Voluntary Implementation of Forestry Best Management Practices in East Texas

Results from Round 7 of
BMP Implementation Monitoring

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

December 2008

Voluntary Implementation of Forestry Best Management Practices in East Texas

Results from Round 7 of BMP Implementation Monitoring
2007-2008

by

Hughes Simpson, BMP Project Leader
Jacob Donellan, BMP Project Forester
Chris Duncan, BMP Project Forester
Shane Harrington, BMP Project Forester

TEXAS FOREST SERVICE
Sustainable Forestry
Best Management Practices Project

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. A total of 152 sites on which silvicultural activities occurred were evaluated. These sites were monitored between June 20, 2007, and November 18, 2008, 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 sites monitored was 91.5%. In general, implementation was highest on sites under public ownership. These national forestland sites had an overall implementation of 100%, while industrial sites had a 91.1% implementation rating. Corporate lands (commercial landowners that do not have wood processing facilities) scored 95.7% overall, while family forest owners scored 88.7%.

Implementation with BMPs was statistically significantly higher when:

- the landowner was familiar with BMPs
- 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
- the landowner was a member of the American Tree Farm System
- the timber was delivered to a Sustainable Forestry Initiative® (SFI®) mill

Implementation was generally lowest on sites when:

- owned by family forest owners
- 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

Major deficiencies noted during the evaluations were:

- failure to remove and stabilize stream crossings on temporary roads
- inadequate SMZ width along intermittent and perennial streams

Major improvements from previous rounds were:

- a decrease in the number of significant risks to water quality
- avoiding or minimizing the number of temporary stream crossings
- higher overall BMP implementation on site preparation and wetlands

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 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 Project, funded by a FY05 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 conducted to document the level of voluntary implementation of BMPs and effectiveness of BMPs in reducing NPS pollution from silvicultural activities. Objectives of the monitoring program are to:

1) Measure the degree of implementation of BMP guidelines 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 the BMP implementation monitoring for 152 sites evaluated between June 20, 2007, and November 18, 2008. This data represents Round 7 of BMP implementation monitoring conducted by Texas Forest Service. Previous surveys were published in October 1992, March 1996, April 1998, September 2000, November 2002, and October 2005. These reports can be viewed online at http://texasforestservice.tamu.edu/sustainable/bmp.

DISTRIBUTION AND SELECTION OF IMPLEMENTATION MONITORING SITES

To obtain a valid estimate of overall implementation of forestry best management practices, monitoring sites were distributed regionally within East Texas and among all forestland ownership categories. Sites were believed to be representative of the distribution of all silvicultural activities across East Texas. The distribution of monitoring sites was based on the estimated annual timber harvest for each county as reported in the Texas Forest Service publication, *Texas Forest Resource Harvest Trends 2005*, and the average annual removals of growing stock by ownership class, as reported in the United States Forest Service publication, *East Texas Forests, 2003 (SRS – 137)*. See Table 1.

Table 1. Distribution of Implementation Monitoring Sites by County.

County	Number of Sites Monitored
Anderson	3
Angelina	8
Bowie	3
Cass	9
Cherokee	5
Gregg	1
Grimes	1
Hardin	8
Harrison	6
Houston	5
Jasper	12
Liberty	6
Marion	3
Morris	1
Nacogdoches	8
Newton	7
Orange	1
Panola	6
Polk	12
Red River	3
Rusk	5
Sabine	4
San Augustine	4
San Jacinto	4
Shelby	4
Smith	2
Titus	1
Trinity	4
Tyler	7
Upshur	4
Walker	4
Wood	1
Total	**152**

QUALITY CONTROL

To eliminate bias, implementation monitoring sites were selected in a random manner using several methods, including aerial detection and information collected by Texas Forest Service (TFS) personnel. All monitoring evaluations were conducted by one or a combination of two trained foresters assigned to the TFS BMP Project. Using only BMP Project employees as inspectors provided greater accuracy and quality control.

At the beginning of the monitoring project, as well as periodically throughout the project, BMP Project foresters jointly evaluated tracts to maintain and improve consistency and fairness. The TFS BMP Project collected monitoring data in accordance with a Quality Assurance Project Plan, approved by TSSWCB and EPA.

MONITORING CHECKLIST

The monitoring checklist that was used in Round 7 was also used for the previous three surveys, a period dating back to 1999. This objective, 42-question form followed 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 evaluated BMPs for seven different categories: Permanent Roads, Temporary (secondary) Roads / Skid Trails, Stream Crossings, Streamside Management Zones, Site Preparation, Landings, and Wetlands. Each question was worded so that a positive answer was recorded with a "Yes," while a negative answer, indicating a departure from BMP recommendations, was answered "No." Questions that were not applicable to the tract were answered "NA." This format allowed readers to quickly determine any problem areas identified during an inspection. A comments section at the end of the form provided additional information regarding BMP implementation.

Each tract was rated with a number representing percent implementation. This score was computed by dividing the number of questions receiving a yes answer by the total applicable questions [Y/(Y+N)]. Tracts were also evaluated to determine if "significant risks" to water quality existed. 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 waterbody. Such change may or may not violate water quality standards.

Tract evaluations were entered into a database for storage and analysis. This data was also imported into a Geographic Information System (GIS) for further analysis and geographical representation. The form is found in the Appendix.

INSPECTION CONTACTS

Landowners were contacted prior to the inspection of the site so that permission for entry onto the property could be obtained. During this initial contact, the forester explained the program and invited the landowner and his/her representative to join the BMP forester on site during the evaluation. Sites were not inspected if the landowner denied access. In nearly all cases on commercial forestland, an industry or corporate forester accompanied the BMP forester.

Landowners, logging contractors, and timber buyers (where applicable and identifiable) were provided a copy of the completed checklist, along with a cover letter explaining the BMP Project and instructions on interpreting the form. Recommendations for remediation, if applicable, were made.

RESULTS

Between June 20, 2007, and November 18, 2008, TFS BMP foresters evaluated BMP implementation on 152 sites, totaling 13,742 acres, throughout East Texas. These 152 tracts are geographically represented by ownership category in Figure 1. Tabulated results by question on the BMP implementation monitoring checklist are located in the Appendix.

SITE CHARACTERISTICS

Ninety of the 152 sites (59%) were on family forest lands. Forty-seven sites (31%) were owned by corporate landowners. Eight sites (5%) were owned by forest industry. Seven sites (5%) were on publicly owned lands.

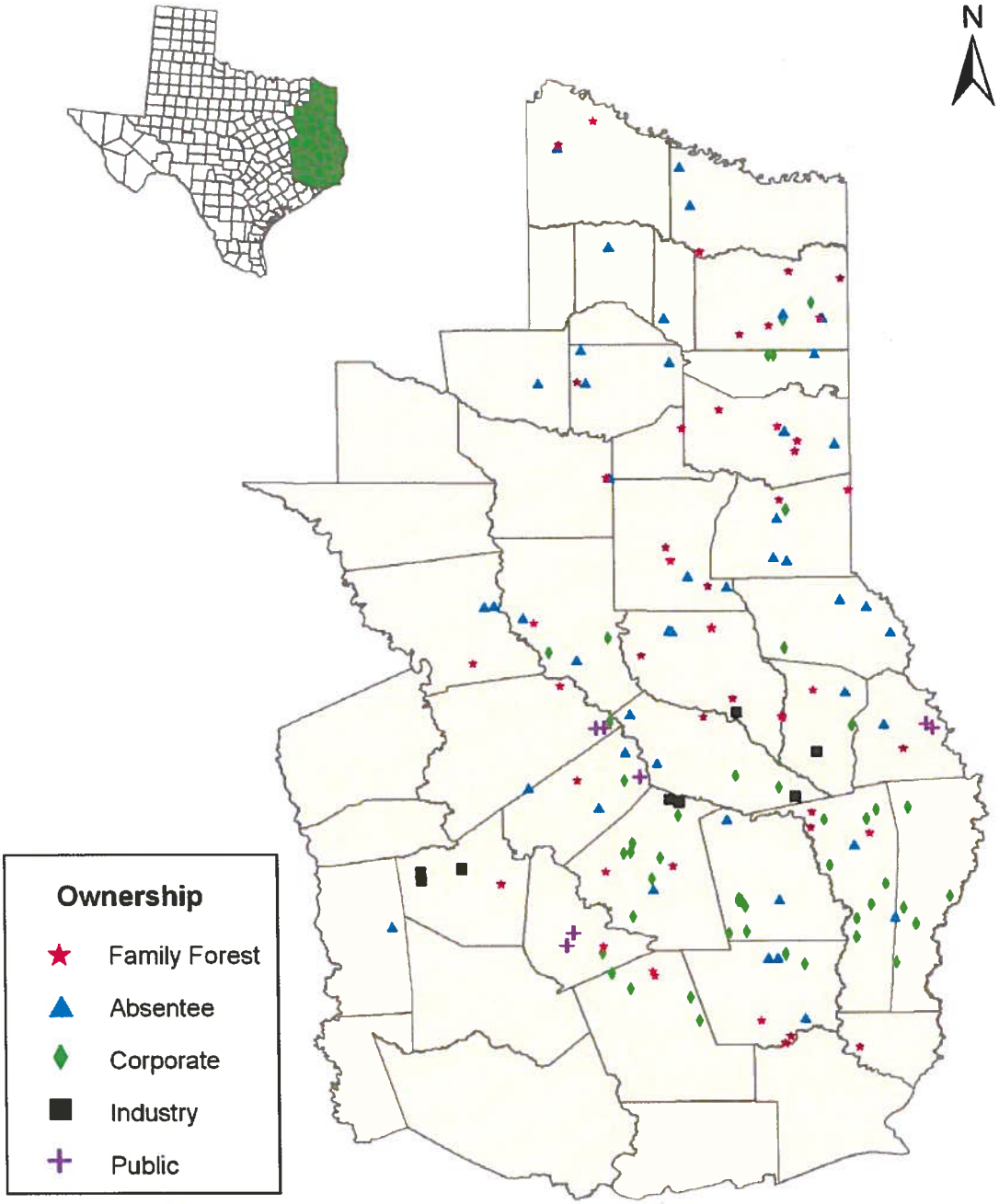
The majority of sites (58%) were monitored after a regeneration harvest, including 87 clearcuts and one partial harvest (seed tree harvest). Forty-five thinning and nineteen site preparation operations were evaluated. In 34 cases, the site preparation evaluation was included in elements of the preceding timber harvest operation or succeeding planting operation.

Professional foresters were involved in planning and/or implementing the silvicultural operation on 103 (68%) of the sites. Private consultants were involved on 49 of the sites. On 47 sites, the forester was employed by forest industry or corporations, while U.S. Forest Service foresters were involved on seven sites.

Terrain classification and soil erodibility were recorded from the Natural Resources Conservation Service (NRCS) Soil Survey, if available, or estimated by the forester in the field. Thirty-six sites (24%) were on flat terrain. One hundred fifteen sites (75%) were on hilly terrain and one (1%) was on steep terrain. Forty-eight sites (32%) were on soils with low erodibility, 95 sites (64%) on medium erodibility soils, and nine (1%) were on high erodibility soils.

Of the 152 sites, 112 had either a perennial (12) or intermittent (68) stream or both perennial and intermittent (32). A permanent water body was found within 1,600 feet of 87 sites (57%).

Figure 1. Site Locations by Ownership Category.



PERMANENT ROADS

Permanent roads were evaluated for implementation of BMPs 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 119 of the 152 sites. The percent implementation for permanent roads was 94% with one significant risk was noted. The lowest average category score (81%) was for having roads well drained with appropriate structures. The area with the highest level of implementation was for roads meeting grade specifications (100%). 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	117	1	34	99	0	1.8
Roads meet grade specifications	119	0	33	100	0	-
Rutting within allowable specs	118	1	33	99	0	1.8
Well drained with appropriate structures	93	22	37	81	1	7.3
Ditches do not dump into streams	101	2	49	98	0	2.8
Roads reshaped and stabilized	100	19	33	84	0	6.7

SKID TRAILS AND TEMPORARY ROADS

Skid trails and temporary roads were evaluated on 95 of the 152 monitoring sites. Skid trails are routes through the logging area in which logs are skidded or dragged to a central loading point called a "set" or "landing." 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 88% with no significant risks noted. The lowest implementation category was for having roads well drained with appropriate water control structures (76%). The area with the highest implementation (99%) was for roads meeting grade specifications. See Table 3 and Figure 3.

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

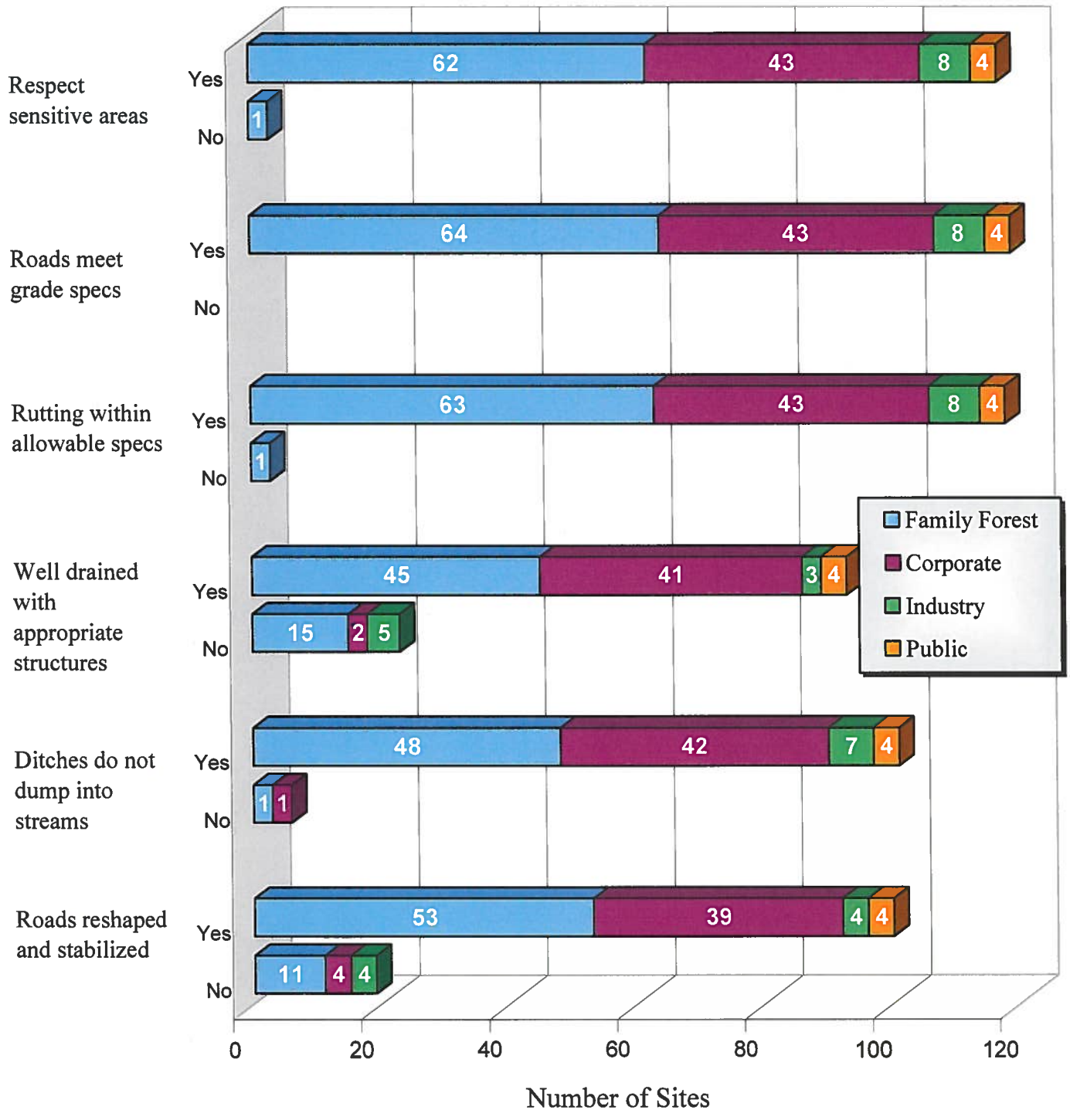


Table 3. Implementation of BMPs Relating to Skid Trails and Temporary Roads.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Slopes less than 15%	94	1	57	99	0	2.0
Respect sensitive areas	91	3	58	97	0	3.5
Roads well drained with appropriate structures	67	21	64	76	0	9.1
Roads stabilized	76	18	58	81	0	8.1
Rutting within allowable specifications	84	11	57	88	0	6.7

STREAM CROSSINGS

Stream crossings were evaluated on 73 sites. Fourteen sites had crossings on permanent roads only, 53 had crossings on temporary roads only, and six had crossings on both permanent and temporary roads. The percent implementation for stream crossings was 82% with a total of 15 significant risks noted. The lowest implementation category for stream crossings on both permanent and temporary roads was stabilization of crossings (75% and 56%, respectively). However, stabilizing crossing on temporary roads was up by (+81%), a tremendous improvement over round six. It is important to note that the highest implementation in both categories was for avoiding or minimizing the number of crossings. See Figure 4 and Table 4.

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

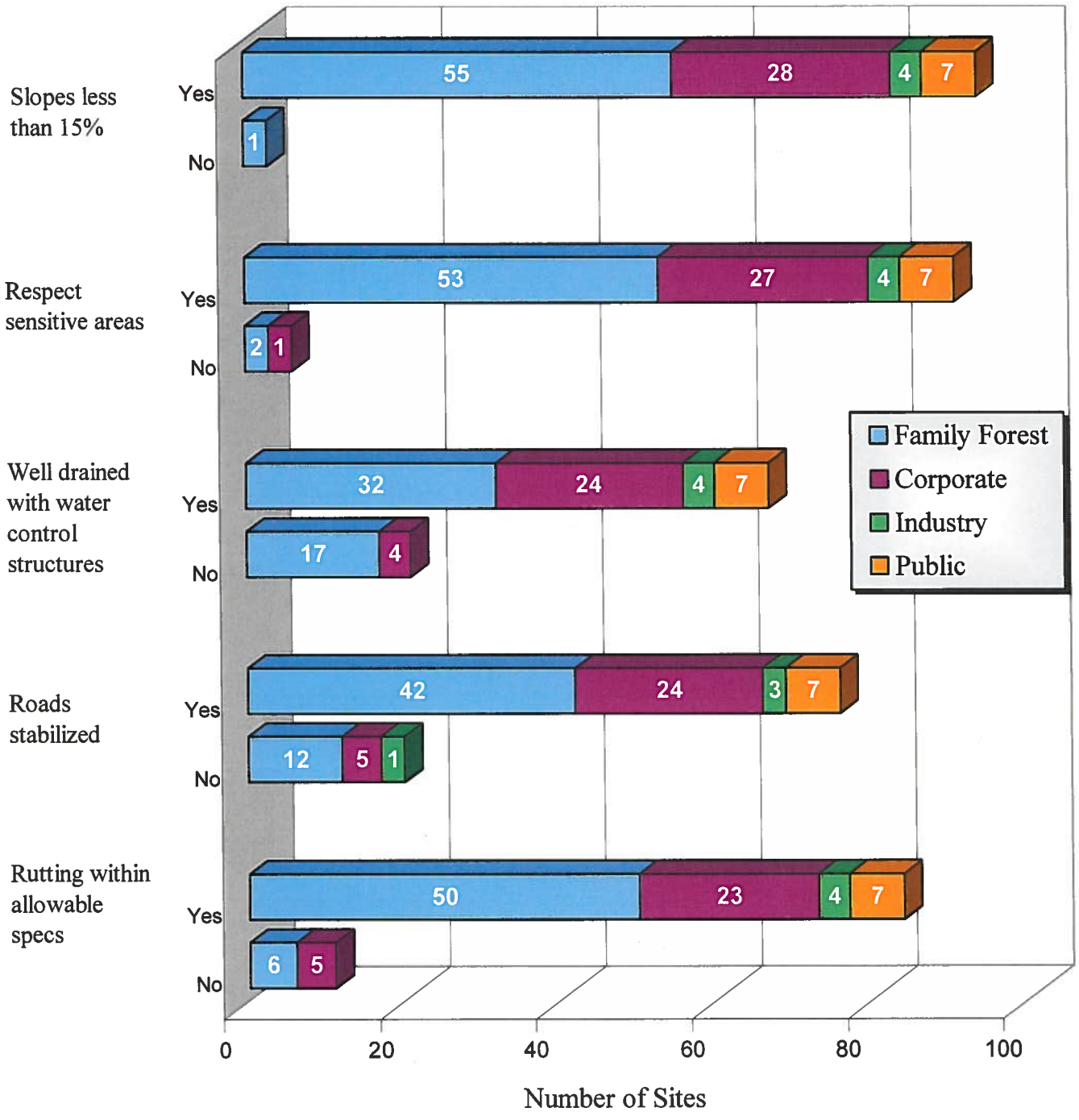


Figure 4. BMP Implementation on Stream Crossings by Ownership Type.

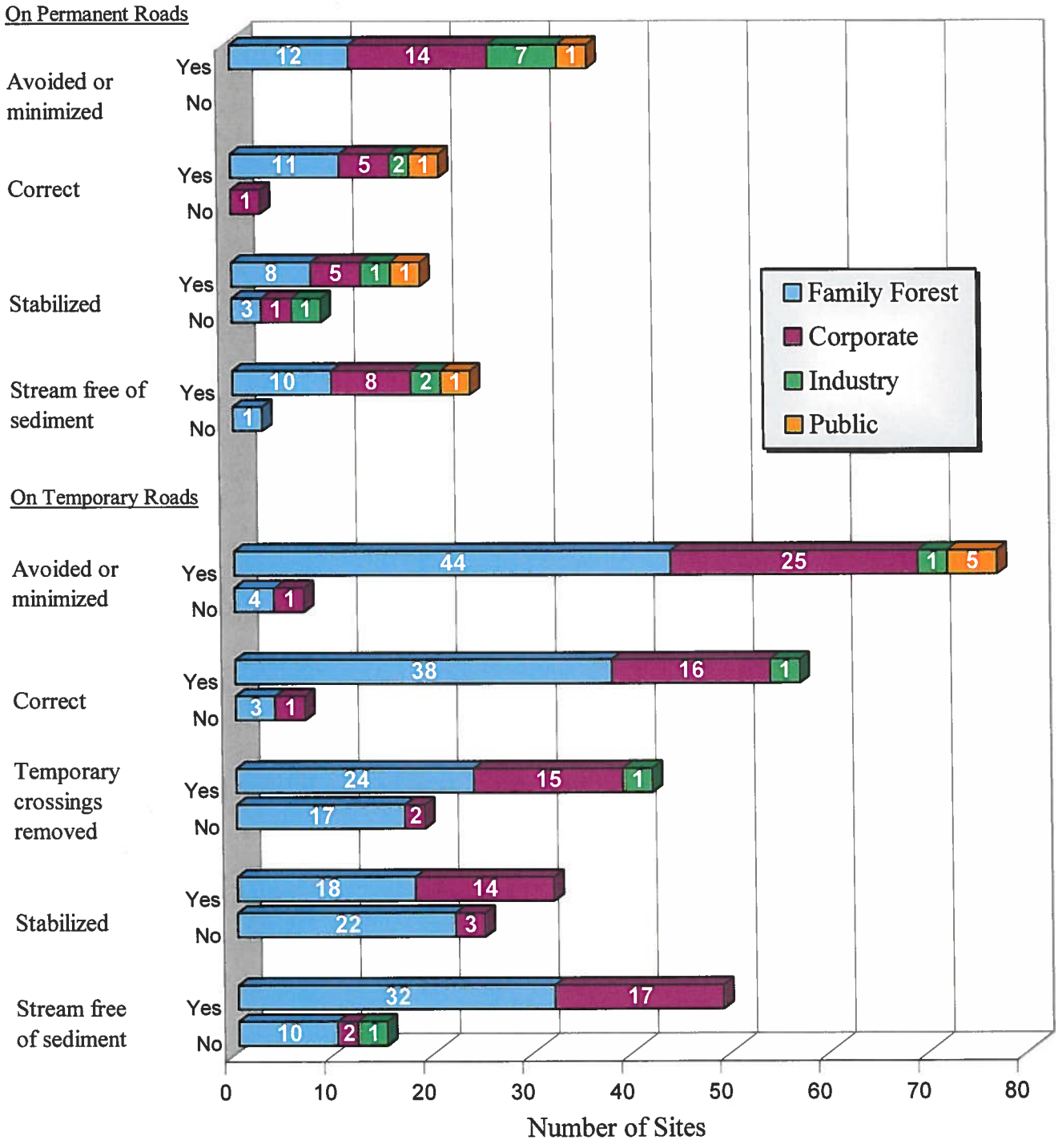


Table 4. Implementation of BMPs Relating to Stream Crossings.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Permanent Roads						
Avoided or minimized	34	0	118	100	0	-
Stream crossings correct	19	1	132	95	0	9.7
Stream crossings stabilized	15	5	132	75	2	19.4
Stream free of sediment	21	1	130	96	1	8.4
Temporary Roads						
Avoided or minimized	75	5	72	94	0	5.3
Stream crossings correct	55	4	91	93	0	6.6
Temporary crossings removed	40	19	93	68	5	12.1
Stream crossings stabilized	32	25	95	56	6	13.1
Stream free of sediment	49	13	90	79	1	10.3

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 112 of the 152 sites. Of these 112 sites, 12 had perennial streams only, 68 had intermittent streams only, and 32 had both perennial and intermittent streams. Overall implementation of SMZs was 88%. One significant risk was noted, a major improvement from the previous round which had seven significant risks. The lowest implementation was for inadequate SMZ width (67%), while the highest was for stream free of sediment and SMZs present on permanent streams (99% and 98% respectively). See Figure 5 and Table 5.

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

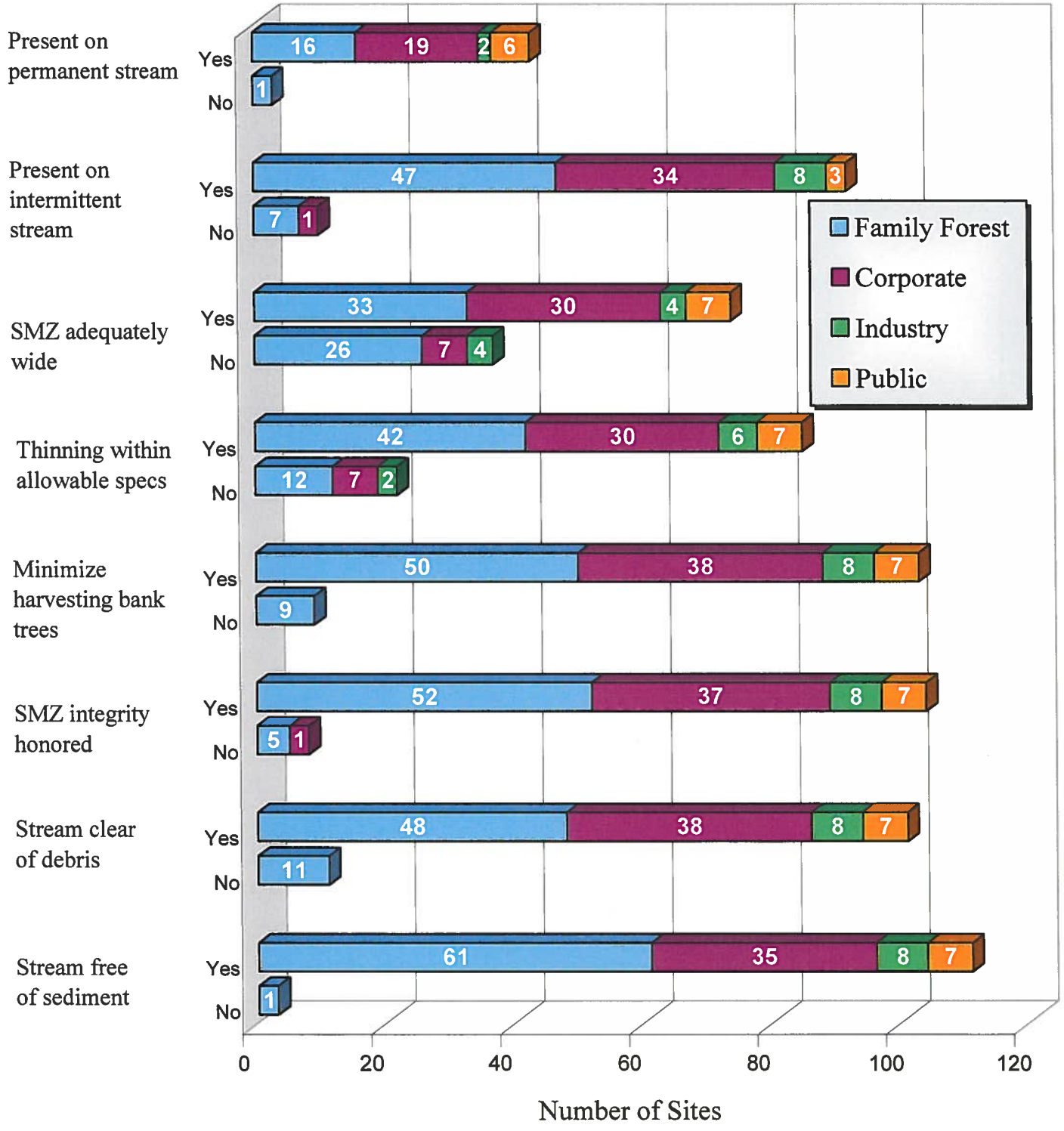


Table 5. Implementation of BMPs Relating to SMZs.

BMP	Yes	No	N/A	% Implementation	Number of Significant Risks	Margin of Error
Present on perennial stream	43	1	108	98	0	4.2
Present on intermittent stream	92	8	52	92	0	5.4
Adequately wide	74	37	41	67	0	8.9
Thinning within allowable specs	85	21	46	80	0	7.8
Minimize harvesting bank trees	103	9	40	92	0	5.1
Integrity honored	104	6	42	95	0	4.2
Stream clear of debris	101	11	40	90	1	5.7
Stream free of sediment	111	1	40	99	0	1.9

SITE PREPARATION

Fifty-three sites were evaluated for implementation with site preparation BMPs. A variety of site preparation techniques were evaluated, including 38 with some combination of shearing, piling, subsoiling, bedding, and/or burning. Fifteen sites involved application of herbicide only. The implementation for site preparation was 98% with one significant risk noted. The lowest implementation was for honoring SMZ integrity and respecting sensitive areas (96% for both categories). 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	2	99	96	1	5.4
No soil movement on site	56	0	96	100	0	-
Firebreak erosion controlled	20	0	132	100	0	-
SMZ integrity honored	43	2	107	96	0	5.8
Windrows on contour/free of soil	9	0	143	100	0	-
No chemicals off site	32	0	120	100	0	-
Mechanical site prep / machine planting on contour	31	1	120	97	0	6.0
Stream free of sediment	43	1	108	98	0	4.2

LANDINGS

Landings, sometimes called sets, are areas where logs are gathered, delimbed, bucked, and loaded onto log trucks. Landings were evaluated on 114 sites with an overall implementation of 98%. Several areas were found to have fully implemented BMPs (100%), including respecting sensitive areas, being on well drained locations, and being located outside of the SMZ. The lowest implementation was for landings being free of oil/trash (90%). There were no significant risks noted on landings. 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	103	11	38	90	0	5.6
Located outside of SMZ	92	0	60	100	0	-
Well drained location	114	0	38	100	0	-
Number and size minimized	113	1	38	99	0	1.9
Respect sensitive areas	114	0	38	100	0	-
Restored/stabilized	112	1	39	99	0	1.9

WETLANDS

Seventeen sites had wetland or "wetland like" areas – not necessarily jurisdictional wetlands. These sites had an overall implementation of 100%. 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	17	0	135	100	0	-
Road drainage structures installed properly	14	0	138	100	0	-
Mandatory road BMPs followed	11	0	141	100	0	-

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

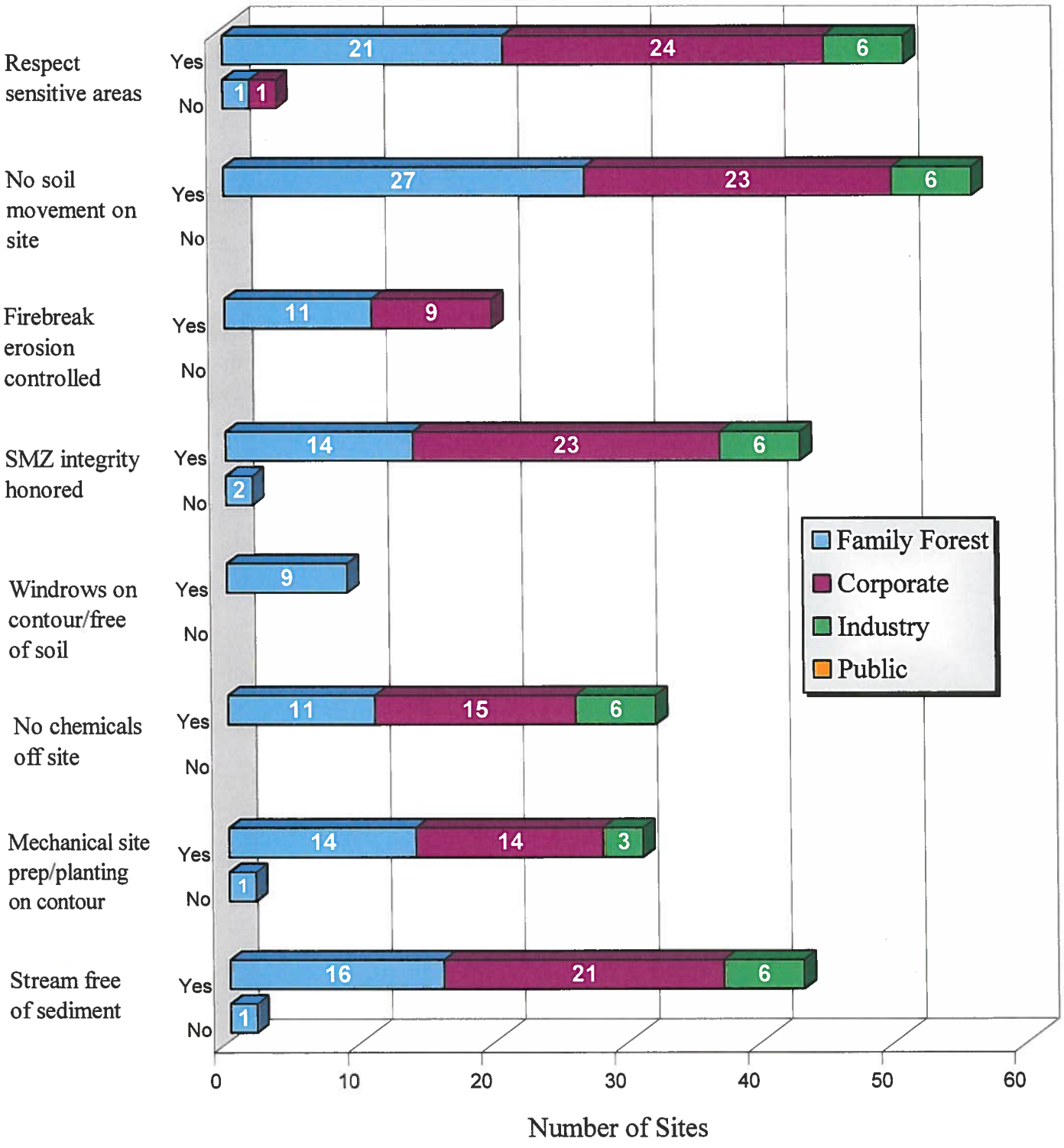


Figure 7. BMP Implementation on Landings by Ownership Type.

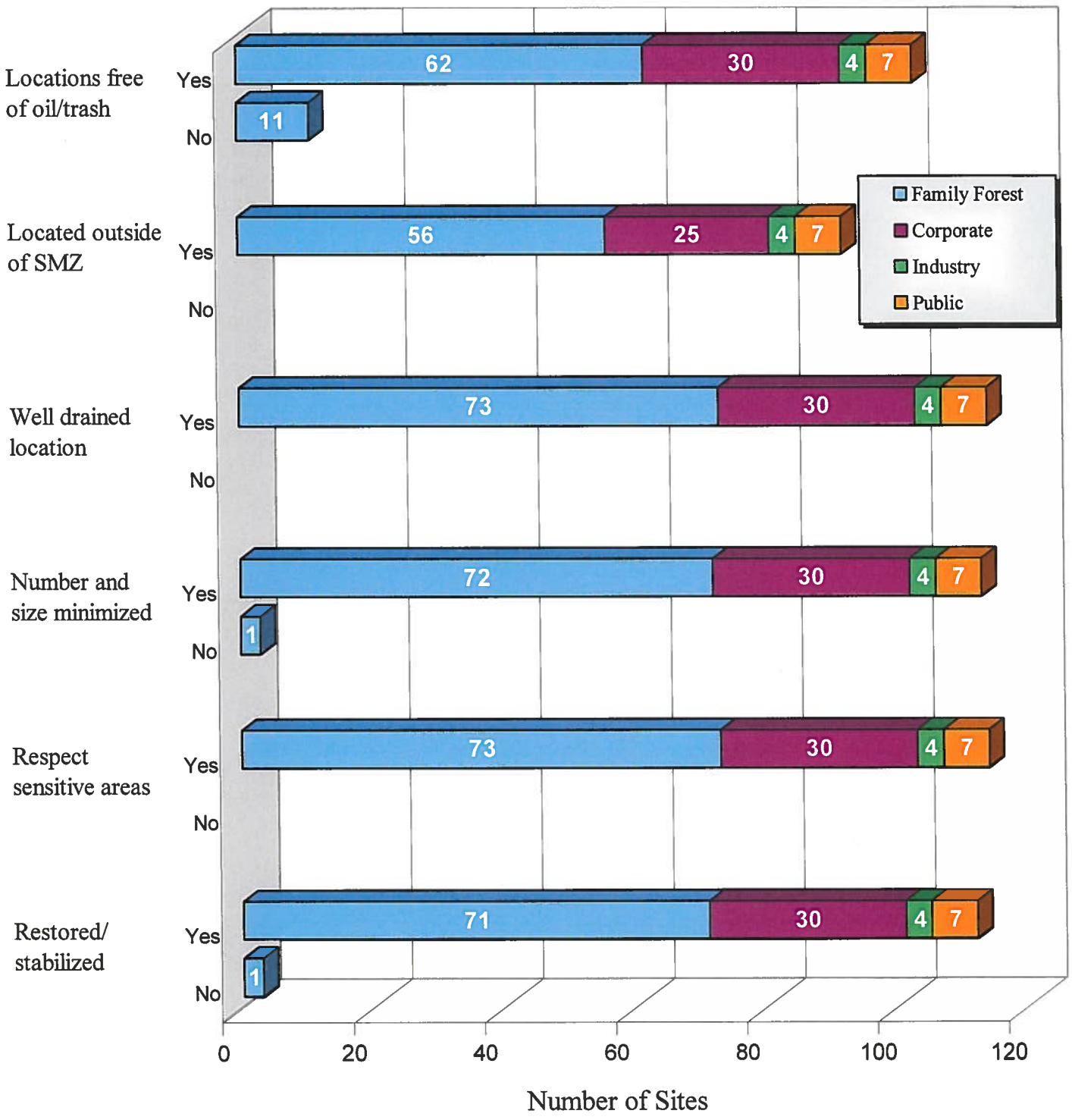
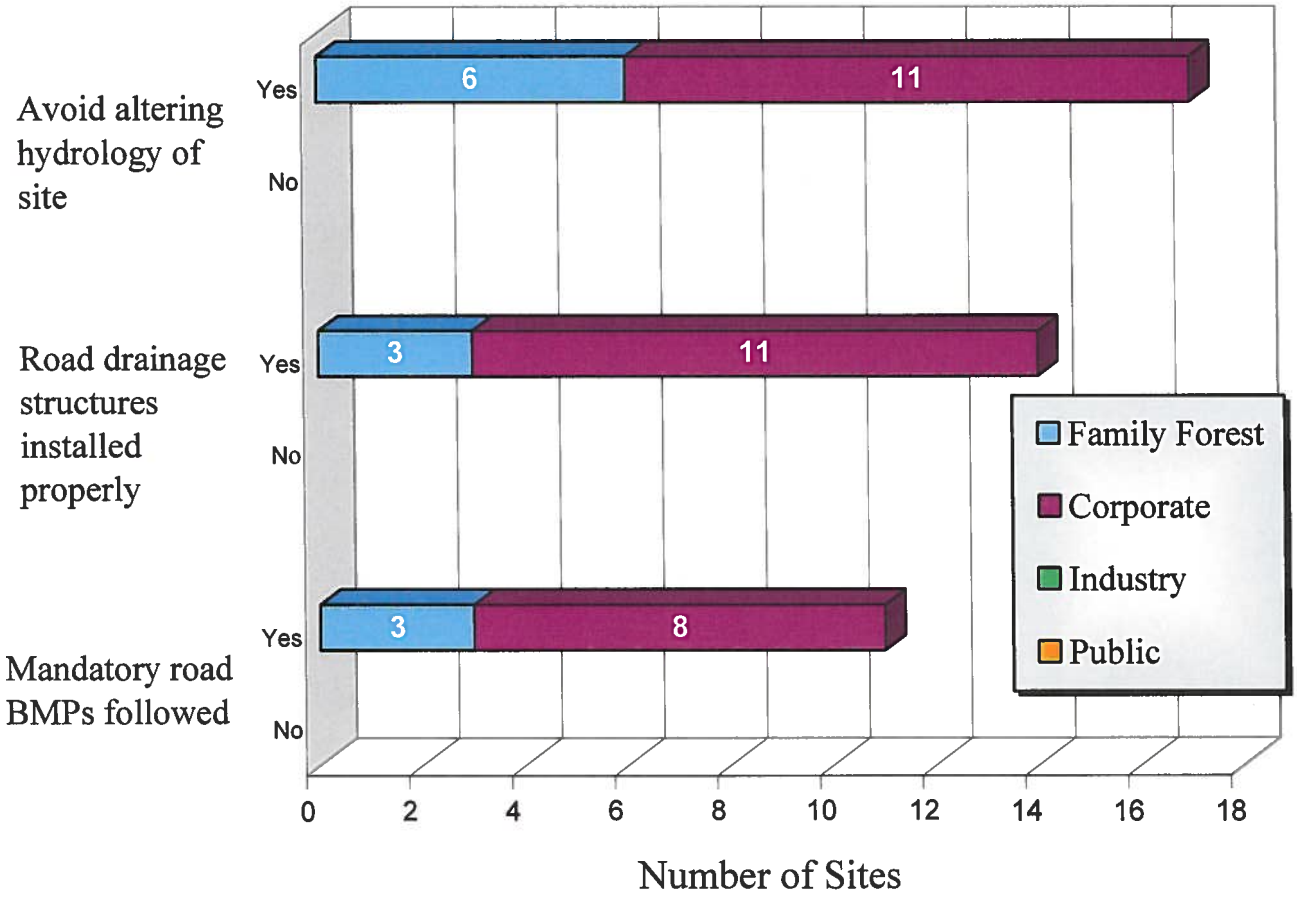


Figure 8. BMP Implementation on Wetlands by Ownership Type.



OVERALL BMP IMPLEMENTATION

To illustrate the range of the overall implementation scores, Figures 9 and 10 separate the results into five categories: 0-50%, 51-70%, 71-80%, 81-90%, and 91-100%. Figure 9 geographically illustrates implementation across all ownership types. Figure 10 provides the number of tracts across all ownership types receiving the respective level of implementation.

IMPLEMENTATION BY SITE CHARACTERISTICS

Ownership

BMP implementation varied by ownership type. The public ownership category fared best, with 100% for the seven tracts with no significant risks noted.

The 47 sites owned by corporate landowners had an overall BMP implementation of 95.7% with only two significant risks.

Forest industry owned eight of the sites and had an overall implementation of 91.1% with only two significant risks.

Family forest owners had an implementation rating of 88.7% with 14 significant risks on 90 sites. This represents the lowest level of the four ownership types.

Type of Activity

Four types of silvicultural activities were monitored: regeneration harvests, partial regeneration cuts, thinning, and site preparation. Nineteen sites were evaluated for site preparation only, although site preparation was evaluated along with a regeneration harvest or planting 34 times. See Table 9.

Table 9. Overall BMP Implementation by Type of Operation.

Type of Operation	BMP Implementation
Regeneration harvest (clearcut)	89.3%
Regeneration harvest (partial cut)	89.4%
Thinning	96.8%
Site preparation (only)	88.8%

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

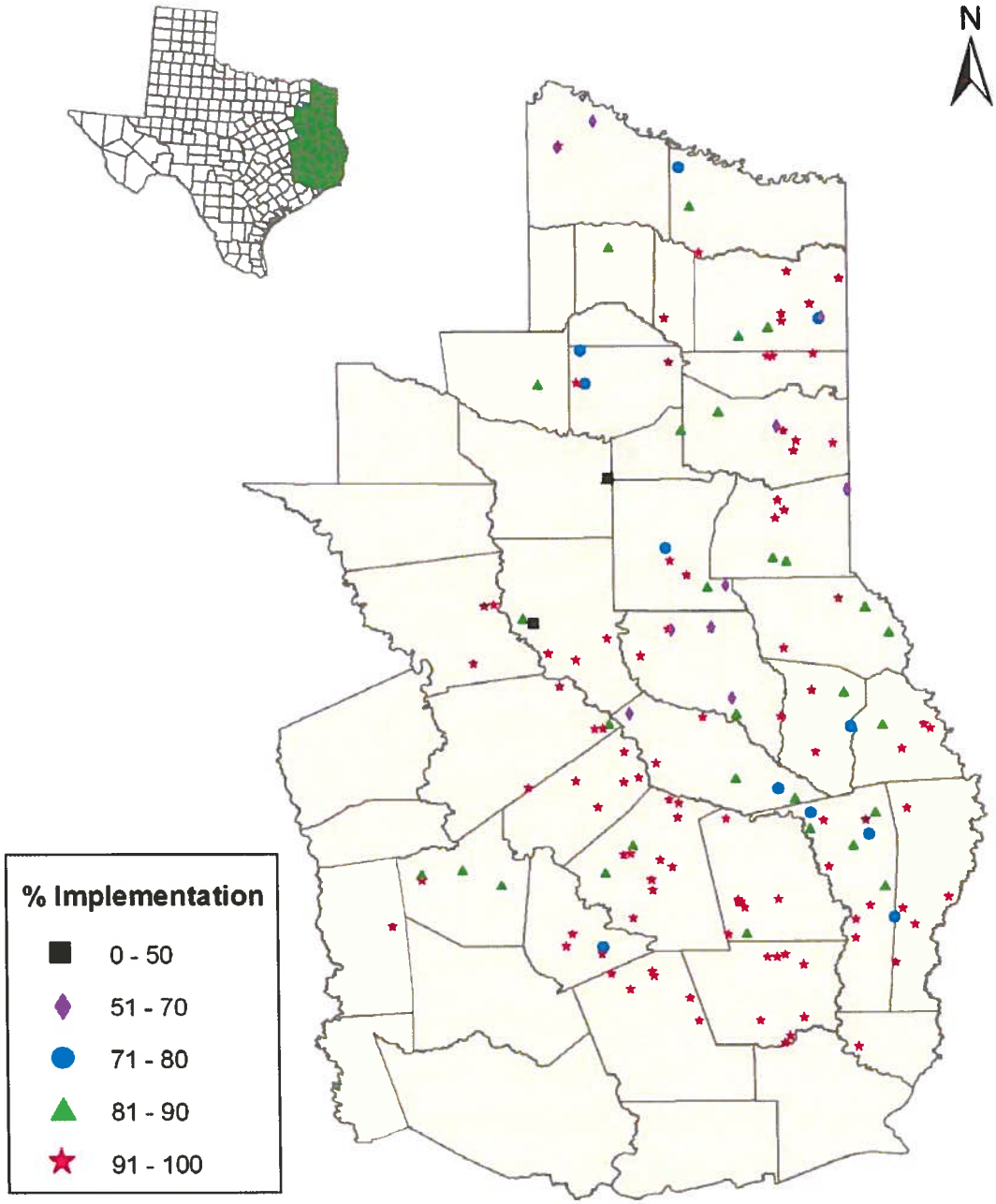
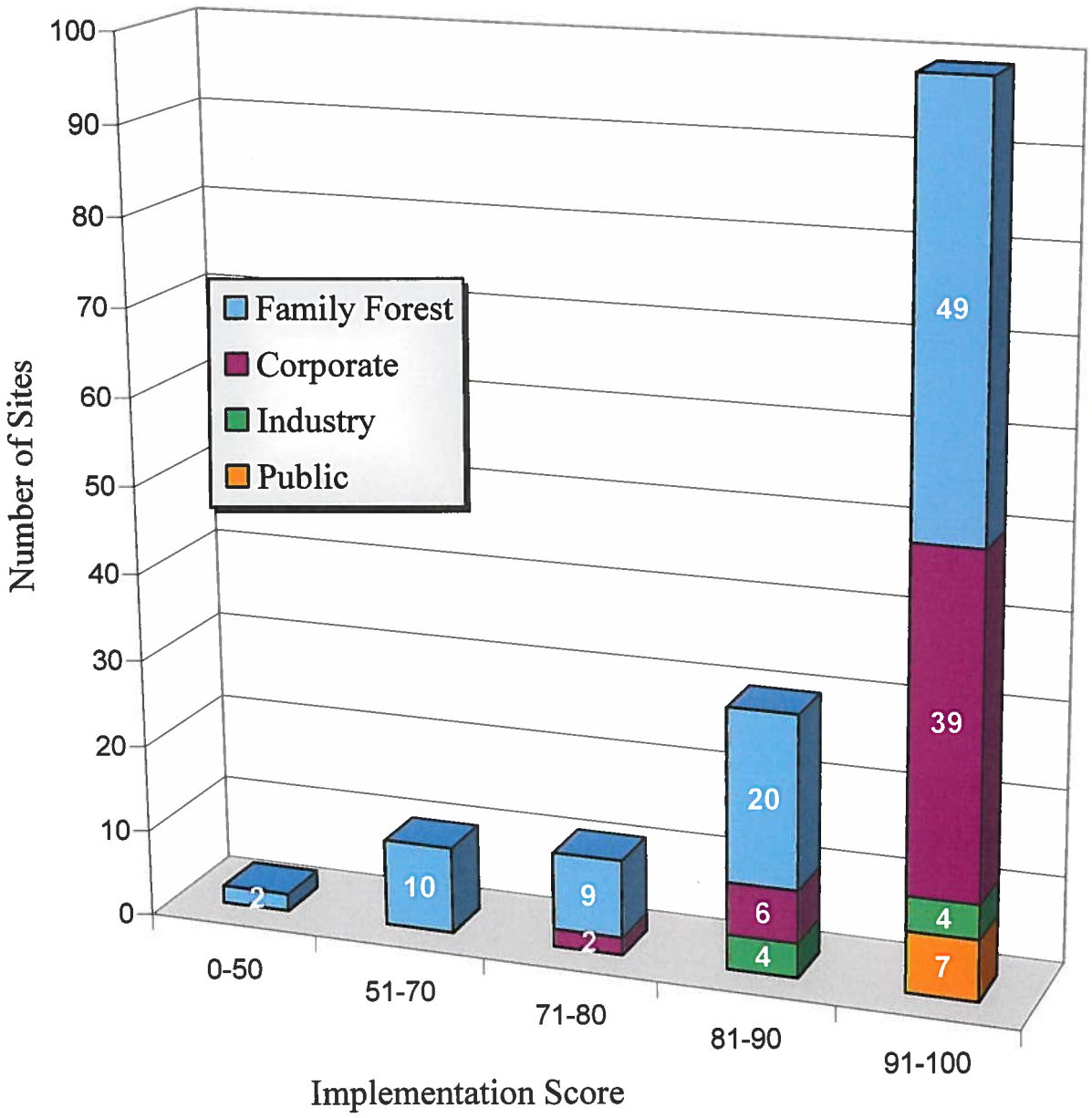


Figure 10. Overall Implementation Scores by Number of Sites and Ownership.



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-seven sites were monitored in the southern region and had an implementation rating of 94.6%, while 65 sites were monitored in the northern region with an implementation rating of 87.4%. The higher BMP implementation in Southeast Texas is expected due to the high concentration of corporate, public, and industrial ownership, flatter topography, and less erodible soils.

Terrain

Monitoring sites were classified as *Flat*, *Hilly*, or *Steep*. BMP implementation on the 36 flat sites was 93.6% with four significant risks; on the 115 hilly sites, 90.9% with 14 significant risks; and on the one steep site, 92.9% with no significant risks.

Erodibility

Monitoring sites were identified as having *Low*, *Medium*, or *High* soil erodibility. BMP implementation on a total of 48 low erodibility sites was 91.6% with six significant risks; on 95 medium erodibility sites, 91.2% with 11 significant risks; and on nine high erodibility sites, 90.9% with nine significant risks.

Distance to Permanent Water

Distance to the nearest permanent waterbody was determined for each monitoring site. BMP implementation on 81 sites with permanent water less than 300 feet away was 91.6% with 14 significant risks. On five sites with permanent water 300 to 800 feet away, implementation was 84.5% with three significant risks. On four sites with permanent water 800 to 1600 feet away, implementation was 90.5% with no significant risks. Of the 62 sites in which permanent water was greater than 1,600 feet away, BMP implementation was 92.1% with one significant risk.

River Basin

Monitoring sites were identified to be in the following river basins: Cypress, Neches, Red, Sabine, San Jacinto, Sulphur, and Trinity. BMP implementation was highest in the San Jacinto River Basin (100%) on 4 sites and lowest in the Red River Basin (74.1%) on two sites. See Table 10 and Figure 11.

Hydrologic Unit Code (Watershed)

Monitoring sites were also tracked by their eight digit hydrologic unit code (HUC). Three HUCs (12030203, 12040101, 12040103) had an implementation score of 100%. Thirteen of the 22 watersheds (59%) scored over 90%. The lowest rated watershed had a BMP implementation rating of 74.1% (1140106). See Table 11 and Figure 12.

Table 10. BMP Implementation by River Basin.

River Basin	Number of Sites	% Implementation	Significant Risks
Cypress	20	89.7	2
Neches	72	91.7	8
Red	2	74.1	1
Sabine	29	90.4	2
San Jacinto	4	100.0	0
Sulphur	7	90.8	2
Trinity	18	94.0	3

Table 11. BMP Implementation by Hydrologic Unit Code.

Hydrologic Unit Code	Number of Sites	% Implementation	Significant Risks
11140106	2	74.1	1
11140302	6	91.1	2
11140303	1	88.9	0
11140304	3	88.5	0
11140305	2	94.4	0
11140306	11	90.5	0
11140307	4	85.7	2
12010002	10	85.2	1
12010004	9	91.4	1
12010005	9	95.9	0
12020001	6	87.8	1
12020002	17	93.4	3
12020003	10	91.6	1
12020004	8	86.4	1
12020005	13	87.4	2
12020006	12	96.1	0
12020007	6	98.1	0
12030201	1	88.1	1
12030202	15	93.5	2
12030203	3	100	0
12040101	1	100	0
12040103	3	100	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. Twenty-four sites were identified to be within one mile of a listed stream segment and had an implementation rating of 92.7%. 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.

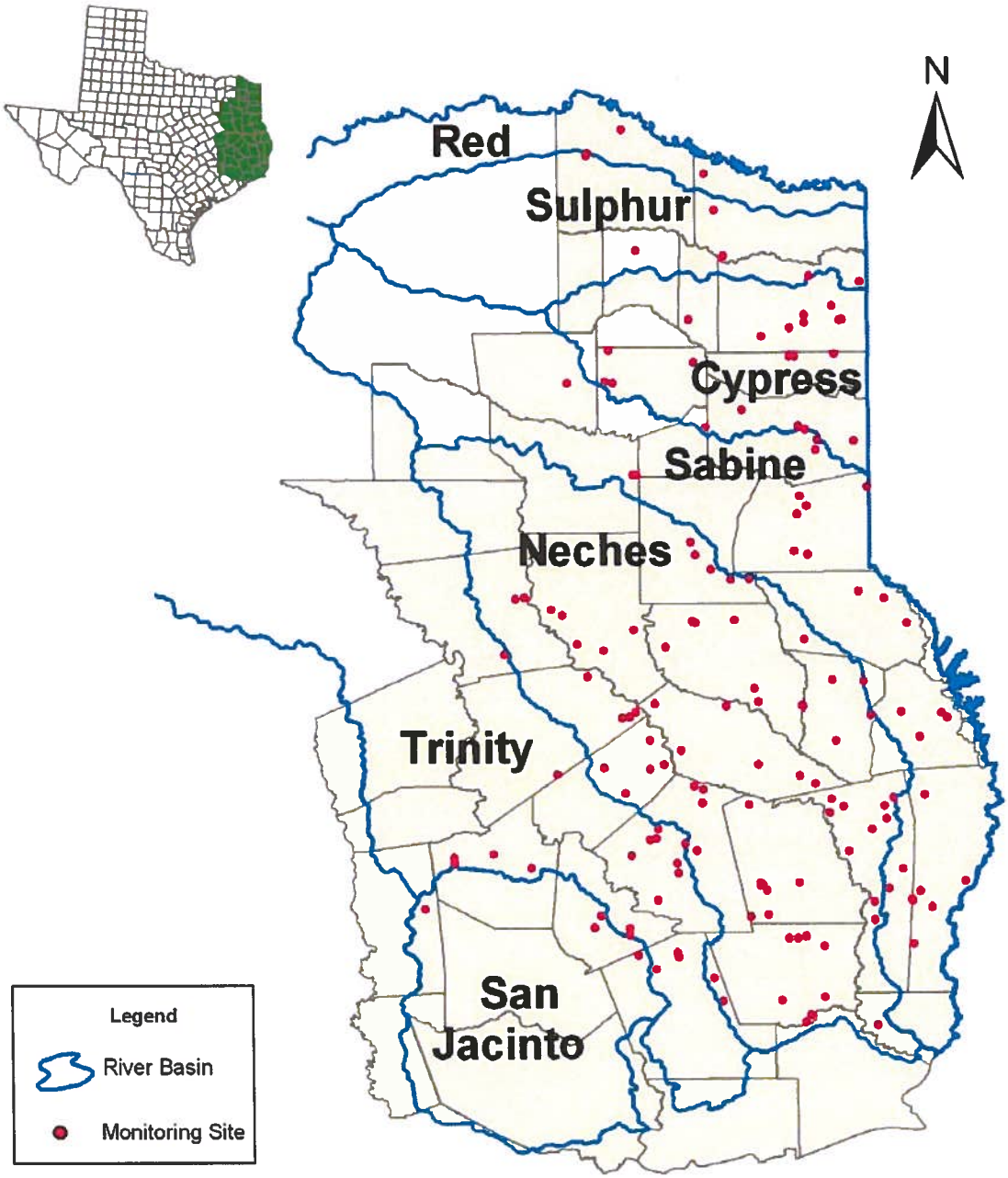
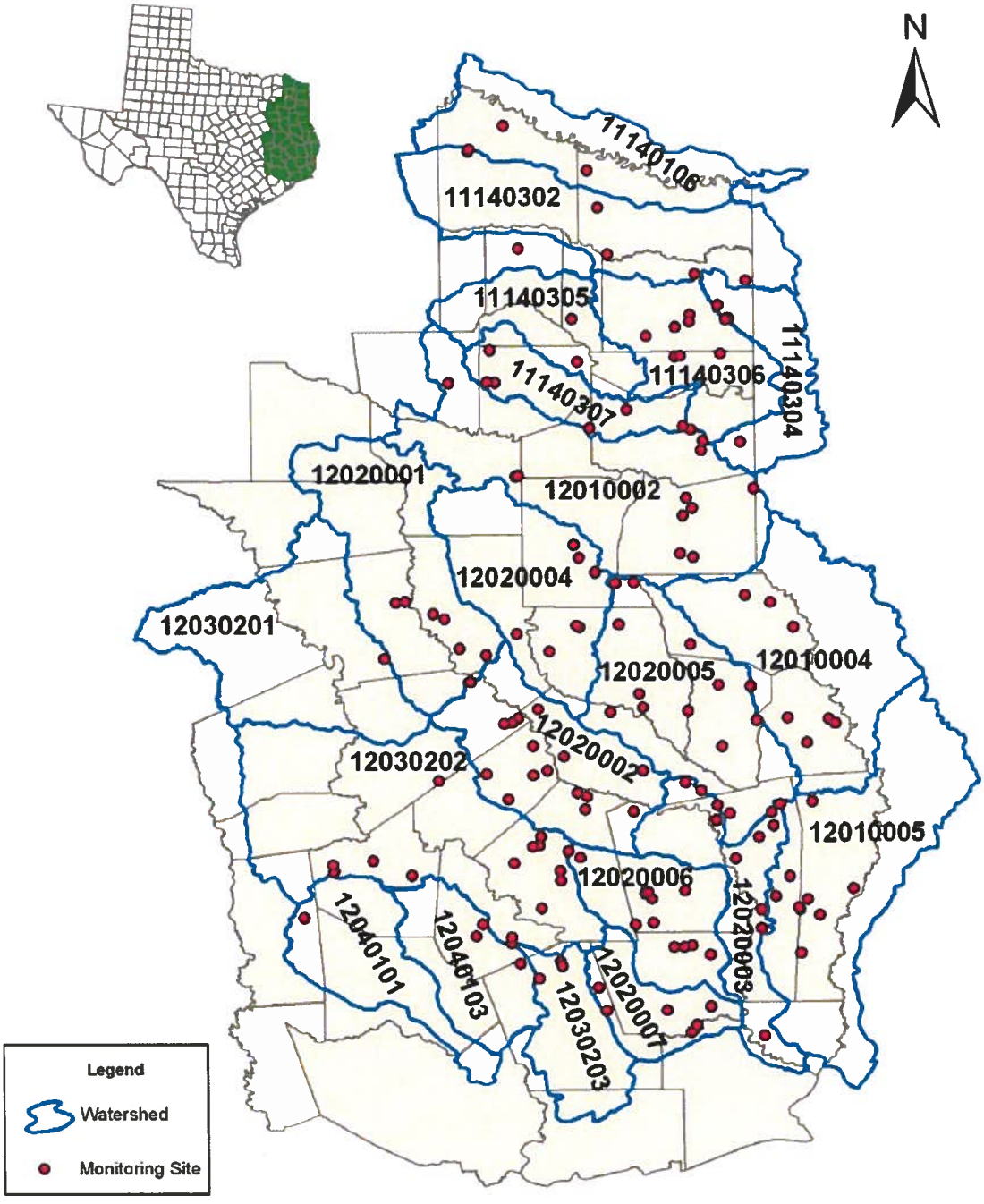


Figure 12. Site Location by Hydrologic Unit Code (Watershed).



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 these trends where higher BMP implementation occurred, Texas Forest Service can develop outreach efforts that encourage the use of these practices.

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 listed 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 7, the 95% confidence interval for the overall BMP implementation across all sites was (89.7, 93.4).

95% CI = Mean ± Margin of Error

STATISTICAL SIGNIFICANCE OF BMP TRENDS

Two different statistical analyses were performed on the following categories:

- Forester Involved in Sale or Activity
- Logger Attended BMP Training
- Landowner Familiar with BMPs
- BMPs Included in the Timber Sale Contract
- Landowner Member of Tree Farm
- Timber Delivered to SFI® Mill

The first statistical analysis was a parametric two sample t-test, which was included because of the large sample size. This percentage data had to undergo an arcsin square root transformation prior to analysis. Percentage data must be transformed because they are not normally distributed, which invalidates the normality assumption of the parametric test. A non-parametric test (Wilcoxon) was also performed to add greater statistical validity. 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 all of these categories. See Table 12.

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

	% Implementation		Parametric *P* value	Non Parametric *P* value	Level of Significance	Statistically Different?
	Yes	No				
Forester Involved	94.9	84.0	< 0.001	< 0.001	0.05	YES
Logger Attended BMP Training	93.9	81.7	< 0.001	< 0.001	0.05	YES
Landowner Familiar with BMPs	95.2	84.5	< 0.001	< 0.001	0.05	YES
BMPs in Contract	95.5	80.6	< 0.001	< 0.001	0.05	YES
Landowner Member of Tree Farm	95.9	87.5	0.009	0.016	0.05	YES
Timber Delivered to SFI® Mill	95.3	85.9	< 0.001	< 0.001	0.05	YES

Forester Involved in the Sale or Activity

BMP implementation was higher when a professional forester was involved in the sale or activity. One hundred three sites were identified as having a professional forester involved and had an implementation rating of 94.9%. Sites in which there was no forester involvement had a BMP implementation rating of 84.0%. See Figure 13.

Logging Contractor Attended BMP Workshop

Logging contractor familiarity with BMPs influenced implementation. Texas Forest Service BMP Project staff offers a BMP workshop in which contractors are made more aware of BMPs and water quality. One hundred twenty-two inspections identified the logging contractor as having attended the formal BMP training, with an implementation of 93.9%. Sites in which there was no attendance by the logger at the formal BMP training or if the logger was unknown had an implementation rating of 81.7%. See Figure 13.

Landowner Familiarity with BMPs

Landowner familiarity with BMPs also influenced BMP implementation. Sites whose owners were not familiar with BMPs (52) had an overall implementation rating of 84.5%, while sites whose owners were familiar with BMPs (100) had an implementation rating of 95.2%. See Figure 13.

BMPs Were Included in the Timber Sale Contract

BMPs were included in the timber sale contract, if applicable, on 111 sites. Implementation on sites with BMPs included in the contract was 95.5%, while implementation on tracts without BMPs in the contract was 80.6%. See Figure 14.

Landowner Member of American Tree Farm System

Membership in the American Tree Farm System can have an impact on implementation. This certification system is primarily open to family forest owners. In order to maintain this certification, members must implement BMPs on their forest operations. Landowners were identified as Tree Farmers on 13 sites and had an implementation rating of 95.9%, while implementation for nonmembers on 77 sites was 87.5%. See Figure 14.

Timber Delivered to SFI® Mill

BMP implementation was higher on sites in which the receiving mill was known to be a SFI® member. This occurrence was documented on 91 sites with a rating of 95.3%, compared to an 85.9% rating on 61 sites in which the timber went to other mills or the receiving mill was unknown. See Figure 14.

Figure 13. Overall Implementation by Various Types of Involvement.

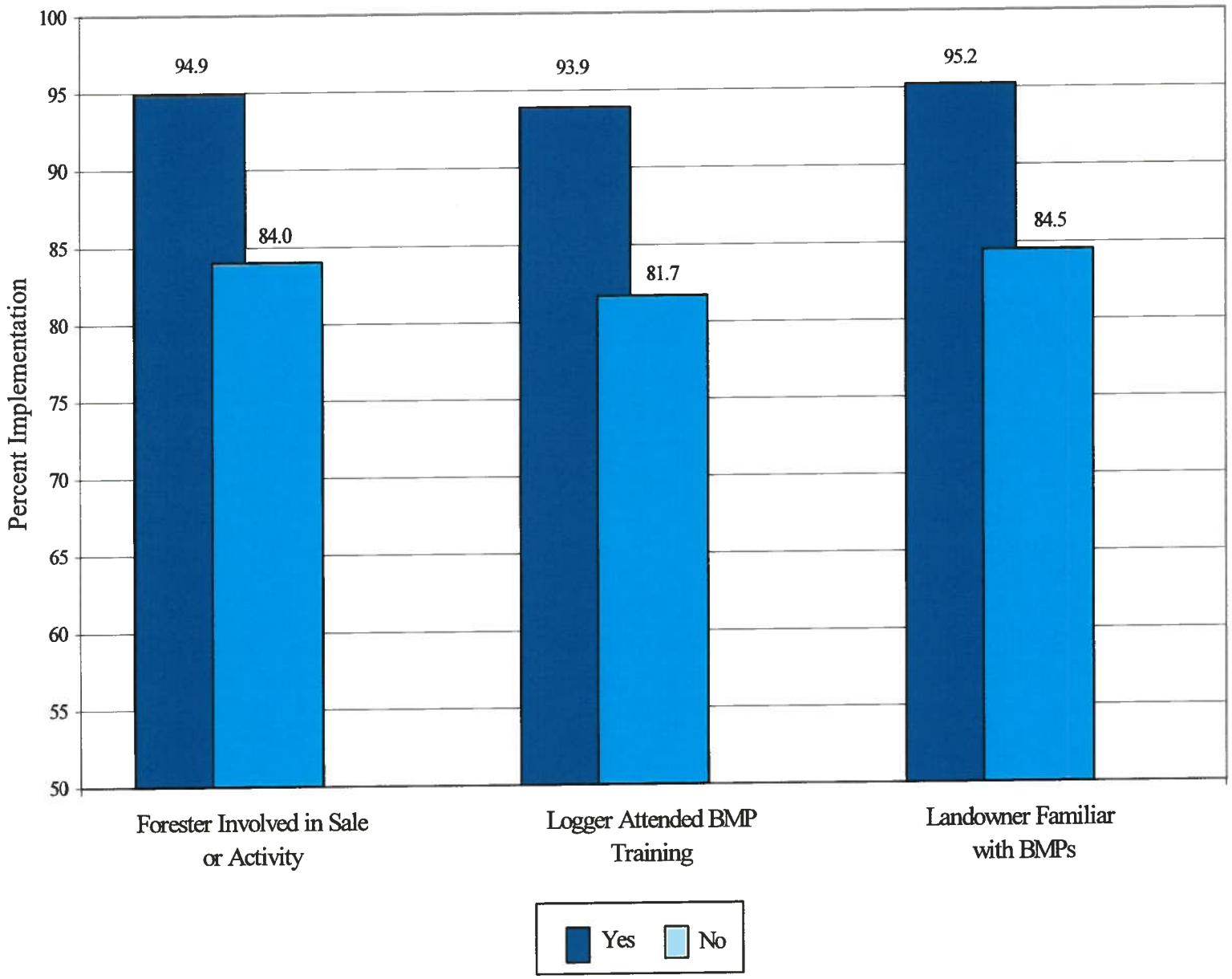
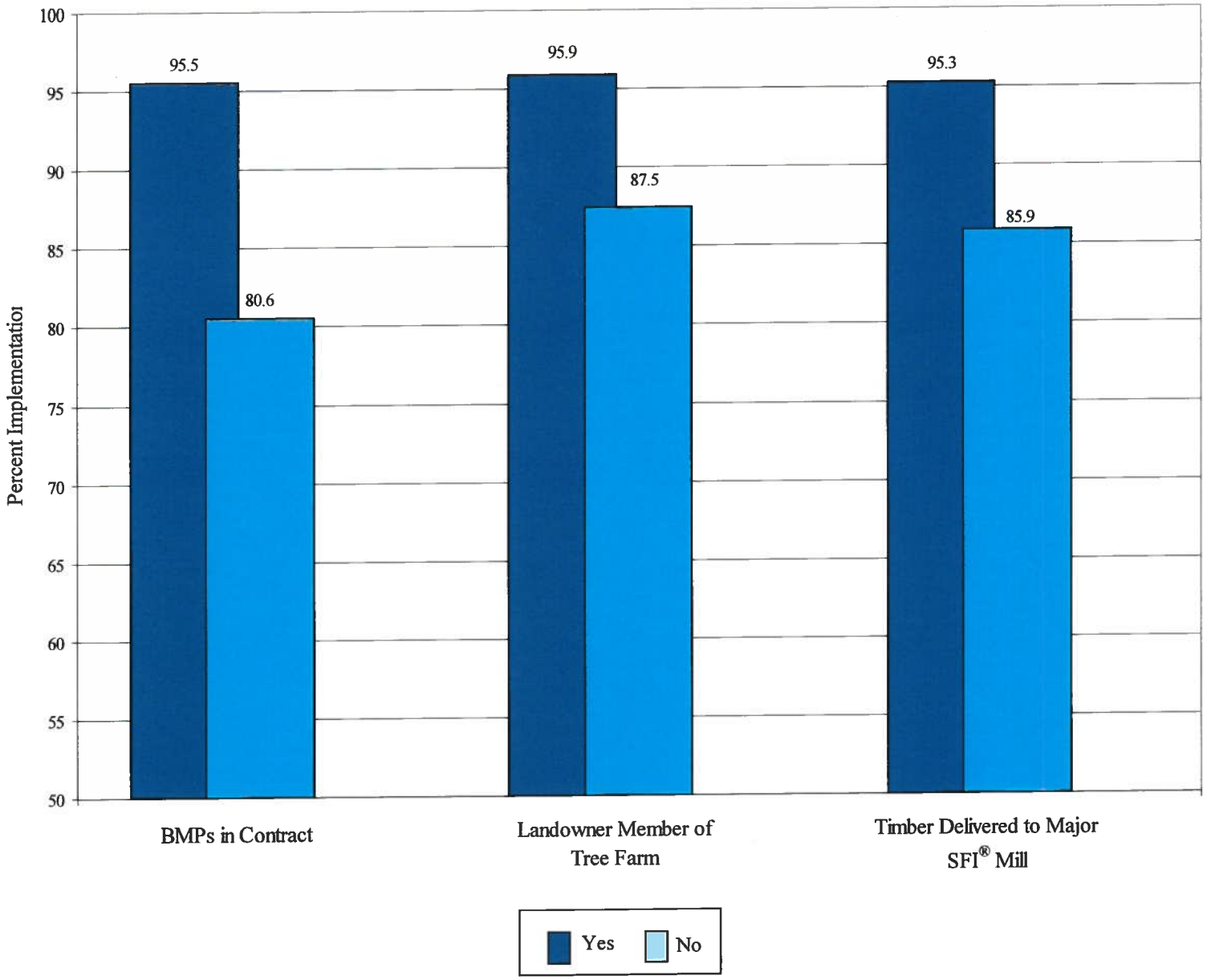


Figure 14. Overall Implementation by Various Categories.



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 tracts were scored as *No Effort, Poor, Fair, Good, or Excellent.* In order to determine percent implementation for an individual tract under this older method, passing tracts (*Fair, Good, or Excellent*) scored 100%, while failing tracts (*No Effort, Poor*) scored 0%.

The current, objective method more accurately scores percent implementation. Individual tracts 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 - 7 *cannot* be directly compared to Rounds 1 - 3. However, tract evaluations conducted in Rounds 1 - 3 were scored using the current method in the Texas 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, 2, 3, 4, 5, and 6

Round 1 of BMP implementation monitoring, completed in 1992, yielded an overall implementation rate of 88.2%. Round 2, which was completed in 1996, showed an overall implementation rate of 87.4%. Round 3, completed in 1998, reported overall BMP implementation at 87.3%. Round 4, completed in 2000, documented overall BMP implementation at 88.6%. Round 5, completed in 2002, showed overall BMP implementation at 91.5%, while Round 6 reported overall BMP implementation at 91.7%.

BMP implementation on industry land had steadily increased from 89.6% in Round 1 to 95.1% in Round 2 to 98.4 % in Round 3. Implementation on industrial lands scored 94.2% in Round 4, 96.1% in Round 5, and 95.7% in Round 6. A new landowner category was developed in Round 6 (corporate) in response to the changes in land ownership from the divestiture of industrial forestlands. Overall BMP implementation for corporate landowners in Round 6 was 96.0%. These consistently high scores document the diligence of forest industry in using voluntary BMPs on their operations.

BMP implementation on publicly owned land has increased from 93.3% in Round 1 to 100% in Round 2, and maintained its 100% implementation through Round 3. Implementation on public lands scored 97.9% in Round 4, 98.4% in Round 5, and 98.3% in Round 6.

In Round 1 of monitoring, implementation on family forest owners was 86.3%. During Round 2, implementation was 82.9% and decreased to 76.3% in Round 3. However, in Round 4, implementation made an upward shift to 81.2%, increased to 86.4% in Round 5, and reached an all time high of 88.7% in Round 6.

OVERALL IMPLEMENTATION – Round 7

BMP implementation on public land for Round 7 was 100% with no significant risks to water quality identified. Implementation on industry land during this time period was 91.1% with two significant risks, while implementation on corporate land was 95.7% with two significant risks. Family forest owners received an implementation rating of 88.7% with 14 significant risks. This resulted in an overall BMP implementation of 91.5% with a total of 18 significant risks across all ownership categories. See Table 14.

BMP implementation on family forest owners lagged behind other ownerships and accounted for 14 of the 18 significant risks. 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. It is important to note that the average size of the harvested family forest owner tract was smaller than the industrial and corporate tracts. This lower level of implementation occurred on smaller tracts while the higher level of BMP implementation occurred on larger tracts of land.

Table 14. Percent Implementation by Ownership and Round.

	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7
Family Forest Owner	86.3	82.9	76.3	81.2	86.4	88.7	**88.7**
Corporate	-	-	-	-	-	96.0	**95.7**
Industry	89.6	95.1	98.4	94.2	96.1	95.7	**91.1**
Public	93.3	100	100	97.9	98.4	98.3	**100**
Overall	88.2	87.4	87.3	88.6	91.5	91.7	**91.5**

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 tracts are weighted more heavily than smaller tracts, primarily because they have a greater opportunity to impact water quality. The results were reanalyzed using the above-mentioned approach. BMP implementation scores actually increased for the family forest owner, industry, and overall. See Table 15.

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

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

Table 15. Area Weighted Percent Implementation by Ownership, Round 7.

Landowner Type	Area Weighted % Implementation
Family Forest Owner	91.4
Corporate	95.7
Industry	91.6
Public	100
Overall	93.7

CONCLUSION

Positive statistical correlations between landowner familiarity with BMPs, forester involvement, 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 industry also played a significant role in increasing BMP implementation. This occurred primarily because of its support of the Texas Forest Service BMP Program and participation in SFI®. Water quality protection is obviously a top priority for the forest industry, 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 and incentives advocated by Texas 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 by giving them special property tax incentives for doing so. The American Tree Farm System requires landowners to implement BMPs on their operations in order to maintain their certification. Texas Forestry Association sponsors many workshops each year emphasizing sustainable forestry.

Overall BMP implementation maintained a very high level. Most notable is the family forest owner, whose implementation increased by 12.4% since Round 3, which had the lowest rate since the monitoring began. This increase 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 remains at a very high level, there is still room for improvement. The past round of monitoring noted a deficiency in removing and stabilizing stream crossings on temporary roads and leaving inadequate streamside management zone widths along waterbodies. Texas Forest Service has already begun to address this issue. A BMP training workshop focusing specifically on stream crossings has been developed. Early response to this course has been excellent. Future courses will be developed on streamside management zones and forest roads. Improvement was also made in reducing the number of significant risks to water quality from the previous round; however, there still is work to do in this area. Continuing effective educational programs for family forest owners, providing technical assistance to the forestry community on BMPs, and conducting BMP training for loggers can minimize the potential water quality impacts from silvicultural operations.

Appendix

Implementation Monitoring Checklist

Evaluation Criteria

Summary of Results

TEXAS FOREST SERVICE

The Texas A&M University System

TEXAS BMP MONITORING CHECKLIST

Site ID: 1

I. General Landowner and Tract Information

County | TFS Block and Grid | Region

Owner Type: ☐ N ☐ A ☐ C ☐ I ☐ P

Latitude | Longitude

Forester Type | Name

Timber Buyer | Contractor

Activity | Acres Affected

Estimated Date of Activity | Date of Inspection

Inspector | Accompanied by

Landowner:

Name | Address | City | State | Zip | Phone

II. Site Characteristics

Terrain: ☐ Flat ☐ Hilly ☐ Steep

Erodibility hazard: ☐ Low ☐ Medium ☐ High

Type stream present: ☐ Perennial ☐ Intermittent

Watershed Code

River Basin

Distance to nearest permanent water body:
☐ < 300' ☐ 300 - 800' ☐ 800 - 1600' ☐ 1600' +

Predominant soil series/texture:
☐ 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	0	0		0
Percent Implementation	N/A			

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

IV. Secondary (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	0	0		0
Percent Implementation	N/A			

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

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	0	0		0
Percent Implementation	N/A			

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	0	0		0
Percent Implementation	N/A			

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	0	0		0
Percent Implementation	N/A			

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	0	0		0
Percent Implementation	N/A			

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	0	0		0
Percent implementation	N/A			

X. Overall Compliance

	YES	NO	NA/NN	Sig. Risk
III. Permanent Roads	0	0	☑	0
IV. Skid trails/Temporary Roads	0	0	☑	0
V. Stream Crossings	0	0	☑	0
VI. Streamside Management Zones	0	0	☑	0
VII. Site Preparation	0	0	☑	0
VIII. Landings	0	0	☑	0
IX. Wetlands	0	0	☑	0
Overall Total	0	0		
Total Significant Risk				0
Percent Implementation	#Error			

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
Texas Forest Service BMP Project

I. General Landowner and Tract Information

County: Texas County inspection was located.
TFS Block and Grid: Enter only entry point if multiple blocks or grids.
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.
Logging 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. Use first entry if multiple entries.
Date of inspection: mmddyy.
Inspector: Name of TFS forester doing BMP inspection.
Accompanied by: Name of landowner, industry or consulting 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? Are ridge tops avoided?
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. Skid Trails/Temporary Roads

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 run 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.

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?
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: Shear/pile/burn, Sheer only, Drum chop, Hot fire, Chemical, Disk/bed, Sub-soil, Disk/burn, Disking only.

Regeneration method: Mechanical, Hand, Natural, None.

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 Compliance Monitoring Checklist Items, All Sites, Round 7

I. General Landowner and Tract Information

Owner type		Forester type		Activity	
Family Forest Owner	45	Industry / Corporate	47	Regeneration Harvest	
Absentee	45	Private Consultant	49	Clearcut	87
Corporate	52	Public	7	Partial	1
Industry	3			Thin	45
Public (Fed, State)	7			Site Prep only	19

II. Site Characteristics

Terrain		Erodibility hazard		Type stream present	
Flat	36	Low	48	Perennial	12
Hilly	115	Medium	95	Intermittent	68
Steep	1	High	9	Both	32
				None	40

Distance to nearest permanent water body

< 300'	81
300 - 800'	5
800 - 1600'	4
1600' +	62

Predominant soil series/texture

Clay	1	Sandy loam	103
Clay loam	15	Sand	10
Loam	23		

III. Permanent Roads — 119 applicable

	Yes	No	NA/NN	Sig. Risk
1. Respect sensitive areas	117	1	34	0
2. Roads meet grade specs	119	0	33	0
3. Rutting within allowable specs	118	1	33	0
4. Well drained with appropriate structures	93	22	37	1
5. Ditches do not dump into streams	101	2	49	0
6. Roads reshaped and stabilized	100	19	33	0

IV. Skid Trails/Temporary (secondary) Roads — 95 applicable

	Yes	No	NA/NN	Sig. Risk
1. Slopes less than 15%	94	1	57	0
2. Respect sensitive areas	91	3	58	0
3. Roads well drained with water bars or other water control structures	67	21	64	0
4. Roads stabilized	76	18	58	0
5. Rutting within allowable specs	84	11	57	0

V. Stream Crossings

		Yes	No	NA/NN	Sig. Risk
On Permanent Roads	34 applicable				
1. Crossings Avoided or minimized		34	0	118	0
2. Stream crossings correct		19	1	132	0
3. Stream crossings stabilized		15	5	132	2
4. Stream free of sediment		21	1	130	1
On Temporary Roads	80 applicable				
5. Crossings avoided or minimized		75	5	72	0
6. Stream crossings correct		55	4	91	0
7. Temporary crossings removed		40	19	93	5
8. Stream crossings and approaches stabilized		32	25	95	6
9. Stream free of sediment		49	13	90	1

VI. Streamside Management Zones — 112 applicable

	Yes	No	NA/NN	Sig. Risk
1. Present on permanent stream	43	1	108	0
2. Present on intermittent stream	92	8	52	0
3. SMZ adequately wide	74	37	41	0
4. Thinning within allowable specs	85	21	46	0
5. Minimize harvesting bank trees	103	9	40	0
6. SMZ integrity honored	104	6	42	0
7. Stream clear of debris	101	11	40	1
8. Stream free of sediment	111	1	40	0

VII. Site Preparation — 56 applicable

	Yes	No	NA/NN	Sig. Risk
1. Respect sensitive areas	51	2	99	1
2. No soil movement on site	56	0	96	0
3. Firebreak erosion controlled	20	0	132	0
4. SMZ integrity honored	43	2	107	0
5. Windrows on contour/free of soil	9	0	143	0
6. No chemicals off site	32	0	120	0
7. Machine planting on contour	31	1	120	0
8. Stream free of sediment	43	1	108	0

VIII. Landings — 114 applicable

	Yes	No	NA/NN	Sig. Risk
1. Locations free of oil/trash	103	11	38	0
2. Located outside of SMZ	92	0	60	0
3. Well-drained location	114	0	38	0
4. Number and size minimized	113	1	38	0
5. Respect sensitive areas	114	0	38	0
6. Restored/stabilized	112	1	39	0

IX. Wetlands — 17 applicable

	Yes	No	NA/NN	Sig. Risk
1. Avoid altering hydrology of site	17	0	135	0
2. Road drainage structures installed properly	14	0	138	0
3. Mandatory road BMPs followed	11	0	141	0

X. Overall Compliance

	Yes	No	NA/NN	Sig. Risk
III. Permanent Roads - 94%	648	45	219	1
IV. Skid Trails/Temporary Roads - 88%	412	54	294	0
V. Stream Crossings - 82%	340	73	953	15
VI. Streamside Management Zones - 88%	713	94	409	1
VII. Site Preparation - 98%	285	6	925	1
VIII. Landings - 98%	648	13	251	0
IX. Wetlands - 100%	42	0	414	0

Follow-up Questions

	Yes	No	NA/NN
Was activity supervised by a professional forester?	103	49	0
Was landowner familiar with BMPs?	100	52	0
Has logger attended BMP workshop?	122	8	22
Were BMPs included in the contract?	111	34	7
Is landowner a member of TFA, CFLOA, ATFS, etc.?	81	58	13
Was timber delivered to SFI mill?	91	31	30
Does landowner have a forest management plan?	108	44	0
Does landowner plan to reforest?	98	3	51

TABLE ONE:

ESTIMATED TOTAL VOLUME OF EROSION AS A RESULT OF FORESTRY ACTIVITIES

Forest Condition	Forestry Activity	Estimated Annual Acreage (Acres)♣	Recovery Period (Years)	Total Area (Acres)	Average Erosion Rate (Tons/Acre/Year)	Erosion Volume (Tons/Year)
Undisturbed		11,205,867	0	0	0.00	0
Harvested	Clearcut (3yr.)*	87,505	3	262,515	0.14	36,752
	Clearcut (1yr.)**	115,995	1	115,995	0.24	27,839
	Partial Cut***	306,900	2	613,800	0.04	24,552
Site Preparation	Shear	26,808	4	107,232	0.26	27,881
	Shear and Pile	2,389	4	9,555	0.52	4,969
	Bedding	6,805	4	27,221	0.17	4,628
	Site Prep Burn	13,127	3	39,382	0.47	18,510
	Drum Chopping	31,998	3	95,995	0.19	18,239
	Chemical	16,409	2	32,819	0.05	1,641
	Chemical and Burn	9,963	3	29,888	0.50	14,944
Other	Prescribed Burn	26,367	2	52,734	0.02	1,055
	Wildfire	5,933	2	11,866	0.13	1,543
	Temp Roads - No BMPs	14,367	4	57,468	4.20	241,366
	Skid Trails - No BMPs	14,367	4	57,468	2.70	155,164
Total Timberland		**11,884,800**		**1,513,938**		**579,083**

* Clearcut, seedtree, and shelterwood harvests without immediate site preparation

** Clearcut, seedtree, and shelterwood harvests with site preparation within one year

*** Partial cuts include less intensive harvests such as pine selection cuts, thins, diameter cuts, high grading, etc.

♣ Estimated from Forest Statistics for East Texas Counties, 1992 and East Texas Forests, 2003

TABLE TWO:

ESTIMATED TOTAL SEDIMENTATION AS A RESULT OF FORESTRY ACTIVITIES WITHOUT ADEQUATE BMPs

Forest Condition	Forestry Activity	Erosion Volume (Tons/Year)	Percent Area No SMZ	Percent Roads No BMPs	Percent Erosion Reaching Stream No SMZ	Estimated Sedimentation (Tons/Year)	Percent of Sedimentation
Undisturbed		0	0	0	0.00	0.00	0.00
Harvested	Clearcut (3yr.)	36,752	100	N/A	3	1,102.56	3.85
	Clearcut (1yr.)	27,839	100	N/A	3	835.16	2.91
	Partial Cut	24,552	100	N/A	3	736.56	2.57
Site Preparation	Shear	27,881	100	N/A	6	1,672.83	5.83
	Shear and Pile	4,969	100	N/A	10	496.86	1.73
	Bedding	4,628	100	N/A	1	46.28	0.16
	Site Prep Burn	18,510	100	N/A	10	1,850.97	6.46
	Drum Chopping	18,239	100	N/A	3	547.17	1.91
	Chemical	1,641	100	N/A	3	49.23	0.17
	Chemical and Burn	14,944	100	N/A	10	1,494.42	5.21
Other	Prescribed Burn	1,055	100	N/A	0	0.00	0.00
	Wildfire	1,543	100	N/A	1	15.43	0.05
	Temp Roads - No BMPs	241,366	100	100	5	12,068.28	42.09
	Skid Trails - No BMPs	155,164	100	100	5	7,758.18	27.06
Total Timberland		**579,083**				**28,673.93**	**100.0**

TABLE THREE:

ESTIMATED REDUCTION IN EROSION VOLUME FROM WOODS ROADS WHEN BMPs ARE IMPLEMENTED

Road Classification	Estimate Annual Acreage	Recovery Period (Years)	Average Erosion Rate (Tons/Acre/Year)	Erosion Volume (Tons/Year)
Without Adequate BMPs – 9%				
Temporary Road	1,293	4	4.20	21,722
Skid Trails	1,293	4	2.70	13,964
With Adequate BMPs – 91%				
Temporary Roads	13,074	4	3.15	164,732
Skid Trails	13,074	4	2.00	104,592
Total	**28,734**			**305,010**

Estimated Annual Volume of Erosion from Woods Roads without BMPs = 396,530 Tons

Estimated Annual Volume of Erosion from Woods Roads with BMPs = 305,010 Tons

Estimates Annual Reduction of Erosion from Woods Roads = 91,520 Tons

TABLE FOUR:

ESTIMATED TOTAL SEDIMENTATION AS A RESULT OF FORESTRY ACTIVITIES WITH CURRENT LEVEL OF BMP IMPLEMENTATION

Forest Condition	Forestry Activity	Erosion Volume (Tons/Year)	Percent Area SMZ	Percent Area No SMZ	Percent Erosion Reaching Stream SMZ/No SMZ	Estimated Sedimentation (Tons/Year)	Percent of Sedimentation
Undisturbed		0	0	0	0.00/0.00	0.00	0.0
Harvested	Clearcut (3yr.)	36,752	95.2	4.8	1/3	403	2.5
	Clearcut (1yr.)	27,839	95.2	4.8	1/3	305	1.9
	Partial Cut	24,552	95.2	4.8	1/3	269	1.6
Site Preparation	Shear	27,881	95.2	4.8	2/6	611	3.7
	Shear and Pile	4,969	95.2	4.8	5/10	260	1.6
	Bedding	4,628	95.2	4.8	0/1	2	0.0
	Site Prep Burn	18,510	95.2	4.8	5/10	970	6.0
	Drum Chopping	18,239	95.2	4.8	2/3	374	2.3
	Chemical	1,641	95.2	4.8	1/3	18	0.1
	Chemical and Burn	14,944	95.2	4.8	5/10	783	4.8
Other	Prescribed Burn	1,055	95.2	4.8	0/0	0.00	0.0
	Wildfire	1,543	95.2	4.8	1/1	15	0.1
	Temp Roads - BMPs	241,366	95.2	4.8	3/5	7,473	45.9
	Skid Trails - BMPs	155,164	95.2	4.8	3/5	4,804	29.5
Total Timberland		**579,083**				**16,287**	**100**

TABLE FIVE:

SUMMARY OF WATER QUALITY IMPROVEMENTS RESULTING FROM AN INCREASE IN BMP IMPLEMENTATION AND A REDUCTION OF SEDIMENTATION

Implementation Level	Percent Implementation Streamside Management Zones	Percent Implementation for Woods Roads *	**Estimated Total Sedimentation (Tons/Year)**	**Percent Reduction**
Baseline (0% Implementation)	**0**	**0**	**28,674**	**0**
2008 Implementation	**95.2**	**91**	**16,287**	**43**

Estimated soil loss as a direct result from timber harvesting = 0.853 Tons/Acre/Year

Estimated sedimentation reaching streams as a direct result of timber harvesting = 0.024 Tons/Acre/Year

* Percent implementation for woods roads is the weighted percent implementation of temporary and permanent roads against acres on which each ere applicable

EXPLANATION OF CALCULATIONS AND DATA PRESENTED IN TABLES 1-5

TABLE 1:

Estimated Annual Acreage: The estimated annual acreage undergoing various disturbances is from Texas Forest Service, industry, and forest survey records.

Recovery Period and Average Erosion Rate: The recovery periods and average erosion rates for various types of disturbances were developed by Dissmeyer and Stump (1978) based on the modified Universal Soil Loss Equation and observations on 9,000 silvicultural sites in the South. Rates for this analysis are for the Lower Coastal Plain, assuming an average of four percent slope.

Total Acreage: Estimated Annual Acreage times Recovery Period

Erosion Volume: Total Acreage times Average Erosion Rate

TABLE 2:

Erosion Volume: From Table 1

Percent Area without SMZs and BMPs: Assumes no BMP implementation

Percent Erosion Reaching Streams: Rates for these percentages were supplied by personal communication with Dissmeyer (10-22-92).

Estimated Sedimentation: Erosion Volume times Percent Area with BMPs times Percent Erosion Reaching Streams

Percent of Sedimentation: Represents the percentage that the particular disturbance contributes to the total estimated sedimentation

TABLE 3:

Estimated Annual Acreage: The estimated annual acreage undergoing various disturbances is from Texas Forest Service, forest industry, and forest survey records.

Recovery Period and Average Erosion Rate: The recovery periods and average erosion rates for various types of disturbances were developed by Dissmeyer and Stump (1978) based on the modified Universal Soil Loss Equation and observations on 9,000 silvicultural sites in the South. Rates for this analysis are for the Lower Coastal Plain, assuming an average of four percent slope.

Erosion Volume: Estimated Annual Acreage times Recovery Period times Average Erosion Rate

TABLE 4:

Erosion Volume: From Table 1. The reduction represented is a result of adding BMPs to roads (Table 3).

Percent Area with/without SMZs: Assumes current level of BMP implementation

Percent Erosion Reaching Streams: Rates for these percentages were supplied by personal communication with Dissmeyer (10-22-92).

Estimated Sedimentation: Erosion Volume times Percent Area with BMPs times Percent Erosion Reaching Streams

Percent of Sedimentation: Represents the percentage that the particular disturbance contributes to the total estimated sedimentation

TABLE 5:

Percent of Area with Streamside Management Zones: BMP implementation monitoring results

Percent Woods Roads with Adequate BMPs: BMP implementation monitoring results

Estimated Total Sedimentation: From Tables 2 and 4.

Percent Reduction: (Baseline Implementation 0% - Implementation Year)/ Baseline Implementation

FOREST LAND EROSION EVALUATION FOR EAST TEXAS

INTRODUCTION

This appendix presents an estimate of the erosion and sedimentation from timberlands in East Texas and an approximation of the improvement in water quality as a result of implementation of voluntary Best Management Practices. The findings are derived from a comparison of estimated sedimentation, assuming current levels of BMP implementation compared to zero implementation levels. The evaluation relies heavily on methodology and estimates provided by George Dissmeyer, USDA Forest Service Region 8 Forest Hydrologist (retired).

The estimated annual acreage undergoing different types of forest management treatments was based on data from East Texas Forests, 2003 and information from a telephone survey of major forest products companies. The area of temporary roads and skid trails was estimated based upon data published by Dissmeyer (1976).

Recovery periods and average erosion rates for various types of disturbances were developed by Dissmeyer and Stump (1978) based upon the Modified Universal Soil Loss Equation and observations on 9,000 silvicultural sites in the South. Rates used in this analysis are for the Lower Coastal Plain, assuming an average four percent slope.

BMP implementation monitoring data were used to estimate the percent of area for which streamside management zones (SMZs) are protecting stream from sedimentation. Dissmeyer (personal communication, 10-22-92) provided estimates of the percent of erosion reaching intermittent stream channels with and without streamside management zone protection.

The results should be viewed as "ballpark" estimates of erosion and sedimentation and are most useful as a means of comparing alternative scenarios and relative impacts rather than as an absolute statement of fact.

DISCUSSION

East Texas, with nearly 12 million acres of timberland, contains the bulk of the state's timber resource. Much of this timberland is actively managed for the sustainable production of timber by forest industries, corporations, family forest landowners, and public agencies. Approximately 679,000 acres, or 6%, undergoes some type of silvicultural treatment each year. Treatments include management activities such as timber harvesting, site preparation, and prescribed burning in addition to unplanned disturbances such as wildfire.

Baseline Erosion and Sedimentation

Based on available evidence, the timberland of East Texas without adequate BMPs would experience approximately 580,000 tons of erosion per year (Table 1). Without the implementation of streamside management zones, approximately 29,000 tons of this soil, five percent, would reach the stream channels (Table 2). The average erosion rate per acre of land undergoing silvicultural treatment would be 0.85 tons per year without BMPs. Voluntary Best Management Practices have been in effect since June, 1990. It should be understood that many forest managers were using Best Management Practices prior to June, 1990. Therefore, these numbers were used as a baseline and do not necessarily indicate the amount of erosion or sedimentation before June, 1990.

Estimated Improvement to Water Quality

Implementation with Best Management Practices recommended guidelines has been assessed through a monitoring system which evaluated BMPs on 152 randomly selected sites between June, 2007 and November, 2008.

Forest Roads: Table 3 shows a reduction of the total volume of erosion from temporary woods roads and skid trails when BMPs are installed correctly. When BMPs were utilized, the total erosion was reduced from 396,530 tons per year to 305,010 tons per year. The reduction in total erosion was 91,520 tons per year. That equates to a 23 percent reduction over a zero percent implementation level.

Streamside Management Zones (SMZs): Table 4 represents the amount of sedimentation that occurred with the current level of BMP implementation on roads in addition to the use of streamside management zones. The reduction in total sedimentation was 12,387 tons per year (from 0.042 to 0.024 tons per treated acre per year).

BMP implementation monitoring determined that overall implementation for SMZs was 95%. It should be noted that the absence of streams on a harvested tract is often a result of proper planning by forest managers. Forest managers have begun using streams as tract boundaries and therefore are reducing potential impact to water quality.

CONCLUSIONS

Under the current level of BMP implementation the amount of sedimentation reaching streams is 16,287 tons per year or a 43 percent reduction over a zero percent implementation level.

Use of voluntary Best Management Practices, specifically streamside management zones, has significantly reduced soil erosion and stream sedimentation due to silvicultural activities in East Texas. Results from this analysis show that soil erosion has been reduced by 23 percent and stream sedimentation by 43 percent. Table 5 is a summary table that illustrates the percent improvement for stream sedimentation.

It is important to recognize that this analysis is based on estimates of erosion and stream sedimentation from broad averages. Results are estimates that compare the relative improvement to water quality as a result of the use of voluntary Best Management Practices.

References

DeHaven, M.G., Blackburn W. H. et. al. 1983. Assessment of stormflow and water quality from undisturbed and site prepared forest land in East Texas. TR-122. Texas Water Resources Institute, Texas A&M University. 125p.

Dissmeyer, G.E. 1976. Erosion and sediment from forest land uses, management practices and disturbances in the Southeastern United States. Proc. Third Federal Inter-agency Sedimentation Conference. Denver, CO, March 22-25, 1976. Prepared by: Sedimentation Committee, Water Resources Council. Pp. I-140 - I-148.

Dissmeyer, G.E. and R.F. Stump. 1978. Predicted erosion rates for forest management activities in the Southeast. USDA Forest Service, Atlanta, GA. 26p.

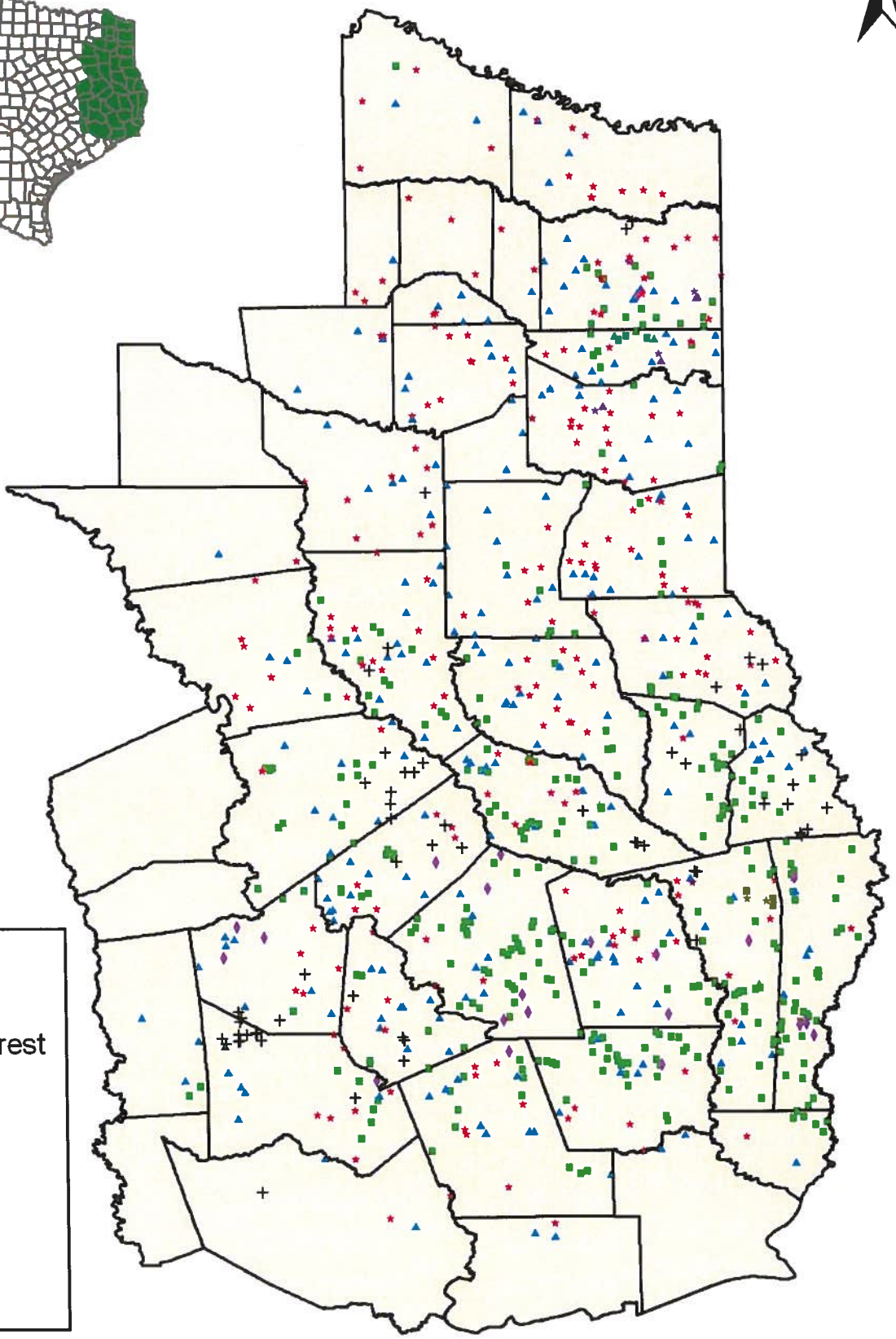
Knight, R.W., Blackburn, W.H. et. al. 1988. Assessment of water yield and quality from intensive silvicultural practices and livestock grazing in southeast forests. Texas Agricultural Experiment Station, Texas A&M University. 266p.

Miller, P.E., Hartsell, A. J. 1992. Forest statistics for East Texas counties – 1992. USDA Forest Service, Southern Forest Experiment Station. 55p.

Rudis, V.A, Carraway, B, et al. 2003. East Texas Forests, 2003. USDA Forest Service, Southern Forest Experiment Station. 172p.

Texas Forest Service. 2008. Voluntary Implementation with forestry Best Management Practices in East Texas. 40p.

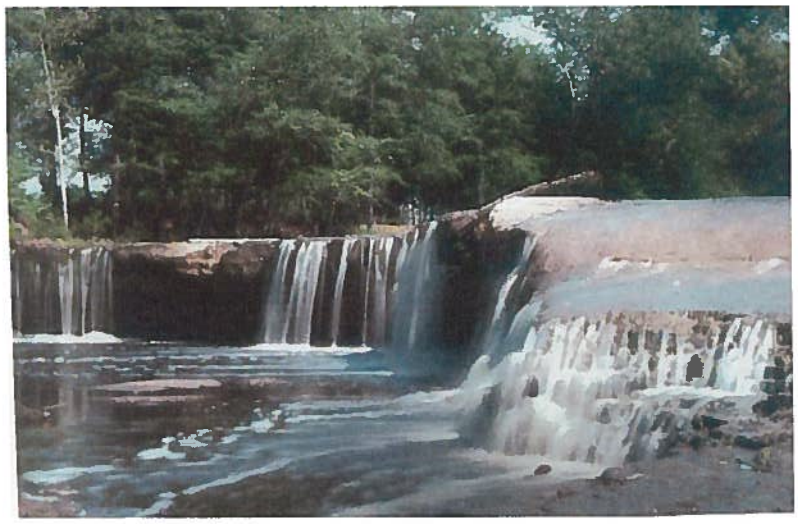
N



Ownership

- Family Forest
- Absentee
- Corporate
- Industry
- Public

Statistical Guidebook for BMP Implementation Monitoring



SOUTHERN GROUP OF STATE FORESTERS

Southern Group of State Foresters
Water Resources Committee

October 2006

Statistical Guidebook for BMP Implementation Monitoring

by

Hughes Simpson, Texas BMP Coordinator
John Greis, USDAFS Region 8 Hydrologist
Dr. Ron McNew, Professor, University of Arkansas

Southern Group of State Foresters
Water Resources Committee

October 2006

Table of Contents

Statistical Guidebook for BMP Implementation Monitoring

Introduction

BMP Implementation Monitoring is the process of measuring the degree of the presence and functionality of environmental guidelines (BMPs) as noted in an individual state's BMP manual. In 1999, the Southern Group of State Foresters (SGSF) endorsed a monitoring framework designed to provide regional guidelines for monitoring BMP implementation so that consistency and reliability of southern state efforts would be maximized. The framework calls for evaluations to be conducted on randomly selected forestry operations and to result in data that is statistically valid.

Field evaluations consist of answering "yes", "no", or "not applicable" to questions regarding proper implementation of specific BMPs. These are typically broken down into several activity categories (roads, trails, stream crossings, etc.). Each question represents a specific BMP ("yes" means the BMP was implemented correctly and "no" means it was not). If a BMP listed on the evaluation form was not applicable to that site, "not applicable" is recorded. Additionally, the presence of a significant risk to water quality is noted for each question if, due to a lack of or malfunction of a BMP, water quality has been impacted or is clearly threatened. To determine the implementation rate, the total number of yes answers is summed and then divided by the total number of applicable answers (yes / yes + no) to determine the total BMP Implementation rate, expressed as a percent, for the site.

After combining all results, BMP implementation may be reported for the state, regions of the state, landowner types, forestry activities, river basins or watersheds, and BMP groups or other categories of interest for reporting purposes. Strengths (BMPs along streams) and weaknesses (BMPs on roads) are generally identified from the results.

In 2004, a task force of the SGSF Water Resources committee was formed to develop this statistical guidebook to assist the southern state forestry agencies with BMP implementation monitoring design and reporting. Included with this guidebook is an excel spreadsheet created to help states to determine how many sites are needed to conduct a statistically reliable survey, calculate the margin of error for each BMP evaluated and reported, and analyze statistical trends in BMP implementation.

Major elements in the design of a statistically valid BMP Implementation survey include:

- Sampling intensity (total number of sites needed for the survey)
- methodology of choosing sites
- how to ensure randomness of the samples
- stratification of field sites (# of samples per county, landowner type, etc.) so that sound conclusions can be drawn from each.

Key calculations for the analysis of a BMP implementation survey will include:

- determining statistical significance of BMP trends
- confidence intervals and margin of error

Survey Design

Determining the sample size, or number of sites to evaluate

$$n = \frac{4p\,(100 - p)}{m^2}$$

Where n = the number of sites to evaluate
p = the estimated overall percent implementation in the state
m = the margin of error (5%)

Notes:

- *p* must be estimated because it is unknown (% implementation from the most recent round of monitoring may be used)
- The closer the estimated value of *p* is to 100, the lower the value of *n* will be.
- *n* is highest when *p* is estimated to be 50%.
- m is the margin of error associated with the estimate of p. That is there is .95 probability that the sample taken will produce an estimate which differs from p by a value of m

Example:

$$n = \frac{4p\,(100 - p)}{m^2}$$

Where p (overall BMP implementation) is estimated at 80%

$$n = \frac{4\,(80) * (100 - 80)}{5^2}$$

$$n = \frac{6400}{25}$$

n = 256

Using the spreadsheet:

The spreadsheet is set up so that all that must be entered is the estimated value of p (Est. % BMP Impl). It will then automatically calculate the number of sites to evaluate based on an embedded formula and a margin of error equal to 5% (as recommended by the SGSF framework).

*** These equations calculate the minimum number of sites necessary to evaluate. Increasing the sample size will yield an even more accurate estimate of BMP implementation. A minimum of 100 sites is recommended.**

Data Storage

BMP implementation monitoring data can be stored in a number of different formats. The easiest is an Access database consisting of the individual state's bmp monitoring form (checklist), data tables, queries, and reports. Site evaluations can then be entered directly into the database in a user friendly format. Queries and filters can be created to display the "target" data (i.e. implementation scores for tracts in which a professional forester was involved) for export to the *Statistical Guidebook Spreadsheet.* Reports can provide a quick glance at the results of the survey (i.e. % implementation by county). GIS programs can import data for geographical representation and further analysis. A sample database is available for states to customize to fit their needs.

Site Selection

BMP field sites may be selected in a number of ways: aerial reconnaissance, severance tax records, timber deeds, drive bys etc. To avoid bias, it is important that personnel involved in the site selection process do not contact consulting foresters, industry foresters, or large landowners to provide a list of recent harvesting operations. This could bias samples to the "good" sites. Of equal importance is to avoid selecting sites thought to be either "good" or "bad". The SGSF framework calls for sites to be no older than 2 years after the most recent treatment activity.

Ensuring Randomness

Ensuring randomness is critical in any type of sampling. One way to help achieve randomness is to identify twice as many sites as are needed for the survey, and use a random number generator to identify specific sites to monitor.

Stratification of Field Sites by Ownership, Watershed, or Other Factors

Stratifying the monitoring sites based on important characteristics such as ownership type, watershed, or physiographic region, can add substantial value to the survey's results. It is important that the sample taken be reflective of the actual conditions. There are two ways to accomplish this:

- Take a truly random sample from the population (this will solve the stratification but is extremely difficult).
- Intentionally select sample sites based on their stratum

Forest Inventory and Analysis (FIA) data may be used to estimate the number of sites undergoing forestry operations by landowner type. This percentage can then be used to estimate the number of monitoring sites each landowner group should comprise.

Data Analysis

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 and can be performed for an individual BMP (i.e. SMZ width). The following formula is used to perform this calculation:

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

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

Notes:

- If the actual value of p is larger than the estimated value of p, then the actual margin of error will be smaller than m.
- This equation is not valid for a subset of all possible sites (i.e. calculating margin of error from the % BMP implementation for NIPF landowners.)
- For a BMP that is not applicable to all sites, the actual margin of error will be larger than m.
- Estimating the average % BMP implementation across all possible sites for a group of BMPs and then using this number of sites will produce a margin of error that is smaller than m.
- If the value of p is 100%, the margin of error is not zero. No calculation can be made.

Example:

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

Where p (% BMP impl. for adequate SMZ width) was evaluated to be 89% on 125 sites

$$m = 2\sqrt{\frac{89\ (100-89)}{125}}$$

$$m = 2\sqrt{\frac{975}{125}}$$

$$m = 2\sqrt{7.832}$$

$$\boldsymbol{m = 5.597}$$

Using the spreadsheet:

The spreadsheet is set up so that all that must be entered is the % implementation for a single BMP (% for single BMP) and the number of sites that BMP was evaluated (# of sites). The spreadsheet will then calculate the margin of error for that particular BMP.

95% 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 within that range. To calculate the 95% confidence interval, you must also calculate the mean, variance, standard deviation, standard error, and margin of error.

Example:

Let's calculate the 95% confidence interval for the following sample:

95%, 80%, 88%, 100%, 77%

First calculate the mean.

$$\frac{95+80+88+100+77}{5} = \frac{440}{5} = \mathbf{88\%}$$

Then calculate the variance.

*Step 1: USS = $95^2 + 80^2 + 88^2 + 100^2 + 77^2$ = **39,098***
*Step 2: SUM = 95 + 80 + 88 + 100 + 77 = **440***
*Step 3: CF = $440^2/5$ = 193,600/5 = **38,720***
*Step 4: CSS = 39,098 – 38,720 = **378***
*Step 5: DF = 5 – 1 = **4***
*Step 6: Variance = 378 / 4 = **94.5***

Next calculate the standard deviation.

Std dev. = $\sqrt{variance}$ = $\sqrt{94.5}$ = **9.721**

After that, calculate the standard error.

Std. error = (Std dev. / $\sqrt{number\ of\ sites}$) = 9.721 / $\sqrt{5}$ = **4.347**

Next, calculate the margin of error.

Margin of Error = 2(Std. error) = 2 (4.347) = **8.695**

Finally, use the margin of error to calculate the 95% confidence interval.

95% Confidence interval = Mean ± Margin of Error = **(79.305, 96.695)**

Using the Spreadsheet

The spreadsheet is set up so that all that must be entered is the individual tract scores (Indiv. % Impl) and the total number of sites (# of sites). The spreadsheet automatically calculates the mean, variance, standard deviation, standard error, margin of error, and the 95% confidence interval (low and high ends).

BMP Trend Analysis

Analyzing trends or patterns in BMP implementation can be useful to target areas or ownership types for concentrated educational efforts (i.e. additional logger training workshops). Commonly reported trends include higher BMP implementation rates when professional foresters are used, the landowner is familiar with BMPs, and the logger has attended BMP training.

In order to determine trends in BMP implementation, several statistical analyses should be performed. First, a parametric two sample t-test is conducted because of the large sample size. This percentage data must undergo an arcsin square root transformation prior to analysis. Percentage data must be transformed because they are not normally distributed, which invalidates the normality assumption of the parametric test. A non-parametric test (Wilcoxon) may also be performed to add greater statistical validity.

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.

Using the spreadsheet:

The spreadsheet is set up so that all you have to do is enter the individual percent implementation scores for the tracts that answered yes to the particular trend question and likewise for the tracts that answered no. It will then automatically perform the arcsin square root transformation and conduct a parametric two sample t-test on the new data, based on a level of significance of .05. This value will be used to determine whether the difference in implementation scores for that particular trend is statistically significant. This classification is noted by the answer TRUE found under the Stat. Diff column.

****The arcsin square root transformation was conducted so that Microsoft Excel could perform the analysis. More robust tests (non parametric tests like the Wilcoxon) may be conducted to add greater statistical validity. These tests are not included in basic Microsoft Excel programs and can be found in programs like *JMP, SAS, or Statistica.***

Area Weighting BMP Implementation Data

Results are typically reported giving equal weight to all sites (i.e. a 20 acre tract counts the same as a 450 acre tract when compiling all data). Statistically, tracts could also be weighted based on their acreage, i.e. larger tracts would have a greater influence on the total % BMP implementation than the smaller tracts. This analysis can be performed to provide you with information on how the practices are impacting the total landscape. Both methods are useful in reporting BMP implementation rates, though the SGSF framework does not call for area-weighting. The following formula may be used to perform this calculation.

$$AW\ \% = \Sigma\ (((indiv\ A/Total\ A) * 100)) * \%\ Impl)))$$

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

Example:

For this example, let's use 5 individual tract scores and their respective size:

95% - 100 acres, 80% - 35 acres, 88% - 75 acres, 100% - 275 acres, %77 – 20 acres

Equal weighted % BMP Implementation = Sum of scores divided by number of sites

$$\frac{95+80+88+100+77}{5} = \frac{440}{5} = \mathbf{88\%}$$

Area weighted % BMP implementation = Sum of scores proportional to tract size

% BMP Impl	*Tract Size*	*% of Total*	*AW %*
95	*100*	*19.8*	*18.81*
80	*35*	*6.9*	*7.2*
88	*75*	*14.8*	*13.02*
100	*275*	*54.5*	*54.5*
77	*20*	*4.0*	*3.08*
Total	***505***	***100***	***96.61***

$$= \mathbf{96.6\%}$$

% of Total = Tract Size / Total Size
*AW % = % of Total * % BMP Implementation for each individual tract*
Area Weighted % BMP Implementation = Sum of individual AW %

Using the spreadsheet:

The spreadsheet is set up so that all that must be entered is the individual percent BMP implementation rates and their respective tract sizes in acres. It will then automatically weight the BMP implementation scores based on the tract size.

Reporting

Using the statistical procedures contained in this guide, BMP Implementation data can be reported in the following ways:

- Overall % BMP implementation for the state
- % BMP implementation by landowner group
- % BMP implementation by BMP category
- Area weighted % BMP implementation

BMP Implementation Monitoring Design - Determining the Number of Sites to Monitor

$$n = \frac{4p\,(100 - p)}{m^2}$$

where n = number of sites to monitor
p = % of estimated BMP rate - [whole number]
m = margin of error (5%) - [whole number]

Est. % BMP Imp	Margin of error	# of Sites
	5	0

BMP Implementation Monitoring Analysis

Margin of Error for a Single BMP

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

where m = margin of error
p = percent implementation of BMP
n = number of sites BMP evaluated on

*** If p (% BMP Implementation for single BMP) is 100%, margin of error cannot be calculated.**

% for single BMP	# of sites	Margin of Error
		#DIV/0!

BMP Implementation Analysis

95% Confidence Intervals

95% CI = Mean ± Margin of Error

Indiv % Impl	# of Sites	Mean % Impl.	Variance	Std Dev.	Std. Error	Margin of Error	Low end Conf. Int	High End Conf. Int
		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**	**#DIV/0!**

Statistical Significance of BMP Trends

Trend	Yes Scores	No Scores	ArcSine "Yes"	ArcSine "No"	Level of Sig.	Par. P value	Stat. Diff
Prof. Assist			0	0	0.05	#DIV/0!	#DIV/0!
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			
			0	0			

BMP Implementation Analysis

<u>Area Weighting Implementation Monitoring Results</u>

$AW\ \% = \Sigma\ ((\text{indiv } A/\text{Total } A) * 100))\ * (\%\ \text{Impl})$

where AW % = area weighted % BMP impl
A = area (acres)
% Impl = individual tract % BMP impl

Indiv % Imp	Tract Size	% of Total	AW %	AW % Total
		#DIV/0!	#DIV/0!	#DIV/0!
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	
		#DIV/0!	#DIV/0!	

A History of Forestry BMP Implementation Monitoring In Texas

Results from 15 years of BMP Implementation Monitoring

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

February 2007

A History of Forestry BMP Implementation Monitoring in Texas

Results from 15 years of BMP Implementation Monitoring
1990 - 2005

by

Hughes Simpson, BMP Project Leader

TEXAS FOREST SERVICE
Sustainable Forestry
Best Management Practices Project

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

For over 15 years, the Texas Forest Service has promoted the use of voluntary Best Management Practices (BMPs) to prevent any potential water quality impacts from occurring on forestry operations. In the early 1990s, a monitoring program was established throughout East Texas to determine the level of implementation with these environmental practices. Since the development of this program, six rounds of monitoring (1992, 1996, 1998, 2000, 2002, and 2005) have been conducted. A total of 904 sites were monitored between July 1, 1991 and July 1, 2005 and are believed to be a representative sample of the forestry activities that occurred in East Texas during that time.

Results from the past 15 years of BMP implementation monitoring were compiled and analyzed. This was done to determine the level of improvement that has occurred since the initial survey. Strengths and weaknesses were also identified so future educational efforts can target the areas that will have the greatest impact on BMP implementation.

General observations over the past 15 years:

- overall BMP implementation is at an all time high (91.7%)
- implementation was highest on landings, permanent roads, wetlands, and site preparation
- implementation was lowest on stream crossings, temporary roads, and Streamside Management Zones (SMZs)

Progress noted over the past 15 years:

- overall BMP implementation increased by 21% since 1996
- temporary roads (+56%) had the greatest improvement
- significant gains were made in temporary crossings (+46%), permanent crossings (+36%), and SMZs (+29%)
- family forest owner BMP implementation increased by 29%

Weaknesses noted over the past 15 years:

- correct installation and restoration of temporary stream crossings
- stabilization of temporary roads to prevent erosion
- inadequate SMZ width

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 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 Project, funded by CWA Section 319(h) grants from the Environmental Protection Agency (EPA) through the Texas State Soil and Water Conservation Board (TSSWCB), requires that a monitoring program be conducted to document the level of voluntary implementation of BMPs and effectiveness of BMPs in reducing NPS pollution from silvicultural activities. Objectives of the monitoring program are to:

1) measure the degree of implementation of BMP guidelines 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 compiles and analyzes the findings of six rounds of BMP implementation monitoring for 904 sites evaluated between July 1, 1991 and July 1, 2005. Please refer to the Texas Forest Service publication *Voluntary Compliance with Forestry Best Management Practices in East Texas,* October 1992 for Round 1; March, 1996 for Round 2; April, 1998 for Round 3; September, 2000 for Round 4; November 2002 for Round 5; and October 2005 for Round 6.

DISTRIBUTION AND SELECTION OF IMPLEMENTATION MONITORING SITES

To get a valid estimate of overall implementation of forestry best management practices, monitoring sites were distributed regionally within East Texas and among all forestland ownership categories. Sites were selected to be representative of the distribution of all silvicultural activities across East Texas. The distribution of monitoring sites was based on the estimated annual timber harvest for each county as reported in the annual Texas Forest Service publication, *Harvest Trends*. Sixty percent of all monitored tracts were located in Southeast Texas. See Table 1.

Table 1. Distribution of Implementation Monitoring Sites by County.

County	Number of Sites Monitored
Anderson	13
Angelina	50
Bowie	14
Camp	6
Cass	48
Chambers	3
Cherokee	42
Franklin	4
Gregg	2
Grimes	5
Hardin	43
Harris	5
Harrison	32
Henderson	2
Houston	30
Jasper	54
Jefferson	2
Liberty	32
Marion	27
Montgomery	31
Morris	3
Nacogdoches	37
Newton	44
Orange	8
Panola	31
Polk	57
Red River	7
Rusk	25
Sabine	26
San Augustine	28
San Jacinto	22
Shelby	33
Smith	15
Titus	3
Trinity	34
Tyler	42
Upshur	16
Walker	23
Wood	5
Total	**904**

METHODOLOGY

Randomly selected tracts, on which normal forestry operations had occurred, were monitored for BMP implementation. The Texas BMP Monitoring Checklist was used to conduct the site evaluations. This form consists of a series of Yes/No questions that are grouped into seven categories: permanent roads, temporary roads, stream crossings, SMZs, site preparation, landings, and wetlands. For simplification, each question was worded so that a positive answer was recorded with a "Yes," while a negative answer, indicating a departure from BMP recommendations, was answered "No."

Once the field data was collected, it was entered into a database for storage and retrieval. The database then computed the percent implementation, or grade, for the tract by dividing the number of "Yes" answers by the total number of applicable questions. Since this checklist has evolved over the years, all questions asked during a particular round were used to calculate the grade for that round and category, even if they were not asked in future rounds. Some questions asked in earlier rounds were paired with similar questions asked in later rounds for analysis.

Results from all site evaluations were combined and summarized by category and question to get a historical perspective. The data was then analyzed to see if any trends existed in overall BMP implementation rates, BMP categories, and individual questions.

RESULTS

Between July 1, 1991 and July 1, 2005, Texas Forest Service BMP foresters evaluated BMP implementation on 904 sites, totaling 108,429 acres throughout East Texas. These tracts are geographically represented by ownership category in Figure 1. Overall BMP implementation rates by round, shown in Figure 2, have increased by 20% and are at an all time high (91.7%). Figure 3 shows the overall BMP implementation by category. Tabulated results by question on the BMP implementation monitoring checklist are located in the respective table for each category.

SITE CHARACTERISTICS

Four hundred seventy-four of the 904 sites (52%) were on family forest lands, and over half of these were considered to be absentee landowners. Three hundred forty-nine tracts (39%) were owned by forest industry. Sixty (7%) sites were on publicly owned lands and 21 (2%) were owned by corporate landowners (commercial landowners that do not have wood processing facilities). The percentage of this final category is sure to increase in the future due to this group's acquisition of 2.5 million acres in the last five years.

Five hundred ninety-two sites (65%) were monitored after a regeneration harvest. Two hundred twenty-five thinning (25%) and 87 (10%) site preparation operations were evaluated. In 186 cases, the site preparation evaluation was included in elements of the preceding timber harvest operation or succeeding planting operation.

Professional foresters were involved in planning and/or implementing the silvicultural operation on 651 (72%) of the sites. Private consultants were involved on 223 sites. On 370 sites, the forester was employed by forest industry, while U.S. Forest Service and Texas Forest Service foresters were involved on 58 sites.

Terrain classification and soil erodibility were recorded from the Natural Resources Conservation Service (NRCS) Soil Survey, if available, or estimated by the forester in the field. Two hundred ninety-three sites (32%) were on flat terrain. Five hundred thirty-three sites (59%) were on hilly terrain and 78 (9%) were on steep terrain. Three hundred twenty-three sites (36%) were on soils with low erodibility, 415 sites (46%) on medium erodibility soils, and 166 (18%) were on high erodibility soils.

Of the 904 sites, 639 had either a perennial (200) or intermittent (335) stream or both perennial and intermittent (104). A permanent water body was found within 1,600 feet of 510 sites (56%).

Figure 1. Site Locations by Ownership Category.

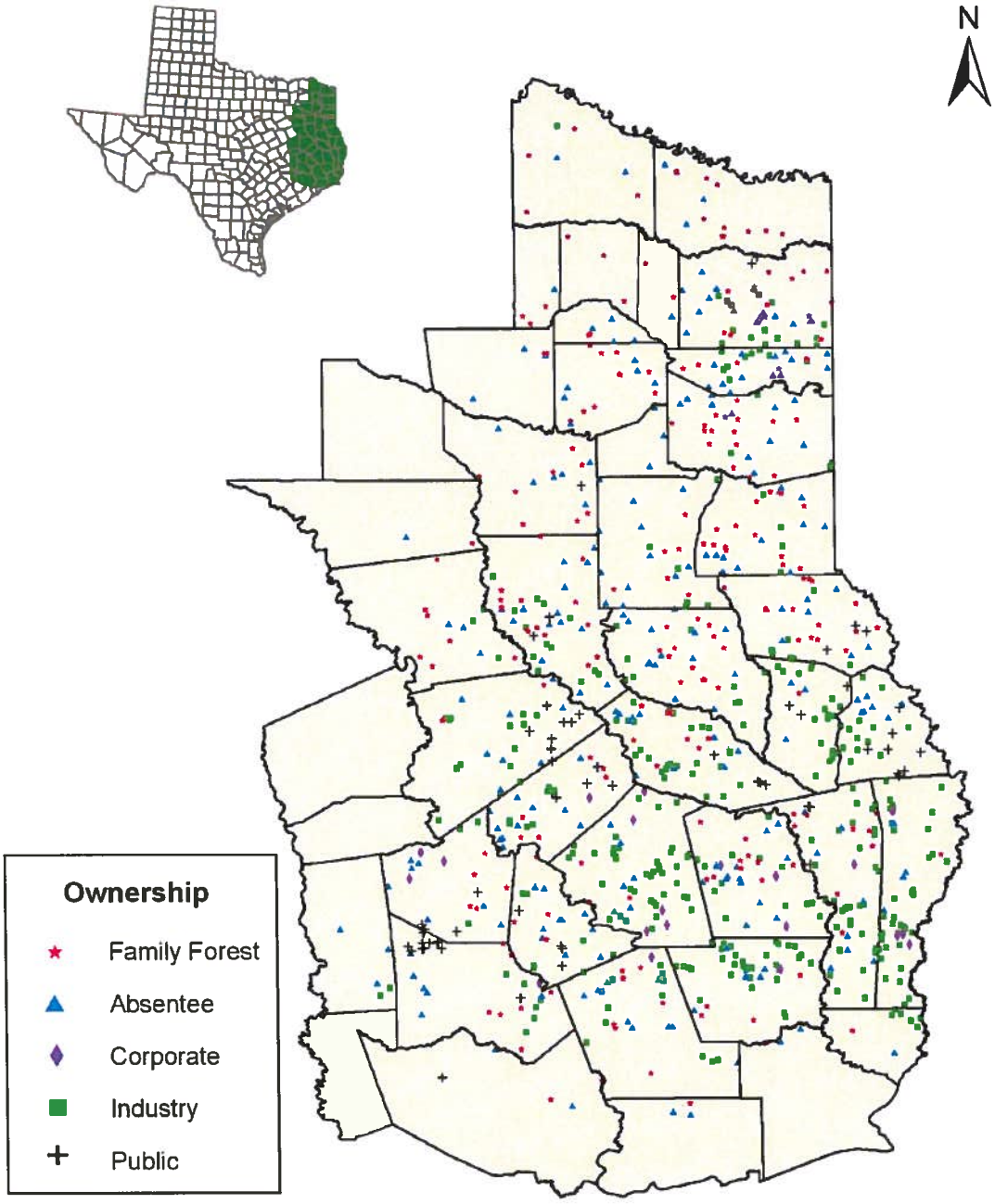


Figure 2. Overall BMP Implementation by Round (1992 - 2005)

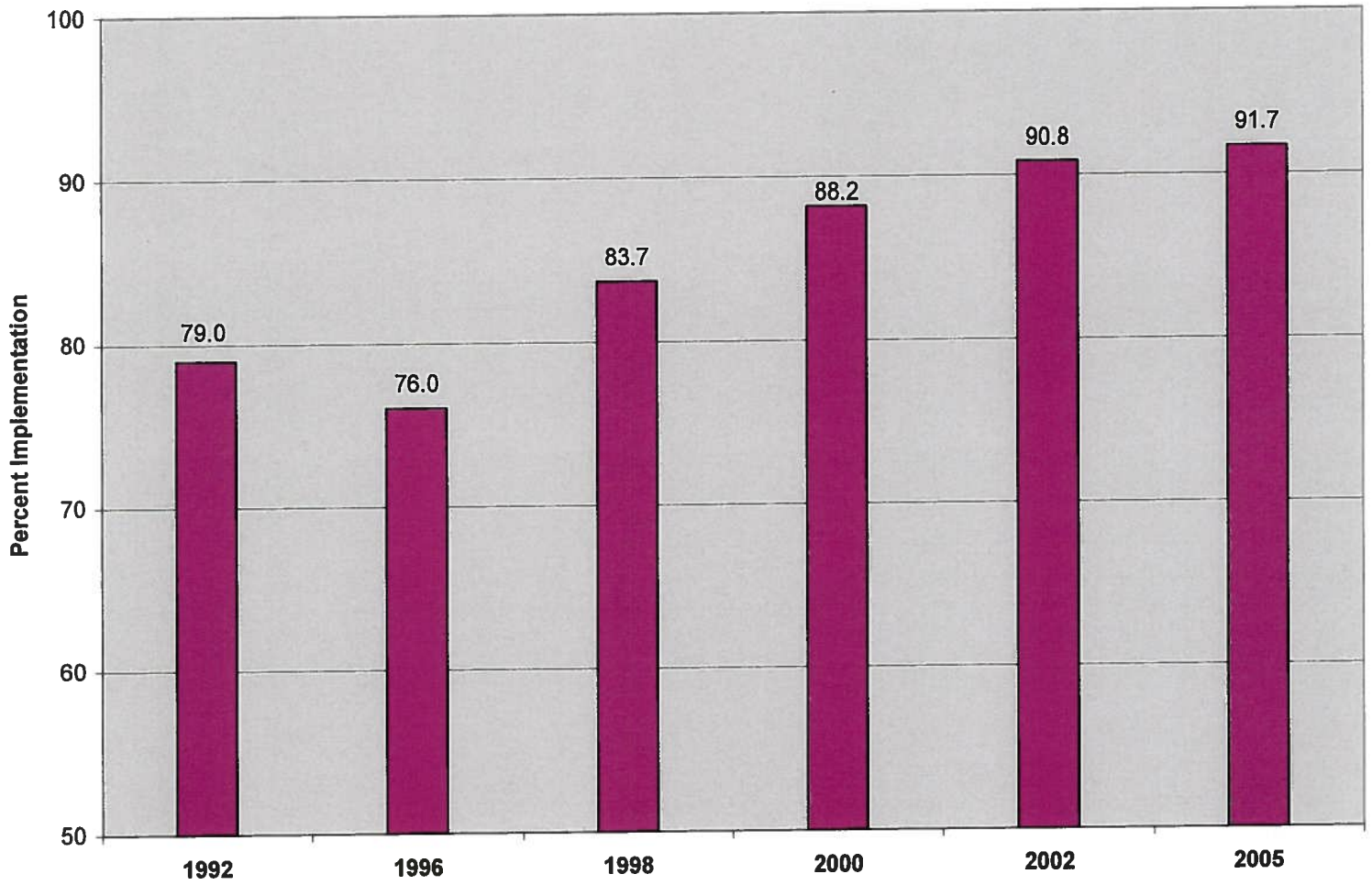
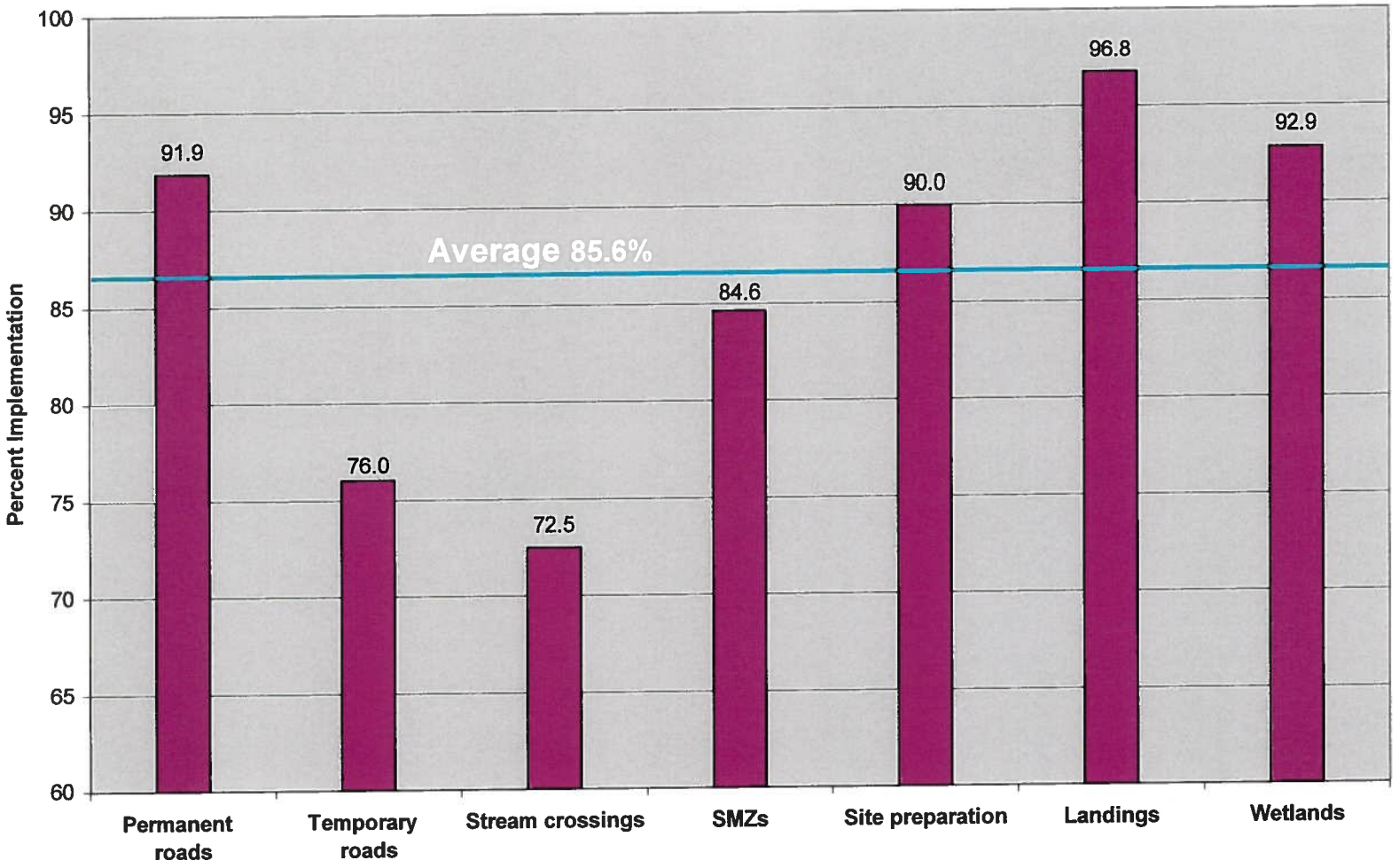


Figure 3. BMP Implementation by Category (1992-2005)



PERMANENT ROADS

Permanent roads in the forestry context are generally graded dirt roads that are used for year-round access. They were applicable on 574 of the 904 sites. The percent implementation for permanent roads was 91.9% with five water quality risks noted. Historically, this category has ranked consistently high in terms of BMP implementation, with scores ranging from 88.4% - 94.1%, and is considered a strength in the monitoring program. The lowest implementation score in this category was for roads well drained with appropriate structures (82.2%). See Table 2, Figure 4 and Figure 5.

Table 2. Implementation of BMPs Relating to Permanent Roads.

BMP	Yes	No	N/A	% Implementation	Water Quality Risks	Margin of Error
Respect sensitive areas	564	10	330	98.3	0	1.1
Roads meet grade specifications	560	13	331	97.7	0	1.3
Rutting within allowable specs	507	21	376	96.0	1	1.7
Well drained with appropriate structures	438	93	373	82.5	3	3.3
Ditches do not dump into streams	392	38	474	91.2	0	2.7
BMPs effective*	183	31	234	85.5	0	4.8
Roads reshaped and stabilized	242	49	165	83.1	1	4.4
Total	**2886**	**255**	**2283**	**91.9**	**5**	

* Question removed from checklist in 2000.

Figure 4. Overall BMP Implementation on Permanent Roads (1992 - 2005)

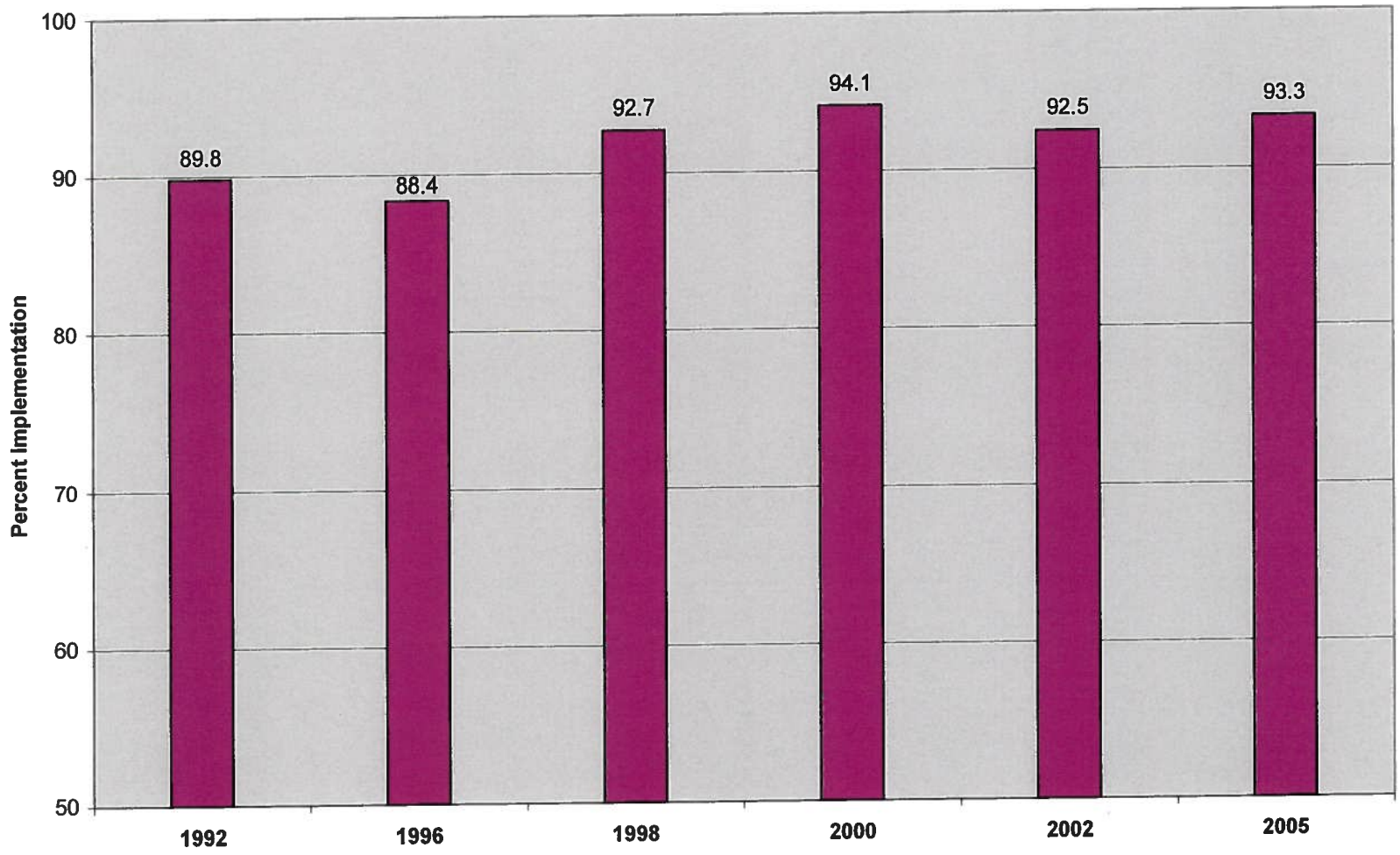
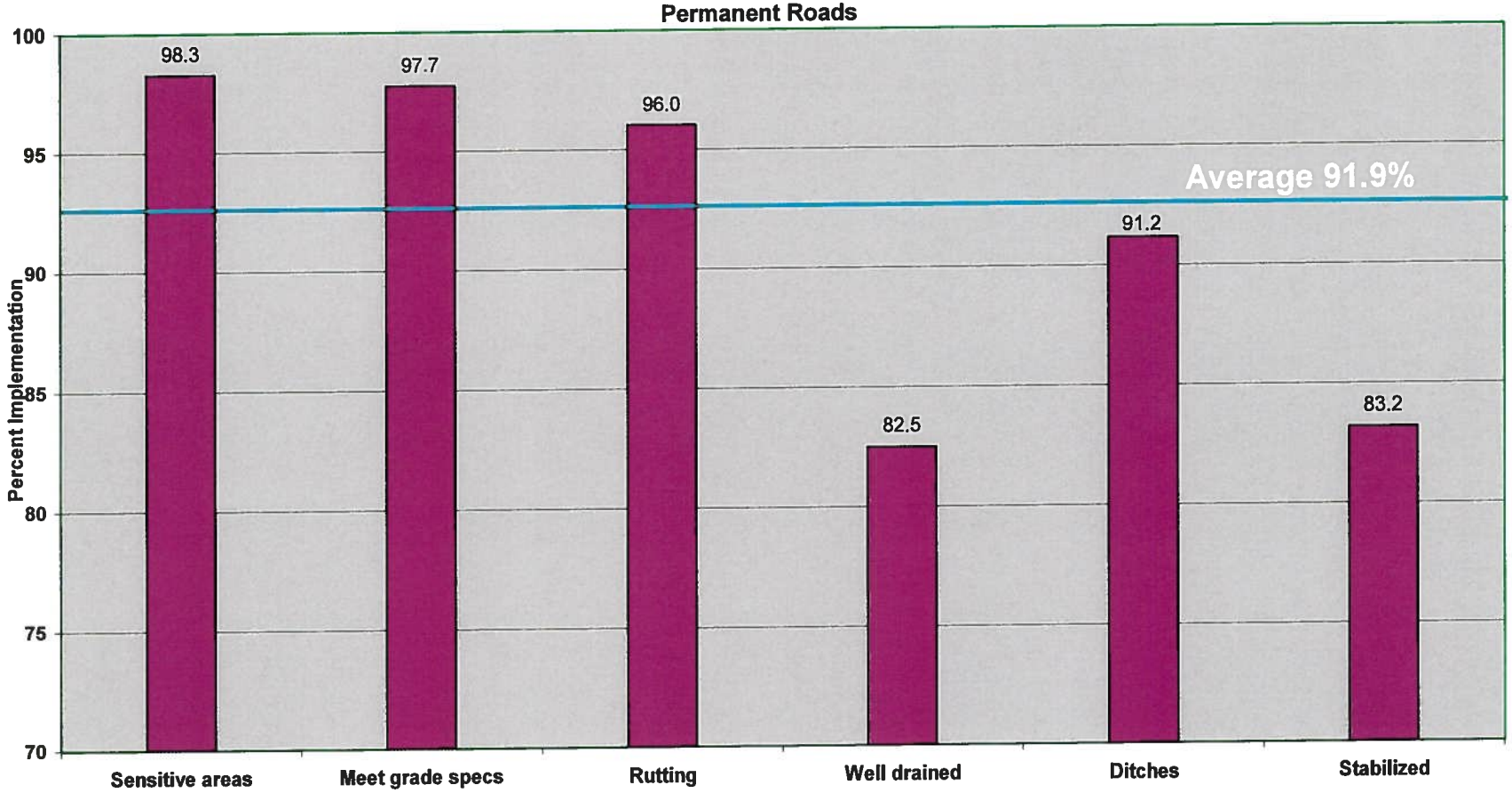


Figure 5. Overall BMP Implementation by Question (1992-2005)
Permanent Roads



TEMPORARY ROADS

Temporary roads are not designed to carry traffic long-term and are usually retired and reforested after the harvest. Skid trails are routes through the logging area in which logs are dragged to a permanent road or central loading point called a "landing." They were applicable on 720 of the 904 sites. The percent implementation for temporary roads was 76% with a total of 11 water quality risks noted. This category has realized the greatest improvement (+56%) in BMP implementation of all categories. However, there is still room for improvement. Increased focus on ensuring that temporary roads are well drained (58.4%) and stabilized (75.7%) is the best way to improve this category's score. It is important to note that the highest scores were for avoiding steep slopes and sensitive areas. Building roads under these conditions can lead to a higher erosion potential. See Table 3, Figure 6 and Figure 7.

Table 3. Implementation of BMPs Relating to Temporary Roads.

BMP	Yes	No	N/A	% Implementation	Water quality Risks	Margin of Error
Slopes less than 15%	686	35	183	95.1	1	1.6
Respect sensitive areas	324	33	99	90.8	3	3.1
Well drained with appropriate structures	375	267	262	58.4	3	3.9
Roads stabilized	254	83	119	75.4	2	4.7
Rutting within allowable specs	573	97	234	85.5	2	2.7
Water bars evident*	96	209	143	31.5	0	5.3
Water bars working*	72	27	349	72.7	0	9.0
Total	**2380**	**751**	**1389**	**76.0**	**11**	

* Questions were consolidated into "Well drained with appropriate structures" in 2000.

Figure 6. Overall BMP Implementation on Temporary Roads (1992-2005)

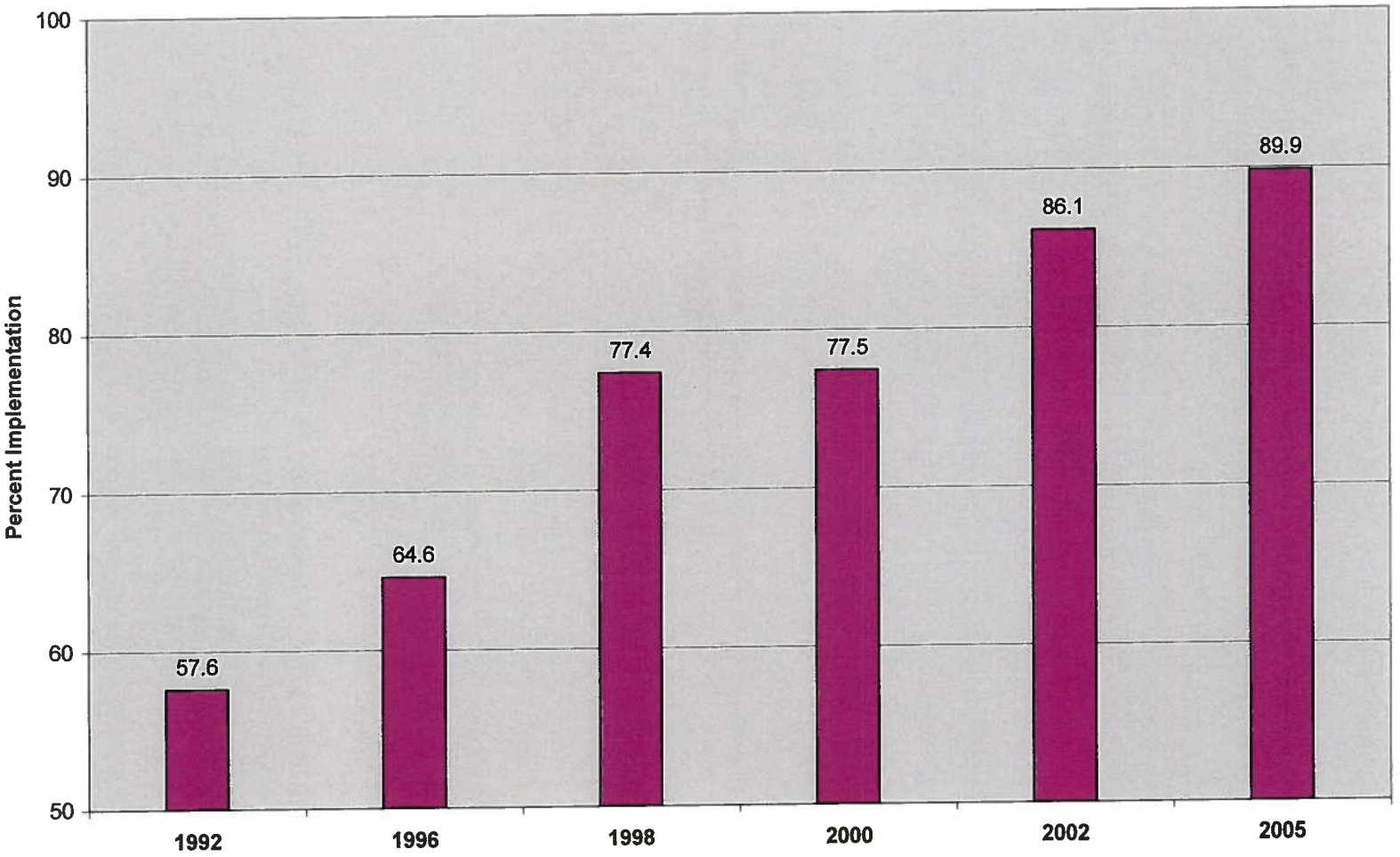
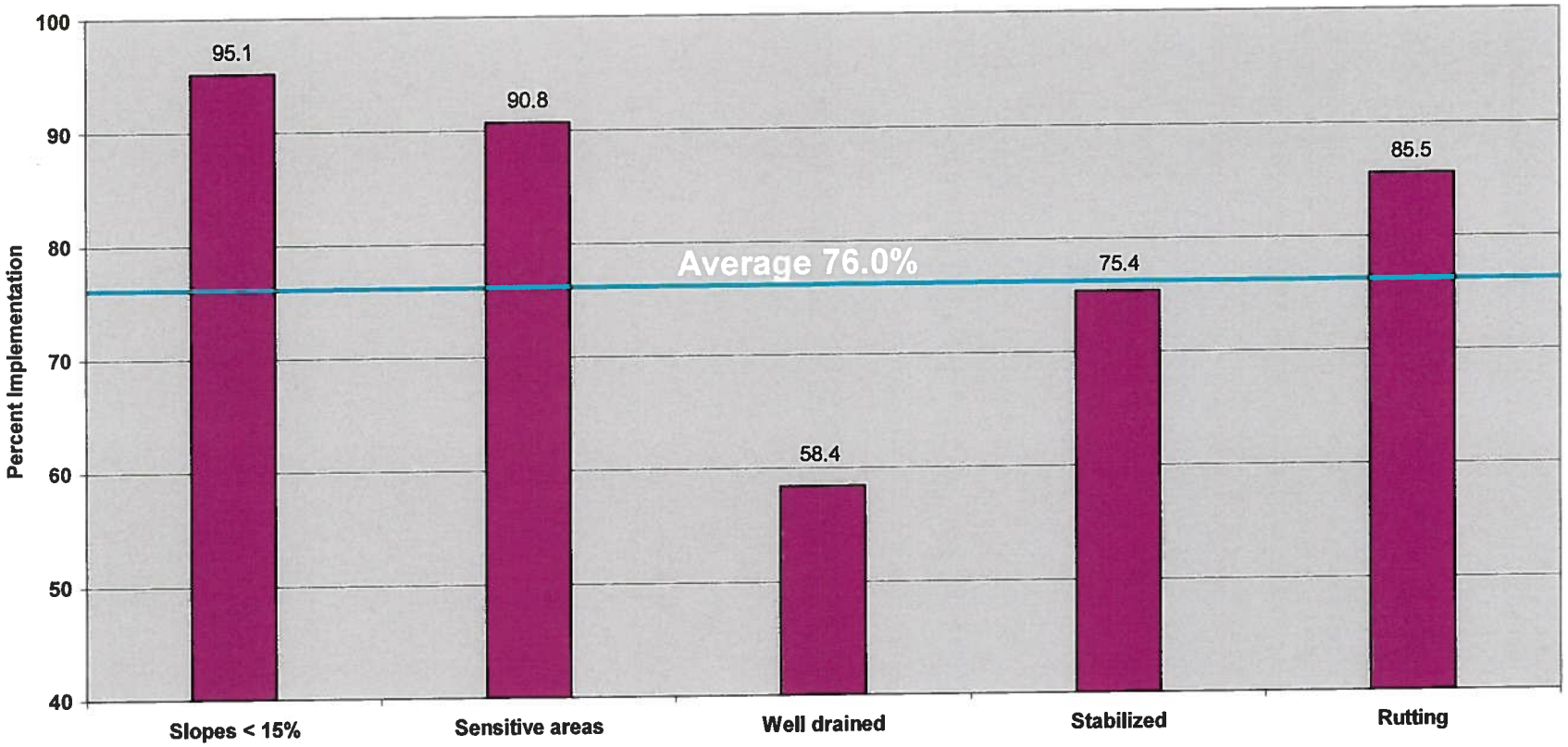


Figure 7. Overall BMP Implementation by Question (1992-2005)
Temporary Roads



STREAM CROSSINGS

Stream crossings were evaluated on 490 sites. One hundred eleven sites had crossings on permanent roads only, 233 had crossings on temporary roads only, and 146 had crossings on both permanent and temporary roads. The percent implementation for stream crossings was 72.7% with a total of 24 water quality risks noted. This category has shown tremendous improvement in BMP implementation (+43%) over the past 15 years, with scores ranging from 58.2% - 84.9%. However, when compared to the 15-year overall average, this category is still shown as a weakness. BMP implementation is much higher on permanent stream crossings (82.6%) than temporary stream crossings (68%). Additional focus needs to be directed to restoring and stabilizing temporary and permanent crossings (34.8% and 76%, respectively) as well as ensuring that temporary crossings are installed correctly (63.7%). It is important to note that the highest score in this category was for minimizing the number of stream crossings on permanent and temporary roads. Operators are not installing unnecessary crossings. See Table 4, Figure 8, Figure 9, and Figure 10.

Table 4. Implementation of BMPs Relating to Stream Crossings.

BMP	Yes	No	N/A	% Implementation	Water quality Risks	Margin of Error
Permanent Roads						
Stabilized	149	47	708	76.0	6	6.1
Ditches do not dump into streams	72	4	380	94.7	0	5.1
Free of sediment	204	53	647	79.4	2	5.0
Crossings minimized	84	3	369	96.6	0	3.9
Total	***509***	***107***	***2104***	***82.6***	***8***	-
Temporary Roads						
Crossings minimized	310	59	535	84.0	3	3.8
Correct	174	99	631	63.7	0	5.8
Approaches at right angles	112	3	340	97.4	0	3.0
Restored / Stabilized	87	163	654	34.8	9	6.0
Free of sediment	259	120	525	68.3	4	4.8
Total	***942***	***444***	***2685***	***68.0***	***16***	-
Overall Total	**1451**	**551**	**4789**	**72.5**	**24**	-

Figure 8. Overall BMP Implementation on Stream Crossings (1992 - 2005)

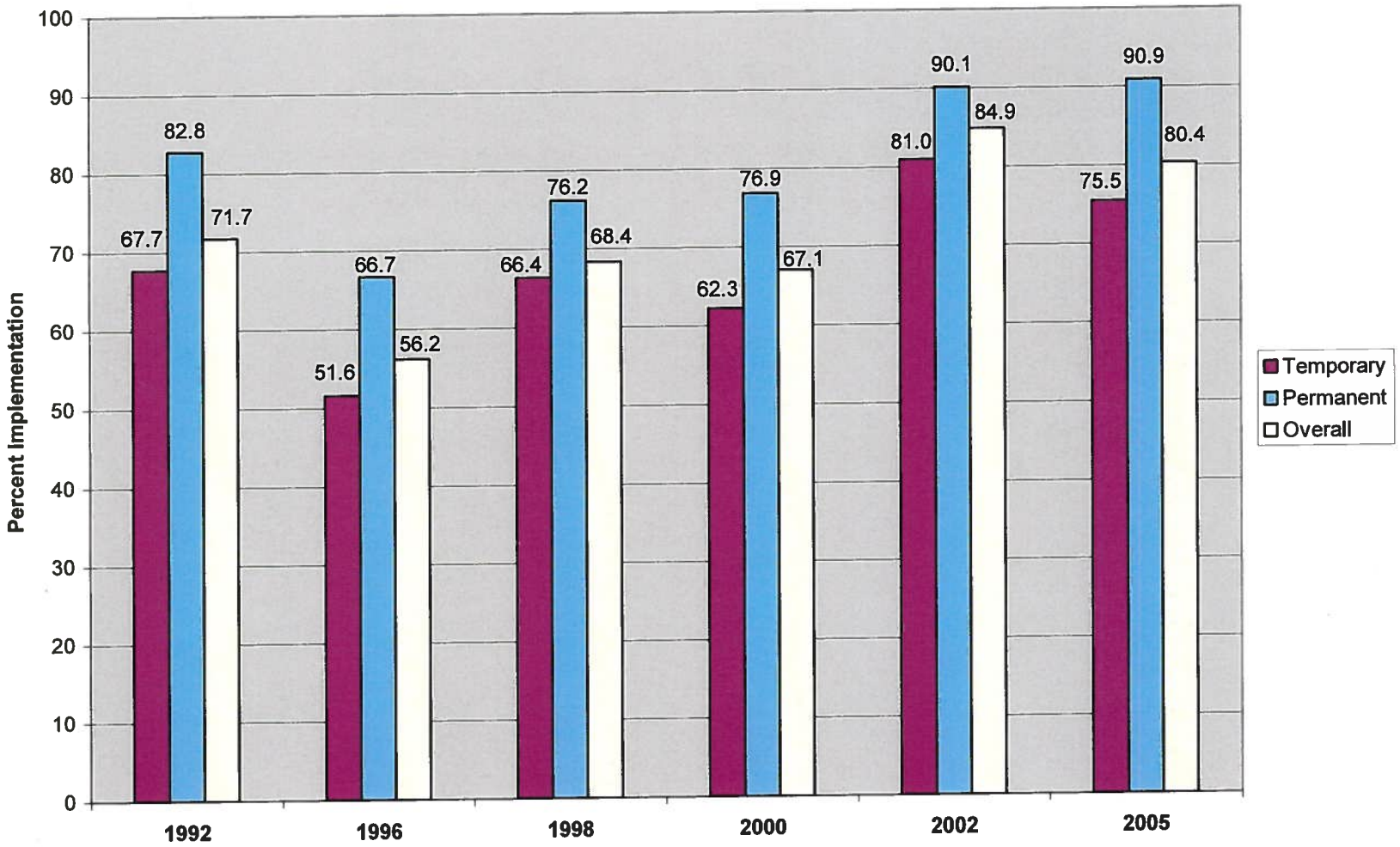


Figure 9. Overall BMP Implementation by Question (1992-2005)
Permanent Stream Crossings

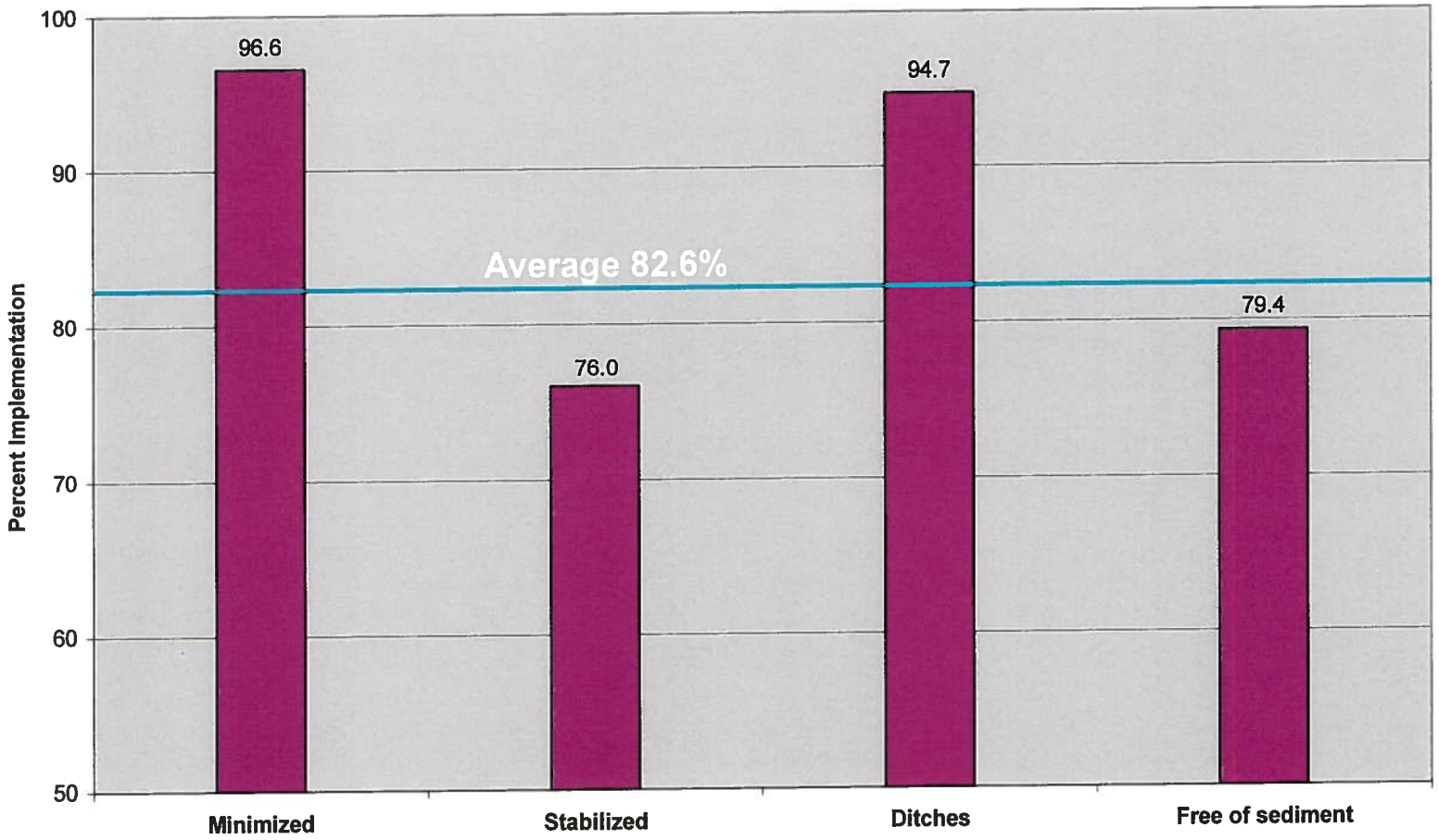
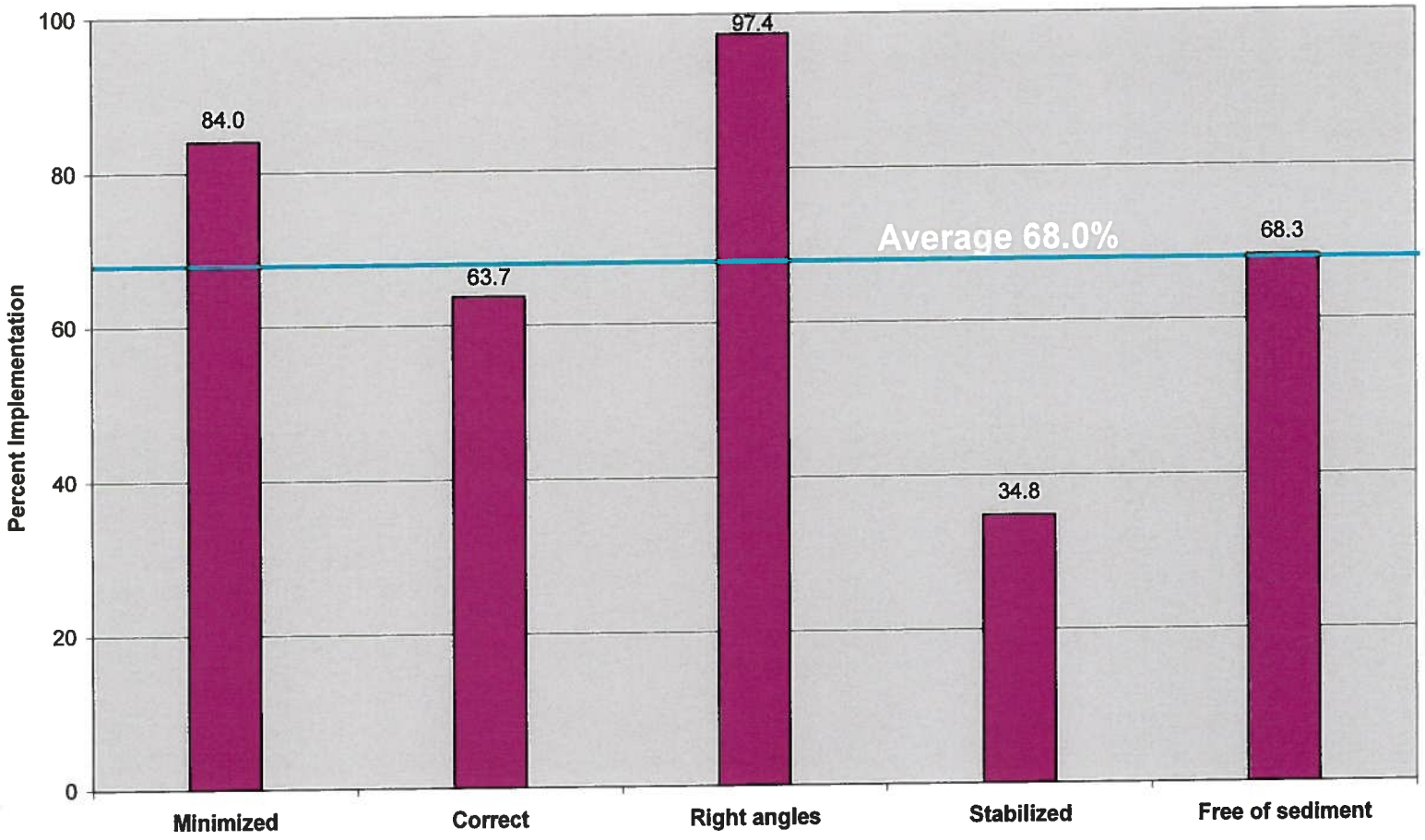


Figure 10. Overall BMP Implementation by Question (1992-2005)
Temporary Stream Crossings



STREAMSIDE MANAGEMENT ZONES

Streamside management zones (SMZs) are forested buffer strips immediately adjacent to the stream channel and are recommended on all perennial and intermittent streams, lakes, ponds, and reservoirs. SMZs were evaluated on 641 sites. The percent implementation of SMZs was 84.6% with 20 water quality risks noted. Over the years, this category has shown significant improvement in BMP implementation (+29%), with scores ranging from 70.6% - 90.9%. The lowest score for this category was shown in 1996, the first survey year that the guidelines recommended leaving SMZs along intermittent streams. When compared to the 15-year overall average, this category could still use a little improvement, primarily in ensuring that these zones are adequately wide (78.2%) and the stream is clear of debris (79.7%). It is important to note that one of the highest scores in this category is for the presence of a SMZ on a perennial stream (91.1%). Landowners are protecting the direct links to our drinking water supplies. See Table 5, Figure 11, Figure 12.

Table 5. Implementation of BMPs Relating to SMZs.

BMP	Yes	No	N/A	% Implementation	Water quality Risks	Margin of Error
Present on perennial stream	277	27	600	91.1	2	3.3
Present on intermittent stream	405	92	407	81.5	6	3.5
Adequately wide	460	128	316	78.2	0	3.4
Thinning within allowable specs	378	85	441	81.6	0	3.6
Integrity honored	487	94	323	83.8	0	3.1
Stream clear of debris	511	130	263	79.7	9	3.2
Free of roads and landings	556	34	314	94.2	0	1.9
Stream free of sediment	569	72	263	88.8	3	2.5
Total	**3643**	**662**	**2927**	**84.6**	**20**	

Figure 11. Overall BMP Implementation on SMZ's (1992 - 2005)

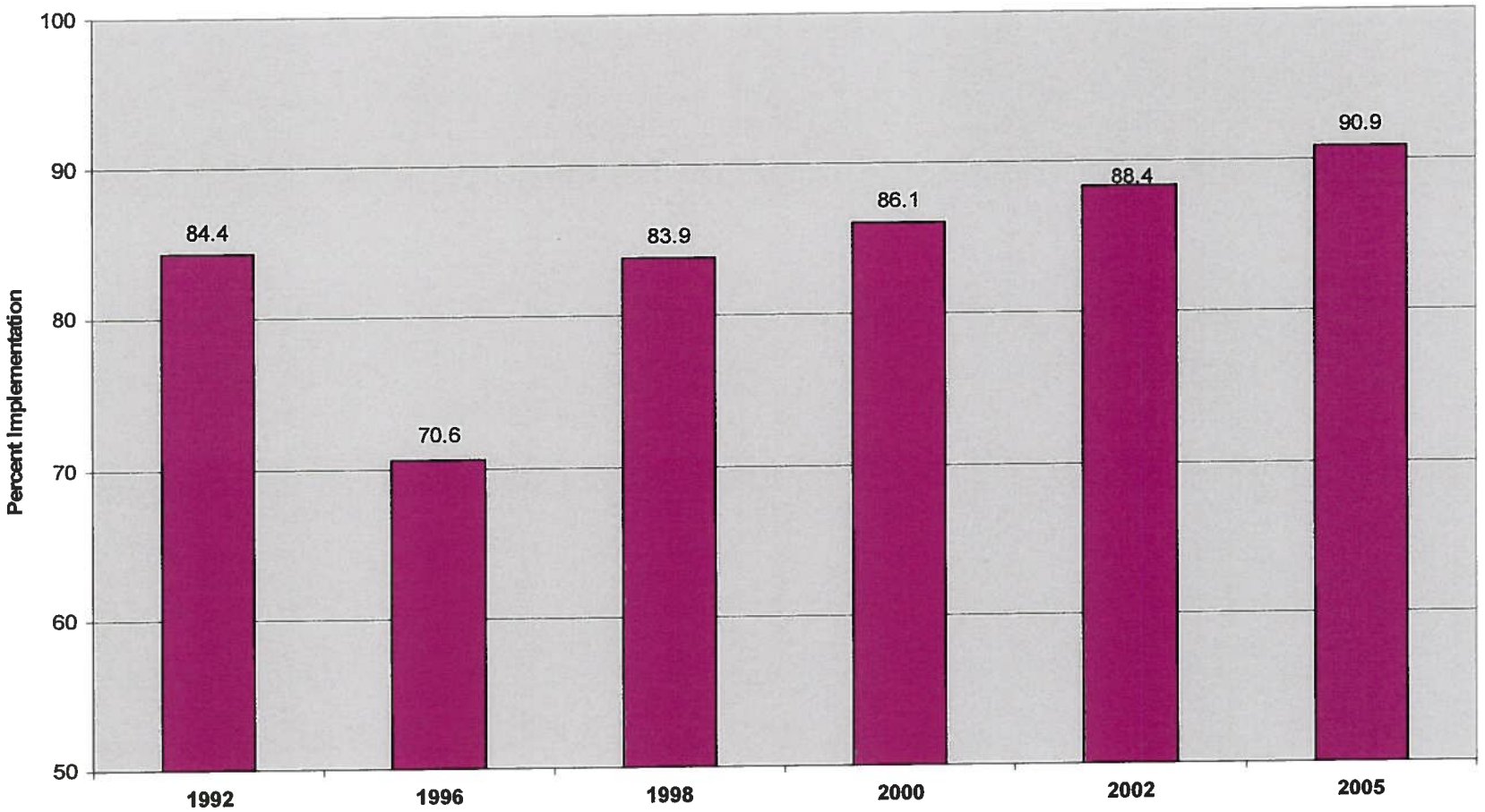
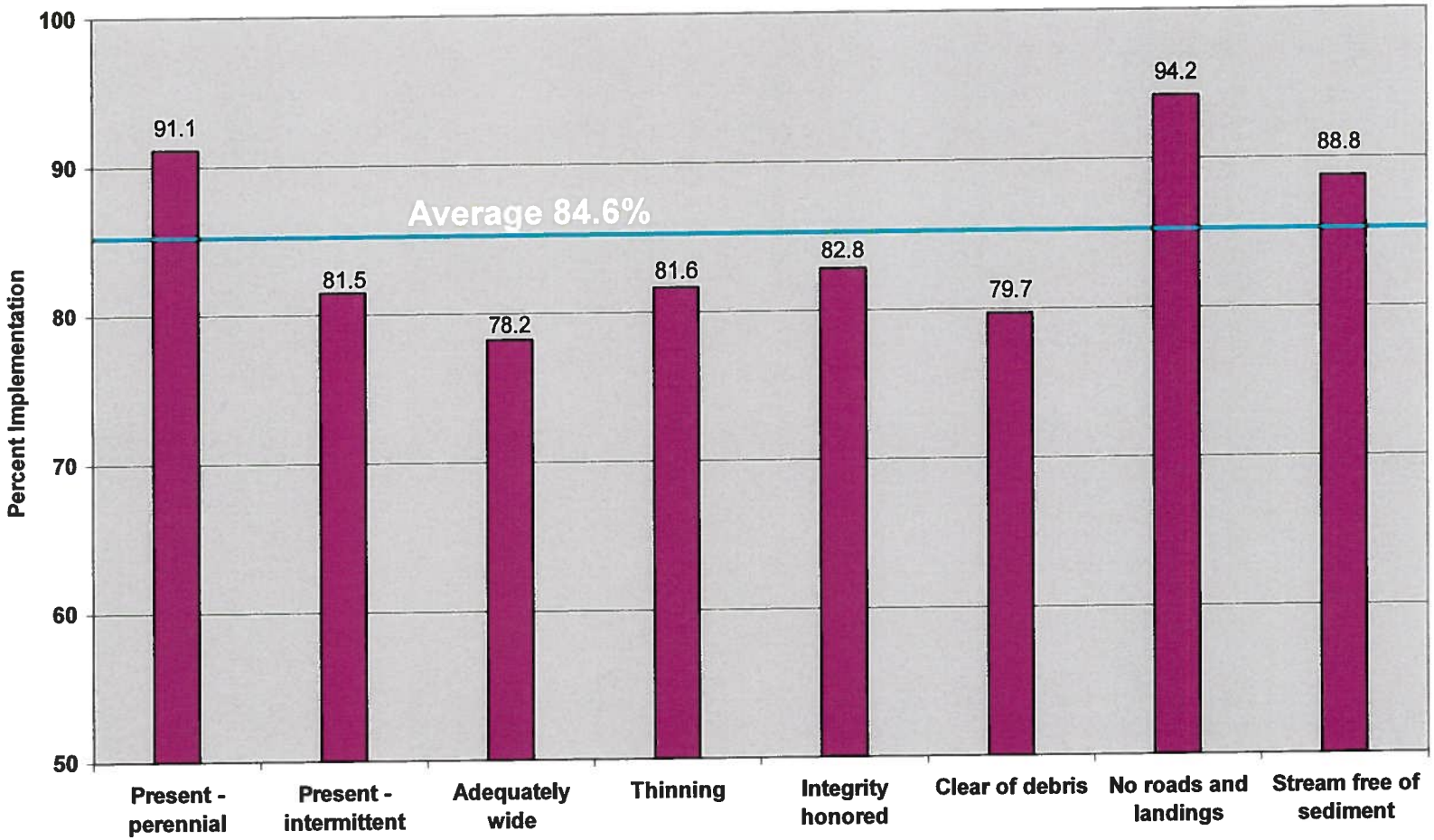


Figure 12. Overall BMP Implementation by Question (1992-2005)
SMZs



SITE PREPARATION

Site preparation is a process done to facilitate the regeneration of trees and may consist of chemical (herbicide) and/or mechanical operations (shear, windrow, bed, etc.). This practice was evaluated on 273 sites. The implementation for site preparation was 92.6% with 1 water quality risk noted. Historically, this category has shown significant improvement in BMP implementation (+23%), with scores ranging from 77.4% – 95%, and is considered a strong point in our monitoring program. The lowest score in this category was for machine planting on the contour (83.8%), which was only evaluated on 37 sites. It is important to note that the highest scores in this category were for preventing sediment (95.4%) and chemicals (97.1%) from reaching the stream or leaving the site. These operations are being conducted in a very environmentally sensitive manner. See Table 6, Figure 13, and Figure 14.

Table 6. Implementation of BMPs Relating to Site Preparation.

BMP	Yes	No	N/A	% Implementation	Water quality Risks	Margin of Error
Respect sensitive areas	142	10	303	93.4	0	4.0
No soil movement on site	253	20	631	92.7	1	3.1
Firebreak erosion controlled	140	15	748	90.3	0	4.8
SMZ integrity honored	177	16	711	91.7	0	4.0
Windrows on contour/free of soil	66	7	831	90.4	0	6.9
No chemicals off site	101	3	800	97.1	0	3.3
Machine planting on contour	31	6	417	83.8	0	12.1
Stream free of sediment	188	9	707	95.4	0	3.0
Were BMPs used*	52	42	354	55.3	0	10.3
Total	**1098**	**86**	**5148**	**90.0**	**1**	

* Question removed from checklist in 2000.

Figure 13. Overall BMP Implementation on Site Preparation (1992 - 2005)

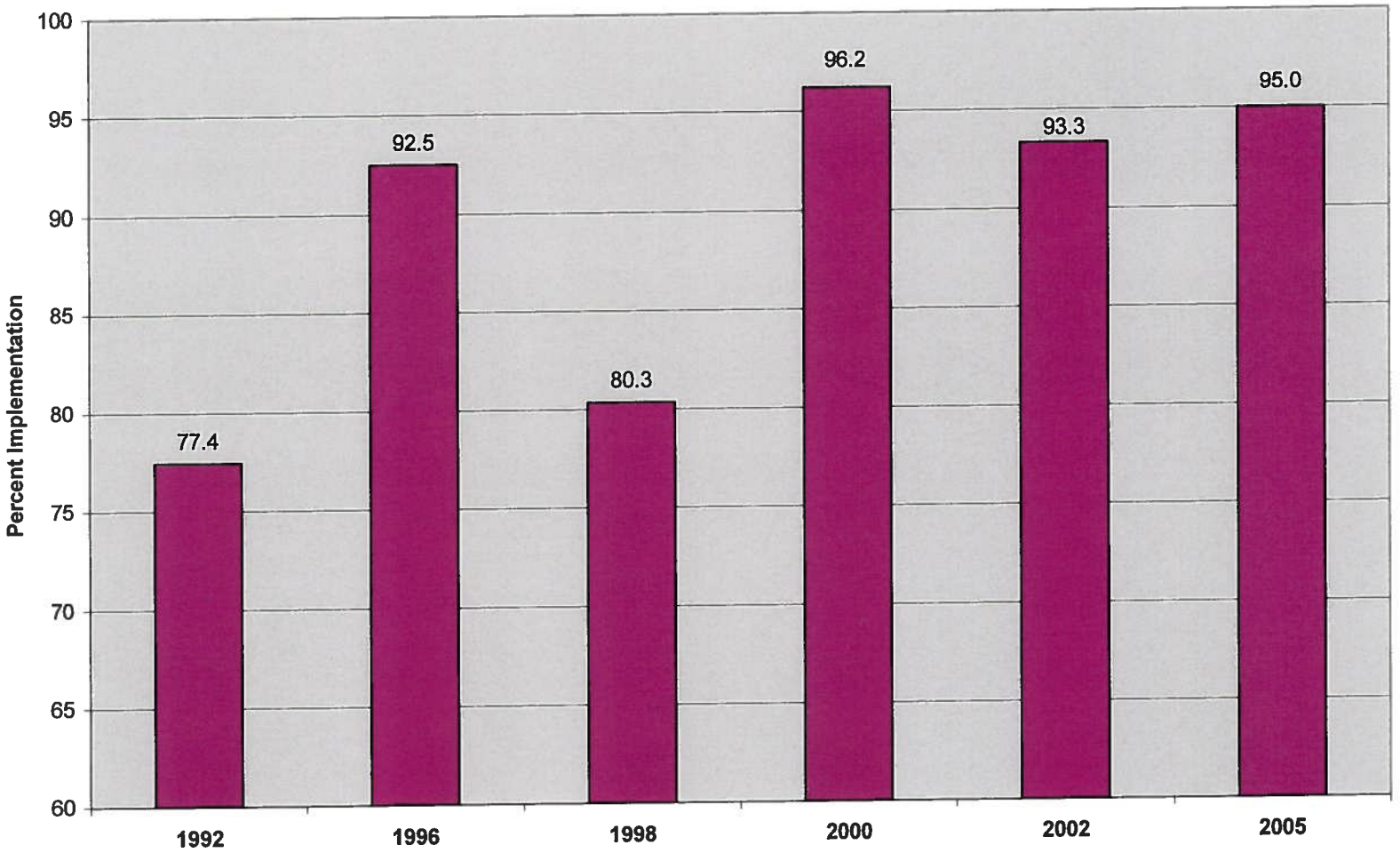
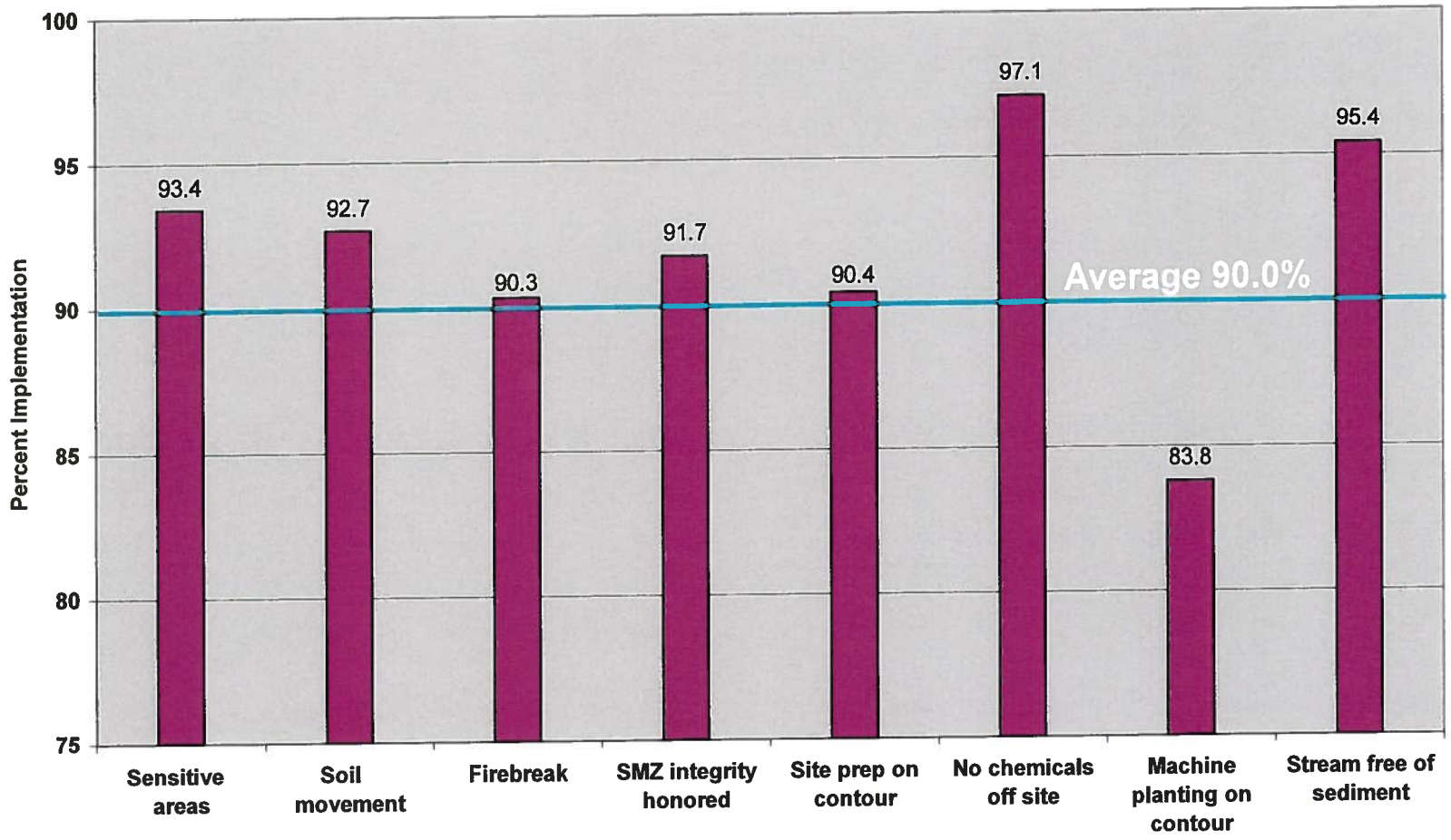


Figure 14. Overall BMP Implementation by Question (1992-2005)
Site Preparation



LANDINGS

Landings, sometimes called sets, are areas where logs are gathered, delimbed, bucked, and loaded onto trucks. Landings were evaluated on 731 sites with an overall implementation of 96.8%, the highest score of any category. Historically, landings have consistently rated at or near the top, and show a slight improvement over time (+6%), with scores ranging from 93.6% – 98.8%. See Table 7, Figure 15, and Figure 16.

Table 7. Implementation of BMPs Relating to Landings.

BMP	Yes	No	N/A	% Implementation	Water quality Risks	Margin of Error
Location free of oil/trash	684	47	173	93.6	0	1.8
Located outside of SMZ	601	7	296	98.8	0	0.9
Well drained location	704	12	188	98.3	0	1.0
Number and size minimized	348	1	106	99.7	0	0.6
Respect sensitive areas	348	1	106	99.7	0	0.6
Restored/stabilized	327	33	544	90.8	0	3.0
Total	**3012**	**101**	**1413**	**96.8**	**0**	

Figure 15. Overall BMP Implementation on Landings (1992 - 2005)

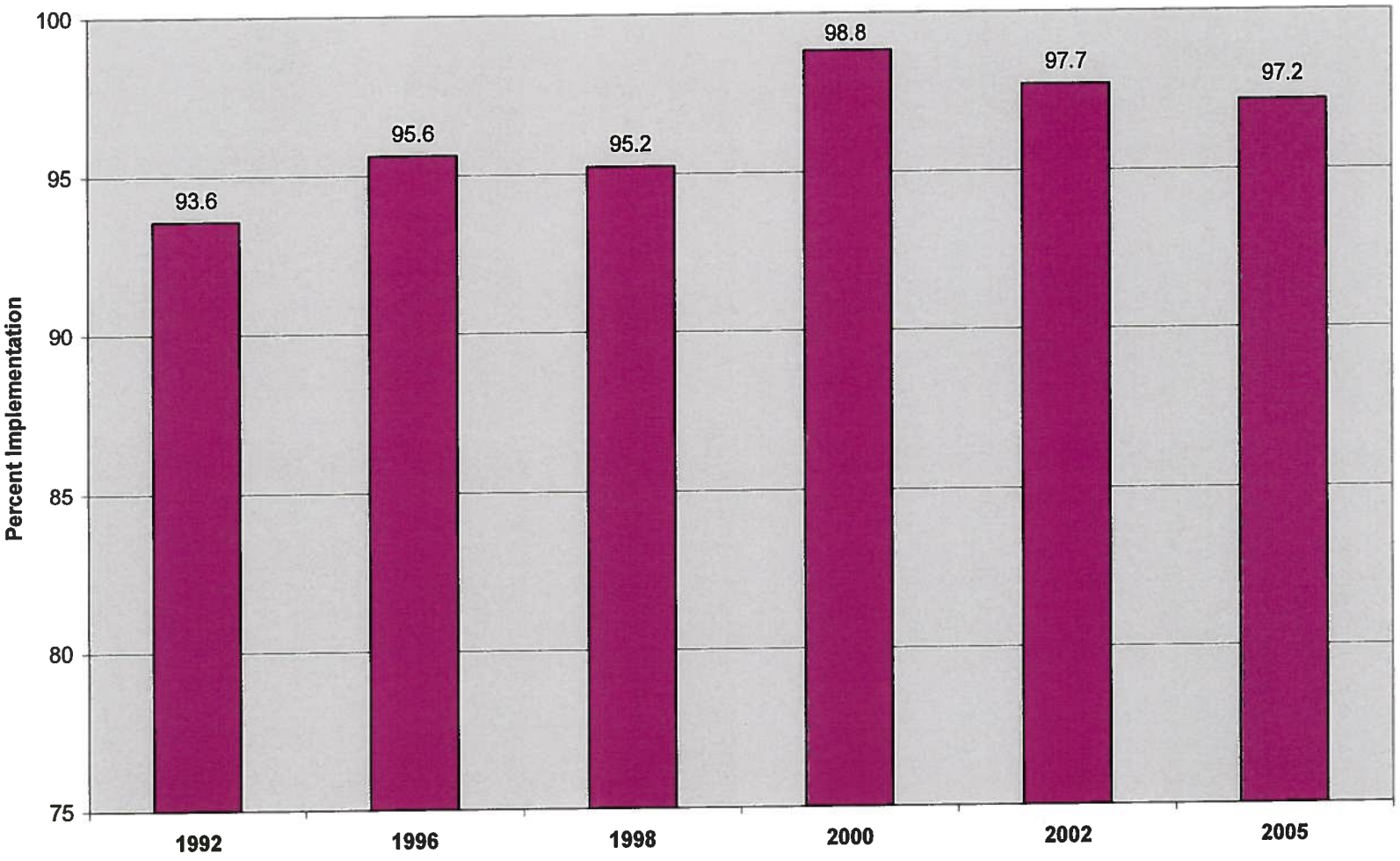
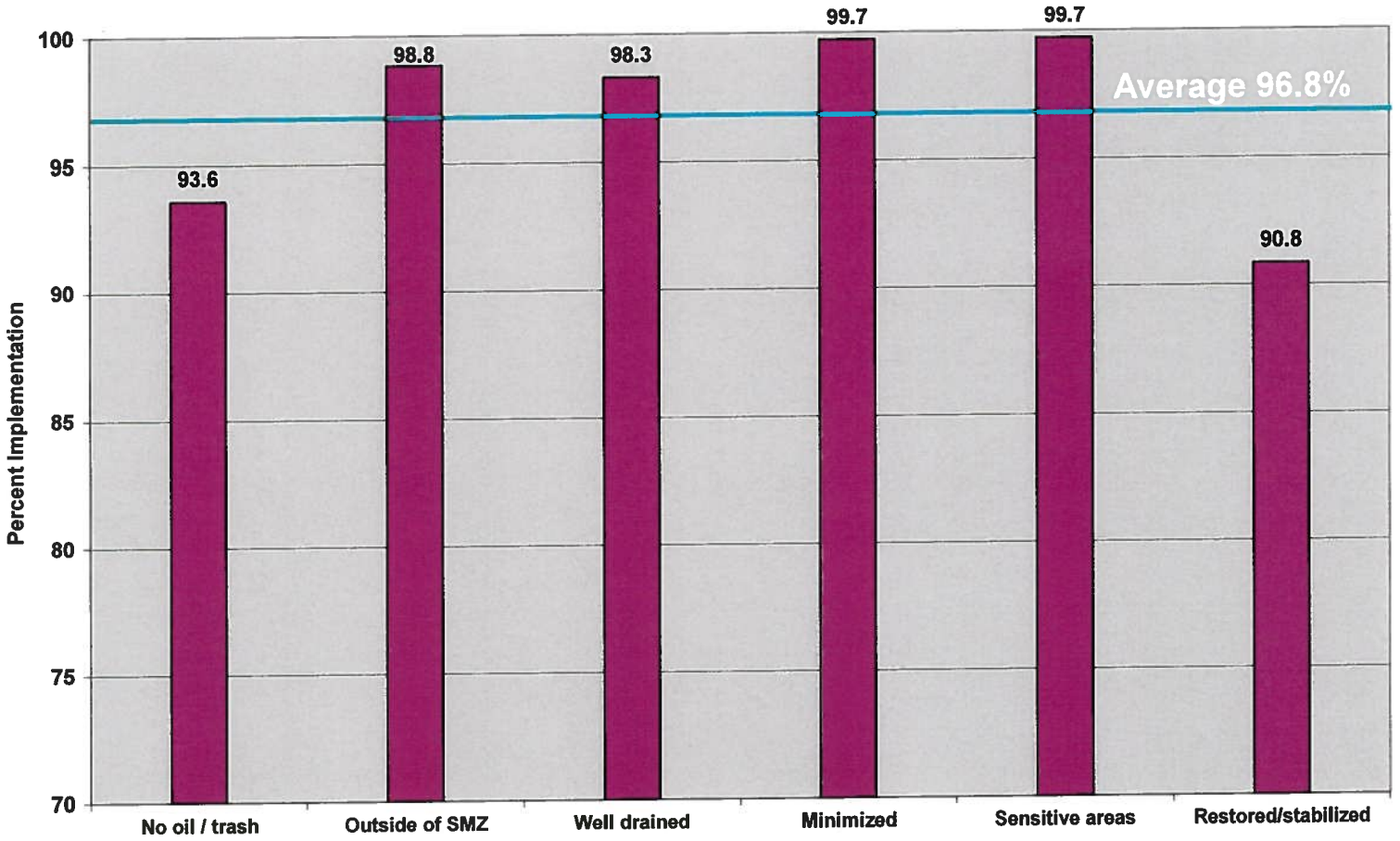


Figure 16. Overall BMP Implementation by Question (1992-2005)
Landings



WETLANDS

Seventy-one sites had wetland or "wetland like" areas (not necessarily jurisdictional) since 2000, the year this category was added. These sites had an overall implementation of 92.9%. Historically, this category has shown improvement in BMP implementation (+10%), with scores ranging from 86.7% – 95.2%, and is considered a strong point in our monitoring program. It is important to note that all mandatory road BMPs for wetlands were followed. See Table 8, Figure 17, and Figure 18.

Table 8. Implementation of BMPs Relating to Wetlands.

BMP	Yes	No	N/A	% Implementation	Water quality Risks	Margin of Error
Avoid altering hydrology of site	62	9	385	87.3	0	7.9
Road drainage structures installed properly	39	2	415	95.1	0	6.7
Mandatory road BMPs followed	42	0	414	100	0	-
Total	**143**	**11**	**1214**	**92.9**	**0**	

Figure 17. Overall BMP Implementation in Wetlands (2000 - 2005)

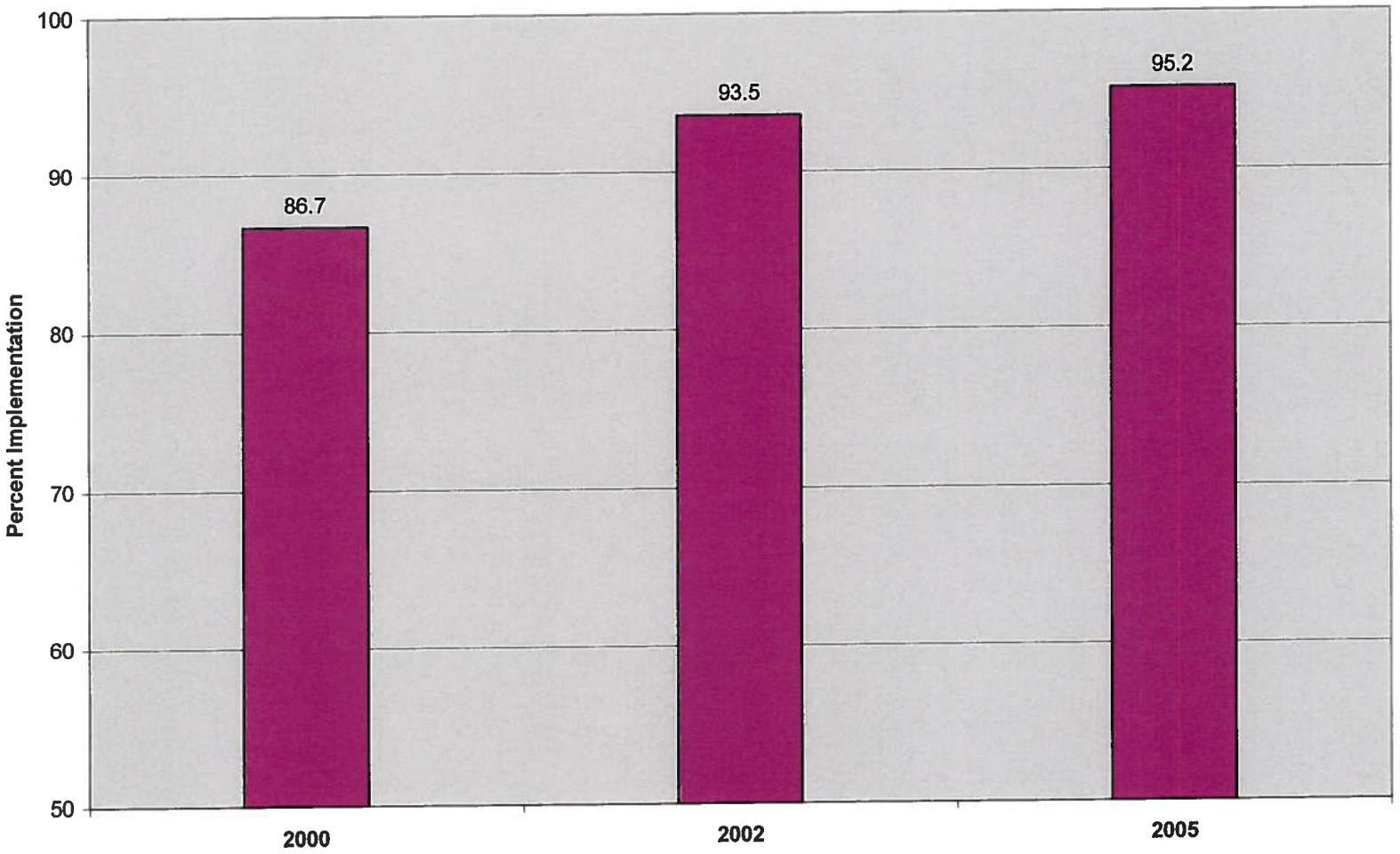
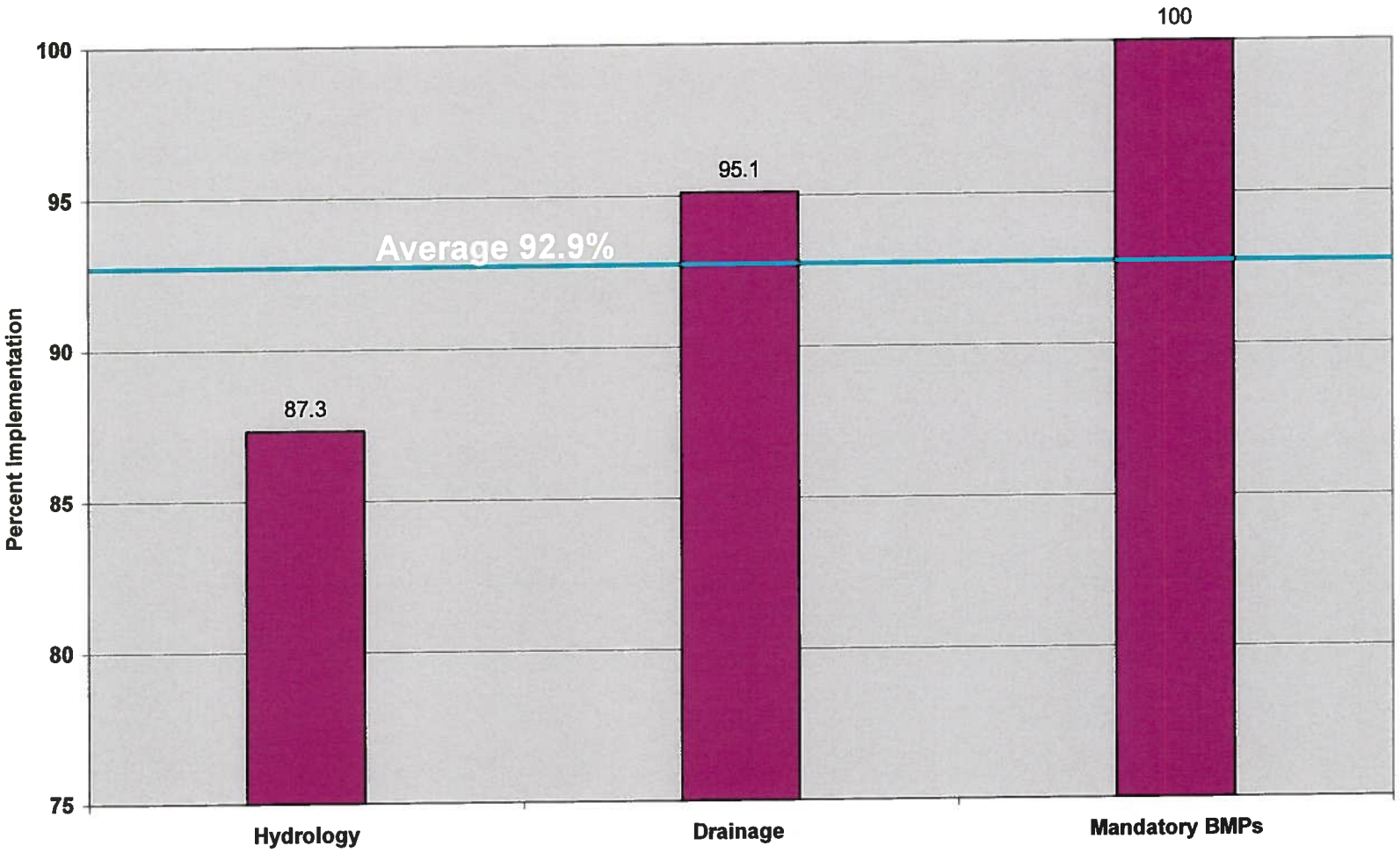


Figure 18. Overall BMP Implementation by Question (2000-2005)
Wetlands



OVERALL BMP IMPLEMENTATION

Significant progress has been made in BMP implementation over the past 15 years (+21%). Figure 19 documents the tremendous improvement in temporary roads, stream crossings, SMZs, and site preparation. Gains were even reported for landings, permanent roads, and wetlands, categories that consistently rank high in implementation.

To illustrate the range of the overall implementation scores, results were separated into five categories: 0-50%, 51-70%, 71-80%, 81-90%, and 91-100%. Figure 20 geographically illustrates the scores across all ownerships while Figure 21 shows the number of tracts by ownership receiving the respective level of implementation.

IMPLEMENTATION BY SITE CHARACTERISTICS

Ownership

The public ownership category fared best, with 95.8% for the 60 tracts with no water quality risks noted.

The 21 sites owned by corporate landowners had an overall BMP implementation of 95.3% and had only one water quality risk.

Forest industry owned 349 of the sites and had an overall implementation of 92.3% with only ten water quality risks.

Family forest owners had an implementation rating of 79.1% with 47 water quality risks on 474 sites. Though this represents the lowest level of the four ownership types, this group has made tremendous progress over the years, increasing overall BMP implementation by 29% to its current level of 88.7%. Even greater strides were made on temporary roads (+68%), site preparation (+59%), stream crossings (+58%), wetlands (+45%), and SMZs (+42%). See Figure 22 and 23.

Type of Activity

Four types of silvicultural activities were monitored: regeneration harvests, partial regeneration cuts, thinning, and site preparation. See Table 9.

Table 9. Overall BMP Implementation by Type of Operation.

Type of Operation	Percent Implementation
Regeneration harvest (clearcut)	82.9%
Regeneration harvest (partial cut)	83.2%
Thinning	92.2%
Site preparation (only)	90.5%

Figure 19. Percent Increase in BMP Implementation by Category (1992 - 2005)

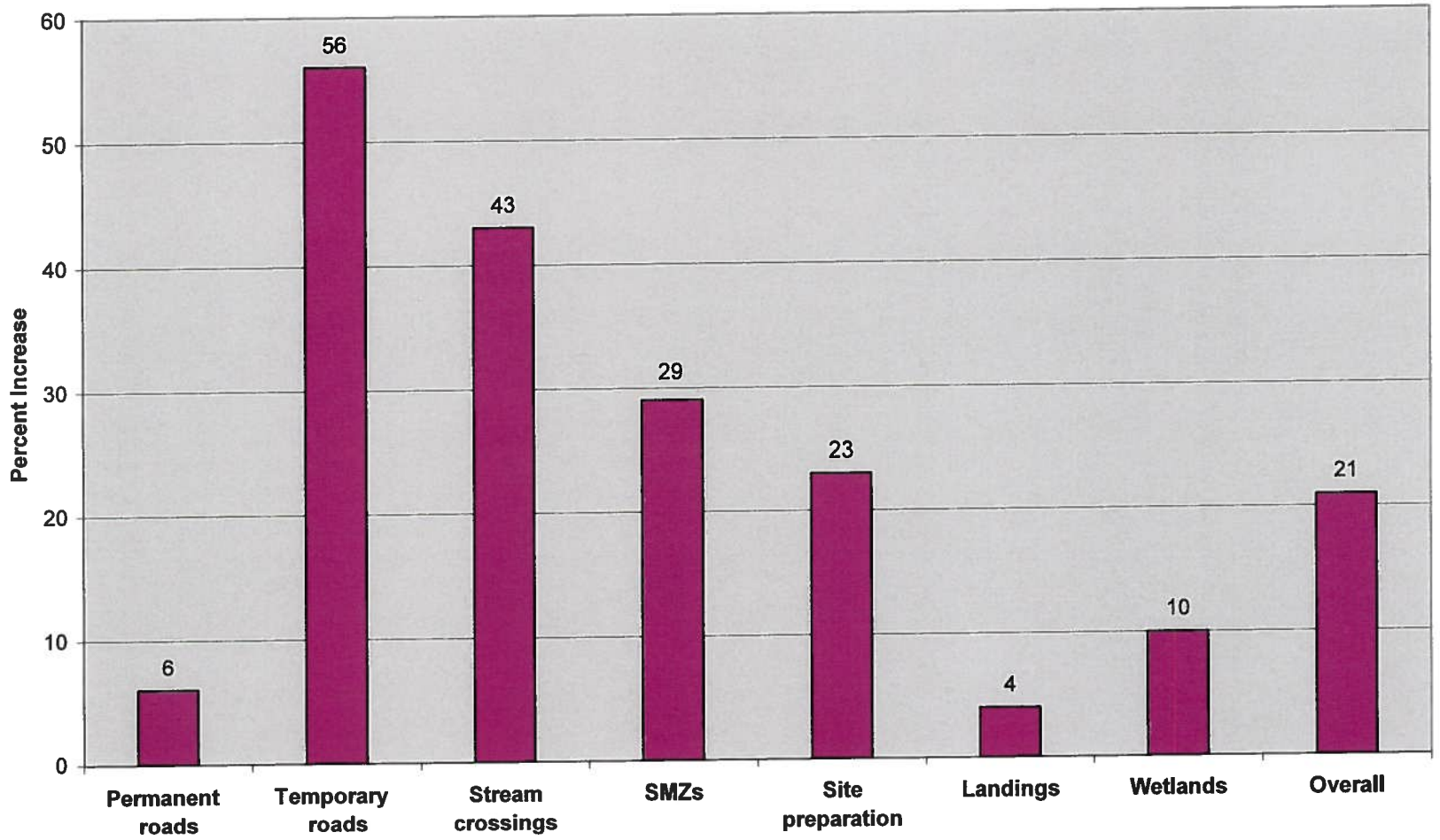


Figure 20. Site Locations by BMP Implementation Scores.

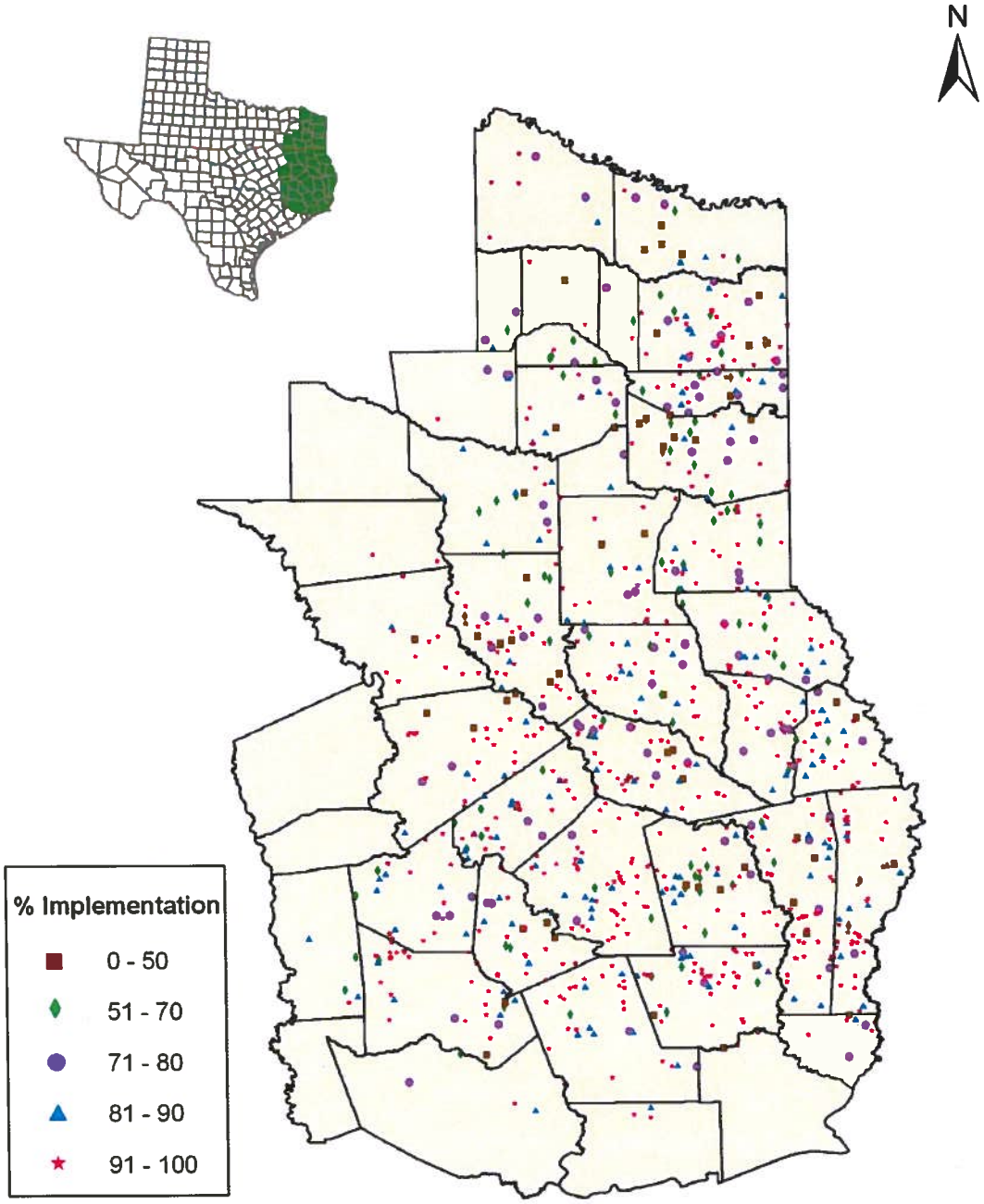


Figure 21. Overall Implementation Scores by Number of Sites and Ownership.

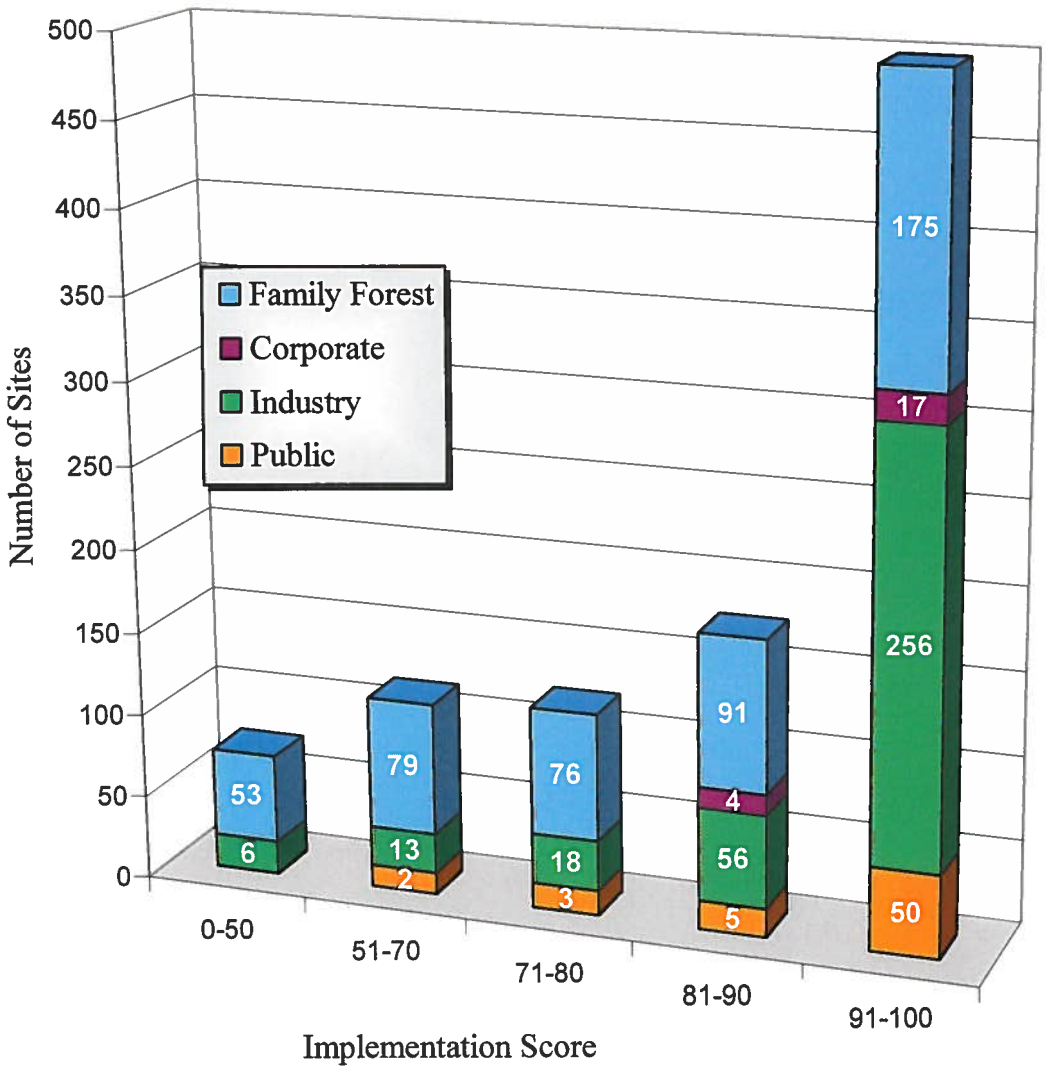


Figure 22. Overall BMP Implementation by Family Forest Owners (1992-2005)

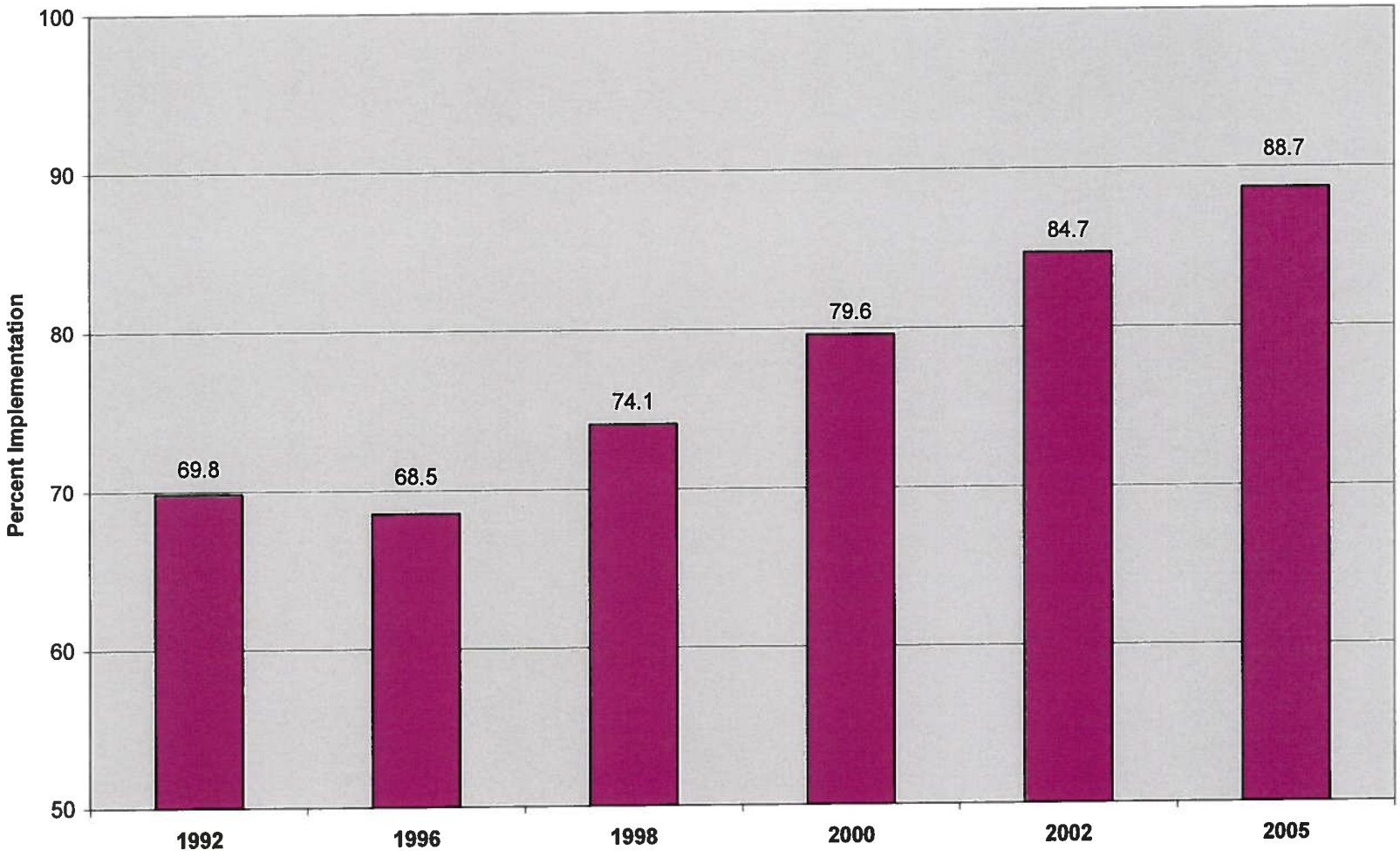
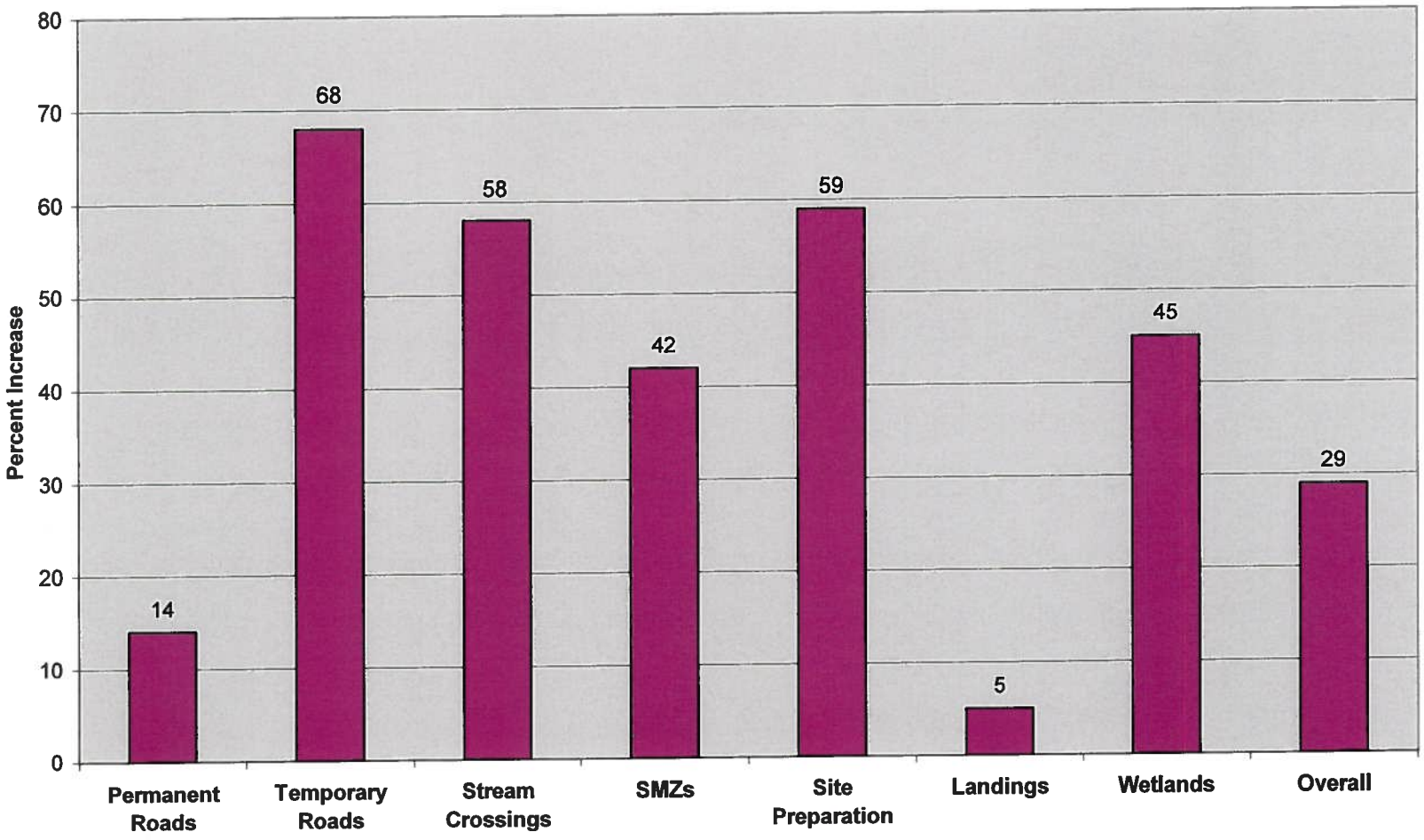


Figure 23. Percent Increase in Family Forest Owner BMP Implementation Categories (1992 - 2005)



CONCLUSION

Major improvements in BMP implementation have been noted in Texas over the past 15 years. Overall BMP implementation rates have increased by 21% since the program began and are now at an all time high (91.7%). Even greater strides have been made in traditional "problem areas" – temporary roads (+56%), stream crossings (+43%), and SMZs (+29%).

Family forest owners are starting to embrace these practices as well and have led the advancement. Tremendous gains have been made on private land, most notably on temporary roads (+68%), site preparation (+59%), stream crossings (+58%), wetlands (+45%), and SMZs (+42%). This dramatic improvement demonstrates the effectiveness of the Texas Forest Service BMP Program in promoting BMP implementation as well as the forestry community's commitment to environmental stewardship.

Forest industry has also played a significant role in encouraging BMP implementation, increasing rates on their own land by 10% to their current level of 96%. This is due primarily because of its support of the Texas Forest Service BMP Program and participation in the Sustainable Forestry Initiative®. Water quality protection is obviously a top priority, as evident by requiring all contractors to attend BMP training workshops, including BMPs in their timber sale contracts, and supporting educational workshops.

Although BMP implementation has increased, there is still room for improvement. This analysis identified several deficiencies in BMP implementation – temporary stream crossings, roads, and SMZs. Focusing educational efforts on correctly installing and restoring temporary stream crossings as well as ensuring that temporary roads are well drained and stabilized appear to be the best way to improve BMP implementation in the future. An all day course concentrating on how to properly install and remediate stream crossings is scheduled for March 2007 that will fit into the Texas Forestry Association's Pro Logger continuing education program. Future courses will include specific focus on BMPs related to forest roads and SMZs. Combining this BMP specific training with effective educational programs and technical assistance to family forest owners should greatly reduce any potential water quality impacts from silvicultural operations.

Appendix

Implementation Monitoring Checklist (Old)

Implementation Monitoring Checklist (New)

Checklist Comparison

TEXAS BMP MONITORING CHECKLIST

SITE ID NO:

GENERAL

1. County_____ 2. Block/Grid_____
3. Latitude_____ Longitude_____
Forester: 4. _____ 5. _____
6. Timber Buyer _____
7. Logger _____

8. Activity _____
9. Estimated date of activity _____
10. Acres affected _____
11. Inspector _____

LANDOWNER:

12. Owner Type: N L A I P

13. Name _____
14. Address_____
15. City _____ ZIP _____
16. Phone _____

17. Date of Inspection _____
18. Accompanied by:_____

SITE CHARACTERISTICS

19. Terrain: F H S
20. Erodability hazard: L M H
21. Type stream present P I

22. Distance to nearest permanent water body:
<300' 300-800' 800-1600' 1600'+
23. Predominant soil series/texture: _____ / C CL L SL S

PERMANENT ROADS

[ ] NOT APPLICABLE

24. Avoid sensitive areas. Y N NA
25. Roads meet grade specs. Y N NA
26. Stabilized stream crossing. Y N NA
27. Rutting within allowable specs. Y N NA
28. Ditches do not dump into streams. Y N NA
29. Were BMP's used. Y N NA
Type: RD WD WB RE OC PL RS CU BR LW
30. Were BMP's effective. Y N NA
31. Stream free of sediment. Y N NA

SKID TRAILS / TEMPORARY ROADS

[ ] NOT APPLICABLE

32. Slopes less than 15%. Y N NA
33. Rutting within allowable specs. Y N NA
34. Water bars evident. Y N NA
35. Water bars working. Y N NA
36. Stream crossings minimized. Y N NA
37. Stream crossings correct. Y N NA
38. Stream crossings restored & stabilized. Y N NA
39. Were BMP's used. Y N NA
Type: RD WD WB RE OC PL RS CU BR LW
40. Stream free of sediment. Y N NA

SMZ

[ ] NOT APPLICABLE

41. SMZ present on permanent stream. Y N NA
42. SMZ present on intermittent stream. Y N NA
43. SMZ adequately wide. Y N NA
44. Thinning within allowable specs. Y N NA
45. SMZ integrity honored. Y N NA
46. Stream clear of debris. Y N NA
47. SMZ free of roads and landings. Y N NA
48. Stream free of sediment. Y N NA

SITE PREPARATION

[ ] NOT APPLICABLE

49. Site prep method _____
50. Regeneration method _____
51. No soil movement on site. Y N NA
52. Firebreak erosion controlled. Y N NA
53. SMZ integrity honored. Y N NA
54. Windrows on contour / free of soil. Y N NA
55. No chemicals off site. Y N NA
56. Were BMP's used. Y N NA
Type: WB RE OC RS
57. Stream free of sediment. Y N NA

LANDINGS

[ ] NOT APPLICABLE

58. Locations free of oil / trash. Y N NA
59. Located outside SMZ. Y N NA
60. Well drained location Y N NA
61. Restored, stabilized. Y N NA

62. **Overall compliance with Best Management Practices**

NEEDS IMPROVEMENT NO EFFORT POOR

PASS FAIR GOOD EXCELLENT

FOLLOW UP QUESTIONS

Was activity supervised by landowner or representative?	Y N NA
Who _____	
Was landowner familiar with BMP Handbook?	Y N NA
Was logger familiar with BMP Handbook?	Y N NA
Were BMP's included in the contract?	Y N NA
Is landowner a member of TFA? Landowner Assn? For. Farmer?	Y N NA

_____

Is remediation planned by landowner (if needed)? Y N Date _____

COMMENTS (Explain discrepancies observed in the field check. Recommendations for better compliance).

MAP / SKETCH AREA

TEXAS FOREST SERVICE

The Texas A&M University System

TEXAS BMP MONITORING CHECKLIST

Site ID 164

I. General Landowner and Tract Information

County | TFS Block and Grid | Region North

Latitude | Longitude

Forester Type | Name

Timber Buyer | Logging Contractor

Activity | Acres Affected

Estimated Date of Activity | Date of Inspection

Inspector | Accompanied by

Owner Type:

☐ N ☐ A ☐ C ☐ I ☐ P

Landowner:

Name

Address

City | State

Zip

Phone

E-mail

II. Site Characteristics

Terrain: ☐ Flat ☐ Hilly ☐ Steep

Erodibility hazard: ☐ Low ☐ Medium ☐ High

Type stream present: ☐ Perennial ☐ Intermittent

Watershed Code HUC

River Basin

Distance to nearest permanent water body:

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

Predominant soil series/texture:

☐ 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 more than fifty feet	☐	☐	☐	☐
4. Well drained with appropriate structures to minimize soil movement	☐	☐	☐	☐
5. Wing ditches, water bars, and water turnouts do not dump into streams	☐	☐	☐	☐
6. Reshaped and/or stabilized to minimize soil movemen	☐	☐	☐	☐
Section Total	0	0		0

BMPs present ☐ RD ☐ WD ☐ WB ☐ RE ☐ OC ☐ PL ☐ RS ☐ CU ☐ BR ☐ LW

Percent Implementation N/A

IV. Skid Trails/Temporary (secondary) Roads

	YES	NO	NA/NN	Sig. Risk
1. Slopes less than 15% and laid out on the contour of the land	☐	☐	☐	☐
2. Respect sensitive areas, such as SMZs, steep slopes, and wet areas	☐	☐	☐	☐
3. Well drained with appropriate water control structures to effectively reduce erosion	☐	☐	☐	☐
4. Stabilized to minimize soil movement	☐	☐	☐	☐
5. Rutting within allowable specs of less than six inches deep for not more than fifty feet	☐	☐	☐	☐
Section Total	0	0		0

BMPs present ☐ RD ☐ WD ☐ WB ☐ RE ☐ OC ☐ PL ☐ RS ☐ CU ☐ BR ☐ LW

Percent Implementation N/A

V. Stream Crossings

	YES	NO	NA/NN	Sig. Risk
On Permanent Roads				
1. Stabilized stream banks, crossings at right angles, and no evidence of washouts	☐	☐	☐	☐
2. Wing ditches, water bars, and water turnouts do not dump into streams	☐	☐	☐	☐
3. Stream free of sediment	☐	☐	☐	☐
4. Number of crossings minimized	☐	☐	☐	☐
On Temporary Roads				
5. Number of crossings minimized	☐	☐	☐	☐
6. Stream crossings correct to minimize potential erosion in the stream channel	☐	☐	☐	☐
7. Approaches at right angles to minimize bank disturbance	☐	☐	☐	☐
8. Stream crossings restored and stabilized by removing temporary crossings	☐	☐	☐	☐
9. Stream free of sediment	☐	☐	☐	☐
Section Total	0	0		0

BMPs present ☐ CU ☐ BR ☐ LW

Percent Implementation N/A

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. SMZ integrity honored by keeping skidders, roads, landings, and firebreaks out	☐	☐	☐	☐
6. Stream clear of debris, such as tops, limbs, and brush	☐	☐	☐	☐
7. SMZ free of roads and landings	☐	☐	☐	☐
8. Stream free of sediment	☐	☐	☐	☐
Section Total	0	0		0

Percent Implementation N/A

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. Machine planting on contour rather than up and down steep slopes	☐	☐	☐	☐
8. Stream free of sediment	☐	☐	☐	☐
Section Total	0	0		0

Percent Implementation N/A

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 minimize puddling, soil degradation, and soil movement	☐	☐	☐	☐
4. Number and size minimized	☐	☐	☐	☐
5. Respect sensitive areas, including SMZs, steep slopes, and wet areas	☐	☐	☐	☐
6. Restored / stabilized by back blading, spreading bark, or seeding to minimize erosion	☐	☐	☐	☐
Section Total	0	0		0

Percent Implementation N/A

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 the flow of water	☐	☐	☐	☐
3. Mandatory road BMPs followed	☐	☐	☐	☐
Section Total	0	0		0
Percent Implementation	N/A			

X. Overall Compliance

	YES	NO	NA/NN	Sig. Risk
III. Permanent Roads	0	0	☑	0
IV. Skid trails/Temporary Roads	0	0	☑	0
V. Stream Crossings	0	0	☑	0
VI. Streamside Management Zones	0	0	☑	0
VII. Site Preparation	0	0	☑	0
VIII. Landings	0	0	☑	0
IX. Wetlands	0	0	☑	0
Overall Total	0	0		
Total Significant Risk				0
Percent Implementation	#Error			

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

Follow Up Questions

	YES	NO	NA/NN	
Was activity supervised by a professional forester or representaive?	☐	☐	☐	
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? Other?	☐	☐	☐	
Organization				
Is remediation planned by landowner?	☐	☐	☐	Date

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

Comparison of BMP Monitoring Checklist Forms

Old Form	New Form
Site ID	Site ID
1. County	County
2. Block/Grid	TFS Block/Grid
	*Region
3. Latitude	Latitude
Longitude	Longitude
4. Forester	Forester Type
5. Name	Name
6. Timber Buyer	Timber Buyer
7. Logger	Logging Contractor
8. Activity	Activity
9. Estimated date of activity	Estimated date of activity
10. Acres affected	Acres affected
11. Inspector	Inspector
12. Landowner Type	Owner Type
13-16. Landowner contact information	Landowner contact information
	*Landowner e-mail
17. Date of inspection	Date of inspection
18. Accompanied by	Accompanied by
19. Terrain	Terrain
20. Erodability hazard	Erodability hazard
21. Type stream present	Type stream present
	*River Basin
22. Distance to nearest permanent water	Distance to nearest permanent water body
	*Watershed code
23. Predominant soil series/texture	Predominant soil series/texture
Permanent Roads	
24. Avoid sensitive areas	III.1. Respect sensitive areas
25. Roads meet grade specs	III.2. Meet grade specifications
26. Stabilized stream crossing	See Question V.1
27. Rutting w/in allowable specs	III.3. Rutting w/in allowable specs
28. Ditches do not dump into streams	III.5. Wing ditches do not dump
**29. Were BMP's used?	III.4. Well drained w/appropriate structures
Type	BMP's present (check boxes)
**30. Were BMP's effective	
	*III.6. Reshaped and/or stabilized
31. Stream free of sediment	See Question V.3
Temporary Roads	
32. Slopes less than 15%	IV.1. Slopes less than 15%
	IV.2. Respect sensitive areas
33. Rutting within allowable specs	IV.5. Rutting w/in allowable specs
**34. Water bars evident	

**35. Water bars working	
36. Stream crossing minimized	See Question V.5
37. Stream crossings correct	See Question V.6
38. Stream crossings restored & stabilized	See Question V.8
39. Were BMPs Used?	IV.4. Well drained w/appropriate structures
Type	BMP's present (check boxes)
40. Stream free of sediment	See Question V.9
	*IV.4. Stabilized to minimize soil movement
Stream Crossings	
See Question 26	V.1 Stabilized
	*V.2 Ditches
See Question 31	V.3 Stream free of sediment
	*V.4 Crossings Minimized – Perm Roads
See Question 36	V.5 Crossings Minimized – Temp Roads
See Question 37	V.6 Correct
	*V.7 Approaches at right angles
See Question 38	V.8 Restored and stabilized
See Question 40	V.9 Free of sediment
SMZs	
41. SMZ present on permanent stream	VI.1. Present on permanent stream
42. SMZ present on intermittent stream	VI.2. Present on intermittent stream
43. SMZ adequately wide	VI.3. SMZ adequately wide by leaving…
44. Thinning w/in allowable	VI.4. Thinning w/in allow
45. SMZ integrity honored.	VI.5. SMZ integrity honored…
46. Stream clear of debris.	VI.6. Stream clear of debris…
47. SMZ free of roads & landings	VI.7. SMZ free of roads & landings
48. Stream free of sediment.	VI.8. Stream free of sediment
Site Preparation	
49. Site prep method	VII. Site preparation method
50. Regeneration method	VII. Regeneration method
	*VII.1. Respect sensitive areas by prevent
51. No soil movement on site	VII.2. No soil movement
52. Firebreak erosion controlled	VII.3. Firebreak erosion controlled
53. SMZ integrity honored	VII.4. SMZ integrity honored
54. Windrows on contour/free of soil	VII.5. Windrows on contour
55. No chemicals off site.	VII.6. No chemicals off site
**56. Were BMP's used/Type	
	*VII.7. Machine planting on contour
57. Stream free of sediment	VII.8. Stream free of sediment
Landings	
58. Locations free of oil/trash	VIII.1. Landings free of oil/trash
59. Located outside SMZ.	VIII.2. Located outside of SMZ
60. Well drained location	VIII.3. Well drained location
	*VIII.4. Number & size minimized

	*VIII.5. Respect sensitive areas
61. Restored, stabilized	VIII.6. Restored/stabilized
Wetlands	
	*IX.1 Hydrology
	*IX.2 Road Drainage
	*IX.3 Mandatory BMPs
Overall Compliance	
	*X. Overall Percent Implementation
62. Overall compliance w/BMP's	Subjective Score
Follow Up Questions	
Was activity supervised by landowner or representative?	Was activity supervised? Name
Was landowner familiar with BMP's?	Was landowner familiar with BMP's?
Was logger familiar with BMP handbook?	Has logger attended BMP workshop?
Were BMP's included in the contract?	Were BMP's included in the contract?
Is landowner a member of TFA/LO Assoc. /For. Farmer?	Is landowner a member of TFA? LO Assoc. /Other?
Is remediation planned by landowner if needed?	Is remediation planned by landowner
Comments	Comments
Map/Sketch area	

* Questions added to the new form

** Questions removed from the old form

BMP Implementation Monitoring Sites in Relation to 303 (d) Listed Stream Segments

% Implementation

&	0 - 50
X	51 - 70
!	71 - 80
#	81 - 90
^	91 - 100

BMP Implementation Monitoring Sites in Relation to 303 (d) listed Stream Segments

Legend

BMP Monitoring Sites

2000 303 (d) listed stream segments

Implementation of Forestry Best Management Practices
A Southern Region Report

Prepared by:

Water Resources Committee

For:

SOUTHERN GROUP OF STATE FORESTERS

June, 2008

Forward

In order to improve and maximize the integrity of forestry Best Management Practices (BMP) implementation monitoring in the southeast, the Southern Group of State Foresters (SGSF) appointed a Task Force to develop recommendations for a more consistent approach to this activity in the region. Specifically, the Task Force was charged with developing guidance on monitoring BMP implementation that would be statistically sound, objective and technically defensible. This framework was to achieve analytical consistency, making monitoring results and data generally comparable among the southeastern states.

In 1997 the Task Force completed the initial document *SILVICULTURE BEST MANAGEMENT PRACTICES IMPLEMENTATION MONITORING - A FRAMEWORK FOR STATE FORESTRY AGENCIES.* In 2002 this document was revised and re-published, and states began working toward conformance. In 2007, the *Statistical Guide for BMP Implementation Monitoring* was included in the Appendix. As envisioned by the SGSF, one aspect of having multistate conformance with the "Framework" was the capability to compile BMP implementation data for participating states, and periodically report this information at a regional level. Among other values, this "regional report" was expected to identify categories of BMPs for which implementation may need improvement throughout the region. It was further expected that those needs would then be addressed by the SGSF Water Resources Committee, through regional BMP training, demonstration and information exchange.

To that end, a small working group from the SGSF Water Resources Committee solicited each of the southeastern states for all BMP implementation data that was collected in conformance with the Framework – the period of record for this data runs from 1997 through 2007. This data was then compiled and analyzed, and is the basis of this initial regional BMP implementation report. Of the 13 states in the region, only two (Alabama and Louisiana) did not have data eligible for the report - these states have conducted BMP implementation monitoring, but not in conformance with the Framework. However, both states have committed to changing their monitoring programs to conform to the Framework and plan to submit data for the next reporting period.

Executive Summary

From 1997 through 2007, 25 statewide BMP implementation monitoring Surveys were conducted throughout the southern region. For this period of record, states submitted data for at least one statewide Survey - the number of Surveys reported on from individual states ranged from one to six.

For the seven BMP categories considered in this report, the lowest average implementation for the region was for Firebreaks (73%), and the highest average implementation was for Chemical Application (97%). The BMP category for Site Preparation scored 90%, with Harvesting, Forest Roads, Stream Crossings and Streamside Management Zones all scoring 85% or higher.

Combining all BMP categories in all states, and using only the most recent Survey data, the average, overall BMP implementation for the southern region was 87%. The range of overall implementation reported by individual states for all Surveys during the period of record was from 68% to 99%.

Progress in BMP implementation has been noted across the region since the Framework was initially published in 1997. For this report, states that reported multiple Surveys showed improvement over previous Surveys, and overall BMP implementation for the southern region increased by 4%. Region wide improvement in implementation was also noted for the following BMP categories: Stream Crossings (+8%), Harvesting (+6%), and Forest Roads (+2%).

Table of Contents

Introduction

Beginning in 1997, states in the southern region were introduced to a BMP monitoring protocol titled *SILVICULTURE BEST MANAGEMENT PRACTICES IMPLEMENTATION MONITORING - A FRAMEWORK FOR STATE FORESTRY AGENCIES* (Framework). At that time, states began working toward this monitoring approach. Currently, eleven of the thirteen states in the region are in conformance. Consequently, data from these states was eligible for and is included in this report.

The Framework calls for the evaluation of seven BMP categories: Harvesting, Site Preparation, Forest Roads, Stream Crossings, Streamside Management Zones, Firebreaks and Chemical Application. In addition, conformance with the Framework requires that BMPs be evaluated at three implementation levels: individual practice, category, and overall, and that implementation be expressed as a percent (Appendix 1). Finally, the Framework calls for each incidence of BMP non-implementation be further evaluated for Significant Risk to water quality.

As agreed to by the SGSF Water Resources Committee, states in conformance with the Framework submitted BMP implementation monitoring data to a small working group. This data was to be extracted from all statewide Surveys conducted since the state came into conformance with the Framework. For some states in the region this included data from as many as six Surveys, for other states as few as one Survey. Also, since forestry practices are different across the region, not all states reported on all categories of BMPs referenced in the Framework. For example, forest chemical use in Kentucky is virtually non-existent, so Kentucky did not report implementation monitoring data for this BMP category. Similarly, some states evaluate BMPs less frequently than others, resulting in disproportionate responses for certain BMP categories. Finally, BMP monitoring forms for states are organized differently with respect to the BMP categories called for in the Framework. For example, Harvesting is a BMP category referenced in the Framework, but North Carolina addresses "harvesting practices" throughout their BMP Manual, and captures these practices under multiple BMP categories during implementation monitoring. Consequently, for consistency in this report, regional criteria for each of the seven BMP categories were developed.

Findings

The following information addresses the data submitted by the states for each BMP category required by the Framework. A brief description of the category is provided below with reference to a bar chart that graphically displays the data by state and year.

Harvesting

The Harvesting category includes BMPs that address forestry activities such as skidding, slash disposal and timber felling. Ten states capture harvesting BMPs directly and responded with data for this category (Figure 1). For all states, all Surveys, implementation ranged from 52% to 100%, and averaged 89% when considering only the

most recent Survey for each state. In states where multiple Surveys were reported, implementation of Harvesting BMPs showed a generally positive trend.

Site Preparation:
The Site Preparation category includes BMPs which address forestry activities that facilitate reforestation, such as chopping, raking, and bedding. Seven states capture Site Preparation BMPs directly and responded with data for this category (Figure 2). For all states, all Surveys, implementation ranged from 70% to 99%, and averaged 90% when considering only the most recent Survey for each state. In states where multiple Surveys were reported, implementation of Site Preparation BMPs showed a generally positive trend.

Forest Roads:
The Forest Roads category includes BMPs that address forestry activities such as road construction, maintenance and stormwater management. Eleven states capture Forest Road BMPs directly and responded with data for this category (Figure 3). For all states, all Surveys, implementation ranged from 43% to 98%, and averaged 86% when considering only the most recent Survey for each state. In states where multiple Surveys were reported, implementation of Forest Road BMPs showed a generally positive trend.

Stream Crossings:
The Stream Crossing category includes BMPs that address forestry activities such as culvert sizing and installation, construction of low-water crossings, and erosion control. Eleven states capture Stream Crossing BMPs directly and responded with data for this category (Figure 4). For all states, all Surveys, implementation ranged from 58% to 100%, and averaged 85% when considering only the most recent Survey for each state. In states where multiple Surveys were reported, implementation of Stream Crossing BMPs showed a generally positive trend.

Streamside Management Zones (SMZ):
The SMZ category includes BMPs that address forestry activities in proximity to streams, rivers, lakes and other water resource features. Eleven states capture SMZ BMPs directly and responded with data for this category (Figure 5). For all states, all Surveys, implementation ranged from 76% to 99%, and averaged 88% when considering only the most recent Survey for each state. In states where multiple Surveys were reported, implementation of SMZ BMPs showed a generally positive trend.

Firebreaks:
The Firebreaks category includes BMPs that address forestry activities such as fireline construction, maintenance and rehabilitation. Seven states capture Firebreak BMPs directly and responded with data for this category (Figure 6). For all states, all Surveys, implementation ranged from 30% to 100%, and averaged 73% when considering only the most recent Survey for each state. In states where multiple Surveys were reported, implementation of Firebreak BMPs showed both positive and negative trends.

Figure 1: BMP Implementation - Harvesting

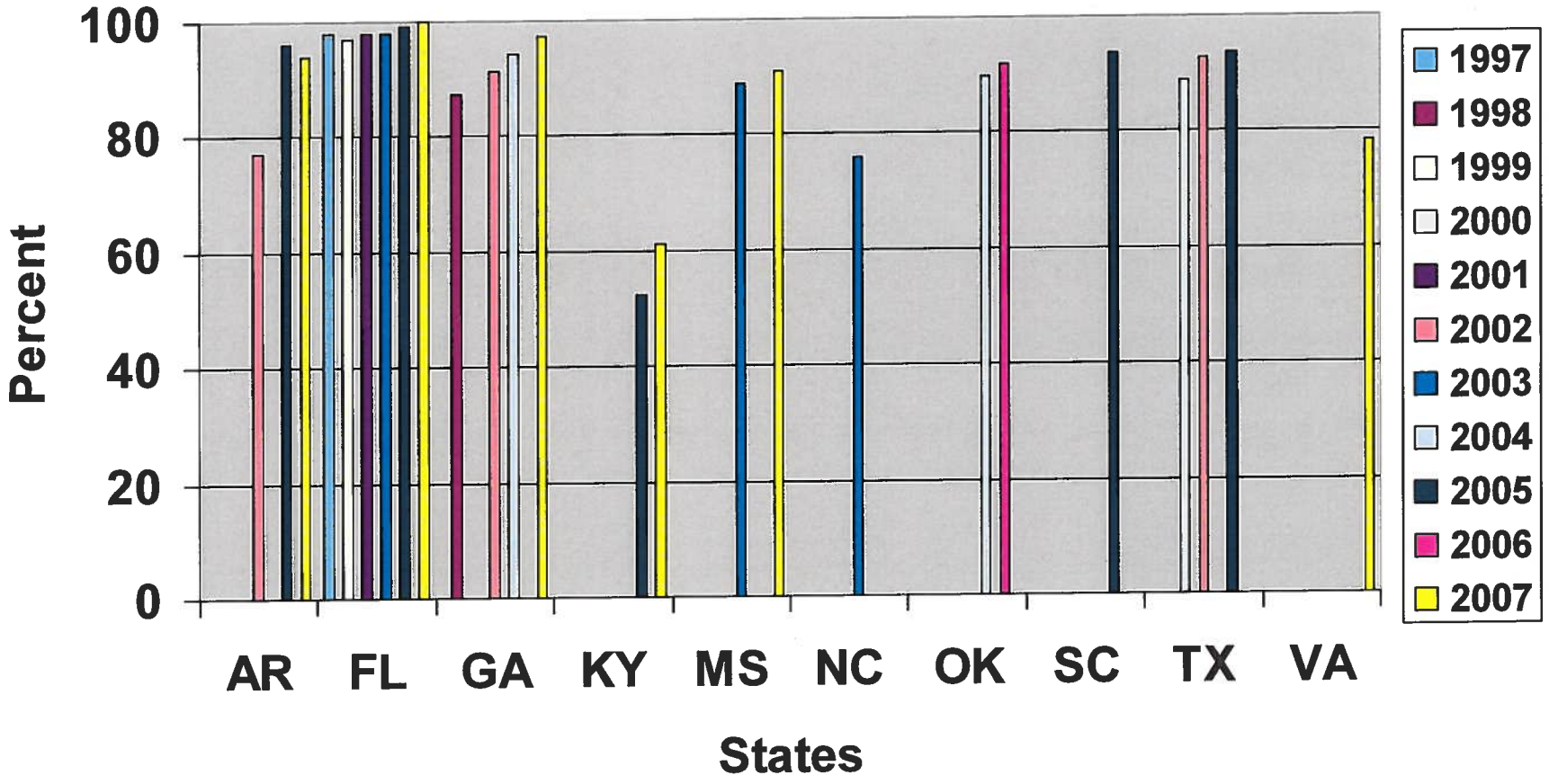


Figure 2: BMP Implementation - Site Preparation

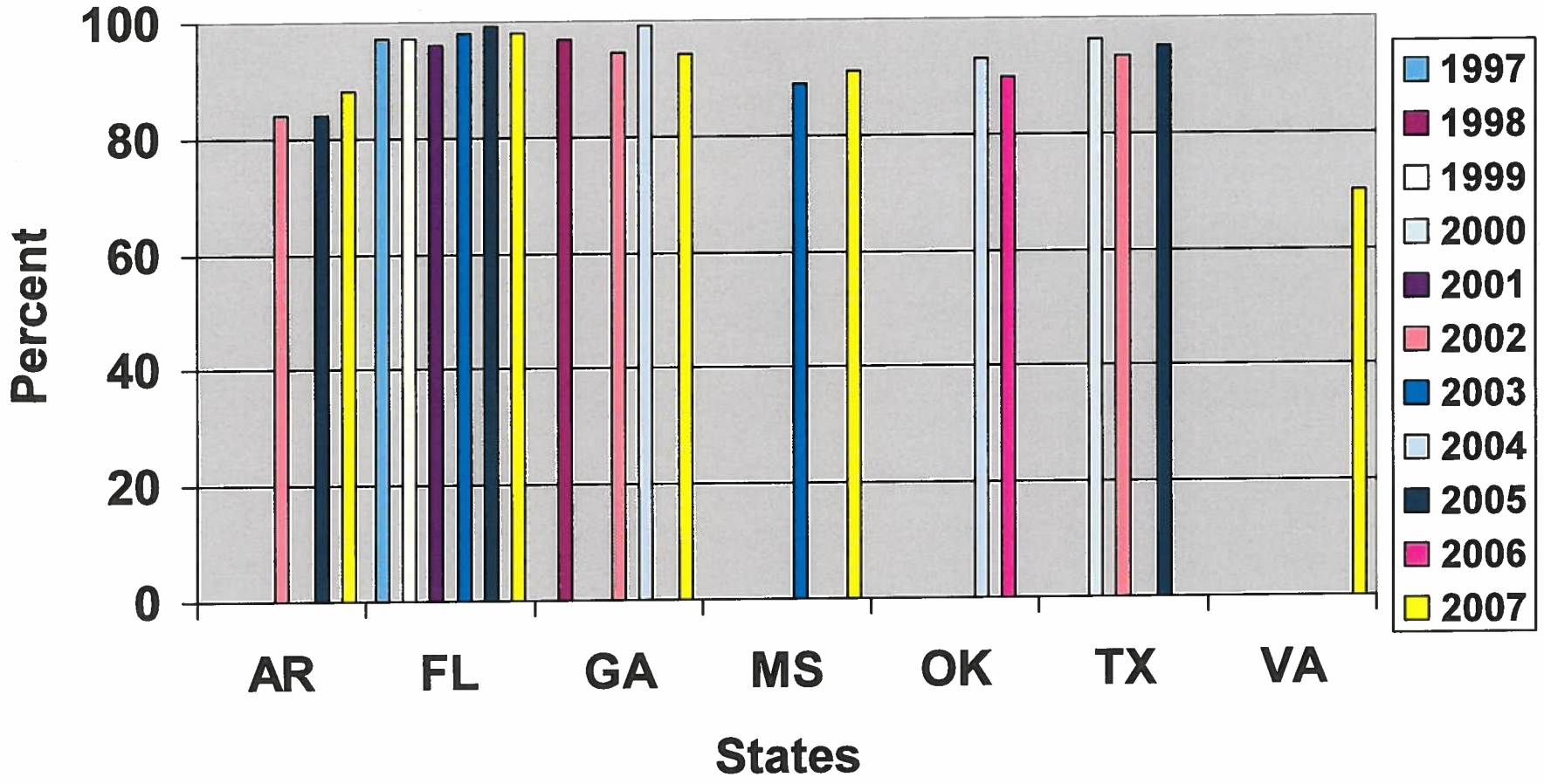


Figure 3: BMP Implementation - Forest Roads

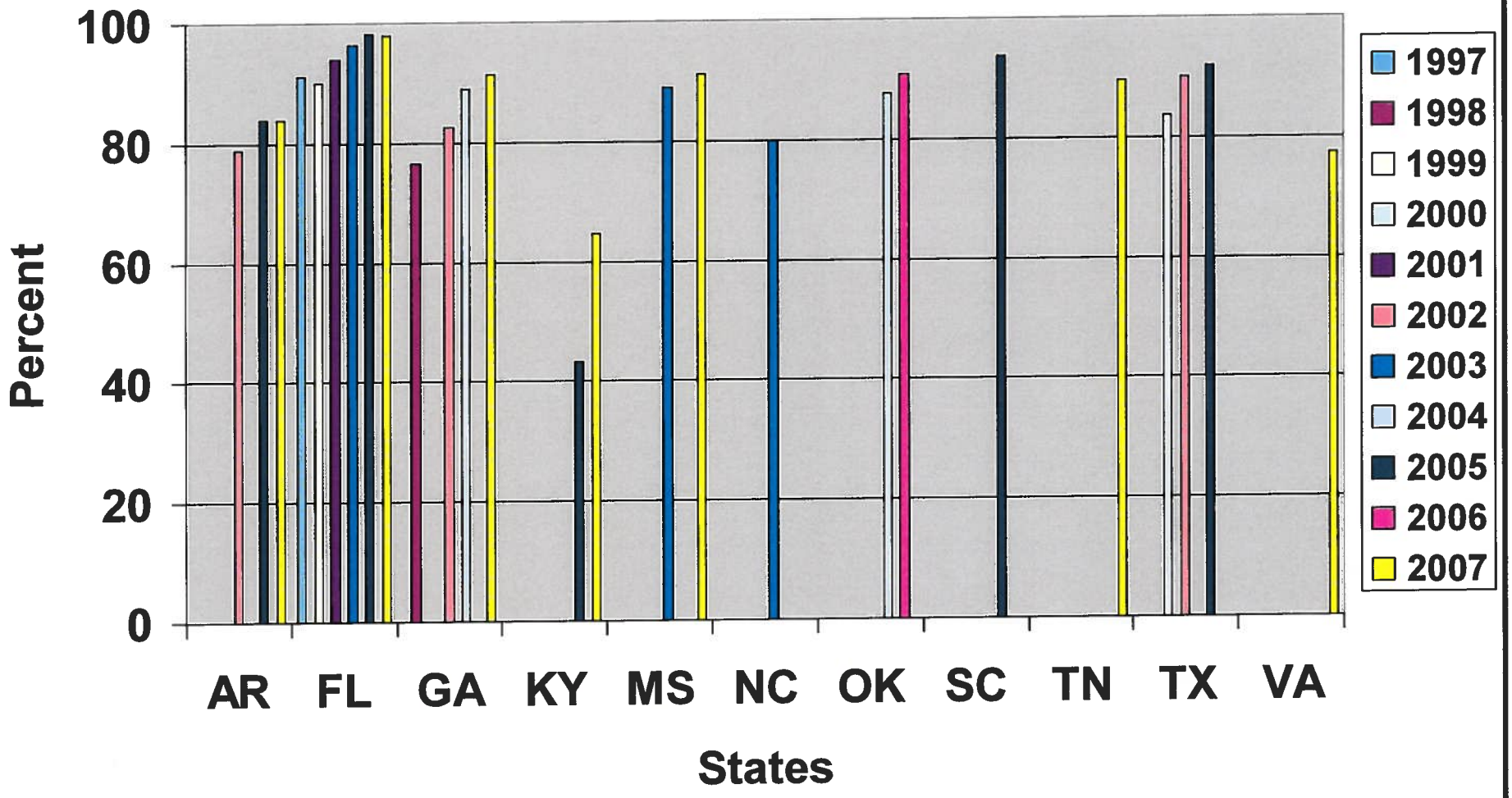


Figure 4: BMP Implementation - Stream Crossings

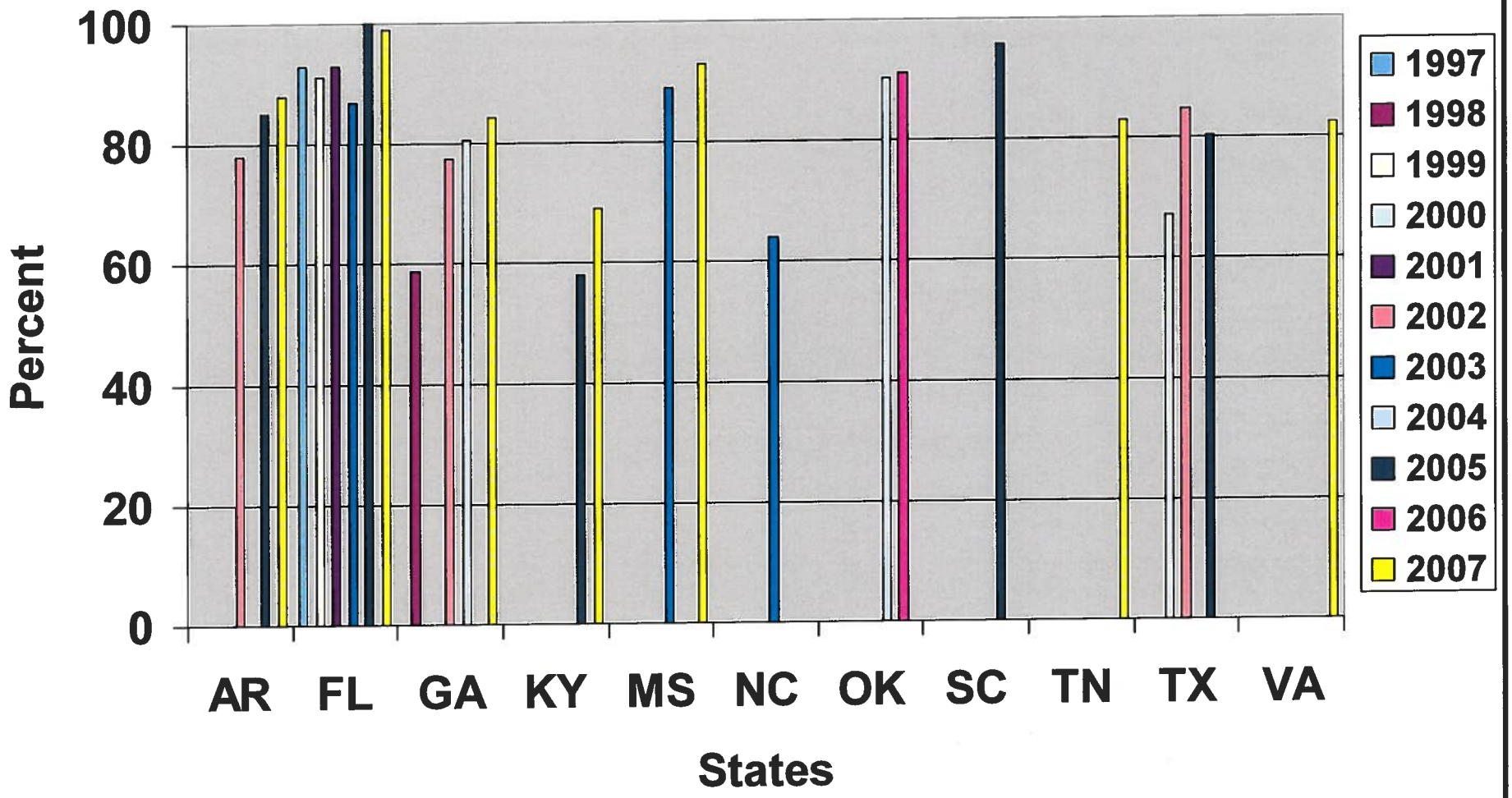


Figure 5: BMP Implementation - SMZs

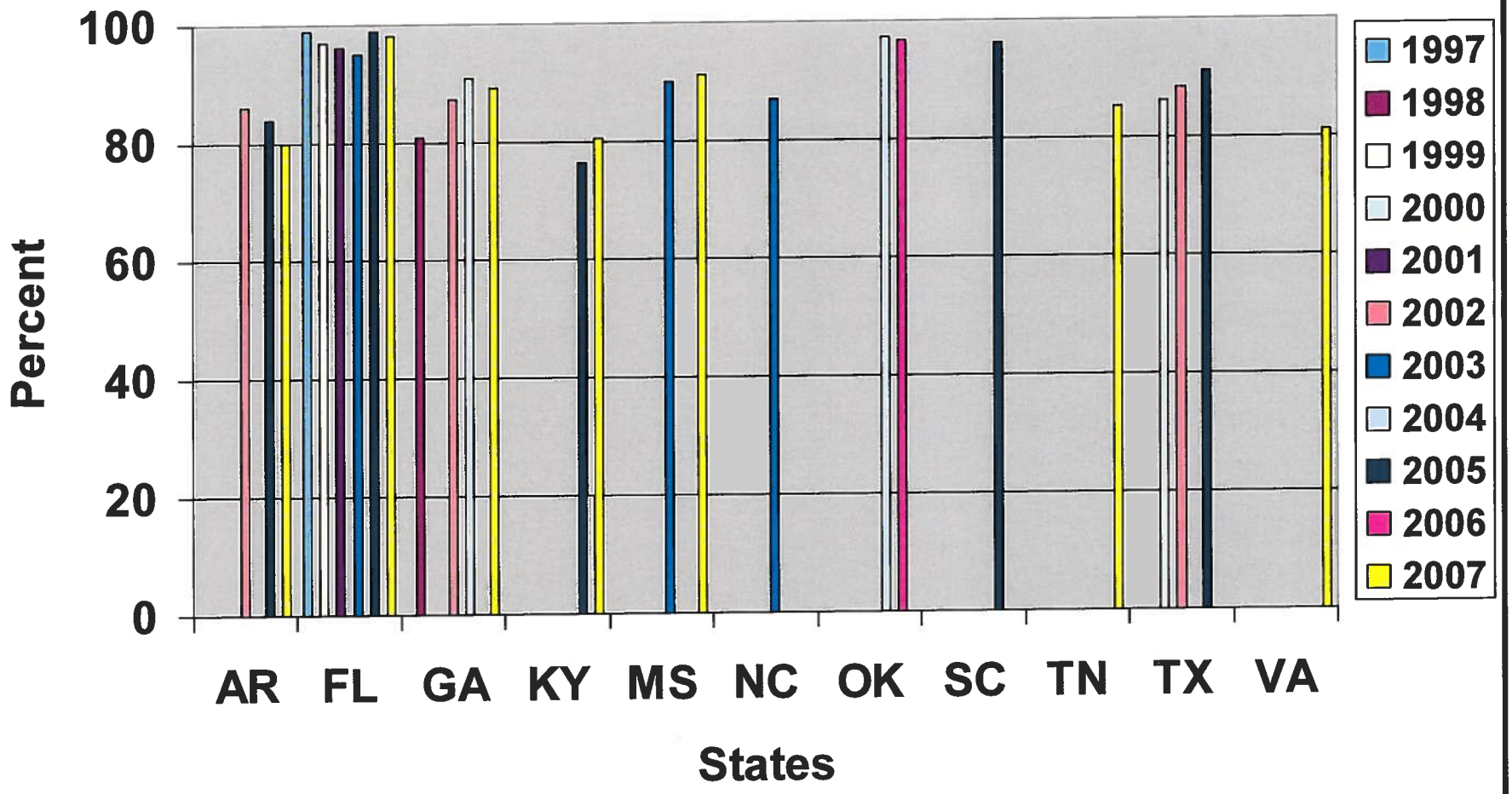
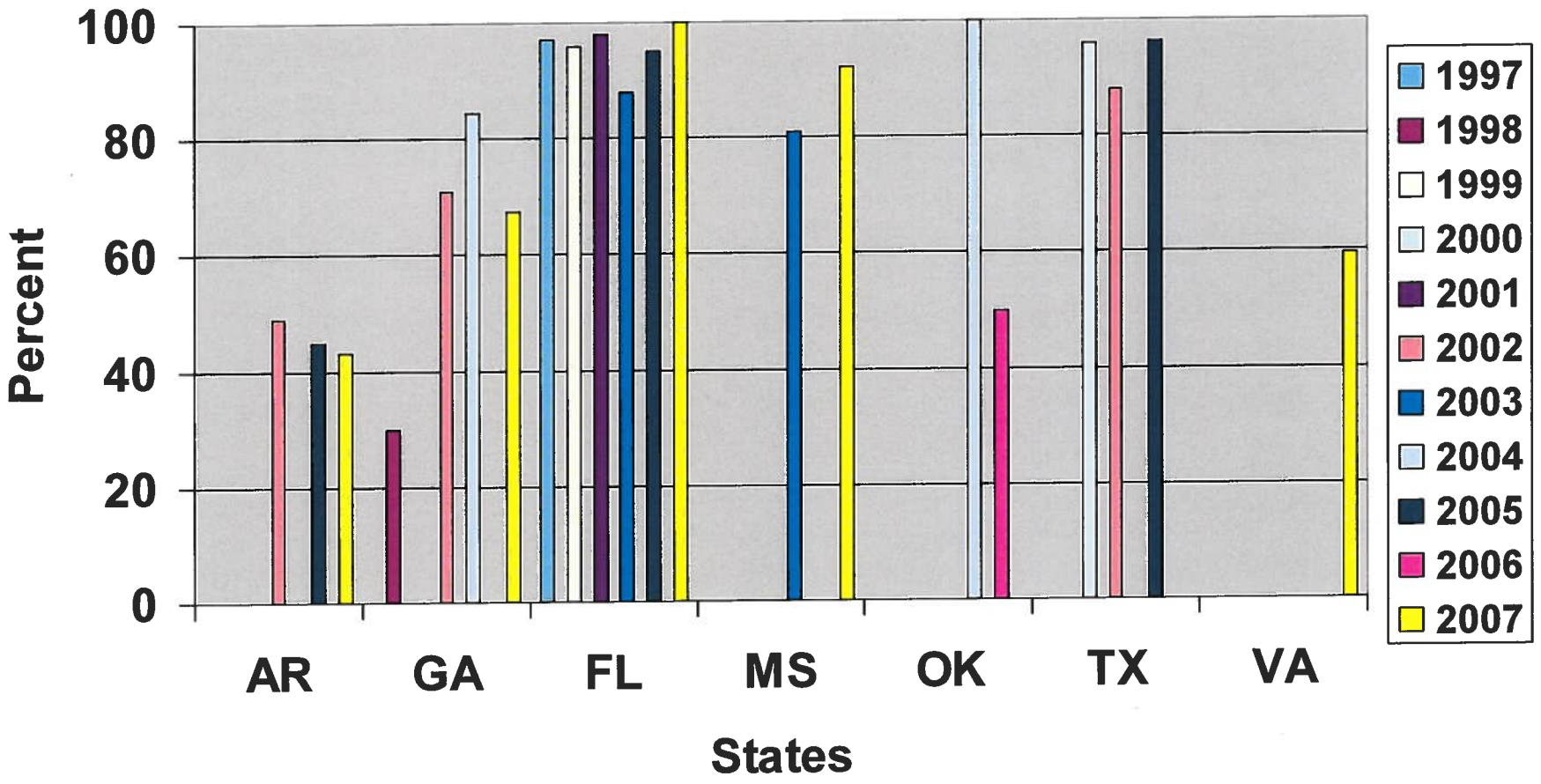


Figure 6: BMP Implementation-Firebreaks



Chemical Application:
The Chemical Application category includes BMPs that address forest chemical use including pesticides, herbicides and fertilizer, especially in close proximity to water resource features. Seven states capture Chemical Application BMPs directly and responded with data for this category (Figure 7). For all states, all Surveys, implementation ranged from 82% to 100%, and averaged 97% when considering only the most recent Survey for each state. In states where multiple Surveys were reported, implementation of Chemical Application BMPs showed a generally positive trend.

Overall Implementation:
The Overall Implementation statistic is reported for each site and accumulated for each Survey. It includes all BMPs for a given forestry operation and is expressed as a percent of all applicable practices. Eleven states capture this statistic and responded with data (Figure 8). For all states, all Surveys, overall implementation ranged from 56% to 99%, and averaged 87% when considering only the most recent Survey for each state. In states where multiple Surveys were reported, overall implementation showed a generally positive trend.

Regional Averages:
Data reported by the individual states were analyzed to determine the current region wide averages for overall BMP implementation and the seven BMP categories (Figure 9). This data was then compared to a region wide average of the initial Surveys conducted for each state to determine if any progress had been made since the Framework was established (Figure 10). The current overall BMP implementation for the southern region is 87%, representing a 4% increase over the initial Survey. Significant improvement was also noted for Stream Crossings (+8%), Harvesting (+6%), and Forest Roads (+6%).

Significant Risk:
According to the Framework: "The field evaluation of significant risk should be based on **existing** on-the-ground conditions resulting from failure to correctly implement BMPs, that if left unmitigated will likely result in an adverse change in the physical, chemical, or biological condition of a waterbody. Such change may or may not violate water quality standards. Some examples of forestry activities where significant risks have been identified are equipment operation in close proximity to surface waters, stream crossings, logging slash disposal and intensive mechanical site preparation.

The identification of Significant Risk to water quality is an area that needs further attention across the region. All eleven states report this statistic; however methodologies used in determining this measure are different from state to state. To help with this, the SGSF Water Resources Committee published a comprehensive list of 14 on-site indicators for significant risk to water quality in 2007 as part of the monitoring protocol (Appendix). These indicators, along with additional training should provide clarity on this issue and produce comparable results across the region in the future.

Figure 7: BMP Implementation - Chemical Application

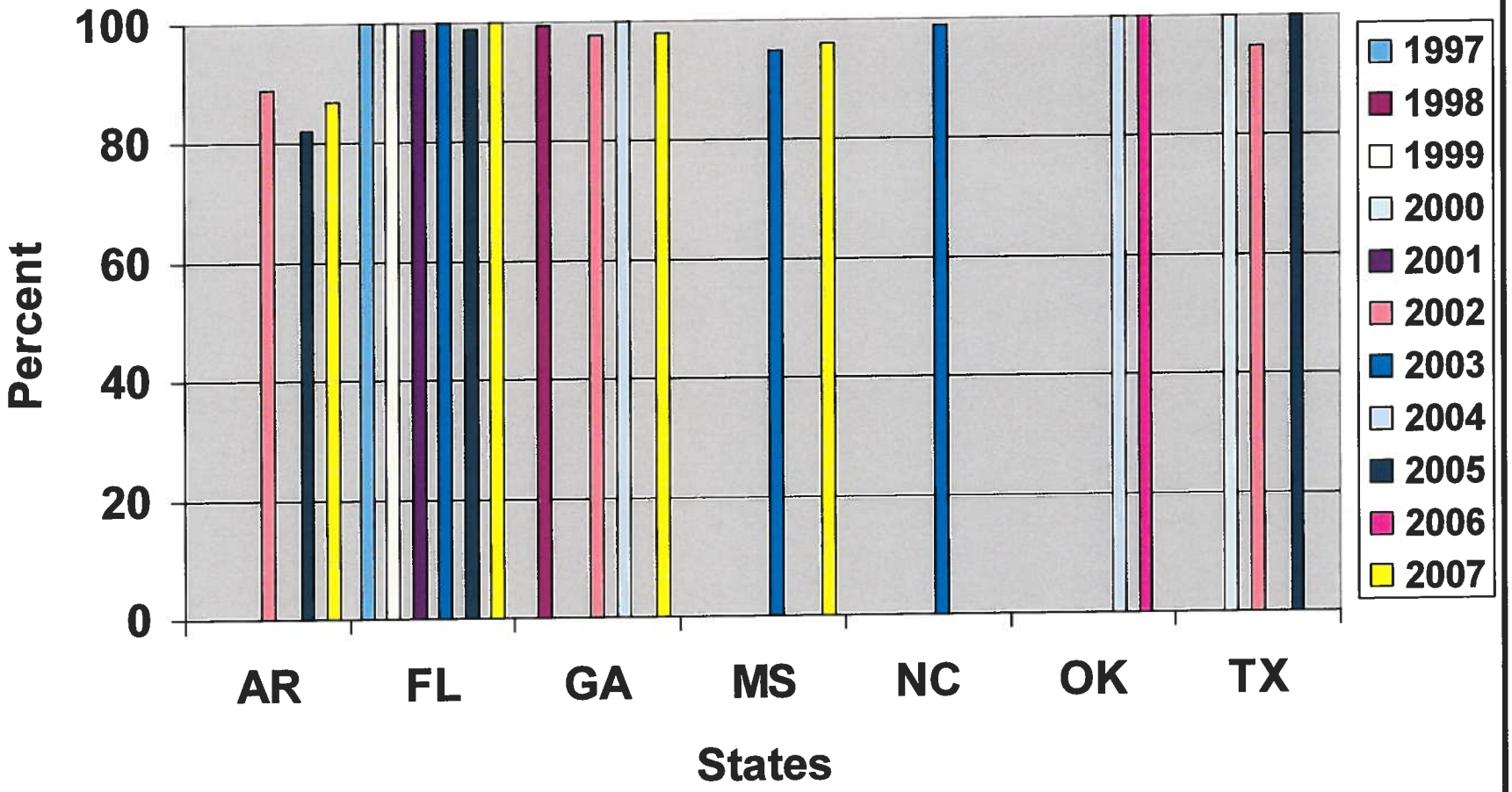


Figure 8: BMP Implementation - Overall

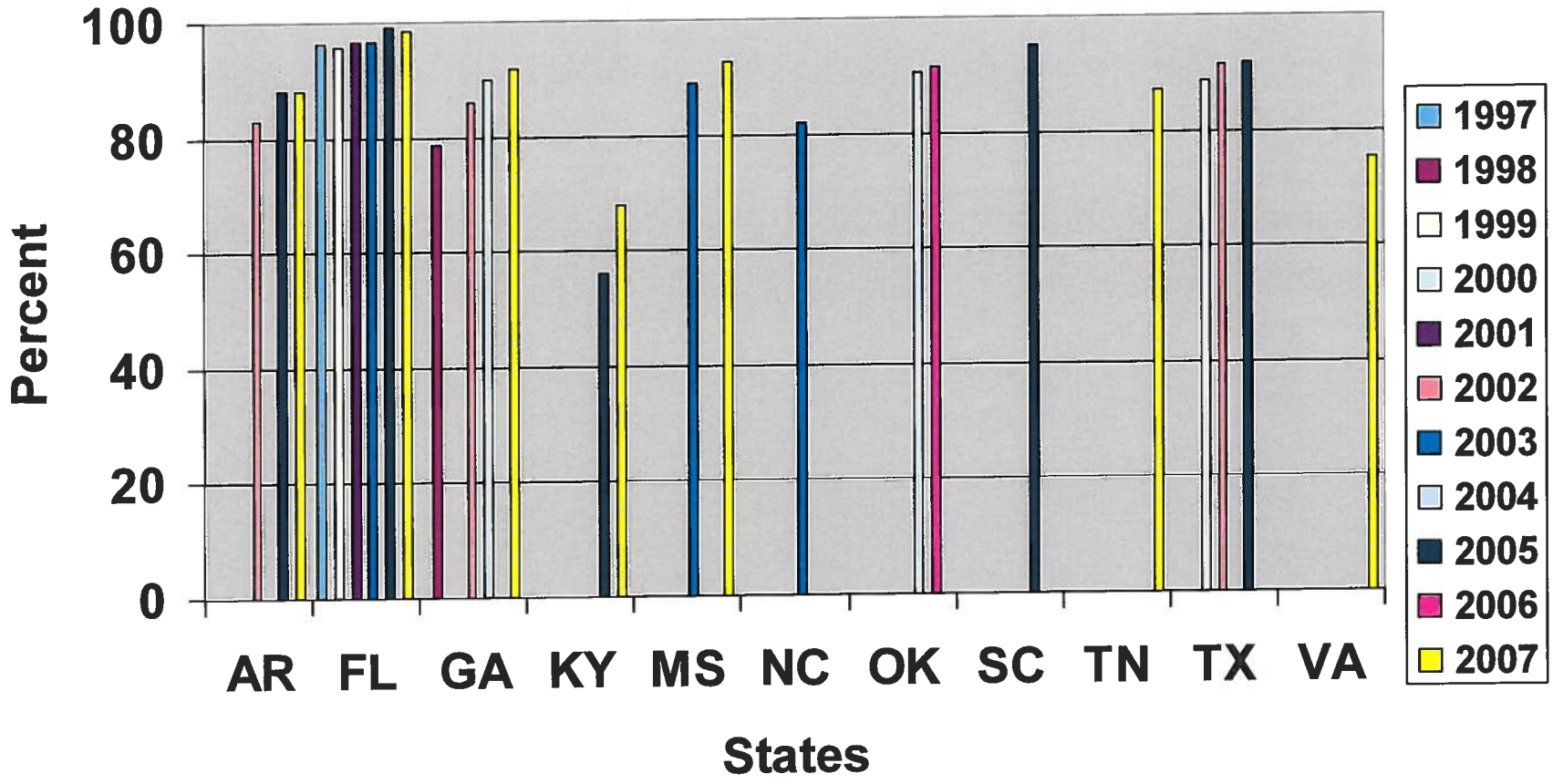


Figure 9: BMP Implementation - Regional Averages

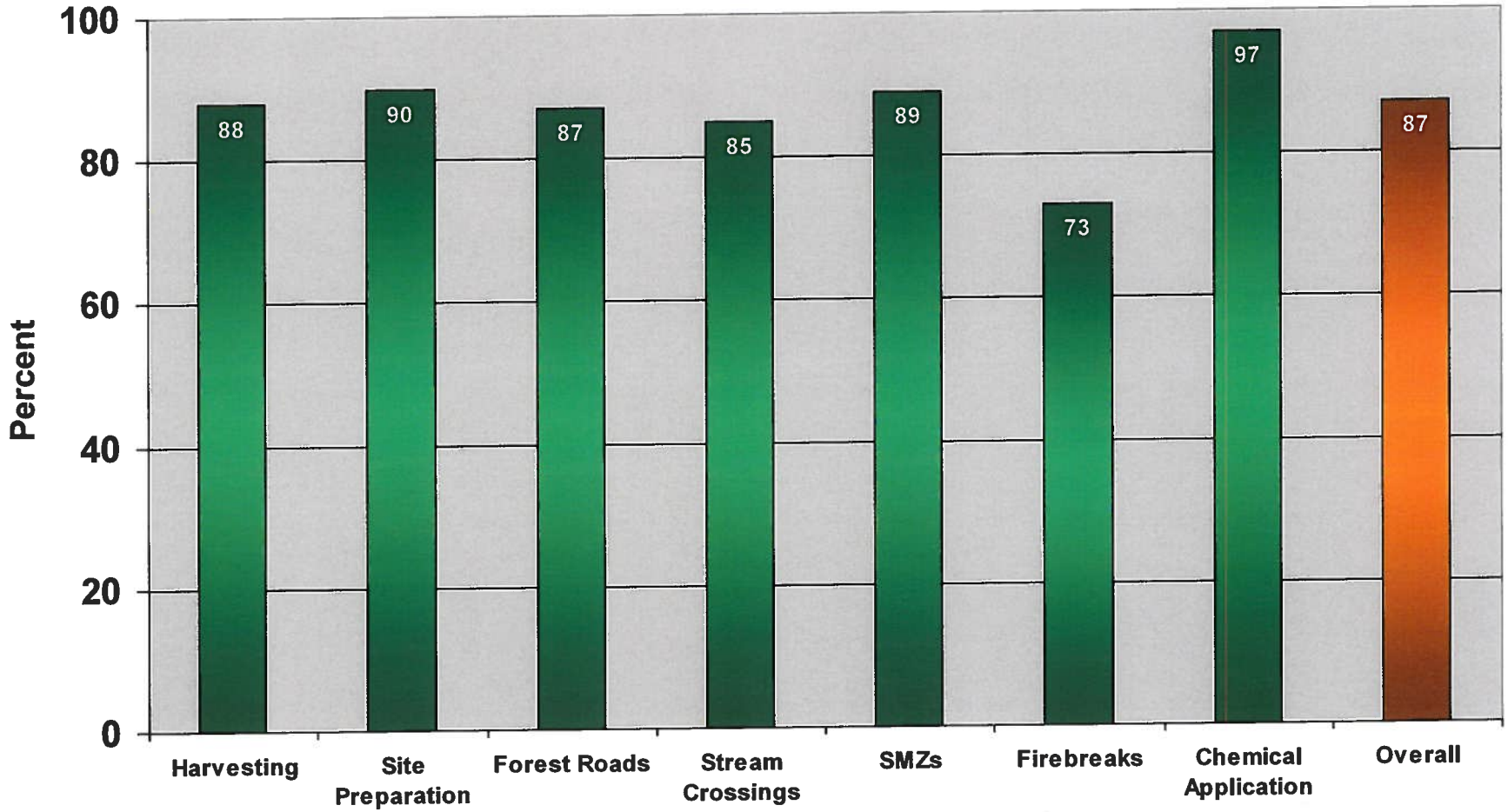
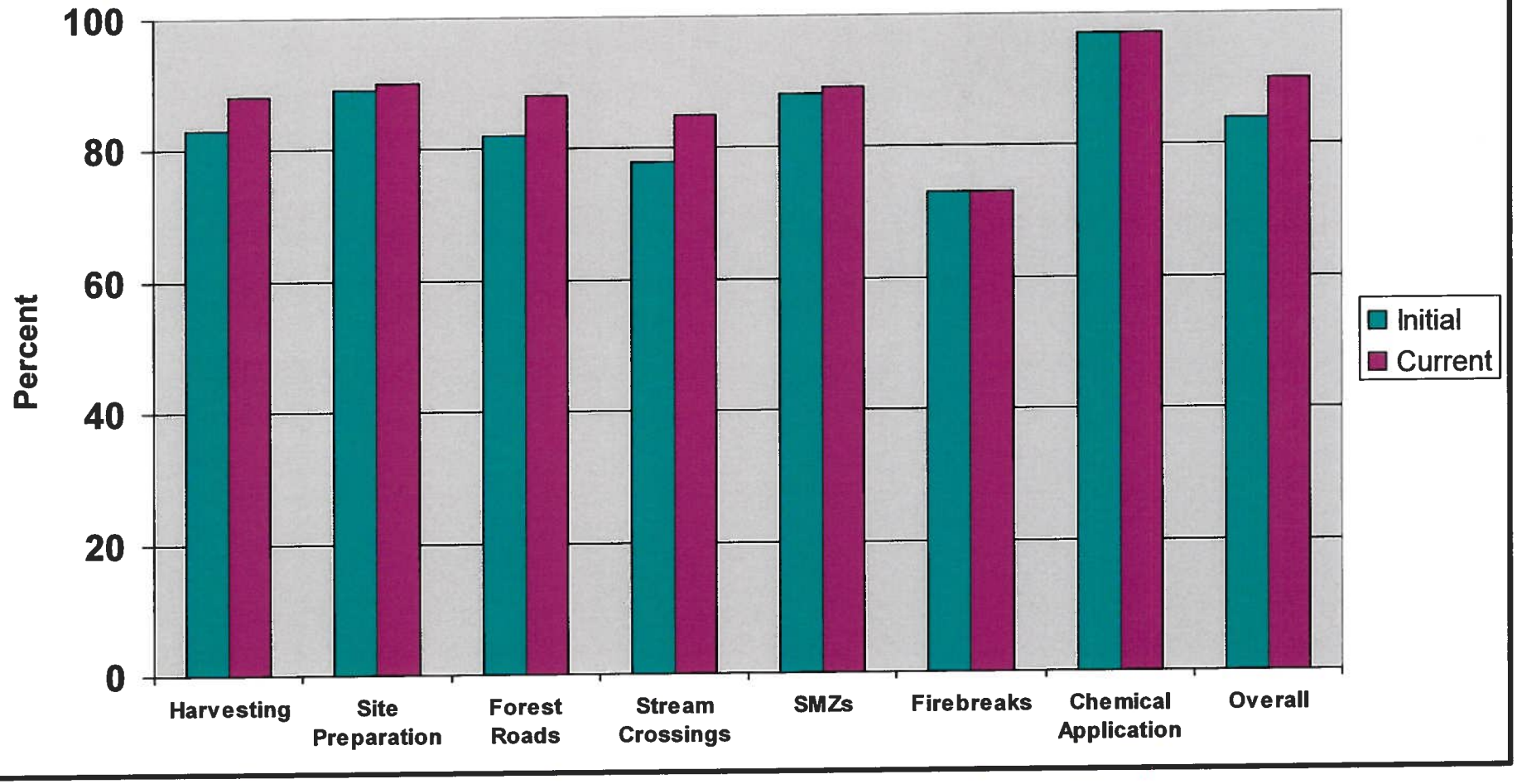


Figure 10: BMP Implementation - Regional Averages Initial Survey vs. Current Survey



Summary

BMP implementation in the southern region is a high priority with the state foresters, as reflected in the continued support and coordination of the SGSF Water Resources Committee. Although the regional data identifies several BMP categories in need of improvement, an overall regional implementation rate of 87% is considered notable. Likewise, "regional progress" has been made in most BMP categories when comparing current Survey data with that from initial Surveys. Specific BMP categories that should be targeted by the SGSF Water Resources Committee for improvement are Firebreaks, Stream Crossings and Forest Roads.

Individual states in which multiple Surveys have been conducted in accordance with the Framework have also shown increases in BMP implementation. This is largely attributed to the numerous educational, outreach, and training efforts being conducted across the southern region by the states and their cooperators, and to the efforts of the SGSF via the Water Resources Committee.

This regional report on forestry BMP implementation monitoring is the first in a planned series to be published every 5 years. The objective of the report is to provide information at a regional level, for the purpose of continuously improving monitoring methods and BMP implementation, and to promote consistency among states in the southern region for this activity.

APPENDIX

(SILVICULTURE BEST MANAGEMENT PRACTICES IMPLEMENTATION MONITORING A FRAMEWORK FOR STATE FORESTRY AGENCIES)

Silviculture Best Management Practices Implementation Monitoring

A Framework for State Forestry Agencies

Southern Group of State Foresters
Water Resources Committee

June 2007

Foreword

The Federal Water Pollution Control Act Amendments recognized nonpoint source pollution, and called on states to develop and implement water quality management plans. Since then, state forestry and state water quality agencies have been working closely with the Environmental Protection Agency (EPA) to minimize silviculture-related sources of nonpoint source pollution.

To address silviculture related water pollution in the southern states, a traditional regulatory approach was initially proposed. However, after further analysis and consultation with the forestry community, EPA and the states generally agreed that a non-regulatory approach was more effective. This approach was based primarily on education and field demonstration, with the following basic components:

1. Identification of Best Management Practices (BMPs) to protect water quality during forestry operations; and

2. Widespread education/training of forestry practitioners and forest landowners to facilitate the implementation of BMPs; and

3. Routine monitoring of forestry operations to determine the level of BMP implementation.

To date, all southern states have developed silviculture BMPs, which have been approved by EPA. Most of these states have recently revised or updated their BMPs to keep current with changing information and technology. Likewise, all southern states have developed and conducted education and training sessions for forestry practitioners, landowners, managers and loggers, which include the distribution of materials and emphasize BMP implementation.

However, not all of these states have developed routine BMP monitoring procedures to measure actual implementation levels. In addition, no model procedure for conducting such monitoring exists. Thus, states with monitoring programs have measured and reported BMP implementation using significantly different methods. Consequently, monitoring results have been met with varying degrees of acceptance by the public and by regulatory agencies. Inconsistency among states with respect to statistical design, reproducibility, and general objectivity have been cited as areas of concern.

In order to improve and maximize the integrity of BMP implementation monitoring in the South, the Southern Group of State Foresters appointed a Task Force to develop recommendations for a more consistent approach to BMP monitoring in the region. Specifically, the Task Force was charged with developing a framework to provide south-wide guidance for monitoring BMP implementation that would be statistically sound, objective, and technically defensible. This framework would achieve analytical consistency and results would be generally comparable among states.

The Task Force, composed of hydrologists and water quality specialists from state forestry agencies, U.S. Forest Service, and forestry industry, in consultation with EPA Region IV, met during 1996 – 1998 and completed the initial document. On March 25-26, 2002, a subcommittee of that Task Force reconvened and completed this revision.

Task Force Members

Jeff Vowell – Chairman, Florida Division of Forestry*
Frank Green, Georgia Forestry Commission*
Tim Adams, South Carolina Forestry Commission
Darryl Jones, South Carolina Forestry Commission*
Robin Bible, Tennessee Division of Forestry
Sam Austin, Virginia Department of Forestry
Matt Poirot, Virginia Department of Forestry*
Gary Cole, Alabama Forestry Commission*
Burl Carraway, Texas Forest Service*
Mike Sampson, Mississippi Forestry Commission*
John Greis, U.S. Forest Service*
David Hoge, U.S. Forest Service*
Bruce Prud'homme, U.S. Forest Service*
Rob Olszewski, Plum Creek Timber Company
Jim Shepard, National Council of the Paper Industry for Air and Stream Improvement

* Subcommittee members, 2002

Introduction

This document is presented as an Implementation Monitoring Framework within which state forestry agencies can build or revise their current monitoring programs. Widespread utilization of this document within the region is expected to improve consistency among states in the specific aspects of BMP monitoring listed below. In addition, the recommendations for each specific aspect are envisioned to be core elements of a credible evaluation and reporting process.

Monitoring Frequency

Issue: How frequently should BMP implementation monitoring be conducted and reported?

Alternatives Considered: Annual, biennial, every three years and continual monitoring.

Recommendation: Statewide implementation monitoring should be conducted and reported at a minimum of every three years.

Rationale: Due to the large number of forestry operations conducted annually, the number of sites necessary to achieve statistical reliability, and the logistics of locating, visiting and evaluating them, annual monitoring and reporting is often not practical. Further, there are no significant advantages of annual monitoring and reporting that justify the additional burdens.

Monitoring and reporting on at least a three year basis is more logistically achievable, and is consistent with typical 319 funding cycles for states receiving federal grants. In addition, monitoring at this frequency is considered often enough to allow visual observations of on-site problems and take timely corrective action.

Site Selection

Issue: What characteristics should a forestry site/operation exhibit in order to qualify as a BMP implementation monitoring site?

Alternatives Considered:
1. Minimum/no minimum area (acres)
2. Presence/absence of surface water on site
3. Time since treatment (years)
4. Site selection methodology (to eliminate bias)
5. Sample size (statistically valid confidence interval)

Recommendations:
1. No minimum area, but a site must be part of a normal, ongoing silvicultural operation, i.e., not in the process of conversion to another land use.

Rationale: Since forestry operations occur on tracts of all sizes and BMPs apply regardless of acres involved, all forestry operations should be eligible for monitoring. However, operations that include timber harvesting as part of a change in use, should be disqualified regardless of the size of the operation. Such activities would not accurately reflect normal silvicultural operations.

2. The presence of surface water features is not necessary for a site to be eligible for BMP implementation monitoring.

Rationale: BMP implementation in most states is not contingent upon the presence of surface water on-site. However, those states that have proximity restrictions associated with BMP implementation should select monitoring sites using the appropriate criteria.

3. The most recent silviculture activity(s) on a site to which BMPs apply must not have been completed more than 2 years prior to implementation monitoring.

Rationale: Forestry operations more than 2 years prior are increasingly difficult to evaluate because of rapid regrowth of vegetation and more difficult access. Likewise, evidence of erosion and sedimentation become less visible over time, as does the opportunity to correct such problems without "re-disturbing" sensitive areas.

4. Sites for implementation monitoring may be located using aerial reconnaissance, severance tax records, notification logs, or other available sources of information. However, it is essential to achieve random, stratified random or randomized cluster statistical design to obtain an unbiased sample.

Rationale: Several data sources can provide the information necessary to select a random sample of forestry operations sites. However, it is important that the sample population accurately reflect actual conditions in a given state. For example, portions of a state in which forestry operations are concentrated should be sampled accordingly, as should those with fewer operations.

5. The sample size should be sufficient to achieve an estimate of implementation that is $\pm$ 5% within the 95% confidence interval.

Rationale: To maximize the validity and credibility of the monitoring results, the number of sites evaluated for BMP implementation should be calculated to provide minimum error ($\pm$ 5%) and high confidence (95%). Designing a statistically valid sampling procedure for implementation monitoring and analyzing the results should be consistent with "*Sampling and Estimating Compliance with BMPs*" (1) and/or the *Statistical Guide for BMP Implementation Monitoring* found in the Appendix.

Practices to be Evaluated

Issue: Which categories of practices should be evaluated for BMP implementation monitoring?

Alternatives Considered: Harvesting; Site Preparation (mechanical, chemical, burning); Forest Roads; Stream Crossings, Streamside Management Zones, Firebreaks, Forest Chemical Application (fertilization, herbicides).

Recommendation: All of the above alternatives should be evaluated.

Rationale: These BMP categories contain all practices that are generally associated with operational silviculture in the South.

Basis for Practice Evaluation and Reporting

Issue: On what basis should BMPs be evaluated and reported?

Alternatives Considered: Individual practices, Categories of practices, Overall site.

Recommendation: Evaluation and reporting should include all three levels of BMPs listed above.

Rationale: Evaluation of BMPs at the practice level provides the basic measure of on-site BMP implementation. This level of information also allows for comparison of a specific practice among all monitoring sites and against any other site variables. Such comparisons are useful for identifying those variables most often associated with non-implementation.

In addition, by evaluating categories of practices, monitoring can provide broader conclusions about BMP implementation for stream crossings, roads, etc. Also, this information can identify training needs for forestry agency personnel, and education needs for forestry practitioners.

It is likewise useful to water quality agencies, other interested parties and particularly forest landowners to know the overall or cumulative level of BMP implementation for individual forestry operations. This is a primary and traditional measure of program success, and indicates the efficacy of the non-regulatory approach to controlling silvicultural related nonpoint source pollution.

Scoring Methodology

Issue: How should BMP implementation monitoring be scored?

Alternatives Considered: Pass/Fail; Graduated Scale; Percent Correct Implementation; Yes/No

Recommendation: An individual practice should be scored as "Yes" when applied as specified in the state's BMP Manual. If a particular practice is not applicable, this should be noted as well. Any significant deviation from practice specifications should result in a

"No" answer for BMP implementation. Categories and overall scores should be expressed as a simple percentage of all applicable practices. For example, if 100 practices were applicable but only 90 were actually implemented correctly, then the score would be 90% for that category or site, as the case may be.

Rationale: Evaluating whether or not BMPs have been properly implemented, and their applicability to specific site conditions yields the most objective and reproducible method of implementation monitoring. While some judgment will always be necessary in questionable situations, objectivity can be maximized by training. In addition, subjectivity and confusion are minimized by avoiding practice evaluations based on graduated scales for partial implementation, or arbitrary "Pass/Fail" declarations. Simple "Yes/No" scoring of BMPs also facilitates the calculation, summarization and reporting of category and overall implementation levels on a percentage basis.

Risk Assessment

Issue: How should the risk to water quality resulting from failure to implement BMPs be evaluated and documented?

Alternatives Considered: No evaluation of risk; Risk evaluated and significant risk noted.

Recommendation: Risk to water quality should be evaluated and significant risk documented. Significant risk may be attributed to non-implementation for a specific BMP, category of BMPs or the overall operation. The field evaluation of significant risk should be based on **existing** on-the-ground conditions 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.

Significant risk should also be considered as a situation or set of conditions that can be remedied or otherwise mitigated (2). In addition, failure to implement BMPs that results in risks to site productivity, road usability or other site values should not be considered a significant risk in the context of implementation monitoring. Significant risk should be directly and exclusively related to water quality impairment.

Key site conditions often associated with significant risk include, but are not limited to: steep topography and highly erodible soils. Forestry operations conducted under one or more of these conditions without proper implementation of certain BMPs may have a high potential to result in significant risk to water quality. Some examples of forestry activities where significant risks have been identified are equipment operation in close proximity to surface waters, stream crossings, logging slash disposal and intensive mechanical site preparation. A comprehensive list of on-site indicators of significant risks to water quality is shown below:

On-Site Indicators of Significant Risk to Water Quality

- Temporary stream crossings remain in channel following operation
- Stream crossings and approaches not stabilized
- Logging debris in waterbody affecting or obstructing flow
- Evidence of excessive sediment entering waterbody from adjacent treated area
- Canopy completely or almost completely removed from SMZ on perennial waterbody
- Evidence of heavy equipment operation in stream channel
- Waterbody banks compromised by equipment or skidding activities
- Water diversion devices absent or severely compromised on roads or skid trails where runoff is likely to enter waterbody
- Ruts or other excessive physical damage to soils and cover within the SMZ
- Fill material in stream crossing without adequate means for conveyance of flow
- Un-stabilized fireline tied directly into waterbody
- Oil, chemicals, batteries or other hazardous materials leaking or remaining on site following operation
- Road or skid trail too steep or so poorly located that stabilization is improbable
- Excessive defoliation of riparian vegetation caused by herbicide application

Rationale: Documenting the occurrence of significant risk serves a number of useful and practical purposes. First, risk assessment lends much credibility and integrity to the BMP monitoring process by recognizing that high risk conditions can occur, and that prevention and/or restoration is a high priority for state forestry agencies. Second, routine documentation of significant risk will determine whether such instances are the exception rather than the rule, and that lack of BMPs during a silviculture operation may not necessarily equate to or result in a water quality problem - this is particularly important as it relates to BMP effectiveness monitoring (3). Finally, providing forest landowners with an objective risk assessment is a valuable public service that not only protects the environment, but can also protect the landowner and/or operator from what might otherwise result in enforcement proceedings or other personal liability.

Follow-up Actions

Issue: What specific actions should states take following BMP implementation monitoring?

Alternatives Considered: No follow-up; Courtesy copies of monitoring results; Personal visit; Referral (where necessary) to regulatory agency.

Recommendation: Landowners who have participated in the implementation monitoring should be provided a copy and explanation of the monitoring results. In addition, participating landowners should receive recommendations for any remedial actions deemed necessary by the field observer. In cases where a significant risk has been identified, state forestry personnel should attempt to schedule a follow-up site visit with

the landowner, to insure that recommendations were understood and implemented satisfactorily.

Rationale: Follow-up activities with landowners and/or loggers serves as a useful educational opportunity, as well as a demonstration of cooperation and courtesy. The BMP monitoring data provides an excellent focal point for reviewing the performance of an operator and the responsibilities of the landowner, in terms of water quality and site protection. Remedial or other actions can also be recommended at this time, as can commendation for a job well done.

Where a significant risk has been identified in the monitoring process, an on-site follow-up can be vital to insuring that the landowner/operator is aware of the seriousness of the situation and advised of remedial actions. Potential consequences of inaction can be explained and discussed at that time also, and should include environmental impacts as well as possible enforcement actions or other liabilities. This effort can provide the basis for fulfilling the responsibilities of the state forestry agency, and provide the landowner with the information from which to make an informed decision.

References

(1) McNew, Ronald W. 1990. Sampling and Estimating Compliance with BMPs, in Workshop on Implementation of Forestry Best Management Practices. Southern Group of State Foresters and USDA Forest Service. Atlanta, GA. January 23-25, 1990. Edited by G. Dissmeyer

(2) Vowell, Jeffery L. and Roy Lima, 2002. Results of the 2001 Silviculture BMP Compliance Survey. Florida Department of Agriculture and Consumer Services, Division of Forestry; Tallahassee, Florida.

(3) Dissmeyer, George E. 1994. Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards. USDA Forest Service, Miscellaneous Publication 1520.

Acknowledgements

The Southern Group of State Foresters wishes to thank the Task Force members and acknowledge the assistance provided by the water resource specialists from other state forestry agencies in the Southern Region. In addition, appreciation is expressed to the U.S. Forest Service Southern Region and the U.S. EPA Region IV for considerable expertise in this effort. Finally a special thanks is expressed to George Dissmeyer (retired, U.S. Forest Service) for his leadership in helping organize and initiate this process.

Glossary

Implementation Monitoring – The process used to determine the proper application of BMPs according to the specifications in individual state BMP Manuals.

Risk Assessment – The process and criteria used to identify a significant risk to the chemical physical or biological integrity of water quality.

Significant Risk – 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.

Statistical Guide for BMP Implementation Monitoring

by

Hughes Simpson, Texas BMP Coordinator
John Greis, USDAFS Region 8 Hydrologist
Dr. Ron McNew, Professor, University of Arkansas

Southern Group of State Foresters
Water Resources Committee

October 2006

Introduction

Implementation monitoring is the process used to determine the proper application of Best Management Practices (BMP) according to the specifications in individual state BMP Manuals. In 1999, the Southern Group of State Foresters (SGSF) endorsed a monitoring framework designed to provide regional guidelines for monitoring BMP implementation so that consistency and reliability of southern state efforts would be maximized. The framework calls for evaluations to be conducted on randomly selected forestry operations and to result in data that is statistically valid.

Field evaluations consist of answering "yes", "no", or "not applicable" to questions regarding proper implementation of specific BMPs. These are typically broken down into several activity categories (roads, trails, stream crossings, etc.). Each question represents a specific BMP ("yes" means the BMP was implemented correctly and "no" means it was not). If a BMP listed on the evaluation form was not applicable to that site, "not applicable" is recorded. Additionally, the presence of a significant risk to water quality is noted for each question if, due to a lack of or incorrectly implemented BMP, water quality has been impacted or is clearly threatened. To determine the implementation rate, the total number of "yes" answers is summed and then divided by the total number of applicable answers (yes / yes + no) to determine the total BMP Implementation rate, expressed as a percent, for the site.

After combining all results, BMP implementation may be reported for the state, regions of the state, landowner types, forestry activities, river basins or watersheds, and BMP groups or other categories of interest for reporting purposes. Strengths (BMPs along streams) and weaknesses (BMPs on roads) are generally identified from the results.

In 2004, a task force of the SGSF Water Resources committee was formed to develop this statistical guidebook to assist the southern state forestry agencies with BMP implementation monitoring design and reporting. Included with this guidebook is an Excel spreadsheet created to help states determine how many sites are needed to conduct a statistically reliable survey, calculate the margin of error for each BMP evaluated and reported, and analyze statistical trends in BMP implementation.

Major elements in the design of a statistically valid BMP implementation survey include:

- sampling intensity (total number of sites needed for the survey)
- methodology of choosing sites
- how to ensure randomness of the samples
- stratification of field sites (# of samples per county, landowner type, etc.) so that sound conclusions can be drawn from each.

Key calculations for the analysis of a BMP implementation survey will include:

- determining statistical significance of BMP trends
- confidence intervals and margin of error

Survey Design

Determining the sample size, or number of sites to evaluate

$$n = \frac{4p\,(100 - p)}{m^2}$$

Where n = the number of sites to evaluate
p = the estimated overall percent implementation in the state
m = the margin of error (5%)

Notes:

- *p* must be estimated because it is unknown (% implementation from the most recent round of monitoring may be used)
- The closer the estimated value of *p* is to 100, the lower the value of *n* will be.
- *n* is highest when *p* is estimated to be 50%.
- m is the margin of error associated with the estimate of p. There is .95 (95%) probability that the sample taken will produce an estimate which differs from p by a value of m

Example:

$$n = \frac{4p\,(100 - p)}{m^2}$$

Where p (overall BMP implementation) is estimated at 80%

$$n = \frac{4\,(80) * (100 - 80)}{5^2}$$

$$n = \frac{6400}{25}$$

n = 256

Using the spreadsheet:

The spreadsheet is set up so that all that must be entered is the estimated value of p (Est. % BMP Impl). It will then automatically calculate the number of sites to evaluate based on an embedded formula and a margin of error equal to 5% (as recommended by the SGSF framework).

*** These equations calculate the minimum number of sites necessary to evaluate. Increasing the sample size will yield an even more accurate estimate of BMP implementation. A minimum of 100 sites is recommended.**

Data Storage

BMP implementation monitoring data can be stored in a number of different formats. The easiest is an Access database consisting of the individual state's BMP monitoring form (checklist), data tables, queries, and reports. Site evaluations can then be entered directly into the database in a user friendly format. Queries and filters can be created to display the "target" data (i.e. implementation scores for tracts in which a professional forester was involved) for export to the *Statistical Guidebook Spreadsheet.* Reports can provide a quick glance at the results of the survey (i.e. % implementation by county). GIS programs can import data for geographical representation and further analysis. A sample database is available for states to customize to fit their needs.

Site Selection

BMP field sites may be selected in a number of ways: aerial reconnaissance, severance tax records, timber deeds, drive-bys etc. To avoid bias, it is important that personnel involved in the site selection process do not contact consulting foresters, industry foresters, or large landowners to provide a list of recent harvesting operations. This could bias samples to the "good" sites. Of equal importance is to avoid selecting sites thought to be either "good" or "bad". The SGSF framework calls for sites to be no older than 2 years after the most recent treatment activity.

Ensuring Randomness

Ensuring randomness is critical in any type of sampling. One way to help achieve randomness is to identify twice as many sites as are needed for the survey, and use a random number generator to identify specific sites to monitor.

Stratification of Field Sites by Ownership, Watershed, or Other Factors

Stratifying the monitoring sites based on important characteristics such as ownership type, watershed, or physiographic region, can add substantial value to the survey's results. It is important that the sample taken be reflective of the actual conditions. There are two ways to accomplish this:

- Take a truly random sample from the population (this will solve the stratification but is extremely difficult).
- Intentionally select sample sites based on their stratum

Forest Inventory and Analysis (FIA) data may be used to estimate the number of sites undergoing forestry operations by landowner type. This percentage can then be used to estimate the number of monitoring sites each landowner group should comprise.

Data Analysis

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 and can be performed for an individual BMP evaluation question (i.e. SMZ width). The following formula is used to perform this calculation:

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

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 were evaluated

Notes:

- If the actual value of P is larger than the estimated value of P, then the actual margin of error will be smaller than m.
- This equation is not valid for a subset of all possible sites (i.e. calculating margin of error from the % BMP implementation for NIPF landowners.)
- For a BMP that is not applicable to all sites, the actual margin of error will be larger than m.
- Estimating the average % BMP implementation across all possible sites for a group of BMPs and then using this number of sites will produce a margin of error that is smaller than m.
- If the value of P is 100%, the margin of error is not zero. No calculation can be made.

Example:

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

Where P (% BMP impl. for adequate SMZ width) was evaluated to be 89% on 125 sites

$$m = 2\sqrt{\frac{89\ (100-89)}{125}}$$

$$m = 2\sqrt{\frac{979}{125}}$$

$$m = 2\sqrt{7.832}$$

$$\boldsymbol{m = 5.597}$$

Using the spreadsheet:

The spreadsheet is designed to calculate the margin of error for a single BMP. All that must be entered is the % implementation for a single BMP (% for single BMP) and the number of sites on which that BMP was evaluated (# of sites).

95% 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 within that range. To calculate the 95% confidence interval, you must also calculate the mean, variance, standard deviation, standard error, and margin of error.

Example:

Let's calculate the 95% confidence interval for the following sample:

95%, 80%, 88%, 100%, 77%

First calculate the mean.

$$\frac{95+80+88+100+77}{5} = \frac{440}{5} = \textbf{88\%}$$

Then calculate the variance.

Step 1: USS = $95^2 + 80^2 + 88^2 + 100^2 + 77^2$ = ***39,098***
Step 2: SUM = 95 + 80 + 88 + 100 + 77 = ***440***
Step 3: CF = $440^2/5$ = 193,600/5 = ***38,720***
Step 4: CSS = 39,098 – 38,720 = ***378***
Step 5: DF = 5 – 1 = ***4***
Step 6: Variance = 378 / 4 = ***94.5***

Next calculate the standard deviation.

Std dev. = $\sqrt{variance}$ = $\sqrt{94.5}$ = **9.721**

After that, calculate the standard error.

Std. error = (Std dev. / $\sqrt{number\ of\ sites}$) = 9.721 / $\sqrt{5}$ = **4.347**

Next, calculate the margin of error.

Margin of Error = 2(Std. error) = 2 (4.347) = **8.695**

Finally, use the margin of error to calculate the 95% confidence interval.

95% Confidence interval = Mean ± Margin of Error = **(79.305, 96.695)**

Using the Spreadsheet

The spreadsheet is set up so that all that must be entered is the individual tract scores (Indiv. % Impl) and the total number of sites (# of sites). The spreadsheet automatically calculates the mean, variance, standard deviation, standard error, margin of error, and the 95% confidence interval (low and high ends).

BMP Trend Analysis

Analyzing trends or patterns in BMP implementation can be useful to target areas or ownership types for concentrated educational efforts (i.e. additional logger training workshops). Commonly reported trends include higher BMP implementation rates when professional foresters are used, the landowner is familiar with BMPs, and the logger has attended BMP training.

In order to determine trends in BMP implementation, several statistical analyses should be performed. First, a parametric two sample t-test is conducted because of the large sample size. This percentage data must undergo an arcsine square root transformation prior to analysis. Percentage data must be transformed because they are not normally distributed, which invalidates the normality assumption of the parametric test. A non-parametric test (Wilcoxon) may also be performed to add greater statistical validity.

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.

Using the spreadsheet:

The spreadsheet is set up so that all you have to do is enter the individual scores for the tracts that answered "yes" to the particular trend question and likewise for those that answered "no" in the respective column. It will then perform the arcsine square root transformation and conduct a parametric two sample t-test on the new data, based on a level of significance of .05. This value will be used to determine whether the difference in implementation scores for that particular trend is statistically significant. This classification is noted by the answer "TRUE" found under the Stat. Diff column.

****The arcsine square root transformation was conducted so that Microsoft Excel could perform the analysis. More robust tests (non-parametric tests like the Wilcoxon) may be conducted to add greater statistical validity. These tests are not included in basic Microsoft Excel programs but can be found in programs like *JMP, SAS, or Statistica.***

Area Weighting BMP Implementation Data

Results are typically reported giving equal weight to all sites (i.e. a 20 acre tract counts the same as a 450 acre tract when compiling all data). Statistically, tracts could also be weighted based on their acreage, i.e. larger tracts would have a greater influence on the total % BMP implementation than the smaller tracts. This analysis can be performed to provide information on how the practices are impacting the total landscape. Both methods are useful in reporting BMP implementation rates, though the SGSF framework does not call for area-weighting. The following formula may be used to perform this calculation.

$$AW\ \% = \Sigma\ (((\text{indiv A}/\text{Total A}) * 100)) * \%\ \text{Impl}))$$

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

Example:

For this example, let's use 5 individual tract scores and their respective size:

95% - 100 acres, 80% - 35 acres, 88% - 70 acres, 100% - 275 acres, 77% – 20 acres

Equal weighted % BMP Implementation = Sum of scores divided by number of sites

$$\frac{95+80+88+100+77}{5} = \frac{440}{5} = \mathbf{88\%}$$

Area weighted % BMP implementation = Sum of scores proportional to tract size

% BMP Impl	*Tract Size*	*% of Total*	*AW %*
95	*100*	*20*	*19*
80	*35*	*7*	*5.6*
88	*70*	*14*	*12.3*
100	*275*	*55*	*55*
77	*20*	*4*	*3.1*
Total	***500***	***100***	***95***

$$= \mathbf{95\%}$$

% of Total = Tract Size / Total Size
*AW % = % of Total * % BMP Implementation for each individual tract*
Area Weighted % BMP Implementation = Sum of individual AW %

Using the spreadsheet:

The spreadsheet is set up so that all that must be entered are the individual percent BMP implementation rates and their respective tract sizes in acres. It will then automatically weight the BMP implementation scores based on the tract size.

Reporting

Using the statistical procedures contained in this guide, BMP Implementation data can be reported in the following ways:

- Overall % BMP implementation for the state
- % BMP implementation by landowner group
- % BMP implementation by BMP category
- Area weighted % BMP implementation