an implementation rating of 94.6%. Sites in which there was no forester involvement had a BMP implementation rating of 76.7%. See Figure 13.

Logging Contractor Attended BMP Workshop

Texas A&M Forest Service conducts BMP training workshops for logging contractors. One hundred thirty-nine inspections identified the logging contractor as having attended the formal BMP training, with an implementation of 94.6%. Sites in which the activities were administered by a logger that did not attend the formal BMP training or where the logger was unknown had an implementation rating of 86.0%. See Figure 13.

Landowner Familiar with BMPs

Sites whose owners were not familiar with BMPs (8) had an overall implementation rating of 89.6%, while sites whose owners were familiar with BMPs (142) had an implementation rating of 94.2%. While not significant at the 0.05 level, it is important to note that the majority of the landowners monitored were familiar with BMPs and that implementation was higher, demonstrating the extended reach of the forest sector's educational efforts. See Figure 13.

BMPs Included in the Timber Sale Contract

BMPs were included in the timber sale contract on 148 sites. Implementation on sites with BMPs in the contract was 94.2%, while implementation on sites without BMPs in the contract, or where BMP inclusion was unknown, was 76.7%. See Figure 14.

Timber Delivered to SFI® Mill

Sites in which the receiving mill was known to be a SFI® member (137) had an implementation rating of 94.3%, compared to an 89.6% rating on the 13 sites in which the timber went to other mills or the receiving mill was unknown. While not significant at the 0.05 level, implementation was higher. See Figure 14.

Landowner Has a Forest Management Plan

On the 143 sites in which landowners had a forest management plan, implementation was 94.3%, compared to an implementation rating of 86.1% on the 7 sites that did not have a forest management plan or where it was unknown if a plan existed. See Figure 14.

Figure 13. Overall Implementation by Various Types of Involvement.

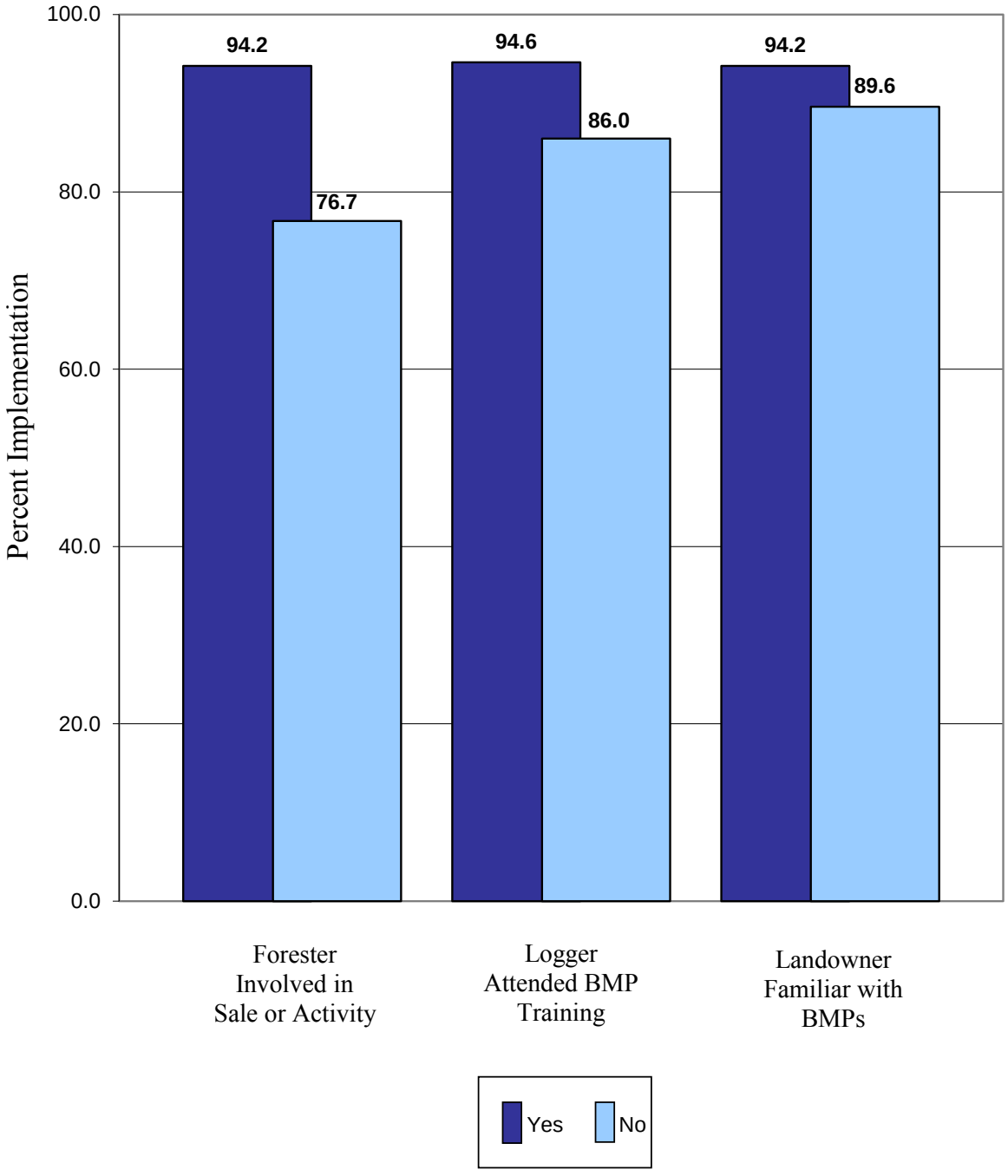
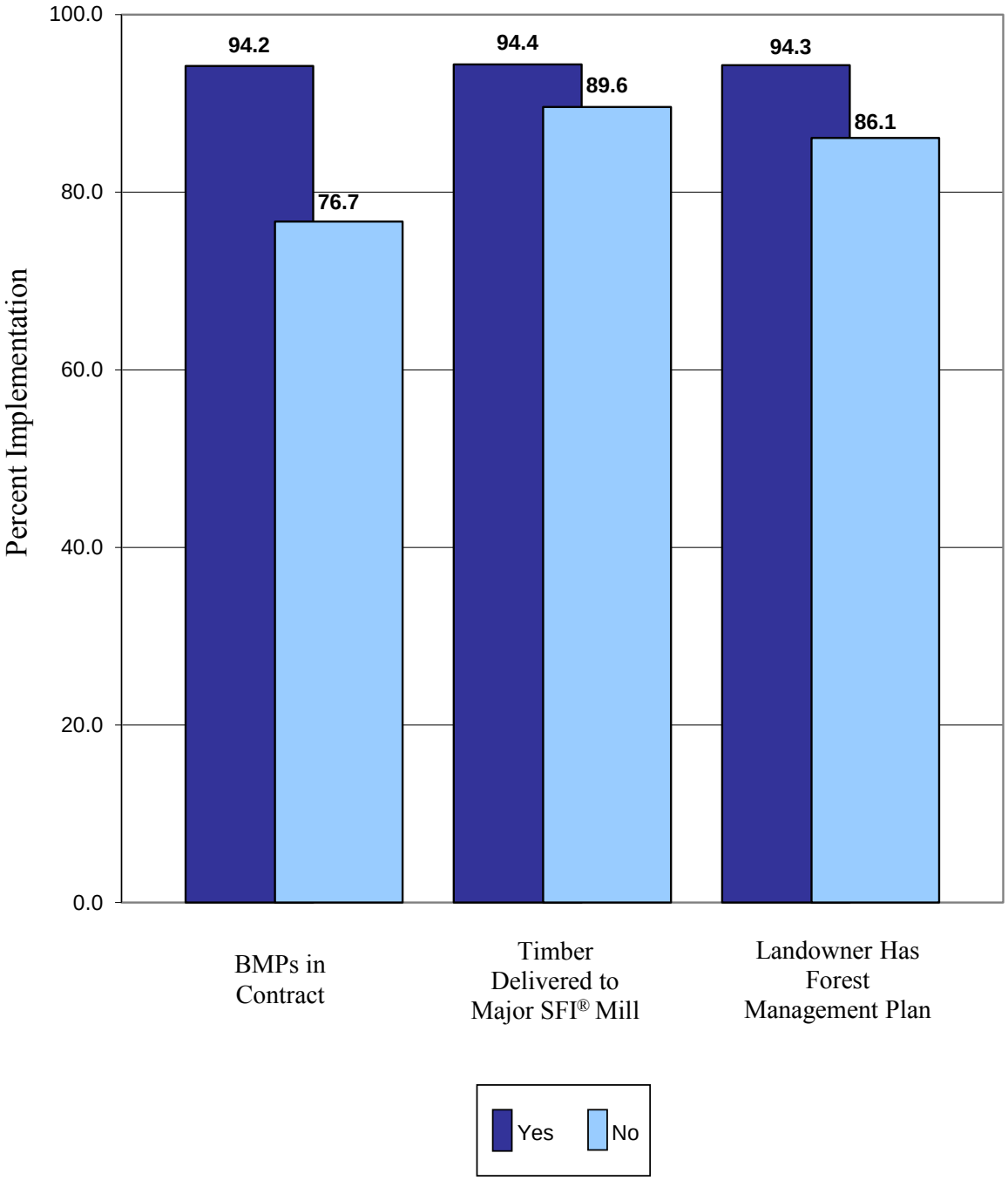


Figure 14. Overall Implementation by Various Categories.



DISCUSSION

As mentioned in the monitoring checklist section of this report, the current methodology used to monitor BMP implementation has been in place since 1999. Prior to that, a more subjective approach was used in which sites were scored as *No Effort, Poor, Fair, Good, or Excellent.* In order to determine percent implementation for an individual site under this older method, passing sites (*Fair, Good, or Excellent*) scored 100%, while failing sites (*No Effort, Poor*) scored 0%.

The current objective method more accurately scores percent implementation. Individual sites are rated on a 0 - 100 percent scale based on their actual level of BMP implementation. Due to the change in reporting methods, results from Rounds 4 - 9 *cannot* be directly compared to Rounds 1 - 3. However, site evaluations conducted in Rounds 1 - 3 were scored using the current method in the Texas A&M Forest Service report, *A History of BMP Implementation Monitoring in Texas, 2007,* to facilitate this comparison.

A brief discussion of the previous rounds of monitoring is provided to give a historical perspective on BMP monitoring in Texas.

OVERALL IMPLEMENTATION – Rounds 1 through 8

Overall BMP implementation on forest operations in East Texas has shown tremendous improvement since the first round of monitoring was completed in 1992 (Figure 15). Implementation on public and industrial sites has shown steady improvement over the previous eight rounds. Implementation on industry lands dropped slightly in Round 7; however, only 8 industry sites were included in that round as compared to an average of 50 sites in the previous six rounds. This is reflective of the divestiture of industrial forestlands that began prior to 2005, which resulted in a shift in ownership type. Implementation on industry lands in Round 8 rebounded to 97.7%, an all-time high for this landowner type. The corporate category was established in Round 6 in response to these changes in ownership and has demonstrated a high, steady rate of implementation over the last three rounds. Of the four ownership categories, family forest owners have shown the most remarkable progress in BMP implementation, improving from 69.8% in Round 1 to 88.0% or more in the last three rounds.

OVERALL IMPLEMENTATION – Round 9

BMP implementation on public land for Round 9 was 100% with no significant risks to water quality identified. Implementation on corporate land during this time period was 94.5% with one significant risk. Family forest owners received an implementation rating of 93.0% with one significant risk. This resulted in an overall BMP implementation rating of 94.0% with a total of 2 significant risks across all ownership categories. See Table 13 and Figure 15.

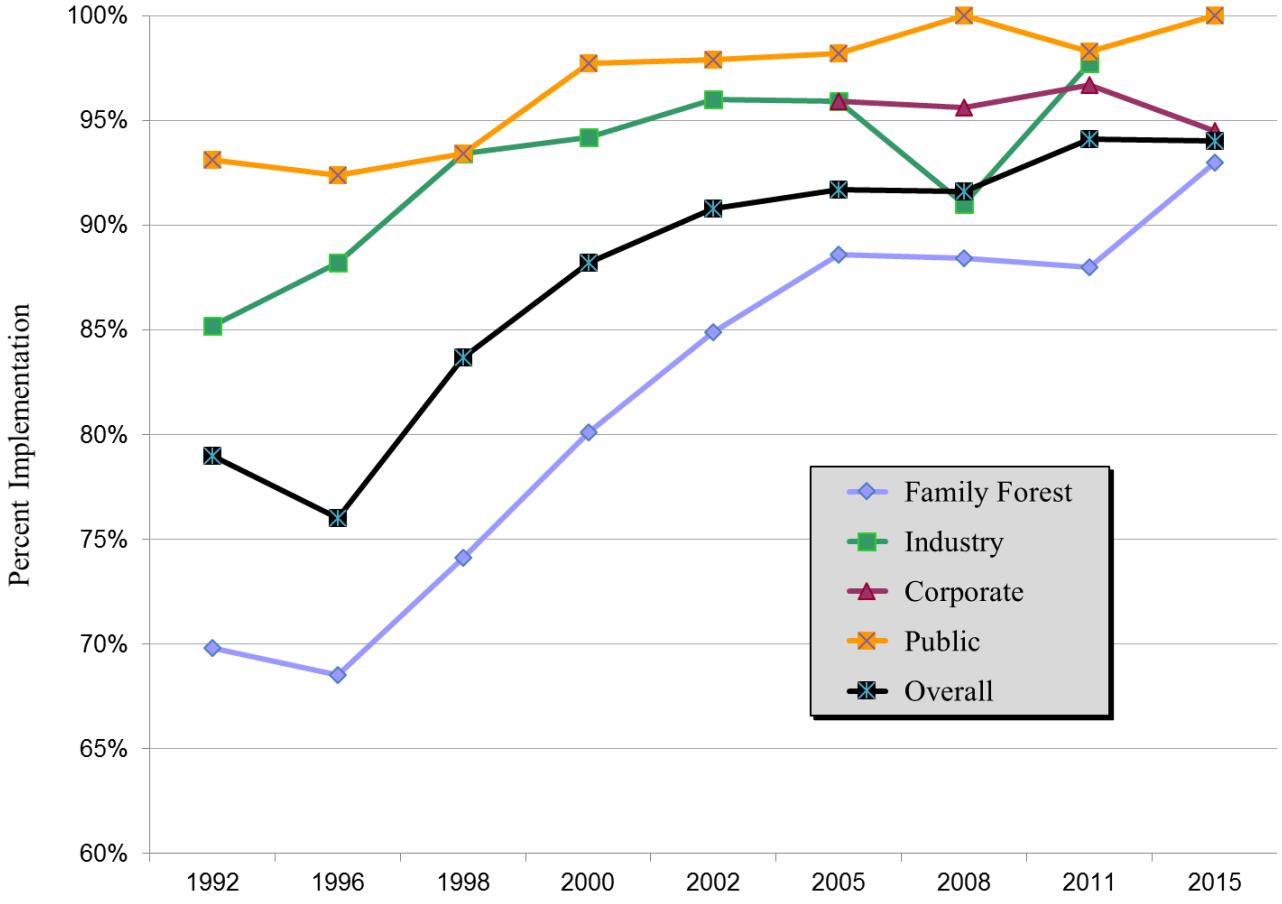
BMP implementation on family forest owners has finally reached similar levels as the other ownership categories. While family forest owners are generally less involved in forest management, only infrequently sell timber, may be absentee, and may lack technical knowledge necessary to implement BMPs, the education and outreach efforts of Texas A&M Forest Service and cooperators are starting to be realized.

Table 13. Percent Implementation by Ownership and Round.

	Family Forest	**Corporate**	**Industry**	**Public**	**Overall**
*Round 1 (1992)	69.8	-	85.2	93.1	79.0
*Round 2 (1996)	68.5	-	88.2	92.4	76.0
*Round 3 (1998)	74.1	-	93.4	93.4	83.7
Round 4 (2000)	80.1	-	94.2	97.7	88.2
Round 5 (2002)	84.9	-	96.0	97.9	90.8
Round 6 (2005)	88.6	95.9	95.9	98.2	91.7
Round 7 (2008)	88.4	95.6	91.0	100	91.6
Round 8 (2011)	88.0	96.7	97.7	98.3	94.1
Round 9 (2015)	**93.0**	**94.5**	**-**	**100**	**94.0**

**Data from these rounds follow the current methodology used to determine BMP implementation*

Figure 15. Percent Implementation by Ownership and Round.



AREA WEIGHTED BMP IMPLEMENTATION

Traditionally, monitoring sites have been weighted equally when determining percent implementation scores. This method is good for determining overall BMP implementation across the state or for a particular landowner category. However, it does not provide this information on a landscape scale like the area weighted BMP implementation method. Using this approach, larger sites are weighted more heavily than smaller sites, primarily because they have a greater opportunity to impact water quality. The results of this monitoring round were reanalyzed using the area weighted approach. BMP implementation scores remained basically the same for all three landowner types and overall. See Table 14.

$$AW\ \% = \Sigma\ (((Site\ A/Total\ A) * 100)) * \%\ BMP)))$$

Where AW % = area weighted BMP implementation %
A = area (acres)
% BMP = individual site % BMP implementation

Table 14. Area Weighted Percent Implementation by Ownership, Round 9.

Landowner Type	Area Weighted % Implementation
Family Forest Owner	93.0
Corporate	94.0
Public	100
Overall	93.9

CONCLUSION

Positive statistical correlations between forester involvement and logging contractor training in BMPs and BMP implementation were shown. This demonstrates the importance for family forest owners to involve a forester and a BMP-trained logging contractor to ensure BMP implementation.

Forest products manufacturers and large corporate landowners played a significant role in increasing BMP implementation. This occurred primarily from their support of the Texas A&M Forest Service Water Resources Program and participation in forest certification programs. Water quality protection is obviously a top priority for this sector, as evident by requiring all contractors to attend BMP training workshops, including BMPs in their timber sale contracts, and procuring wood for their mills from landowners that implement BMPs.

Special programs advocated by Texas A&M Forest Service are continuing to have an effect on BMP implementation. The Texas Reforestation and Conservation Act of 1999 encouraged landowners to leave a streamside management zone when harvesting timber through special property tax reductions. Texas Forestry Association sponsors many workshops and field days each year emphasizing sustainable forestry and water resource protection.

Overall BMP implementation (94.0%) remained steady and was just below the record levels set in the last round (94.1%). Most impressive is the considerable progress demonstrated by family forest owners since monitoring began. BMP implementation on family forest owner sites was 93.0%, representing a 33% increase since 1992. This improvement demonstrates that the ongoing education and training strategies geared towards loggers, landowners, and foresters were the driving force behind the increases in implementation.

Although BMP implementation remained high, there is still room for improvement. The past round of monitoring noted a deficiency in draining and stabilizing temporary roads and skid trails. Also, during site preparation, soil movement on site and firebreak erosion needed more attention. Texas A&M Forest Service continues to target these areas. Focused BMP training workshops on forest roads and stream crossings have been conducted. Site-based training has also been delivered to contractors through tailgate sessions, in which Water Resources foresters provide technical assistance during active forest operations. An online, GIS pre-harvest planning application (http://tfsfrd.tamu.edu/planmylandoperation) was released in May 2015 to further increase implementation by helping loggers and foresters plan for BMPs prior to an operation. Continuing effective educational programs for family forest owners, providing technical assistance on BMPs to the forestry community, and conducting BMP training for loggers will continue to minimize the potential water quality impacts from silvicultural operations in Texas.

References

Edgar, Chris, Y. Li, and B. Carraway. September 2012. Texas forest resource harvest trends 2011. Page 10. [Also available on internet: https://tfsweb.tamu.edu/uploadedFiles/TFSMain/Data_and_Analysis/Forest_Economics_and_Resource_Analysis/Resource_Analysis/Resource_Analysis_publications/HarvestTrends2011.pdf]

Miles, P.D. Mon June 10 08:56:59 CST 2013. Forest Inventory EVALIDator web-application version 1.5.1.05. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. [Available only on internet: http://apps.fs.fed.us/Evalidator/evalidator.jsp]

Simpson, Hughes. February 2007. A History of forestry BMP implementation monitoring in Texas. Page 7. [Also available on internet: http://texasforestservice.tamu.edu/uploadedFiles/Sustainable/bmp/TFS%20BMP%20Trend%20Analysis%20(1990-2005).pdf]

Southern Group of State Foresters Water Resources Committee. June 2007. Silviculture Best Management Practices implementation monitoring - a framework for state forestry agencies. Pages 23-33 in Water Resources Committee for Southern Group of State Foresters. June 2008. Implementation of forestry Best Management Practices - a southern region report. [Also available on internet: http://www.southernforests.org/resources/publications/Regional%20BMP%20Report%202008.pdf/view]

Sustainable Forestry Initiative. Web: http://www.sfiprogram.org

Texas A&M Forest Service. Recommended reforestation incentive eligibility guidelines and forest zone determination rules related to Texas Reforestation and Conservation Act of 1999. Circular 400. January 2000. Web: http://txforestservice.tamu.edu/uploadedFiles/Sustainable/tax/brochure.pdf

Appendix

Implementation Monitoring Checklist

Evaluation Criteria

Summary of Results

TEXAS A&M FOREST SERVICE

TEXAS BMP MONITORING CHECKLIST

Site ID

I. General Landowner and Tract Information

County | TFS Block and Grid | Region

Owner Type: ☐ N ☐ A ☐ C ☐ I ☐ P

Latitude | Longitude

Landowner:

Forester Type | Name

Name | Address

Timber Buyer | Contractor

City | State

Activity | Acres Affected

Zip

Estimated Date of Activity | Date of Inspection

Phone

Inspector | Accompanied by

II. Site Characteristics

River Basin

Terrain: ☐ Flat ☐ Hilly ☐ Steep

Distance to nearest permanent water body:

Erodibility hazard: ☐ Low ☐ Medium ☐ High

☐ < 300' ☐ 300 - 800' ☐ 800 - 1600' ☐ 1600' +

Type stream present: ☐ Perennial ☐ Intermittent

Predominant soil series/texture:

Watershed Code

☐ Clay ☐ Clay Loam ☐ Loam ☐ Sandy Loam ☐ Sand

III. Permanent Roads

	YES	NO	NA/NN	Sig. Risk
1. Respect sensitive areas, such as SMZs, steep slopes, and wet areas	☐	☐	☐	☐
2. Meet grade specifications by having slopes between two and ten percent	☐	☐	☐	☐
3. Rutting within allowable specs of less than six inches deep for not more than fifty feet	☐	☐	☐	☐
4. Well drained with appropriate structures to minimize soil movement	☐	☐	☐	☐
5. Wing ditches, waterbars, and water turnouts do not dump into streams	☐	☐	☐	☐
6. Reshaped and/or stabilized to minimize soil movement	☐	☐	☐	☐
Section Total				

BMPs present: ☐ RD ☐ WD ☐ WB ☐ RE ☐ OC ☐ PL ☐ RS ☐ CU ☐ SD ☐ BD

Percent Implementation

IV. Temporary Roads / Skid Trails

	YES	NO	NA/NN	Sig. Risk
1. Respect sensitive areas, such as SMZs, steep slopes, and wet areas	☐	☐	☐	☐
2. Slopes less than 15% and laid out on the contour of the land	☐	☐	☐	☐
3. Rutting within allowable specs of less than six inches deep for not more than fifty feet	☐	☐	☐	☐
4. Well drained with appropriate structures to minimize soil movement	☐	☐	☐	☐
5. Stabilized to minimize soil movement	☐	☐	☐	☐
Section Total				

BMPs present: ☐ WD ☐ WB ☐ RE ☐ OC ☐ PL ☐ RS ☐ LS

Percent Implementation

V. Stream Crossings

	YES	NO	NA/NN	Sig. Risk
On Permanent Roads				
1. Crossings avoided or minimized	☐	☐	☐	☐
2. Stream crossings correct	☐	☐	☐	☐
3. Stream crossing stabilized	☐	☐	☐	☐
4. Stream free of sediment	☐	☐	☐	☐
On Temporary Roads				
5. Crossings avoided or minimized	☐	☐	☐	☐
6. Stream crossings correct	☐	☐	☐	☐
7. Temporary crossings removed	☐	☐	☐	☐
8. Stream crossings and approaches stabilized	☐	☐	☐	☐
9. Stream free of sediment	☐	☐	☐	☐
Section Total				
Percent Implementation				

BMPs Present ☐ CU ☐ BR ☐ LW

VI. Streamside Management Zones

	YES	NO	NA/NN	Sig. Risk
1. Present on permanent stream	☐	☐	☐	☐
2. Present on intermittent stream	☐	☐	☐	☐
3. SMZ adequately wide by leaving fifty feet on both sides of the stream	☐	☐	☐	☐
4. Thinning within allowable specs by leaving 50 square feet of BA	☐	☐	☐	☐
5. Minimize harvesting bank trees	☐	☐	☐	☐
6. SMZ integrity honored by keeping skidders, roads, landings, and firebreaks out	☐	☐	☐	☐
7. Stream clear of debris, such as tops and limbs	☐	☐	☐	☐
8. Stream free of sediment	☐	☐	☐	☐
Section Total				
Percent Implementation				

VII. Site Preparation

Site preparation method

Regeneration method

	YES	NO	NA/NN	Sig. Risk
1. Respect sensitive areas by preventing site prep intrusion	☐	☐	☐	☐
2. No soil movement on site, especially broad scale sheet erosion	☐	☐	☐	☐
3. Firebreak erosion controlled to prevent potential erosion	☐	☐	☐	☐
4. SMZ integrity honored by preventing site prep intrusion	☐	☐	☐	☐
5. Windrows on contour / free of soil to minimize soil disturbance	☐	☐	☐	☐
6. No chemicals off site or entering water bodies	☐	☐	☐	☐
7. Mechanical site prep, machine planting on contour	☐	☐	☐	☐
8. Stream free of sediment	☐	☐	☐	☐
Section Total				
Percent Implementation				

VIII. Landings

	YES	NO	NA/NN	Sig. Risk
1. Locations free of oil / trash and properly disposed of	☐	☐	☐	☐
2. Located outside of SMZ to minimize traffic and erosion in the SMZ	☐	☐	☐	☐
3. Well drained location to mimimize puddling, soil degradation, and soil movement	☐	☐	☐	☐
4. Number and size minimized	☐	☐	☐	☐
5. Respect sensitive areas, including steep slopes and wet areas	☐	☐	☐	☐
6. Restored / stabilized by back blading, spreading bark, or seeding to minimize erosion	☐	☐	☐	☐
Section Total				
Percent Implementation				

IX. Wetlands (may or may not be jurisdictional)

	YES	NO	NA/NN	Sig. Risk
1. Avoid altering hydrology of site by minimizing ruts and soil compaction	☐	☐	☐	☐
2. Road drainage structures installed properly to maintain flow of water	☐	☐	☐	☐
3. Mandatory road BMPs followed	☐	☐	☐	☐
Section Total				
Percent Implementation				

X. Overall Implementation

	YES	NO	NA/NN	Sig. Risk
III. Permanent Roads	☐	☐	☐	☐
IV. Skid trails/Temporary Roads	☐	☐	☐	☐
V. Stream Crossings	☐	☐	☐	☐
VI. Streamside Management Zones	☐	☐	☐	☐
VII. Site Preparation	☐	☐	☐	☐
VIII. Landings	☐	☐	☐	☐
IX. Wetlands	☐	☐	☐	☐
Overall Total				
Total Significant Risk				
Percent Implementation				

Needs Improvement		Pass		
☐ No Effort	☐ Poor	☐ Fair	☐ Good	☐ Excellent

Follow Up Questions

	YES	NO	NA/NN
Was activity supervised by landowner or representative?	☐	☐	☐
Who?			
Was landowner familiar with BMPs?	☐	☐	☐
Has logger attended BMP Workshop?	☐	☐	☐
Were BMPs included in the contract?	☐	☐	☐
Is landowner a member of TFA? Landowner Association? Tree Farm? Other?	☐	☐	☐
Organization			
Was timber delivered to SFI mill?	☐	☐	☐
Does landowner plan to reforest?	☐	☐	☐
Does landowner have a forest management plan?	☐	☐	☐
Is remediation planned by landowner (if needed)?	☐	☐	☐

Date

Comments (Explain observed actions in the field check. Make recommendations.)

Evaluation Criteria for BMP Monitoring Checklist

I. General Landowner and Site Information

County: Texas County inspection was located.
TFS Block and Grid: Enter only entry point if multiple blocks or grids.
Region: TFS Water Resources Region (N or S)
Latitude and Longitude: coordinates in decimal degree (D.d) format.
Forester Type: Professional, i.e. consultant, industry, etc.
Forester Name: First and last name.
Timber Buyer: First and last name or Corporation name.
Contractor: First and last name or business name.
Activity: Type activity occurring, e.g. harvesting, site preparation, etc.
Acres Affected: Acres affected by activity.
Estimated Date of Activity: Quarter and year activity appears to have occurred.
Date of inspection: mmddyy.
Inspector: Name of TFS forester doing BMP inspection.
Accompanied by: Name of landowner, forester, logger, etc. who is present during the inspection.
Owner Type: Nonindustrial (N), Absentee nonindustrial (A), Corporate (C) Industry (I), Public (P).
Name, Address, City, Zip, and Phone: Contacts for the landowner.

II. Site Characteristics

Terrain: Check only one; Flat, Hilly, or Steep.
Erodibility hazard: Check only one; Low, Medium, or High.
Type stream present: Perennial or Intermittent.
Watershed Code: 8 digit hydrologic unit code where site is located.
River Basin: River basin where site is located.
Distance to nearest permanent water body: Distance to nearest blue line stream or lake.
Predominant soil series: Series name from Soil Survey data (if available).
Predominant soil texture: Check only one; Clay, Clay Loam, Loam, Sandy Loam, or Sand.

III. Permanent Roads

1. Respect sensitive areas: Do roads avoid wet areas, SMZs, steep slopes if an alternative exist, erosion prone areas if an alternative exists, etc.?
2. Roads meet grade specs: Pertains to new roads or roads which are substantially reworked. Are roads within 2-10 percent grade except for short distances? Are roads on contour?
3. Rutting within allowable specs: Is the road free of ruts in excess of 6 inches deep for more than 50 feet?
4. Well drained with appropriate structures: Are roads constructed so that water will quickly drain from them to minimize soil movement?
5. Ditches do not dump into streams: Are water turn outs and water bars venting far enough from the stream to prevent sediment from entering the stream channel?

6. Roads reshaped and stabilized: If needed, are roads reworked to minimize soil movement?

BMPs present: Which types of BMPs were used? Rolling dips (RD), Wing ditches (WD), Water bars (WB), Revegetate (RE), On contour (OC), Proper placement (PL), Reshaping (RS), Culverts (CU), Side Ditch (SD), Broad based dip (BD).

IV. Temporary Roads/ Skid Trails

1. Respect sensitive areas: Do skid trails and temporary roads avoid wet areas, SMZs, steep slopes if an alternative exist, erosion prone areas if an alternative exists, etc.?
2. Slopes less than 15 %: Are skid trails laid out on or near contour, rather than up and down steep slopes?
3. Rutting within allowable specs: Are skid trails and temporary roads free of ruts in excess of 6 inches deep for more than 50 feet?
4. Roads well drained with water bars or other water control structures: Were BMPs installed effectively to reduce erosion from the road?
5. Roads stabilized: If needed, are skid trails and temporary roads reworked to minimize soil movement?

BMPs present: See Section III above. Logging Slash (LS).

V. Stream Crossings

On Permanent Roads:

1. Crossings avoided or minimized: Was an effort made to use as few crossings as possible?
2. Stream crossings correct: Are crossings installed correctly? Are crossing located properly? Are culverts properly sized? Are bridges used where necessary? Are crossings at right angles?
3. Stream crossings stabilized? Are stream banks and approaches stabilized? Are washouts evident?
4. Stream free of sediment: Has sedimentation from the road into the stream channel been minimized?

On Temporary Roads

5. Crossings avoided or minimized: Was an effort made to use as few crossings as possible?
6. Stream crossings correct: Are crossings installed correctly? Is the crossing located so as to minimize the potential erosion in the stream channel? Is the crossing at a right angle to the stream channel? Was a proper stream crossing method used?
7. Temporary crossings removed: Have the temporary crossings been removed? Excess fill removed from the stream channel
8. Stream crossings stabilized: Banks and approaches stabilized against erosion? Are washouts evident?
9. Stream free of sediment: Has sedimentation from the road into the stream channel been minimized?

BMPs present: Which types of BMPs were used? Culverts (CU), Bridge (BR), Low water crossing (LW).

VI. Streamside Management Zones

1. Present on permanent stream: Is there an SMZ present on any permanent stream?
2. Present on intermittent stream: Is there an SMZ present on any intermittent stream?
3. SMZ adequately wide: Is the stream being protected from erosion and deposition of sediment? Does the width meet the guidelines recommendations?
4. Thinning within allowable specs: If thinning was done, is the basal area remaining at least 50 square feet? Is there minimal soil disturbance from felling and skidding?
5. Minimize harvesting bank trees: Was an effort made to minimize harvesting bank trees? Were trees felled across the stream?
6. SMZ integrity honored: Was an effort made to stay out of the SMZ with skidders, landings, roads, etc. (except for designated stream crossings)? Is the SMZ free of firebreaks?
7. Stream clear of debris: Are tops and limbs removed from permanent and intermittent stream channels? Has any brush or debris pushed into the stream channel been removed?
8. Stream free of sediment: Has sedimentation reaching the stream channel through the SMZ been minimized?

VII. Site Preparation

Site preparation method: Mechanical, chemical, prescribed burn.
Regeneration method: Mechanical, Hand, Natural.

1. Respect sensitive areas. Effort to prevent site prep intrusion into sensitive areas? Effort to prevent heavy equipment intrusion into sensitive areas? Effort to prevent fire intrusion into sensitive areas?
2. No soil movement on site: Is there no soil movement on site? Are rills or gullies prevented? Is there no problem with broad scale sheet erosion?
3. Firebreak erosion controlled: If present, has potential erosion from firebreaks been minimized as per guideline recommendations?
4. SMZ integrity honored: Effort to prevent site prep intrusion into the SMZ? Effort to prevent heavy equipment intrusion into the SMZ? Effort to prevent fire intrusion into the SMZ? Are perennial or intermittent streams free of debris?
5. Windrows on contour / free of soil: Are windrows on contour on hilly lands rather than up and down slopes? Was soil disturbance minimized? Was soil in windrows minimized?
6. No chemicals off site: Does it appear that chemicals were used according to label directions? Have they remained on site and out of water bodies?
7. Mechanical site prep and machine planting on contour: Are rows on contour on hilly lands rather than up and down slopes?
8. Stream free of sediment: Has sedimentation reaching the stream channel because of site prep activities been minimized?

VIII. Landings

1. Locations free of oil/trash: Any sign of deliberate oil spills on soil? Is trash picked up and properly disposed of?
2. Located outside of SMZ: Was the landing located 50 feet outside SMZ so as to minimize traffic and erosion in the SMZ?
3. Well drained location: Were the landings located so as to minimize puddling, soil degradation and soil movement?
4. Number and size minimized: Were the number and size of landings kept to a minimum?
5. Respect sensitive areas: Were landings kept out of wet areas, steep slopes, and other erosion prone areas if an alternative exist?
6. Restored/stabilized: Has the landing been back bladed or otherwise restored as per guideline recommendations? Has erosion been minimized through spreading bark, etc., seeding, water bars, or other recommended BMP practices?

IX. Wetlands (may or may not be jurisdictional)

1. Avoid altering hydrology of site: Were ruts and soil compaction kept to a minimum?
2. Road drainage structures installed properly: Were BMPs installed effectively to maintain the flow of water and keep erosion to a minimum in the wetland?
3. Mandatory road BMPs followed: Were the 15 federal mandatory BMPs followed?

X. Overall Implementation

Section implementation percentages are determined by dividing the number of questions receiving a yes answer by the total applicable questions in each section. Y/(Y+N)

Overall implementation is determined in a similar manner using the totals from all sections combined. Y/(Y+N)

Significant Risk. A significant risk is an existing on-the-ground condition resulting from failure to correctly implement BMPs, that if left unmitigated will likely result in an adverse change in the chemical, physical or biological condition of a waterbody. Such change may or may not violate water quality standards.

Subjective Score.

No Effort Substantial erosion as a result of operations. Sedimentation in streams. Temporary stream crossings not removed. No SMZ when needed, etc. Poor attitude evident about the job.

Poor: Some effort at installing BMPs. Generally poor quality construction or no effort in certain locations which suffer from erosion, stream sedimentation, etc. Substantial lack of BMPs in a particular emphasis such as roads, skid trails or SMZ.

Fair: (1) Generally a pretty good effort at BMPs. Poor application procedures perhaps. Lack of BMPs in a particular emphasis but with moderate

consequences. (2) No BMPs on a site which requires few BMPs but has some resultant minor problems.

Good: (1) BMPs generally installed correctly. Guidelines generally followed. Allows for some failures of BMP devices or failure to observe guidelines but with light consequences. (2) Good quality job which required no BMPs and has few problems.

Excellent: (1) BMPs installed correctly. Guidelines followed. (2) Some BMPs implemented even when they might not have been required. Few if any problems exist.

Follow up Questions

Was activity supervised by a professional forester or representative? Check Yes, No, or NA
Who? If yes, list name of individual.
Was landowner familiar with BMPs? Check Yes, No, or NA.
Has logger attended BMP workshop? Check Yes, No, or NA
Were BMPs included in the contract? Check Yes, No, or NA
Is landowner a member of TFA? Landowner Association? Other? Check Yes, No, or NA
Organization: If yes, list name of organization.
Was timber delivered to SFI mill? Check Yes, No, or NA
Does landowner have a forest management plan? Check Yes, No, or NA
Is remediation planned by the landowner? Check Yes, No, or NA.
Date: If yes, include date of planned remediation.

Summary of Responses to BMP Implementation Monitoring Checklist Items, All Sites, Round 9

I. General Landowner and Tract Information

Owner type		Forester type		Activity	
Family Forest Owner	54	Corporate	69	Regeneration Harvest	
Absentee	27	Private Consultant	74	Clearcut	73
Corporate	64	Public	5	Thin	36
Public (Fed, State)	5			Site Prep &/or planting	41

II. Site Characteristics

Terrain		Erodibility hazard		Type stream present	
				Perennial	23
Flat	90	Low	88	Intermittent	57
Hilly	38	Medium	56	Both	38
Steep	22	High	6	None	32

Distance to nearest permanent water body		Predominant soil series/texture			
< 300'	90	Clay	3	Sandy loam	100
300 - 800'	23	Clay loam	12	Sand	14
800 - 1600'	15	Loam	21		
1600' +	22				

III. Permanent Roads

126 applicable

	Yes	No	NA	Sig. Risk
1. Respect sensitive areas	119	7	24	0
2. Roads meet grade specs	125	1	24	0
3. Rutting within allowable specs	116	10	24	0
4. Well drained with appropriate structures	109	17	24	0
5. Ditches do not dump into streams	118	5	27	0
6. Roads reshaped and stabilized	109	17	24	0

IV. Skid Trails/Temporary Roads

121 applicable

	Yes	No	NA	Sig. Risk
1. Slopes less than 15%	119	2	29	0
2. Respect sensitive areas	116	5	29	0
3. Roads well drained with water control structures	101	20	29	0
4. Roads stabilized	102	18	30	0
5. Rutting within allowable specs	107	14	29	0

V. Stream Crossings

On Permanent Roads	42 applicable	Yes	No	NA	Sig. Risk
1. Crossings Avoided or minimized		40	2	108	0
2. Stream crossings correct		42	0	108	0
3. Stream crossings stabilized		37	4	109	0
4. Stream free of sediment		39	3	108	0
On Temporary Roads	35 applicable				
5. Crossings avoided or minimized		33	2	115	0
6. Stream crossings correct		31	1	118	0
7. Temporary crossings removed		34	0	116	0
8. Stream crossings and approaches stabilized		22	12	116	0
9. Stream free of sediment		31	3	116	0

VI. Streamside Management Zones

117 applicable

	Yes	No	NA	Sig. Risk
1. Present on permanent stream	66	1	83	0
2. Present on intermittent stream	99	1	50	0
3. SMZ adequately wide	112	4	34	0
4. Thinning within allowable specs	114	2	34	0
5. Minimize harvesting bank trees	115	1	34	0
6. SMZ integrity honored	115	1	34	0
7. Stream clear of debris	112	5	33	0
8. Stream free of sediment	116	1	33	0

VII. Site Preparation

53 applicable

	Yes	No	NA	Sig. Risk
1. Respect sensitive areas	51	1	98	0
2. No soil movement on site	39	14	97	1
3. Firebreak erosion controlled	18	4	128	0
4. SMZ integrity honored	49	1	100	1
5. Windrows on contour/free of soil	16	2	132	0
6. No chemicals off site	36	0	114	0
7. Mechanical site prep/planting on contour	41	2	107	0
8. Stream free of sediment	52	0	98	0

VIII. Landings

97 applicable

	Yes	No	NA	Sig. Risk
1. Locations free of oil/trash	93	3	54	0
2. Located outside of SMZ	96	0	54	0
3. Well-drained location	90	6	54	0
4. Number and size minimized	96	0	54	0
5. Respect sensitive areas	93	3	54	0
6. Restored/stabilized	85	12	53	0

IX. Wetlands

16 applicable

	Yes	No	NA	Sig. Risk
1. Avoid altering hydrology of site	14	1	135	0
2. Road drainage structures installed properly	14	2	134	0
3. Mandatory road BMPs followed	14	0	136	0

X. Overall Compliance

	Yes	No	NA	Sig. Risk
III. Permanent Roads - 92.4%	696	57	147	0
IV. Temporary Roads /Skid Trails- 90.2%	545	59	146	0
V. Stream Crossings - 92.0%	309	27	1014	0
VI. Streamside Management Zones - 98.2%	849	16	335	0
VII. Site Preparation - 92.6%	302	24	874	2
VIII. Landings - 95.8%	553	24	323	0
IX. Wetlands - 93.3%	42	3	405	0

Follow-up Questions

	Yes	No	NA
Was activity supervised by a professional forester?	148	2	0
Was landowner familiar with BMPs?	142	8	0
Has logger attended BMP workshop?	139	9	2
Were BMPs included in the contract?	148	2	0
Was timber delivered to SFI mill?	137	9	4
Does landowner have a forest management plan?	143	7	0
Does landowner plan to reforest?	134	0	16