Voluntary Compliance with Forestry Best Management Practices in East Texas

Results from BMP Compliance Monitoring Project

by

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EXECUTIVE SUMMARY

A system to evaluate the level of compliance and effectiveness of forestry Best Management Practices in East Texas was designed and implemented. A total of 162 sites on which silvicultural activities had occurred between mid-1990 and mid-1992 were evaluated. These sites were a representative sample of the forestry activities which occurred in the state during that time period.

Eight-eight percent of the sites received a passing grade of Fair or better overall compliance rating. Compliance varied by ownership, type of operation, landowner and contractor knowledge of BMPs, level of forester involvement, and other site specific factors. Generally, compliance was highest on sites:

- managed under public ownership
- where a forester was involved
- with low soil erodibility
- where the landowner was familiar with BMPs
- where the logger or other contractor was familiar with BMPs
- where the activity was supervised by the landowner or a representative
- where the activity was site preparation or commercial thinnings

Compliance was generally lowest on sites:

- owned by non-industrial private forest landowners with less than 1,000 acres
- where a forester was not involved
- where soil was highly erodible
- where the landowner was unfamiliar with BMPs
- where the logger or contractor was unfamiliar with BMPs
- where work was unsupervised
- where the activity was clearcutting

Major deficiencies noted during the evaluations were:

PERMANENT ROADS
- Failure to stabilize stream crossings
- Roadside ditches dumping into streams

TEMPORARY ROADS
- Lack of waterbars or other diversion structures
- Incorrect stream crossings (poor location or wrong angles)
- Use of log and pushed-in dirt stream crossings
- Failure to restore and stabilize stream crossings

STREAMSIDE MANAGEMENT ZONES
- Lack of SMZs on intermittent streams (these are not required under the current version of BMPs
- Tops and limbs in stream channels on sites without SMZs

SITE PREPARATION
- Erosion on firelines surrounding the tract

In terms of water quality impact, stream crossings are the most significant problem. The use of log and dirt crossings on temporary roads and the failure to restore and stabilize stream crossings on both permanent and temporary roads are major deficiencies that should receive priority attention in the future.

Compliance checks were also helpful in evaluating BMP effectiveness. When implemented properly, BMPs are effective in controlling nonpoint source pollution. Failures observed were the result of either incorrect implementation or failure to use other needed BMPs in conjunction with those that were used. Although the BMPs appear to be effective means of preventing nonpoint source pollution, two weak areas were identified. These weaknesses resulted in recommendations that BMP be revised to include:

- Extension of streamside management zones to include protection of intermittent streams
- Increased attention to control of fireline erosion

These changes have already been incorporated into a revised set of BMP guidelines, which are currently under final review.

BMP compliance has historically been superior on lands managed by government agencies, particularly the USDA Forest Service. Results from this round of compliance monitoring provide evidence of this.

The major forest products companies have done a commendable job since 1990 in incorporating BMPs into operations on fee-owned lands, although improvements are possible. Large non-industrial private landowners appeared to do at least as well as forest industry in terms of compliance. Most of these tracts are managed by a private consulting forester.

The major weakness in compliance is on non-industrial private tracts. Results show, however, that compliance is higher when both logger and landowner are familiar with Best Management Practices. Education is clearly the key to improving compliance among this ownership category. With over 150,000 landowners and 2,500 loggers and contractors to reach, this will require a long-term educational effort.

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BACKGROUND AND OBJECTIVES

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

The *Texas Silvicultural Nonpoint Source Pollution Project,* funded by a Section 319 Grant from the EPA requires the completion of 6 Tasks by the Texas Forest Service. One of those tasks relates to the development of a monitoring program to evaluate the implementation and effectiveness of the voluntary silvicultural BMP program. Objectives of the monitoring program are to:

1) Measure the degree of compliance with BMP guidelines by forest landowners, contractors, forest industry, and government agencies

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

The Texas Forest Service, after conducting an extensive review of the BMP monitoring programs in other states, designed and implemented the monitoring program described herein to meet these objectives. This report discusses the findings of the BMP Monitoring Program for 162 sites monitored between July 1, 1991 and August 31, 1992.

MONITORING DESIGN & IMPLEMENTATION

OVERSIGHT

The Texas BMP Monitoring Program was designed by the Texas Forest Service. However, industry input was actively sought as the program was developed. An Industry BMP Monitoring Advisory Committee composed of industry and agency representatives, private landowners, logging contractors, and a private forestry consultant, was formed to provide policy direction and comment on the program. The Texas Forestry Association's BMP Task Force also provided input in monitoring program design and implementation.

DISTRIBUTION AND SELECTION OF COMPLIANCE MONITORING SITES

In order to get a valid estimate of overall compliance with Silvicultural Best Management Practices in East Texas, compliance check sites were distributed regionally among forest ownership categories based on the proportion of total harvest. Sites were intended to be representative of the distribution of all silvicultural operations across East Texas. The distribution of check sites was based on estimated annual timber harvest for each county based on the annual Texas Forest Service publication*, Texas Forest Resource Harvest Trends*. See Table 1.

Table 1. Distribution of Compliance Monitoring Sites by County.

County	1987-89 Average Annual Harvest (cubic feet)	Percent of Harvest	Target # of sites	Completed # Sites
NORTHEAST TEXAS				
Anderson	5,232,355	0.9	2	1
Bowie	7,858,985	1.4	3	2
Camp	1,549,450	0.3	0	1
Cass	26,524,210	4.8	13	6
Cherokee	27,308,322	4.9	13	9
Franklin	507,231	0.1	0	1
Gregg	2,724,534	0.5	1	0
Harrison	17,799,630	3.2	8	7
Marion	12,583,115	2.3	6	6
Morris	5,608,224	1.0	2	1
Nacogdoches	21,227,509	3.8	10	7
Panola	10,796,510	1.9	5	5
Red River	4,220,534	0.8	2	2
Rusk	14,442,657	2.6	7	3
Shelby	19,983,315	3.6	9	4
Smith	6,299,410	1.1	3	2
Titus	1,036.541	0.2	0	0
Upshur	8,915,289	1.6	4	3
Wood	2,496,248	0.4	1	1
(Other)	6,900,388	1.2	3	0
TOTAL N.E. TEXAS	204,014,458	36.8	92	61
SOUTHEAST TEXAS				
Angelina	30,155,334	5.4	15	9
Chambers	4,056,743	0.7	2	0
Grimes	4,839,539	0.9	2	2
Hardin	37,202,085	6.7	18	10
Harris	5,989,295	1.1	2	2
Houston	19,837.993	3.6	9	9
Jasper	33,407,416	6.0	16	11
Jefferson	4,004,609	0.7	2	0
Leon	368,873	0.1	0	0
Liberty	26,103,533	4.7	13	2
Montgomery	19,333,977	3.5	9	8
Newton	27,773,125	5.0	13	3
Orange	7,107,698	1.3	3	1
Polk	34,087,479	6.1	17	15
Sabine	13,877,828	2.5	6	5
San Augustine	16,973,343	3.1	8	4
San Jacinto	12,964.294	2.3	6	6
Trinity	16,896,287	3.0	8	2
Tyler	21,137,075	3.8	10	10
Walker	13,296,270	2.4	6	2
Waller	1,511,344	0.3	0	0
TOTAL S.E. TEXAS	350,924,140	63.2	165	101
TOTAL	554,938,598	100.0	257	162

Three years of data were used in order to reduce the estimation error inherent in the county-level *Harvest Trends* data.

The target distribution of compliance checks by ownership was based on the proportional harvest from each ownership category. Harvest from each ownership and region, based on the 1986 Forest Survey, is presented in Table 2. The resulting proposed distribution of the 257 compliance checks by ownership and region is presented in Table 3.

Table 2. Average annual removals of growing stock timber by ownership class.

Ownership	Southeast Texas		Northeast Texas		East Texas	
	Million Cubic Feet	Percent of Total	Million Cubic Feet	Percent of Total	Million Cubic Feet	Percent of Total
Public	27.7	5	6.7	1	34.4	6
Non-industrial Private	101.5	17	176.0	29	277.5	45
Forest Industry	254.5	42	45.4	7	299.9	49
TOTAL	383.7	63	228.1	37	611.8	100

Table 3. Target and actual distribution of compliance check sites by region and ownership class.

REGION/Ownership	Target Percentage Distribution	Actual Percentage Distribution	Target Number of Sites	Actual Number of Sites
NORTHEAST TEXAS				
Public	1	1	3	2
Non-industrial Private	29	28	74	45
Forest Industry	7	9	19	14
TOTAL	37	38	96	61
SOUTHEAST TEXAS				
Public	5	8	12	13
Non-industrial Private	17	22	43	35
Forest Industry	42	33	107	53
TOTAL	63	62	161	101
EAST TEXAS				
Public	6	9	14	15
Non-industrial Private	45	49	117	80
Forest Industry	49	41	126	67
TOTAL	100	100	257	162

Using the formula of one compliance check site per two million cubic feet of timber harvest yielded a target of 257 check sites. At the time the monitoring system was designed, this target appeared to be a reasonable goal for a 12-month period given the TFS manpower that would be available for compliance monitoring. The resulting distribution of check sites by county is listed in Table 1. Ninety-six checks, or 37 percent of the total, were planned in Northeast Texas, in line with the estimate that 37 percent of the East Texas timber harvest comes from these counties. In Southeast Texas, 161 compliance checks were planned. This is 63 percent of the total, and again is in line with the estimate that 63 percent of the state's timber harvest is form these counties.

To eliminate bias and randomize the selection of the check sites would have required an extensive aerial survey to identify all possible sample sites and a random drawing from that list using a random number generator. This procedure would obviously be expensive and time-consuming and was not considered practical. However, compliance check sites were selected in as random a manner as is possible using several methods to

identify sites including aerial reconnaissance in association with SPB detection flights (the favored means), information from TFS field personnel, or other methods.

QUALITY CONTROL

All monitoring evaluations were conducted by two foresters assigned full-time to the BMP Project. Using two inspectors allowed greater consistency in evaluations and thus provided better quality control. At the beginning of the monitoring project, and periodically during the year-long effort, both foresters jointly evaluated tracts so that consistency and fairness in evaluations would be improved.

MONITORING CHECKLIST

The Texas BMP Monitoring Checklist was developed by TFS staff after extensive review of survey designs in other states. The checklist was then reviewed by the TFA BMP Task Force, the Industry BMP Monitoring Advisory Committee, and the Texas State Soil and Water Conservation Board. Some changes were made based on comments received. The form was then field tested by the TFS staff and finalized.

The Monitoring Checklist is comprised of 73 questions. A sample Monitoring Checklist along with an explanation of each question is provided in Appendix A. To simplify the form, each question was worded so that a positive answer was recorded as a "yes" while negative answer, indicating a departure from BMP recommendations or a negative water quality impact, was a "no". This simplified the field evaluation and allowed readers to quickly pick out problem areas identified during an inspection.

PRE-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 TFS employee explained the program and invited the landowner or his/her representative to join the BMP forester during the compliance monitoring. Sites would not be inspected if the landowner denied access, although this did not occur on any of the sites inspected during this round of monitoring.

In many instances, industry foresters accompanied the inspector during the compliance check providing many valuable opportunities to clarify BMP recommendations and provide one-on-one training to these silvicultural operators as well as feedback to the inspectors.

POST-INSPECTION CONTACTS

Landowners, loggers, and timber buyers (if they could be identified) were provided with a copy of the completed inspection form, along with a two-page cover letter explaining the water quality project and interpreting the survey form.

RESULTS

Between July 1, 1991, and August 31, 1992, two Texas Forest Service BMP foresters evaluated BMP compliance on 162 sites, totaling over 25,000 acres. This was only 63 percent of the planned 257 sites. In retrospect, the monitoring effort was much more time consuming than was anticipated during the planning stage. Especially significant was the time require for initial contact with the landowner, gathering background information, and post-inspection follow-up. In many cases, various parties involved expressed interest in being present during the evaluation. Efforts were made to accommodate these requests, providing significant opportunities for one-on-one training and feedback. We believe this will enhance future compliance with BMPs.

Table 4 tabulates results by questions for all sites monitored. Appendix B provides similar tables by ownership category and by region.

SITE CHARACTERISTICS

The 162 monitoring sites were well distributed both geographically and by ownership, closely matching the target distributions, as shown in Table 1, Table 3, and Figure 1. Eighty of the 162 sites were owned by non-industrial private forest landowners (NIPF), including 68 sites held by owners of less than 1,000 acres, and 12 sites owned by NIPF owners with larger holdings. Sixty-seven sites were on forest industry fee lands. Fifteen sites were on publicly owned forestland managed by the USDA Forest Service, Resolution Trust Corp., or the Army Corps of Engineers.

The majority (51%) of the sites were monitored after a regeneration harvest, including 70 clearcuts and 13 partial harvests (such as seedtree cuts, shelterwood, or selection harvests). Thirty-six thinning operations were evaluated along with 43 site preparation activities. Often the site preparation evaluation included evaluation of elements of the preceding timber harvesting operation as well.

Professional foresters were involved in planning and/or implementing the silvicultural operation on 80 % of the sites. On 73 sites, the foresters were employed by industry (usually the timber buyer). Private consulting foresters were involved in 43 of the operations. Federal foresters managed activities on 13 of the sites.

Terrain classification and soil erodibility were recorded from the SCS soil survey, if available, or estimated in the field. Slightly less than half of the operations (78) occurred on flat terrain. Seventy operations were on hilly terrain and 14 were in steep terrain. Seventy sites were on soils with low erodibility, 74 had medium erodibility, and 18 were on highly erodible soils.

Of the 162 sites, 130 had a perennial (57) and/or intermittent (73) stream on the tract. A permanent water body was found within 800 feet of 102 sites, while 60 tracts did not have a permanent water body within 800 feet.

PERMANENT ROADS

Permanent roads were evaluated for compliance with BMPs when they were on the monitored tract and had been recently constructed or re-worked. Permanent roads in the forestry context are generally unpaved woods roads which are maintained to provide year round access. Old permanent roads were not evaluated, recognizing that these roads were planned and constructed long before BMPs were adopted and cannot easily be moved. County roads were not checked; only those roads under the management of the landowner were evaluated. Permanent roads were inspected on 90 of the 162 sites. Figure 2 shows the summarized results by question.

Generally, recently constructed or re-worked permanent road systems reflect proper planning. Eighty-nine of 90 roads avoided sensitive areas such as streamside zones, wet areas, and steep slopes. Eighty-eight of the 90 roads met grade specifications, maintaining slopes of less than 10 degrees except for short distances, following the contour, and avoiding ridge tops where water quality problems might develop.

Rutting was not found to be a problem on permanent road networks. Only 2 of the 90 sites had significant rutting on permanent roads.

Problems were more apparent at stream crossings, which were found and evaluated at 48 sites. Twelve of the 48 stream crossings on permanent roads were not adequately stabilized, leading to sedimentation of the stream at 6 of the crossings. By contrast, at the 36 stabilized stream crossings, only 1 showed signs of sedimentation of the stream. This clearly indicates the need to properly stabilize stream crossings using reshaping, rock, revegetation, or other methods.

Thirteen sites had side ditches which channeled water directly into the stream channel. Of those sites, 8 had visible signs of stream sedimentation as a result. Conversely, at the 52 sites which did not have side ditches dumping directly into the stream, only 2 sites showed signs of stream sedimentation. This data illustrates the importance of installing water turnouts (wing ditches) prior to a stream crossing to channel water flow from side ditches onto the undisturbed forest floor.

Question 29 of the evaluation recorded the use of 10 specific BMPs in relation to the permanent road. It is important to note that the nonuse of a specific BMP practice in a particular location does not imply a lack of compliance with BMPs. Best Management Practices are flexible; often there are many alternative methods that could be applied in a given instance. The real value of this question is that it indicates whether an effort was made to use at least one of the more commonly recommended BMPs.

In 71 of the 90 roads evaluated (79%), at least one of the 10 listed BMPs was utilized. Wind ditches were the most commonly used BMP, occurring on 46 of the 71 sites. Re-shaping was used 30 times, special care in proper placement of the road was evidenced 27 times, culverts were found in 19 cases, and roads were especially planned to follow contours in 17 cases. Waterbars were found on 13 roads. Less frequently encountered BMP methods include low water crossings (4), revegetation (4), rolling dips (3), bridges (2).

The effectiveness of the BMPs tallied above was also judged by the monitoring staff. It is significant to note that at all 71 sites where these specific BMPs were encountered, the BMPs were evaluated as having been effective at minimizing nonpoint source pollution. BMPs properly installed where needed, are effective.

Overall, when BMPs are adhered to on permanent roads, water quality is significantly improved. The "bottom line" question for this section asked whether or not sedimentation occurred as a result of the permanent road. Results indicate that streams were free of sediment 95 percent of the time when some BMPs were followed on the road system. On the 3 sites where sediment did result in spite of some BMPs being applied, analysis of the monitoring forms shows that the sedimentation resulted from sources other than failure of the BMPs themselves. In all 3 cases, side ditches dumped directly into streams. In one case, rutting and an unstable stream crossing added to the sedimentation problem. In these 3 cases, although some effort was made to control erosion by utilizing BMPs, failure to use other BMPs which were called for resulted in the stream sedimentation on the site.

When BMPs were not used at all, one out of three sites had evidence of stream sedimentation as a result of the permanent road system.

SKID TRAILS & TEMPORARY ROADS

Skid trails and temporary roads were evaluated on 129 of the 162 monitoring sites. Skid trails are routes through the harvest unit by which logs are moved via skidding equipment to a centralized log set or road. Temporary roads are roads installed primarily for transporting wood products from the harvest site by truck. Temporary roads are not designed to carry long term traffic and are usually retired or closed to traffic after logging is completed. Responses to each of the 9 questions on skid trails and temporary roads are illustrated in Figure 3.

Evidence of compliance with Best Management Practices was less common for temporary roads and skid trails than for permanent rods. As a result, more water quality impacts were noted. Skid trails and temporary roads did not meet BMP grade specifications on 13 of the 129 sites (10%) where they were found. Excessive rutting was a problem on 21 of the sites (16%).

Waterbars were found on only 24 of the 129 sites (19%). Of those sites with waterbars, 21 were functioning effectively. Incorrect installation of waterbars on the 3 sites where they were not functioning is evidenced by the following comments from the Checklists for those sites:

"Waterbars were utilized in places but were not effective because they were not put in at an angle and extended off the road, and because no outlet to the side was provided…"

"…roads waterbarred but too far apart. Breaching of waterbars and heavy gullying…"

Stream crossings on skid trails and temporary roads were identified as a major problem area in many instances. Of the 162 sites surveyed, 108 had both streams and temporary roads or skid trails present. Many of these were contributing sediment to the stream channel.

On a positive note, on 37 of these sites (34 percent) temporary roads or trails did not cross the stream. On 58 other sites (54 percent), evaluators judged that efforts had been made to minimize the number of stream crossings. However, the number of stream crossings was excessive on 13 of the 108 sites (12 percent). Proper planning could have reduced the number of crossings needed on these sites, and reduced potential for water quality degradation.

Streams crossings were also evaluated for location. A correct crossing location is one which minimizes potential sedimentation of the stream and crosses at right angles. On this basis, stream crossings were judged to be inadequate 37 percent of the time.

In most cases, these unacceptable crossings consisted of logs and/or dirt pushed into the stream and left to collapse into the stream after the logging job was completed. Some had steep banks which had been cut down and were eroding. Many of these were on intermittent streams rather than perennial streams.

More often than not, temporary stream crossings were not restored and stabilized following completion of the operation. This was true in 43 of the 54 sites on which restoration was needed. Again, the common practice of pushing logs and dirt into a channel and failing to remove it afterwards is a frequent problem.

Use of 10 specific Best Management Practices was recorded for skid trails and temporary roads. Again, it is important to note that the nonuse of a specific BMP practice in a particular location does not imply a lack of compliance with BMPs. Best Management Practices are flexible; often there are many alternative methods that could be applied in a given instance. The real value of this question is that is indicates whether an effort was made to use at least one of the more commonly recommended BMPs.

Results indicate that use of these 10 measures was much less common than for permanent roads. Two-thirds of the 129 sites with temporary roads or skid trails had none of the 10 BMPs present. At least 1 BMP was in use at only 42 of the 129 sites. Waterbars were the most commonly used BMP device, found at 25 of the sites. Reshaping of the road or trail following use was evidenced at 18 sites, special care in placement was evidenced at 16 sites, and roads were on contour on 13 sites. Wing ditches were installed at 12 sites, culverts and low water crossings were observed on 2 sites.

When BMPs are utilized, there is much less chance of stream sedimentation from skid trails and temporary roads. On 30 of the 37 sites (81 percent) where BMPs were utilized and there was a stream present, the stream was not adversely impacted by the temporary roads or skid trails. On the 7 sites on which streams were adversely impacted in spite of the presence of some BMPs, failure generally resulted from failure to use other BMPs rather than from the BMPs which were used. For example, waterbars and other BMPs may have been used along the trail, but no effort was made to stabilize the stream crossing. In another case, waterbars were improperly constructed. Runoff from a large storm event resulted in erosion around a culvert installation at another site.

When BMPs were not utilized, significantly more water quality impacts were noted. On 21 of the 71 sites (30 percent) where BMPs were not used and a stream was present, sediment to the stream resulted from skid trails and temporary roads. Most sedimentation was observed at stream crossings. No evidence of sedimentation was observed on 50 of the sites, in spite of the lack of BMPs, and streams were not present on the remaining 16 sites.

STREAMSIDE MANAGEMENT ZONES

All sites with either perennial or intermittent streams present were evaluated for the presence and adequacy of a Streamside Management Zone (SMZ). Streams were present on 130 of the sites. Out of these 130 sites with streams present, 100 sites, 77 percent, had SMZs. Figure 4 summarizes responses to 8 questions pertaining to SMZs.

SMZs were most common on perennial streams. Of the fifty-seven sites with a perennial stream course present, 51 sites (89 percent) had an SMZ.

SMZs were only encountered on 68 percent of the intermittent streams; 75 of 110 sites. However, it should be noted that the current version of the BMP Handbook specifies SMZs alongside *perennial* streams only. It is widely held, however, that intermittent streams need protection by an SMZ, and this change is being incorporated into the next BMP revision. It is important to point out that several of the major forest products companies, in particular, have already begun delineating SMZs on intermittent streams even though they were not required by the state's BMP guidelines.

Twenty-six sites had SMZs on both perennial and intermittent streams on the tract.

When SMZs were present, evidence indicates that SMZ width recommendations were generally followed. On 93 sites (93 percent), the SMZ was judged to be adequately wide (50 feet or more), while it was not adequate on only 7 sites.

Individual tree removal, or thinning, was conducted within the SMZ on 61 of the 100 SMZ sites. In 57 of these, the thinning was carried out within allowable specifications. Residual basal area was at least 50 sq. ft. and soil disturbance was minimal from felling and skidding.

The integrity of the SMZ was protected 86 percent of the time (86 sites). This indicates that an effort was made to stay out of the SMZ with skidders, log sets, roads, and firebreaks in accordance with BMP guidelines. SMZs were free of roads and landings in 96 of the 100 sites.

Of the 130 sites with streams, tops and limbs were found in the stream in 33 cases (25 percent). Sites with SMZs on the stream had a much lower occurrence of debris in streams. Debris was found in the stream in 12 of the 100 sites with SMZs present. Of the 30 sites without an SMZ, 70 percent (21 sites) had logging debris in the stream channel.

The higher incidence of debris in streams for sites without SMZs is a reflection both of the generally poorer quality effort on those sites as well as an indication of the effectiveness of SMZs in keeping debris out of a stream. Obviously, if fewer or no trees are cut adjacent to a stream, one would expect less debris to fall into the stream. Also, operations using SMZs presumably spent more effort in keeping debris out of the stream and also removing debris if it entered the stream channel.

When applied correctly, SMZs are effective in minimizing stream sedimentation. The improvement in erosion and sedimentation prevention is significant. Ninety-three percent of sites with SMZs had no evidence of sedimentation through the SMZ. Conversely, only 57 percent of the 30 sites without SMZs had no evidence of sedimentation along the stream bank.

As noted, 7 sites with SMZs nevertheless failed to keep sediment out of the stream channel. An analysis of the monitoring forms for those sites indicates that these were sites on which the SMZ width was inadequate, SMZ integrity was violated, or a stream crossing within the SMZ was inadequately stabilized. The following statement from one of these sites illustrates the problems encountered:

> *"Although there were SMZs present on the intermittent streams in the tract, 2 out of 3 were not wide enough to allow for the protection of the stream channels through shading and filtering of sediment. The was evidence of a pushed fireline around the perimeters of the SMZs and on one of the more narrow ones, there was sediment from these lines being deposited into the stream. There was a significant number of trees in the SMZ that were downed through wind throw…"*

SITE PREPARATION

Fifty-three sites were evaluated for compliance with site preparation BMPs and the impact of these activities on water quality. A variety of site preparation methods were evaluated, including 32 sites with some combination of shearing, piling, and/or burning. Prescribed burning was evaluated on 8 sites, as was drum chopping. Four operations involved application of herbicide. One site included hand planting only. Figure 5 illustrates findings relating to site preparation activities.

Soil movement was encountered on 5 of the 53 sites evaluate, or 9 percent. This includes gully and rill erosion as well as sheet erosion. The problem on 3 of the 5 sites stemmed from erosion on firelines. Firelines in these cases did not have erosion control structures such as waterbars. The 2 other cases involved sites with high erodibility – deep sandy soils and moderate to steep slopes. One of these cases was a shear and windrow operation, which was generally done on contour as per BMP recommendations. However, given the deep sandy soils on the tract, the method exposed too much soil to erosion. Windrows were also too far apart. The site prep method used was inappropriate for the site. The other site involved piling of logging slash on a site with highly erodible, sandy soils. In this particular case, a properly functioning SMZ filtered out sediment and protected the stream.

Erosion on firebreaks was controlled on 24 of the 30 sites with firebreaks. SMZ integrity was honored on 31 of 38 sites which had SMZs. Windrows generally good; they were on contour and free of soil on 5 of 6 sites.

Five sites where chemical site preparation was performed, including one spray and burn operation, were evaluated. In 4 cases, there was no evidence of chemicals being applied off the target site. On one site, there was evidence that chemicals, applied aerially, had been applied over the stream.

Site preparation sites were evaluated for the presence of 4 major site preparation BMPs, including waterbars, re-seeding of erosion prone areas, work done on contour, and re-shaping. Twenty-six of the 53 sites, 46 percent, showed evidence of at least one of these practices being applied. The most common practice was operating along contours. This was found on 22 sites, including 21 shearing operations and one drum chopping operation. Twelve sites involving shearing were not done on contour. Seven drum chopping operations were not done on contour. Waterbars were found on 4 sites, re-shaping was found on 3 sites, and re-seeding was not found on any sites.

Overall, water quality was found to be adversely impacted, as evidenced by visible sedimentation, on 3 of the 40 sites with streams present. In 2 of the 3 cases where stream sedimentation occurred, the source was firelines which did not have erosion control devices installed. In the other case, the major source of sedimentation was a permanent road and lack of adequate SMZ.

LOG SETS

Log sets (sometimes called landings) are areas where logs are gathered, delimbed, bucked into proper length, and loaded onto log trucks. Sets are areas of concentrated activity and can become a water quality issue if drainage is not properly controlled.

Use of BMPs was evaluated on log sets on 128 sites. Generally, results did not indicate that sets were a significant water quality concern (Figure 6).

BMPs for log sets require clean up of any trash and garbage associated with the operation and protection from leakage or spillage of oil and other petroleum products. Results from the monitoring show that 121 of the 128 sites, 95 percent, were free of trash and oil. However, seven sites failed in this evaluation. In 4 cases, oil cans, hydraulic fluid cans, and/or trash was found on site. In one case, hydraulic fluid cans were in the flood plain of a stream. In 2 cases, an oil leakage occurred, either accidentally or during equipment maintenance, and was not cleaned up. Petroleum product spills seem to be relatively uncommon, but are a serious concern because of the high risk of surface or groundwater contamination. This was a more significant problem 10 years ago, according to field personnel, but the problem seems to have been resolved to some extent in recent years. This question seemed to be a good indicator of the overall quality of the operation. If problems were encountered here, it was very likely that the entire job was haphazard.

Log sets should also be located outside of SMZs. This was the case for 109 of the 113 sites which had log sets and had or should have had an SMZ. In 4 cases, log sets were located too close to the stream.

Log sets were on well-drained locations on 125 of 128 sites. Soil movement, degradation, and puddling were minimized on these sites.

Evaluators found 11 sites on which restoration and stabilization of log sets was needed but was not performed. On 9 sites, there was evidence that some work in stabilization and restoration had been undertaken. On 108 other sites, set restoration was judged not to be needed to protect the site.

OVERALL COMPLIANCE WITH BEST MANAGEMENT PRACTICES

Evaluators used a 5-level grading scale to provide an indicator of overall compliance with Best Management Practices as an indication of the impact of the silvicultural activity on water quality. The five grades were as follows:

1. **NO EFFORT** – Substantial erosion and water quality degradation as a result of operations. Sedimentation evident in streams. Non-compliance with several BMPs that were needed with a resulting adverse impact on water quality. Poor attitude evident about the job.

2. **POOR** – Some effort made at installing BMPs. Generally poor quality construction or no effort at certain locations which now suffer from erosion and stream sedimentation. Substantial lack of BMPs in a particular emphasis such as roads, skid trails, or SMZs, with significant problems as a result.

3. **FAIR** – (1) Generally, a pretty good effort at BMPs. Poor application procedures perhaps. Lack of BMPs in a particular emphasis area, but with moderate consequences. (2) No BMPs on a site which requires few BMPs but has some resultant minor problems.

4. **GOOD** – (1) BMPs generally installed correctly. Guidelines followed. Allows for some failure of devices or failure to observe guidelines, but with light consequences. (2) Good quality operation which requires no BMPs and has few problems.

5. **EXCELLENT** – (1) BMPs installed correctly. Guidelines followed. (2) Some BMPs implemented even though they might not have been required. Few if any problems exist.

These ratings, though subjective in nature, provide an overall feel of the level of BMP compliance versus the need for BMPs on the particular tract, as well as the visible impact of the forestry activity on water quality.

Overall, 88 percent of sites received a "passing" grade of Fair, Good, or Excellent. Of the 162 sites evaluated, the majority (58 percent), received an overall evaluation of Good. Thirty-five sites, 22 percent, received a Fair rating. Fourteen sites, (9 percent) received an "Excellent" rating. Fifteen sites (9 percent) received a Poor rating and 4 sites (2 percent) received the lowest, No Effort, rating. Figure 7 maps the site locations by compliance rating. Figure 8 illustrates the overall distribution of compliance ratings.

An average score, calculated by assigning 5 points to Excellent ratings, 4 points to Good ratings, 3 points to Fair ratings, 2 points to Poor ratings and 1 point to No Effort ratings, yields an average score for all sites of 3.61 out of 5.0. This scoring system is useful in analyzing results by sub-groups of sites.

COMPLIANCE BY SITE CHARACTERISTICS

Ownership

Performance varied somewhat by ownership category (Figure 9). The public ownership category fared best, with 93 percent of the 15 sites evaluated receiving a Fair or better grade. The average score for public ownership was 4.0 out of 5.0. Significantly, 27 percent of sites on publicly managed properties received an Excellent rating for BMP compliance. This is a credit to the management of the National Forests of Texas by the USDA Forest Service, which received Excellent ratings on 3 sites.

Non-industrial private owners with holdings of more than 1,000 acres, classified as "Large NIPF", had a passing rate of 92 percent, and an average score of 3.75. Twelve tracts were evaluated under this category. Many tracts are managed by consulting foresters.

Sixty-seven tracts on forest industry fee-owned land were monitored, yielding a passing percentage of 90 percent. The average score for this ownership was 3.70. Nine percent of these tracts received an Excellent rating. Ten percent, higher than average, received a rating of Poor.

The lowest level of BMP compliance, as expected, was on small NIPF tracts. Of the 68 tracts monitored, 85 percent received a Fair or better rating. The average score was 3.41. This ownership category had the lowest proportion with an Excellent rating (3 sites), and was the only category which received No Effort scores (4 sites).

Date of Activity

Texas Silvicultural BMPs were published in June, 1990. It would be expected that over time, as BMPs become more widely distributed and more familiar, compliance would improve. The estimated time of the activity was recorded for 160 of 162 sites, to the nearest quarter year. (Dates could not be established for 2 sites).

As shown in Figure 10, BMP compliance has improved somewhat over time, and showed marked improvement in 1992. The average score for sites on which the activity was completed in 1990 was 3.57 out of 5.0, with 89 percent of sites receiving a passing rating of Fair or better.

One hundred nine sites were evaluated based on activities conducted in 1991. The average score for this set of sites was 3.58 and 87 percent. Sixteen sites were evaluated based on activities conducted in 1992. Marked improvement in this category is noted, although the sample size is limited. The average score for 1992 sites was 3.88 and 94 percent of the sites passed. Twenty-five percent of the sites received an excellent rating. This is a significant improvement from earlier sites in which only 6 to 7 percent of the sites received the highest rating.

Industry made marked progress in improving its average score over time. The average score for tracts on fee-owned lands was 3.2, 3.7, and 3.8 in 1990, 1991, 1992, respectively. Trends are less obvious for non-industrial tracts, since only 5 of these were for 1992 activities. Trends are also less obvious for public tracts because of the small sample size.

Region

Figure 11 shows compliance rating distribution by region. The average score for 101 Southeast Texas sites was 3.55, while the average for the 61 Northeast sites was 3.70. This would seem to indicate better compliance in Northeast Texas, however, this is not the case. Eight-seven percent of Northeast Texas sites received a passing grade of fair or better, while 89 percent did so in Southeast Texas. Northeast Texas had a larger share of Excellent ratings, but this was offset by a high proportion of Poor grades. Figure 11 illustrates the distribution of ratings by region.

Professional Forester Involvement

Evidence from the monitoring results indicates that having a forester involved tends to improve the quality of the silvicultural operation. A forester was involved in 80 percent of the sites monitored. Overall, sites which had a forester involved received a fair or better rating 91 percent of the time, versus 78 percent for tracts with no forester involvement. The average score for sites where foresters were involved was 3.7 compared to 3.3 for sites where no forester was involved in the planning and implementation of the silvicultural activity. Additionally, all sites receiving an Excellent rating involved a forester, while only one No Effort site was know to have involved a forester.

Type of Activity

Four types of operations were monitored: clearcuts, partial regeneration cuts, site preparation, and thinning. Results by type of operation are illustrated in Figure 13. Site preparation activities on 43 sites received a Fair or better rating 95 percent of the time, and had the highest average score at 3.9. Thinning operations (36 sites) passed on 94 percent of the sites, yielding an average score of 3.7. Thirteen partial regeneration harvests, such as seedtree and shelterwood cuts, were evaluated. These rated Fair or better in 85 percent of the cases and had a 3.7 average. Clearcut received the worst overall scores. Seventy clearcuts were evaluated, with results indicating a Fair or better rating 81 percent of the time, and an average score of 3.4.

Other Site Characteristics

Compliance by other site characteristics including distance to nearest permanent water body, highest order stream present, terrain class, and erodibility hazard are summarized in Figures 14-15.

FOLLOW-UP QUESTIONS

A series of 5 follow-up questions was posed to the landowner and contractor to determine the impact of other factors on BMP compliance. The results were as follows:

Table 5. Responses to follow-up questions.

	All Sites			NIPF Sites Only		
Question	Yes	No	N/A	Yes	No	N/A
Was the activity supervised by the landowner or representative?	126	11	25	47	11	22
Was the landowner familiar with BMP Handbook?	89	45	28	14	42	24
Was the logger/contractor familiar with BMP Handbook?	63	21	78	18	15	47
Were BMPs included in the contract?	60	47	55	9	31	40
Is the landowner a member of a county forest landowner assoc., TFA, or Forest Farmer Assoc.?	20	60	82	20	60	82

N/A = Information could not be obtained from landowner or question was not applicable.

Level of Supervision

Sites on which the activity was supervised by either the landowner or a landowner representative (e.g., a consulting forester) generally had a greater level of compliance and less impact on water quality than those that had no supervision (Figure 16). Of the 162 sites, supervision was reported for 126. Eleven sites reported that there had been no supervision of the activity, and level of supervision could not be determined for 25 sites.

All 14 sites which received an Excellent rating were supervised. Supervised sites also had a higher proportion of Good sites, and lower proportion of Poor and No Effort sites. In fact, only one of the 4 No Effort sites was supervised. The average score for supervised sites was 3.7 compared to 3.0 for unsupervised activities.

Supervision was important on non-industrial private tracts as well as for other ownerships. The average compliance score was 3.6 for NIPF sites on which the activity was supervised, compared to 3.0 for

unsupervised activities. Only 73 percent of NIPF sites passed when not supervised, in contrast to 92 percent that passed when supervision was present.

Landowner Familiarity

Landowner familiarity with BMPs seems to be an important factor in the level of compliance (Figure 17). Landowners expressing familiarity with BMPs had a passing rate of 93 percent and an average score of 3.8. Those without such familiarity passed at a rate of 86 percent and had a 3.4 average score. Landowners indicated previous knowledge of BMPs on all sites receiving Excellent ratings. Landowners with BMP knowledge also had a higher proportion of Good ratings and lower proportions of Fair, Poor, and No Effort ratings. This pattern held true in general for all owners as a group and for NIPF owners as well.

Contractor Knowledge

The loggers and other silvicultural contractor's familiarity with BMPs also seems to influence overall compliance, as shown in Figure 18. The difference in passing ratings is striking. Where operators were familiar with BMPs, 92 percent of the sites received a passing rating. Only 66 percent of sites passed when the operator did not have prior familiarity with BMPs. Sites where the operator was familiar with BMPs had higher proportions with ratings of Excellent and Good, and an average score of 3.8. The average score was 3.1 for sites where the operator was not familiar with BMPs.

The influence of this variable is found on NIPF sites, although the difference is less striking. Eighty-nine percent of NIPF sites passed when the operator had prior knowledge of BMPs compared to a 73 percent passing rate when the operator had no prior exposure to BMPs. This may strengthen the argument that NIPF landowner familiarity with BMPs is critical, in addition to operator familiarity, to BMP implementation on NIPF tracts.

Contract Specification

When BMPs are specified in the contract between the landowner and operator, compliance is generally better (Figure 19). Ninety-two percent of sites where BMPs were included in the contract received a Fair or better rating, compared to 85 percent of the tracts without BMPs specified in the contract. The average score was 3.8 when BMPs were in the contract compared to 3.3 otherwise. This finding is true for NIPF tracts as well, although in most cases BMPs are not included in a contract (many NIPF timber sales involve no written contract at all). For NIPF tracts, all sites receiving an Excellent rating had contractual BMPs.

Membership in Forestry Organizations

Figure 20 shows the distribution of compliance ratings by whether or not the NIPF landowner was a member of a forestry organization (Texas Forestry Association, a county forest landowner association, or Forest Farmer's Association). Results do not indicate any strong correlation between association membership and BMP compliance. However, the sample size for responses to this questions was relatively small, since a yes/no answer was only obtained for 44 sites.

DISCUSSION

Evaluation of 162 sites for compliance to BMP has provided a great deal of information on patterns and levels of current BMP compliance in East Texas. Although fewer sites were monitored than originally planned, the distribution of sites seems to correspond well with the distribution of timber harvest by ownership and region in East Texas. Therefore, it can be assumed that the results presented are representative of the silvicultural operations which occurred during 1990-1992.

BMP COMPLIANCE

The first objective of the monitoring program was to measure the degree of compliance to BMP standards by forest landowners, contractors, forest industry, and government agencies. This objective has been met. Information on compliance with specific BMPs has been presented along with the overall assessment of BMP compliance based on a 5-level rating system. Eighty-eight percent of sites received a Fair or better compliance rating.

It is worthwhile to review again the definitions of the 5 compliance ratings:

1. **NO EFFORT** – Substantial erosion and water quality degradation as a result of operations. Sedimentation evident in streams. Non-compliance with several BMPs that were needed with a resulting adverse impact on water quality. Poor attitude evident about the job.

2. **POOR** – Some effort made at installing BMPs. Generally poor quality construction or no effort at certain locations which now suffer from erosion and stream sedimentation. Substantial lack of BMPs in a particular emphasis such as roads, skid trails, or SMZs, with significant problems as a result.

3. **FAIR** – (1) Generally, a pretty good effort at BMPs. Poor application procedures perhaps. Lack of BMPs in a particular emphasis area, but with moderate consequences. (2) No BMPs on a site which requires few BMPs but has some resultant minor problems.

4. **GOOD** – (1) BMPs generally installed correctly. Guidelines followed. Allows for some failure of devices or failure to observe guidelines, but with light consequences. (2) Good quality operation which requires no BMPs and has few problems.

5. **EXCELLENT** – (1) BMPs installed correctly. Guidelines followed. (2) Some BMPs implemented even though they might not have been required. Few if any problems exist.

Overall compliance ratings were distributed as follows:

Table 6. Number and percent of sites by compliance rating.

Rating	Number of Sites	Percent of Sites
No Effort	4	2.5
Poor	15	9.3
Fair	35	21.6
Good	94	58.0
Excellent	14	8.6

The rating system, though subjective in nature, provides for an overall "feel" of the level of BMP compliance versus need for BMPs on the particular tract, and the overall visible impact of the activity on water quality. It should be noted that a Fair or Good rating does not necessarily reflect implementation of BMPs on the site. These scores were also assigned to sites where few or no BMPs were installed *if* the site was such that few BMPs were called for and the resulting impact on water quality was judged to be minor.

Compliance ratings were affected by a number of variables such as ownership, landowner knowledge, and forester involvement. To test the correlation between site characteristics and the overall compliance rating,

the stepwise linear regression technique was applied to the data set. Stepwise regression is a widely used technique which can identify the set of independent variables which are most influential in determining the value of the dependent variable. In this case, 14 independent variables were tested: 1) region, 2) forester involvement, 3) type of activity, 4) year of activity, 5) ownership category, 6) terrain class, 7) soil erodibility class, 8) highest order stream present, 9) distance to nearest permanent water body, 10) level of on-site supervision, 11) landowner familiarity with BMPs, 12) contractor familiarity with BMPs, 13) inclusion or exclusion of BMPs from a written contract, and 14) membership in a forestry organization. The effect of these variables was tested against the independent variable, which was overall compliance rating.

Because of the number of "missing values" for the variables 10-14, one regression was performed using only the first 9 variables. This allowed use of the data from 160 of the 162 sites and provided a stronger statistical basis. From this analysis, the following variables were found to be statistically correlated with overall compliance at a 90 percent or better confidence level:

Variable	Significance Level
Soil Erodibility	0.0001
Region	0.0011
Ownership Category	0.0003
Type of Activity	0.0124
Distance from Permanent Water Body	0.0837

The significance level is the probability (measured from 0 to 1) that the model is calling the effect significant when it is not. As the significance level approaches 0, confidence in concluding that the independent variable has a significant effect on the dependent variable becomes stronger.

A second stepwise regression analysis was performed using all 14 independent variables listed above. Because the procedure cannot use site records which include one or more missing values for the independent variables, this process used only 83 of the site observations. Therefore, conclusions are statistically weaker than in the previous model. This analysis resulted in the following variables being significant at the 80 percent confidence level:

Variable	Significance Level
Region	0.0010
Soil Erodibility	0.0014
Landowner Familiarity	0.0015
Distance from Permanent Water Body	0.0060
Forester Involvement	0.0115
Type of Activity	0.1347
Logger Familiarity	0.1395
Supervision by Landowner/Representative	0.1640
Year of Activity	0.1880

The results of this cursory statistical analysis reveals which variables may be most important in determining BMP compliance. It should be noted that there is wide variability in the data and the resulting linear regression models were only poor predictors of compliance, with R^2 values of only 0.30 and 0.49. There are some obvious problems of interaction between variables, or multicollinearity, that make interpretation difficult. For instance, ownership is related to forester involvement, landowner supervision, and several other variables. A more rigorous analysis, which could separate out these effects, is beyond the scope and objectives of this report.

Some conclusions can be drawn, however. It is significant to note that both landowner and contractor familiarity with BMPs are important determinants of BMP compliance. The results show that increased familiarity with BMPs is associated with an improved level of compliance. This finding indicates that continued emphasis should be placed on both landowner and contractor education.

As was stated earlier, the statistical analysis showed that forester involvement in the sale also tended to increase BMP compliance.

The soil erodibility on a given location has a negative effect on BMP compliance. Sites that were more highly erodible tended to have lower compliance ratings. This is likely because these sites required more attention to BMPs than has been typically given. As a result, these sites showed a greater degree of site degradation and potential for water quality problems. Conversely, less erodible sites were more forgiving and did not require the extent of BMP implementation to mitigate water quality impacts. The lack of BMP practices on these less erodible sites did not result in the adverse impacts that would have lowered the compliance rating.

The regression analysis shows that region of the state (Northeast versus Southeast) very likely had a strong effect on compliance. The explanation for this finding is not apparent. It is possible that differences in ownership patterns and other characteristics are strongly correlated with region and these other variables are interacting to make region appear to be more significant than it is.

The year of activity was found to be only marginally significant, although based on average compliance scores and percent of sites passing, there does seem to be an improvement in compliance over time, especially for 1992 sites. It is likely, however, that the small sample size for the 1992 sites did not allow a strong statistical correlation to be shown.

Compliance to specific BMPs varied widely. The major deficiencies noted for each category of BMPs are as follows:

PERMANENT ROADS

- Failure to stabilize stream crossings
- Roadside ditches dumping into streams

TEMPORARY ROADS

- Lack of waterbars or other drainage structures
- Incorrect stream crossings (poor location or wrong angles)
- Use of log and pushed-in dirt stream crossings
- Failure to restore and stabilize stream crossings

STREAMSIDE MANAGEMENT ZONES

- Lack of SMZs on intermittent streams (although this practice is not indicated in the current version of the BMP Handbook)
- Tops and limbs in stream channels on sites without SMZs

SITE PREPARATION

- Erosion on firelines surrounding the tract

In terms of water quality impact, stream crossings are the most significant problem. The use of log and dirt crossings on temporary roads, and the failure to restore and stabilize stream crossings on both permanent and temporary roads, are major deficiencies that should receive priority attention in the future.

BMP EFFECTIVENESS

The second objective of the monitoring program was to evaluate the effectiveness of BMPs as applied in the field and identify weaknesses in the BMP guidelines that need revisions.

Results from monitoring show that BMPs themselves are effective means of limiting nonpoint source pollution. Shortcomings in BMP effectiveness, as was noted in earlier sections, arose not from poor BMP specifications, but from poor implementation. For instance, waterbars failed when they were installed at an incorrect angle, left no side opening, or were spaced too far apart. In some cases, BMPs failed when other supporting BMPs were absent. For instance, streamside management zones were properly installed in several sites, but insufficient attention to stream crossing stabilization and restoration resulted in sediment reaching the stream at the stream crossing site.

Two significant needed revisions to the BMPs have been identified, however. In the first version of silvicultural BMPs for Texas, streamside management zones were only specified for perennial streams. Field evaluations and discussions with practicing foresters throughout the state indicate a need to expand this requirement to cover intermittent streams as well. High banks and well-defined channels are common on intermittent streams throughout East Texas, and these often carry large volumes of fast flowing water after major storm events or during wet seasons. Sediment and debris that accumulates in these dry channels is flushed down through the intermittent channel and into permanent water bodies. This problem is made more severe by the common practice of constructing makeshift crossings of logs and dirt during harvesting operations, which are often left to collapse into the channel. The revision of the BMP guidelines, currently in draft form, incorporates this much needed change.

Another significant modification, or rather expansion, of BMPs is indicated for fireline construction and maintenance. Firelines received scant attention in the first version of Texas BMPs. However, firelines were identified as a major source of sedimentation, especially during site preparation activities. Additional guidelines for firelines have been incorporated into the BMP revision which is currently in draft form.

CONCLUSIONS

The results of the first round of BMP compliance monitoring generally shows levels of compliance on par with other southern states. Overall compliance in East Texas was found to be 88 percent, although this varied based on ownership, type of operation, landowner and contractor familiarity with BMPs, and other factors. By comparison, compliance monitoring from other southern states found the following levels of compliance:

TEXAS (1992)	88%
South Carolina (1991)	84%
Florida (1989)	94%

Although current compliance levels might be viewed by some as adequate, there is substantial room for improvement. Additional emphasis should be placed on improving BMP compliance at stream crossings on both permanent and temporary roads, installing additional drainage structures on temporary roads and skid trails, extending streamside management zone protection to intermittent streams, and controlling erosion of firelines.

BMP compliance on public lands is superior. This is largely due to the strong commitment by the USDA Forest Service to protect water quality, their high standards in road construction and stringent harvesting contract specifications.

Forest industry should be commended for the progress which has been made on implementation of BMPs on fee-owned lands. In fact, at least one major forest products company has implemented a set of internal BMPs that are more rigorous than the statewide BMP guidelines. At least 2 forest products companies have implemented internal BMP auditing systems. Visible improvement on industry lands has been seen in just the 13 months in which the statewide monitoring has been conducted.

As expected, non-industrial private landowners with small land holdings have tended to lag behind larger landowners in BMP compliance. These landowners are generally less intensively involved in forest management, only infrequently sell timber, have limited cash flow from which to pay the additional expenses of BMPs, and most often lack the technical background needed to consistently implement BMPs when they are needed. At times, they are taken advantage of because of their lack of experience in timber marketing.

However, results show a positive correlation between landowner familiarity with BMPs and compliance levels. As landowners become more familiar with BMPs they are more likely to implement them. This correlation of knowledge with implementation has also shown to be true for silvicultural contractors.

There are an estimated 150,000 non-industrial private landowners in East Texas and an estimated 2,500 silvicultural contractors. A long-term educational effort to reach these target audiences with the "BMP message" is essential to further improvement in BMP compliance and reductions in nonpoint source pollution from silvicultural activities.

APPENDIX A: Compliance Monitoring Checklist

TEXAS BMP MONITORING CHECKLIST

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

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

NEEDS IMPROVEMENT NO EFFORT POOR

PASS FAIR GOOD EXCELLENT

See Evaluation Criteria for a full description of numbered questions.

Evaluation Criteria for BMP Monitoring Checklist
Texas Forest Service BMP Project

I. General Landowner and Tract Information

County: TFS County code.
TFS Block and Grid: Enter only entry point if multiple blocks or grids.
Latitude and Longitude:
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), 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.
Distance to nearest permanent water body: Distance to nearest blue line stream or lake.
Predominant soil series: Series number form 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), Bridge (BR), Low water crossing (LW).

IV. Skid Trails/Temporary Roads

1. Slopes less than 15 %: Are skid trails run on or near contour as per guideline recommendations, rather than up and down steep slopes?
2. 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.?
3. Roads well drained with water bars or other water control structures: Were BMPs installed effectively to reduce erosion from the road?
4. Roads stabilized: If needed, are skid trails and temporary roads worked to minimize soil movement?
5. Rutting within allowable specs: Are skid trails and temporary roads free of ruts in excess of 6 inches deep for more than
   50 feet?

BMPs present: see section III above.

V. Stream Crossings

On Permanent Roads:

1. Stabilized: Are stream banks and fill stabilized? Are culverts properly sized? Are bridges used where necessary?
   Are washouts evident? Are crossings at right angles?
2. 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?
3. Stream free of sediment: Has sedimentation from the road into the stream channel been minimized?
4. Number of crossings minimized: Was an effort made to use as few crossings as possible?

On Temporary Roads

5. Number of crossings minimized: Was an effort made to use as few crossings as possible?
6. Stream crossings correct: 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. Approaches at right angles: Are approaches at right angles to the stream channel to minimize bank disturbance?
8. Stream crossings restored and stabilized: Have the temporary crossings been removed, excess fill removed from the stream channel and the banks been stabilized against erosion? Has the SMZ been stabilized in the area of the crossing?
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 sediments? 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. 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?
6. 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?
7. SMZ free of roads and landings: Were guidelines followed in locating roads and landings outside of the SMZ?
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. 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 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, SMZs, steep slopes if an alternative exist, erosion prone areas if an alternative exists, etc.?
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 to 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 Compliance

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

Significant Risk. A significant risk to water quality exists if during a normal rainfall sediment is likely to be delivered to a permanent water body.

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.

APPENDIX B: Tables B.1 – B.24

Table 8.1 - Summary of responses to BMP compliance monitoring checklist items, public sites.

Site Characteristics (15 Sites Evaluated 4,325 Total Acres)

Owner Type	Forester	Terrain	Erodability	Highest Order Stream Present	Distance to Nearest Permanent Water Body		Type of Activity Monitored #	Acres	
	0 Industry				9	< 300'	6	1,936	Regen Hrv-Clearcut
0 Small NIPF	1 Consultant	11 Flat	10 Low	7 Perennial	0	300-800'	1	558	Regen Hrv-Partial
0 Large NIPF	13 Federal	3 Hilly	5 Medium	6 Intermittent	1	800-1600'	7	1,791	Thinning
0 Industry	0 State	1 Steep	0 High	2 None	5	1600'+	1	40	Site Prep
15 Public	1 None/Unknown								

Permanent Roads: 9 Applicable 6 Not Applicable

Skid Trails/Temporary Roads: 15 Applicable 0 Not Applicable

	Yes	No	N/A		Yes	No	N/A
24. Avoid sensitive areas	9	0	6	32. Slopes less than 15%	13	2	0
25. Roads meet grade specifications	9	0	6	33. Rutting within allowable specs	15	0	0
26. Stream crossings stabilized	6	0	9	34. Water bars evident	9	6	0
27. Rutting within allowable specs.	9	0	6	35. Water bars working	8	1	6
28. Ditches do not dump into stream	7	0	8	36. Stream crossings minimized	14	0	1
29. Were BMP's used	9	0	6	37. Stream crossings correct	5	1	9
30. BMP's effective	9	0	6	38. Stream crossings restored & stabilized	3	2	10
31. Stream free of sediment	8	0	7	39. Were BMP's used	11	4	0
				40. Stream free of sediment	13	1	1

Streamside Management Zones: 13 Applicable 2 Not Applicable

	Yes	No	N/A		Yes	No	N/A
41. SMZ present on permanent stream	7	0	8	45. SMZ integrity honored	11	1	3
42. SMZ present on intermittent stream	7	1	7	46. Stream clear of debris	13	0	2
43. SMZ adequately wide	12	0	3	47. SMZ free of roads and landings	12	0	3
44. Thinning within allowable specs	7	0	8	48. Stream free of sediment	13	0	2

Site Preparation: 1 Applicable 14 Not Applicable

49. Site prep method:

0 Shear/Pile/Burn 0 Shear/Pile 0 Shear Only 0 Drum Chop 1 Hot Fire 0 Chemical 0 Disk/Bed 0 Disk Only 0 Sub-Soil

50. Regeneration Method: 0 Mechanical 1 Hand-plant

	Yes	No	N/A		Yes	No	N/A
51. No soil movement on site	1	0	14	54. Windrows on contour/free of soil	0	0	15
52. Firebreak erosion controlled	1	0	14	55. No chemical off site	0	0	15
53. SMZ integrity honored	0	1	14	56. Were BMP's used	1	0	14
				57. Stream free of sediment	1	0	14

Log Sets: 14 Applicable 1 Not Applicable

	Yes	No	N/A		Yes	No	N/A
58. Locations free of oil/trash	14	0	1	60. Well drained location	13	1	1
59. Located outside SMZ	12	0	3	61. Restored, stabilized	4	0	11

62. Overall Compliance with Best Management Practices

Needs Improvement			Pass	
No Effort	Poor	Fair	Good	Excellent
0	1	2	8	4
0.0%	6.7%	13.3%	53.3%	26.7%

Table 8.2 - Summary of responses to BMP compliance monitoring checklist items, forest industry sites.

Site Characteristics (67 Sites Evaluated 11,435 Total Acres)

Owner Type	Forester	Terrain	Erodability	Highest Order Stream Present	Distance to Nearest Permanent Water Body		Type of Activity Monitored #	Acres	
	67 Industry				29	< 300'	26	3,385	Regen Hrv-Clearcut
0 Small NIPF	0 Consultant	35 Flat	30 Low	25 Perennial	5	300-800'	4	969	Regen Hrv-Partial
0 Large NIPF	0 Federal	26 Hilly	29 Medium	30 Intermittent	10	800-1600'	6	2,155	Thinning
67 Industry	0 State	6 Steep	8 High	12 None	23	1600'+	31	4,926	Site Prep
0 Public	0 None/Unknown								

Permanent Roads: 50 Applicable 17 Not Applicable

Skid Trails/Temporary Roads: 43 Applicable 24 Not Applicable

	Yes	No	N/A		Yes	No	N/A
24. Avoid sensitive areas	50	0	17	32. Slopes less than 15%	40	3	24
25. Roads meet grade specifications	50	0	17	33. Rutting within allowable specs	32	11	24
26. Stream crossings stabilized	23	2	42	34. Water bars evident	9	34	24
27. Rutting within allowable specs.	49	1	17	35. Water bars working	8	1	58
28. Ditches do not dump into stream	29	10	28	36. Stream crossings minimized	30	7	30
29. Were BMP's used	49	1	17	37. Stream crossings correct	16	3	48
30. BMP's effective	49	0	18	38. Stream crossings restored & stabilized	5	10	52
31. Stream free of sediment	36	3	28	39. Were BMP's used	17	26	24
				40. Stream free of sediment	28	8	31

Streamside Management Zones: 55 Applicable 12 Not Applicable

	Yes	No	N/A		Yes	No	N/A
41. SMZ present on permanent stream	25	0	42	45. SMZ integrity honored	45	6	16
42. SMZ present on intermittent stream	42	5	20	46. Stream clear of debris	49	6	12
43. SMZ adequately wide	46	5	16	47. SMZ free of roads and landings	48	3	16
44. Thinning within allowable specs	25	3	39	48. Stream free of sediment	48	7	12

Site Preparation: 32 Applicable 35 Not Applicable

49. Site prep method:

3 Shear/Pile/Burn	1 Shear/Pile	19 Shear Only	8 Drum Chop	0 Hot Fire	1 Chemical	0 Disk/Bed	0 Disk Only	0 Sub-Soil

50. Regeneration Method: 20 Mechanical 8 Hand-plant

	Yes	No	N/A		Yes	No	N/A
51. No soil movement on site	31	1	35	54. Windrows on contour/free of soil	1	0	66
52. Firebreak erosion controlled	17	2	48	55. No chemical off site	1	0	66
53. SMZ integrity honored	24	1	42	56. Were BMP's used	22	10	35
				57. Stream free of sediment	24	1	35

Log Sets: 41 Applicable 26 Not Applicable

	Yes	No	N/A		Yes	No	N/A
58. Locations free of oil/trash	40	1	26	60. Well drained location	41	0	26
59. Located outside SMZ	35	1	31	61. Restored, stabilized	4	3	60

62. Overall Compliance with Best Management Practices

Needs Improvement			Pass	
No Effort	Poor	Fair	Good	Excellent
0	7	12	42	6
0.0%	10.4%	17.9%	62.7%	9.0%

Table 8.3 - Summary of responses to BMP compliance monitoring checklist items, nonindustrial private sites.

Site Characteristics (80 Sites Evaluated 9,670 Total Acres)

Owner Type	Forester	Terrain	Erodability	Highest Order Stream Present	Distance to Nearest Permanent Water Body		Type of Activity Monitored #	Acres	
	6 Industry				33	< 300'	38	3,592	Regen Hrv-Clearcut
68 Small NIPF	42 Consultant	32 Flat	30 Low	25 Perennial	26	300-800'	8	923	Regen Hrv-Partial
12 Large NIPF	0 Federal	41 Hilly	40 Medium	37 Intermittent	13	800-1600'	23	4,739	Thinning
0 Industry	0 State	7 Steep	10 High	18 None	8	1600'+	11	416	Site Prep
0 Public	32 None/Unknown								

Permanent Roads: 31 Applicable 49 Not Applicable

Skid Trails/Temporary Roads: 71 Applicable 9 Not Applicable

	Yes	No	N/A		Yes	No	N/A
24. Avoid sensitive areas	30	1	49	32. Slopes less than 15%	63	8	9
25. Roads meet grade specifications	29	2	49	33. Rutting within allowable specs	61	10	9
26. Stream crossings stabilized	7	10	63	34. Water bars evident	6	65	9
27. Rutting within allowable specs.	30	1	49	35. Water bars working	5	1	74
28. Ditches do not dump into stream	15	3	62	36. Stream crossings minimized	52	6	22
29. Were BMP's used	13	18	49	37. Stream crossings correct	23	22	35
30. BMP's effective	13	0	67	38. Stream crossings restored & stabilized	3	31	46
31. Stream free of sediment	21	6	53	39. Were BMP's used	14	57	9
				40. Stream free of sediment	39	19	22

Streamside Management Zones: 62 Applicable 18 Not Applicable

	Yes	No	N/A		Yes	No	N/A
41. SMZ present on permanent stream	19	6	55	45. SMZ integrity honored	30	7	43
42. SMZ present on intermittent stream	26	29	25	46. Stream clear of debris	35	27	18
43. SMZ adequately wide	35	2	43	47. SMZ free of roads and landings	36	1	43
44. Thinning within allowable specs	25	1	54	48. Stream free of sediment	49	13	18

Site Preparation: 20 Applicable 60 Not Applicable

49. Site prep method:

1 Shear/Pile/Burn 7 Shear/Pile 1 Shear Only 0 Drum Chop 7 Hot Fire 3 Chemical 0 Disk/Bed 0 Disk Only 0 Sub-Soil

50. Regeneration Method: 1 Mechanical 11 Hand-plant

	Yes	No	N/A		Yes	No	N/A
51. No soil movement on site	16	4	60	54. Windrows on contour/free of soil	4	1	75
52. Firebreak erosion controlled	6	4	70	55. No chemical off site	3	1	76
53. SMZ integrity honored	7	6	67	56. Were BMP's used	3	17	60
				57. Stream free of sediment	12	2	60

Log Sets: 73 Applicable 7 Not Applicable

	Yes	No	N/A		Yes	No	N/A
58. Locations free of oil/trash	67	6	7	60. Well drained location	71	2	7
59. Located outside SMZ	62	3	15	61. Restored, stabilized	1	8	71

62. Overall Compliance with Best Management Practices

Needs Improvement			Pass	
No Effort	Poor	Fair	Good	Excellent
4	7	21	44	4
5.0%	8.8%	26.3%	55.0%	5.0%

Table 8.4 - Summary of responses to BMP compliance monitoring checklist items, Northeast Texas sites.

Site Characteristics (61 Sites Evaluated 7,857 Total Acres)

Owner Type	Forester	Terrain	Erodability	Highest Order Stream Present	Distance to Nearest Permanent Water Body		Type of Activity Monitored #	Acres	
	17 Industry				25	< 300'	32	4,098	Regen Hrv-Clearcut
41 Small NIPF	21 Consultant	13 Flat	10 Low	21 Perennial	22	300-800'	2	254	Regen Hrv-Partial
4 Large NIPF	2 Federal	36 Hilly	41 Medium	33 Intermittent	11	800-1600'	14	2,524	Thinning
14 Industry	0 State	12 Steep	10 High	7 None	3	1600'+	13	981	Site Prep
2 Public	21 None/Unknown								

Permanent Roads: 27 Applicable 34 Not Applicable

Skid Trails/Temporary Roads: 51 Applicable 10 Not Applicable

	Yes	No	N/A		Yes	No	N/A
24. Avoid sensitive areas	26	1	34	32. Slopes less than 15%	42	9	10
25. Roads meet grade specifications	26	1	34	33. Rutting within allowable specs	41	10	10
26. Stream crossings stabilized	11	5	45	34. Water bars evident	11	40	10
27. Rutting within allowable specs.	26	1	34	35. Water bars working	9	2	50
28. Ditches do not dump into stream	16	3	42	36. Stream crossings minimized	42	5	14
29. Were BMP's used	15	12	34	37. Stream crossings correct	17	17	27
30. BMP's effective	15	0	46	38. Stream crossings restored & stabilized	6	20	35
31. Stream free of sediment	21	5	35	39. Were BMP's used	13	38	10
				40. Stream free of sediment	32	14	15

Streamside Management Zones: 54 Applicable 7 Not Applicable

	Yes	No	N/A		Yes	No	N/A
41. SMZ present on permanent stream	17	4	40	45. SMZ integrity honored	28	6	27
42. SMZ present on intermittent stream	24	22	15	46. Stream clear of debris	34	20	7
43. SMZ adequately wide	32	2	27	47. SMZ free of roads and landings	33	1	27
44. Thinning within allowable specs	25	1	35	48. Stream free of sediment	43	11	7

Site Preparation: 21 Applicable 40 Not Applicable

49. Site prep method:

2 Shear/Pile/Burn 5 Shear/Pile 2 Shear Only 0 Drum Chop 7 Hot Fire 4 Chemical 0 Disk/Bed 0 Disk Only 0 Sub-Soil

50. Regeneration Method: 3 Mechanical 12 Hand-plant

	Yes	No	N/A		Yes	No	N/A
51. No soil movement on site	18	3	40	54. Windrows on contour/free of soil	4	1	56
52. Firebreak erosion controlled	9	4	48	55. No chemical off site	4	1	56
53. SMZ integrity honored	11	6	44	56. Were BMP's used	6	15	40
				57. Stream free of sediment	16	2	40

Log Sets: 56 Applicable 5 Not Applicable

	Yes	No	N/A		Yes	No	N/A
58. Locations free of oil/trash	53	3	5	60. Well drained location	54	2	5
59. Located outside SMZ	55	1	5	61. Restored, stabilized	3	4	54

62. Overall Compliance with Best Management Practices

Needs Improvement			Pass	
No Effort	Poor	Fair	Good	Excellent
1	7	11	32	10
1.6%	11.5%	18.0%	52.5%	16.4%

Table 8.5 - Summary of responses to BMP compliance monitoring checklist items, Southeast Texas sites.

Site Characteristics (101 Sites Evaluated 17,573 Total Acres)

Owner Type	Forester	Terrain	Erodability	Highest Order Stream Present	Distance to Nearest Permanent Water Body		Type of Activity Monitored #	Acres	
	56 Industry				46	< 300'	38	4,815	Regen Hrv-Clearcut
27 Small NIPF	22 Consultant	65 Flat	60 Low	36 Perennial	9	300-800'	11	2,196	Regen Hrv-Partial
8 Large NIPF	11 Federal	34 Hilly	33 Medium	40 Intermittent	13	800-1600'	22	6,161	Thinning
53 Industry	0 State	2 Steep	8 High	25 None	33	1600'+	30	4,401	Site Prep
13 Public	12 None/Unknown								

Permanent Roads: 63 Applicable 38 Not Applicable

Skid Trails/Temporary Roads: 78 Applicable 23 Not Applicable

	Yes	No	N/A		Yes	No	N/A
24. Avoid sensitive areas	63	0	38	32. Slopes less than 15%	74	4	23
25. Roads meet grade specifications	662	1	38	33. Rutting within allowable specs	67	11	23
26. Stream crossings stabilized	25	7	69	34. Water bars evident	13	65	23
27. Rutting within allowable specs.	62	1	38	35. Water bars working	12	1	88
28. Ditches do not dump into stream	35	10	56	36. Stream crossings minimized	54	8	39
29. Were BMP's used	56	7	38	37. Stream crossings correct	27	9	65
30. BMP's effective	56	0	45	38. Stream crossings restored & stabilized	5	23	73
31. Stream free of sediment	44	4	53	39. Were BMP's used	29	49	23
				40. Stream free of sediment	48	14	39

Streamside Management Zones: 76 Applicable 25 Not Applicable

	Yes	No	N/A		Yes	No	N/A
41. SMZ present on permanent stream	34	2	65	45. SMZ integrity honored	58	8	35
42. SMZ present on intermittent stream	51	13	37	46. Stream clear of debris	63	13	25
43. SMZ adequately wide	61	5	35	47. SMZ free of roads and landings	63	3	35
44. Thinning within allowable specs	32	3	66	48. Stream free of sediment	67	9	25

Site Preparation: 32 Applicable 69 Not Applicable

49. Site prep method:

2 Shear/Pile/Burn 3 Shear/Pile 18 Shear Only 8 Drum Chop 1 Hot Fire 0 Chemical 0 Disk/Bed 0 Disk Only 0 Sub-Soil

50. Regeneration Method: 18 Mechanical 8 Hand-plant

	Yes	No	N/A		Yes	No	N/A
51. No soil movement on site	30	2	69	54. Windrows on contour/free of soil	1	0	100
52. Firebreak erosion controlled	15	2	84	55. No chemical off site	0	0	101
53. SMZ integrity honored	20	2	79	56. Were BMP's used	20	12	69
				57. Stream free of sediment	21	1	69

Log Sets: 72 Applicable 29 Not Applicable

	Yes	No	N/A		Yes	No	N/A
58. Locations free of oil/trash	68	4	29	60. Well drained location	71	1	29
59. Located outside SMZ	54	3	44	61. Restored, stabilized	6	7	88

62. Overall Compliance with Best Management Practices

Needs Improvement			Pass	
No Effort	Poor	Fair	Good	Excellent
3	8	24	62	4
3.0%	7.9%	23.8%	61.4%	4.0%

Table B.6 - Overall compliance rating by ownership category

Ownership Category	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Industry	67	3.70	9.0	62.7	17.9	10.4	
NIPF - Large	12	3.75	8.3	66.7	16.7	8.3	
NIPF - Small	68	3.41	4.4	52.9	27.9	8.8	5.9
Public	15	4.00	26.7	53.3	13.3	6.7	
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.7 - Overall compliance rating by year in which activity occurred.

Year of Activity	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
1990	35	3.57	5.7	60.0	22.9	8.6	2.9
1991	109	3.58	7.3	58.7	21.1	10.1	2.8
1992	16	3.88	25.0	43.8	25.0	6.3	
NA	2	4.00		100.0			
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.8 - Overall compliance rating by region of Texas.

Region	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Northeast TX	61	3.70	16.4	52.5	18.0	11.5	1.6
Southeast TX	101	3.55	4.0	61.4	23.8	7.9	3.0
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table 8.9 - Overall compliance rating by county.

County	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Anderson	1	5.00	100.0				
Angelina	9	3.56	11.1	55.6	22.2		11.1
Bowie	2	4.00		100.0			
Camp	1	4.00		100.0			
Cass	6	4.00	16.7	66.7	16.7		
Cherokee	9	3.56	11.1	44.4	33.3	11.1	
Franklin	1	5.00	100.0				
Grimes	2	3.50		50.0	50.0		
Hardin	10	3.70		70.0	30.0		
Harris	2	3.50		50.0	50.0		
Harrison	7	2.86		28.6	42.9	14.3	14.3
Houston	9	3.78		77.8	22.2		
Jasper	11	3.64		72.7	18.2	9.1	
Liberty	2	4.00		100.0			
Marion	6	3.50		66.7	16.7	16.7	
Montgomery	8	3.75		87.5		12.5	
Morris	1	4.00		100.0			
Nacogdoches	7	3.71	28.6	42.9		28.6	
Newton	3	4.00		100.0			
Orange	1	2.00				100.0	
Panola	5	3.60		60.0	40.0		
Polk	15	3.60	6.7	53.3	33.3	6.7	
Red River	2	4.50	50.0	50.0			
Rusk	3	4.67	66.7	33.3			
Sabine	5	4.20	40.0	40.0	20.0		
San Augustine	4	2.25			25.0	75.0	
San Jacinto	6	3.33		66.7	16.7		16.7
Shelby	4	4.25	25.0	75.0			
Smith	2	3.00		50.0		50.0	
Trinity	2	4.00		100.0			
Tyler	10	3.00		30.0	50.0	10.0	10.0
Upshur	3	3.00		33.3	33.3	33.3	
Walker	2	4.00		100.0			
Wood	1	4.00		100.0			
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.10 - Overall compliance rating by forester involvement.

Forester Involvement	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
None/Unknown	33	3.30		60.6	18.2	12.1	9.1
Prof. Forester	129	3.69	10.9	57.4	22.5	8.5	0.8
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.11 - Overall compliance rating by type of forester involved.

Type of Forester Involved	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Consultant	43	3.58	9.3	51.2	30.2	7.0	2.3
Federal	13	4.23	30.8	61.5	7.7		
Industry	73	3.66	8.2	60.3	20.5	11.0	
None	18	3.33		66.7	11.1	11.1	11.1
Unknown	15	3.27		53.3	26.7	13.3	6.7
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.12 - Overall compliance rating by type of operation.

Type of Operation	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Clearcut	70	3.39	7.1	48.6	25.7	12.9	5.7
Partial Cut	13	3.69	15.4	53.8	15.4	15.4	
Site Prep	43	3.88	9.3	74.4	11.6	4.7	
Thinning	36	3.69	8.3	58.3	27.8	5.6	
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.13 - Overall compliance rating by highest order stream present.

Highest Stream Order Present	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
None	32	3.78	3.1	75.0	18.8	3.1	
Intermittent	73	3.47	9.6	45.2	30.1	12.3	2.7
Perennial	57	3.70	10.5	64.9	12.3	8.8	3.5
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.14 - Overall compliance rating by distance to nearest permanent water body.

Distance to Nearest Perm. Water Body	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
< 300'	71	3.62	8.5	60.6	18.3	9.9	2.8
300-800'	31	3.58	9.7	51.6	29.0	6.5	3.2
800-1600'	24	3.83	16.7	54.2	25.0	4.2	
1600'+	36	3.47	2.8	61.1	19.4	13.9	2.8
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.15 - Overall compliance rating by terrain class.

Terrain Class	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Flat	78	3.72	7.7	64.1	21.8	5.1	1.3
Hilly	70	3.53	10.0	52.9	20.0	14.3	2.9
Steep	14	3.43	7.1	50.0	28.6	7.1	7.1
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.16 - Overall compliance rating by erodability hazard rating.

Erodability Hazard	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Low	70	3.91	11.4	71.4	14.3	2.9	
Medium	74	3.50	5.4	54.1	27.0	12.2	1.4
High	18	2.89	11.1	22.2	27.8	22.2	16.7
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.17 - Overall compliance rating by level of supervision.

Activity Supervised by owner or Rep.?	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Unknown	25	3.36		60.0	20.0	16.0	4.0
No	11	3.00		45.5	27.3	9.1	18.2
Yes	126	3.71	11.1	58.7	21.4	7.9	0.8
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.18 - Overall compliance rating by level of supervision, NIPF sites.

Activity Supervised by owner or Rep.?	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Unknown	22	3.36		59.1	22.7	13.6	4.5
No	11	3.00		45.5	27.3	9.1	18.2
Yes	47	3.62	8.5	55.3	27.7	6.4	2.1
Total	80	3.46	5.0	55.0	26.3	8.8	5.0

Table B.19 - Overall compliance rating by landowner familiarity with BMP's.

Landowner Familiar with BMPs?	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Unknown	28	3.43	3.6	57.1	21.4	14.3	3.6
No	45	3.31		53.3	28.9	13.3	4.4
Yes	89	3.82	14.6	60.7	18.0	5.6	1.1
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.20 - Overall compliance rating by landowner familiarity with BMP's, NIPF sites.

Landowner Familiar with BMPs?	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Unknown	24	3.46	4.2	58.3	20.8	12.5	4.2
No	42	3.36		54.8	31.0	9.5	4.8
Yes	14	3.79	21.4	50.0	21.4		7.1
Total	80	3.46	5.0	55.0	26.3	8.8	5.0

Table B.21 - Overall compliance rating by contractor familiarity with BMP's.

Logger/Operator Familiar with BMPs?	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Unknown	78	3.63	2.6	67.9	20.5	7.7	1.3
No	21	3.05	4.8	38.1	23.8	23.8	9.5
Yes	63	3.78	17.5	52.4	22.2	6.3	1.6
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.22 - Overall compliance rating by contractor familiarity with BMP's, NIPF sites.

Logger/Operator Familiar with BMPs?	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Unknown	47	3.51	2.1	59.6	27.7	8.5	2.1
No	15	3.13		53.3	20.0	13.3	13.3
Yes	18	3.61	16.7	44.4	27.8	5.6	5.6
Total	80	3.46	5.0	55.0	26.3	8.8	5.0

Table B.23 - Overall compliance rating by inclusion of BMP's in contract.

Were BMP's Included in Contract?	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Unknown	55	3.64	3.6	70.9	12.7	10.9	1.8
No	47	3.32	2.1	46.8	36.2	10.6	4.3
Yes	60	3.82	18.3	55.0	18.3	6.7	1.7
Total	162	3.61	8.6	58.0	21.6	9.3	2.5

Table B.24 - Overall compliance rating by inclusion of BMP's in contract, NIPF sites.

Were BMP's Included in Contract?	Number of Sites	Average Score	Overall Compliance Rating				
			Excellent (5.0)	Good (4.0)	Fair (3.0)	Poor (2.0)	No Effort (1.0)
			Percent of Sites				
Unknown	40	3.58	5.0	65.0	15.0	12.5	2.5
No	31	3.29		48.4	38.7	6.5	6.5
Yes	9	3.56	22.2	33.3	33.3		11.1
Total	80	3.46	5.0	55.0	26.3	8.8	5.0

APPENDIX C: Figures 1 – 20

-- Figure 1 --

Site Locations & Ownership Category

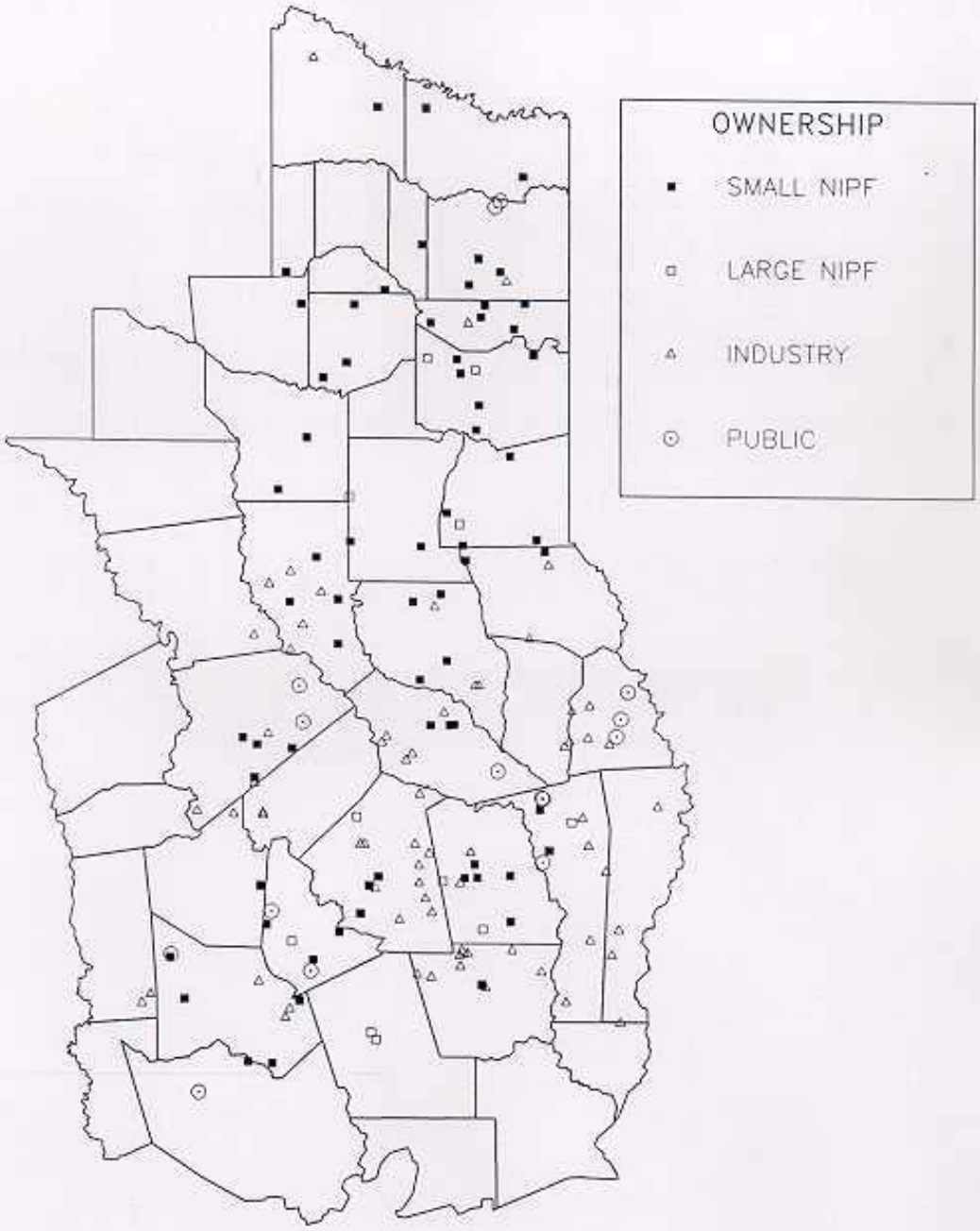


Figure 2
Permanent Roads

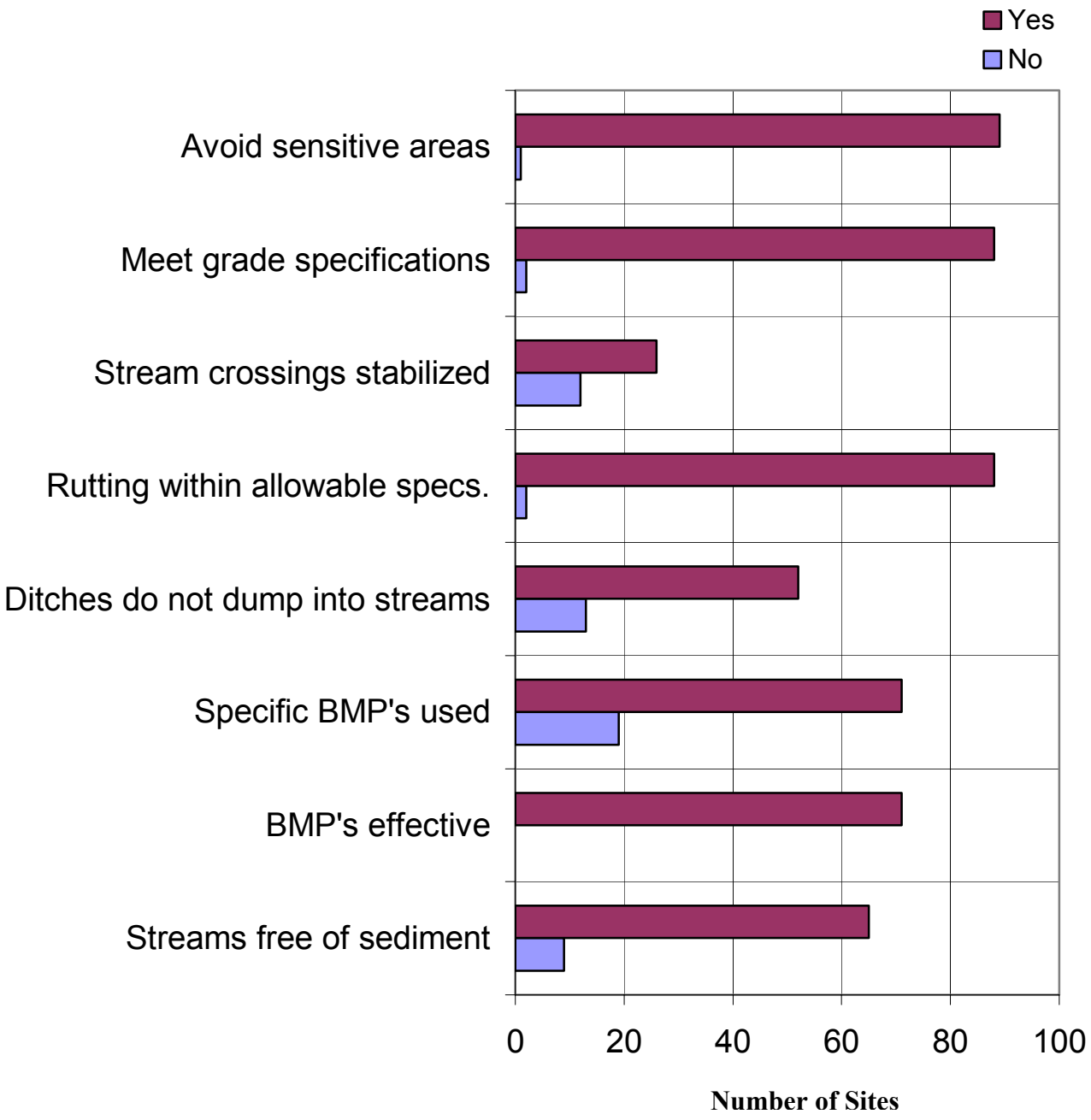


Figure 3
Skid Trails & Temporary Roads

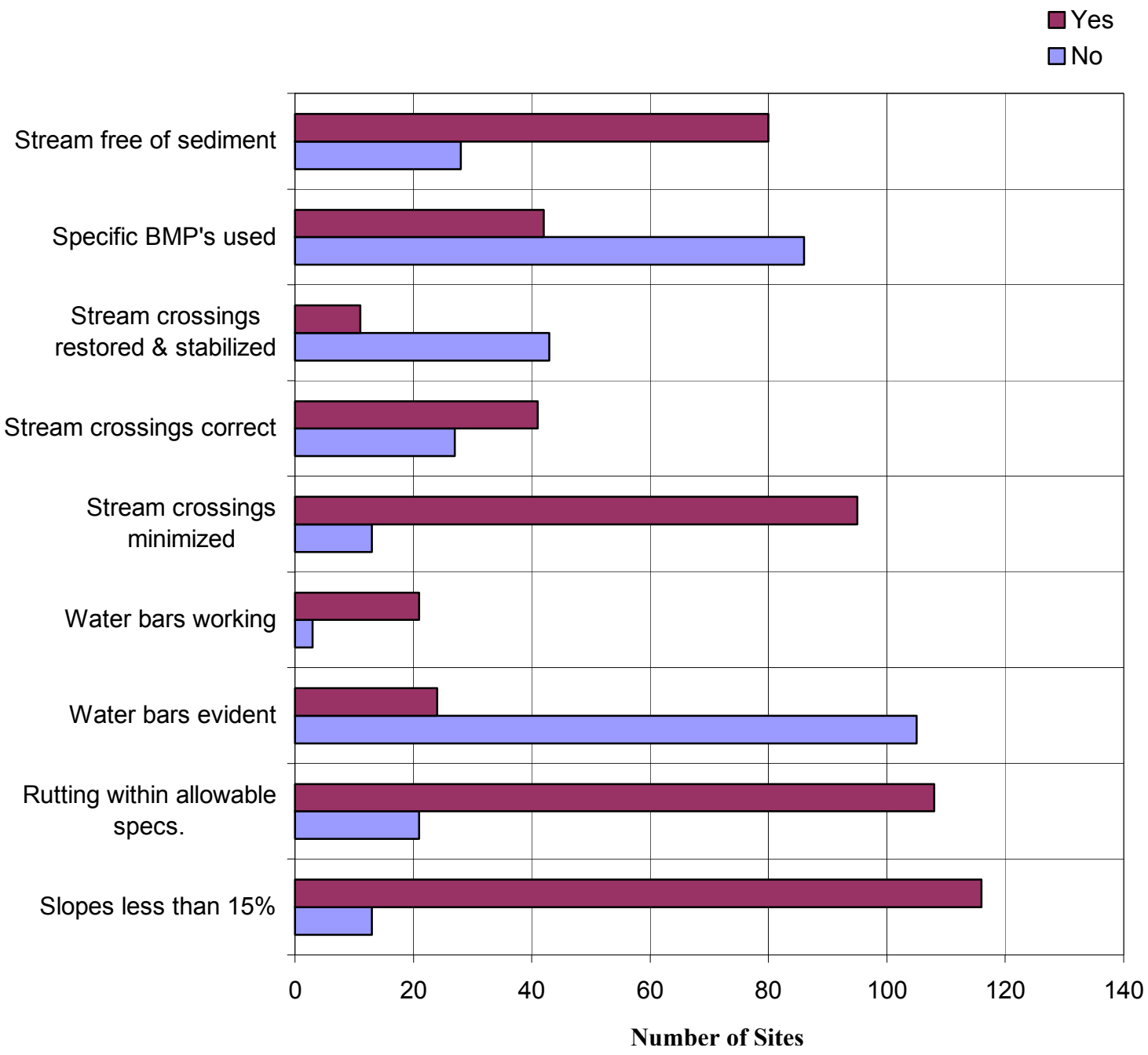


Figure 4
Streamside Management Zones

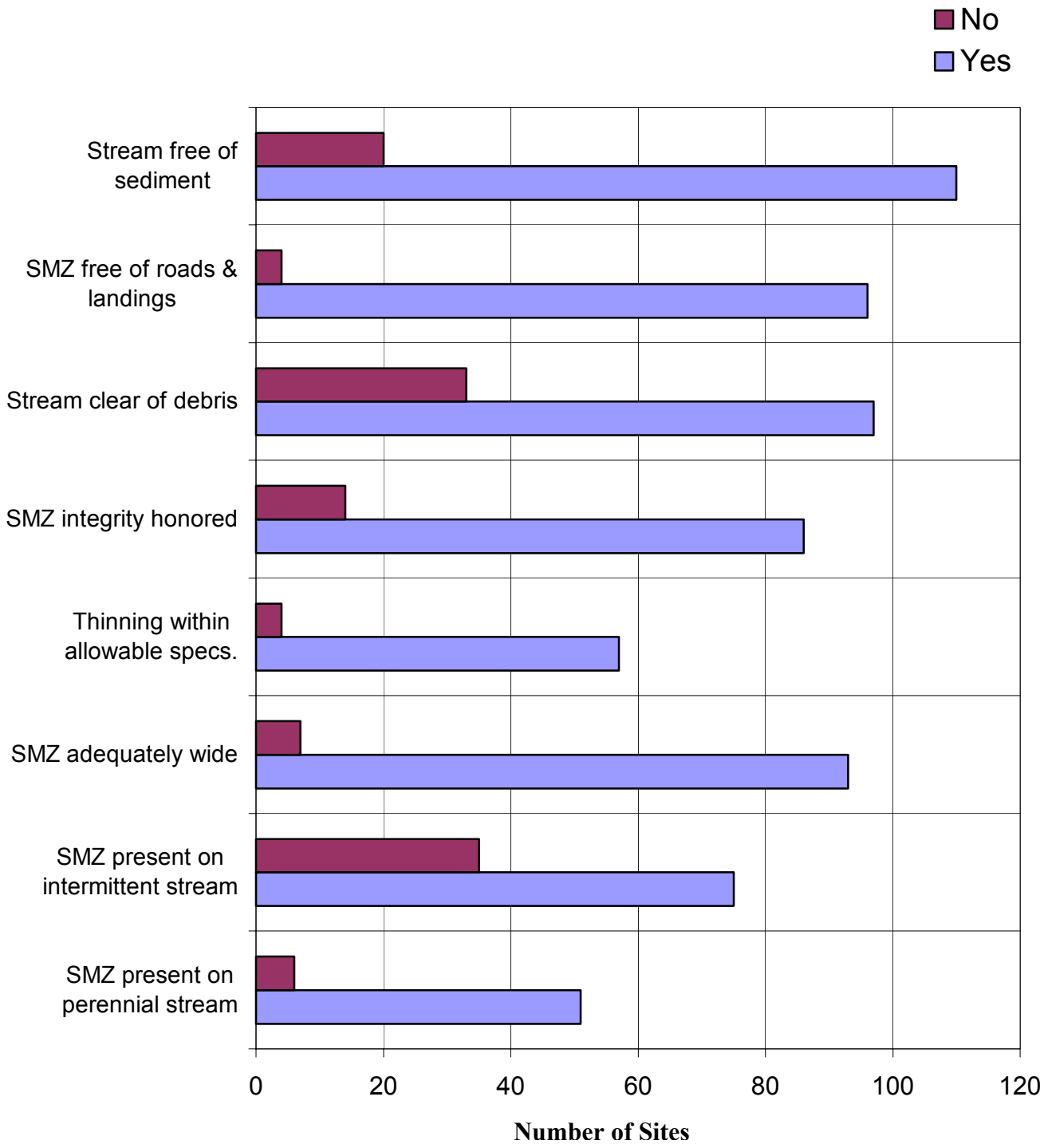


Figure 5
Site Preparation

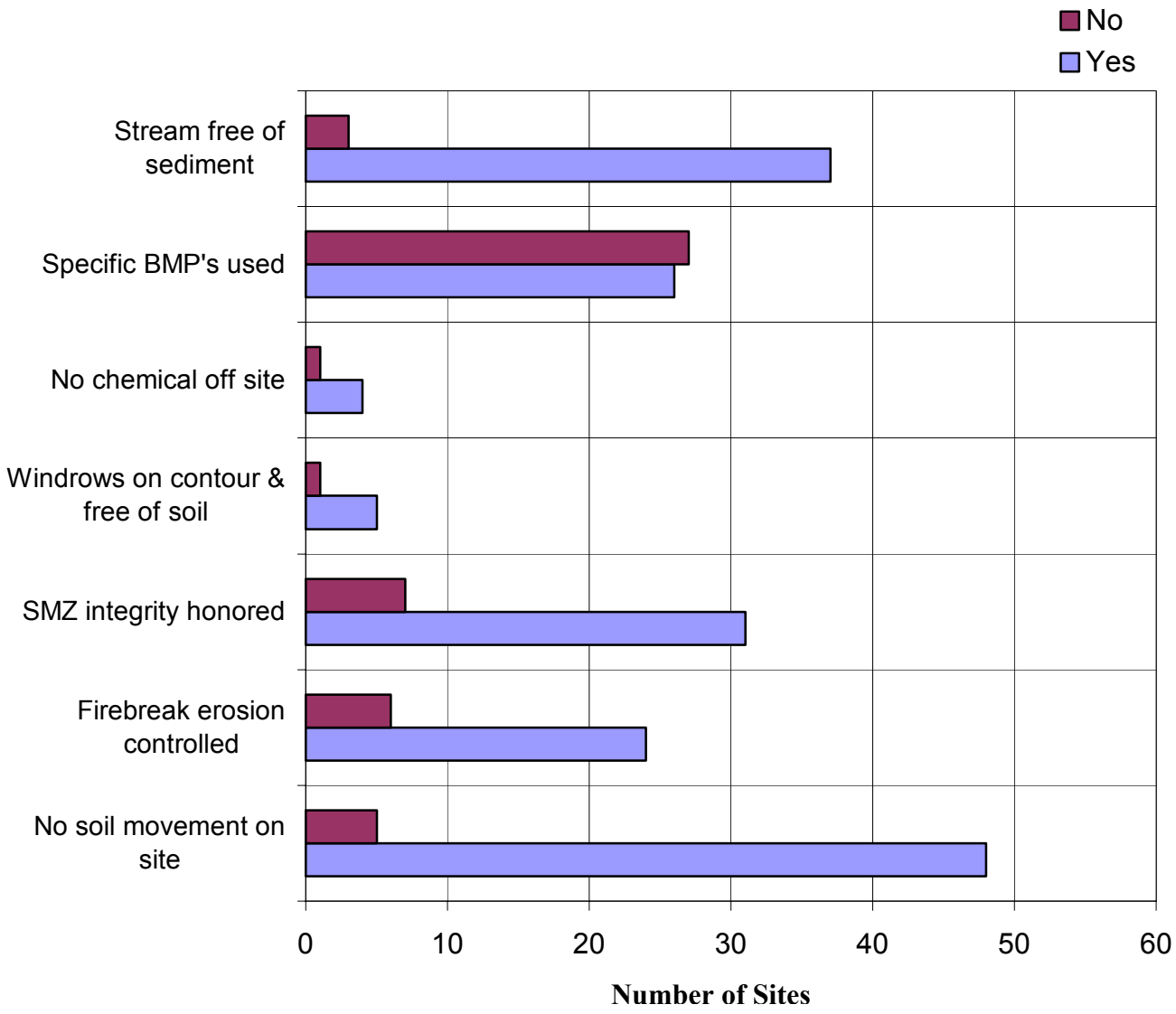
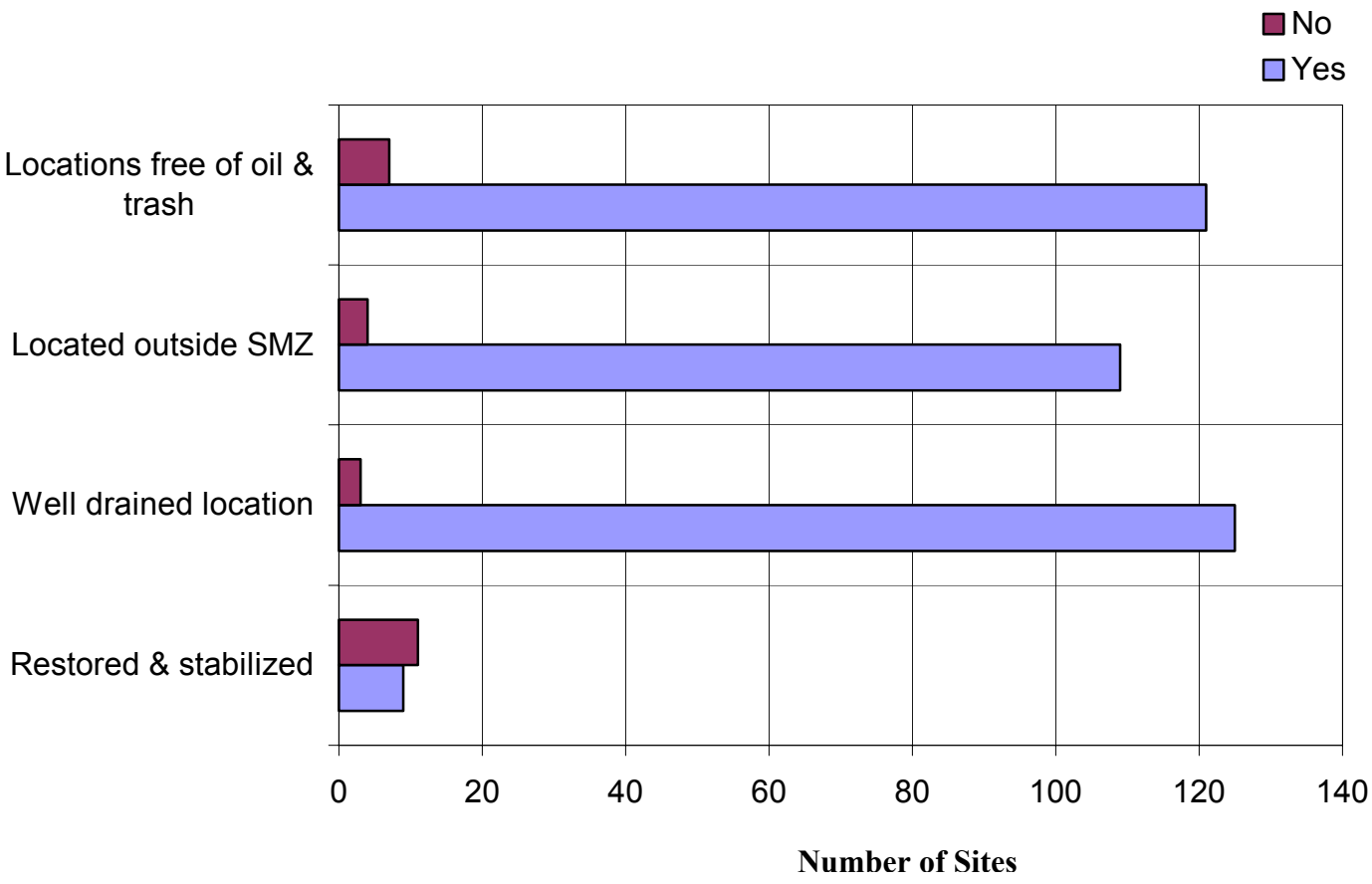


Figure 6
Log Sets (Landings)



-- Figure 7 --

Site Locations & Overall Compliance Rating

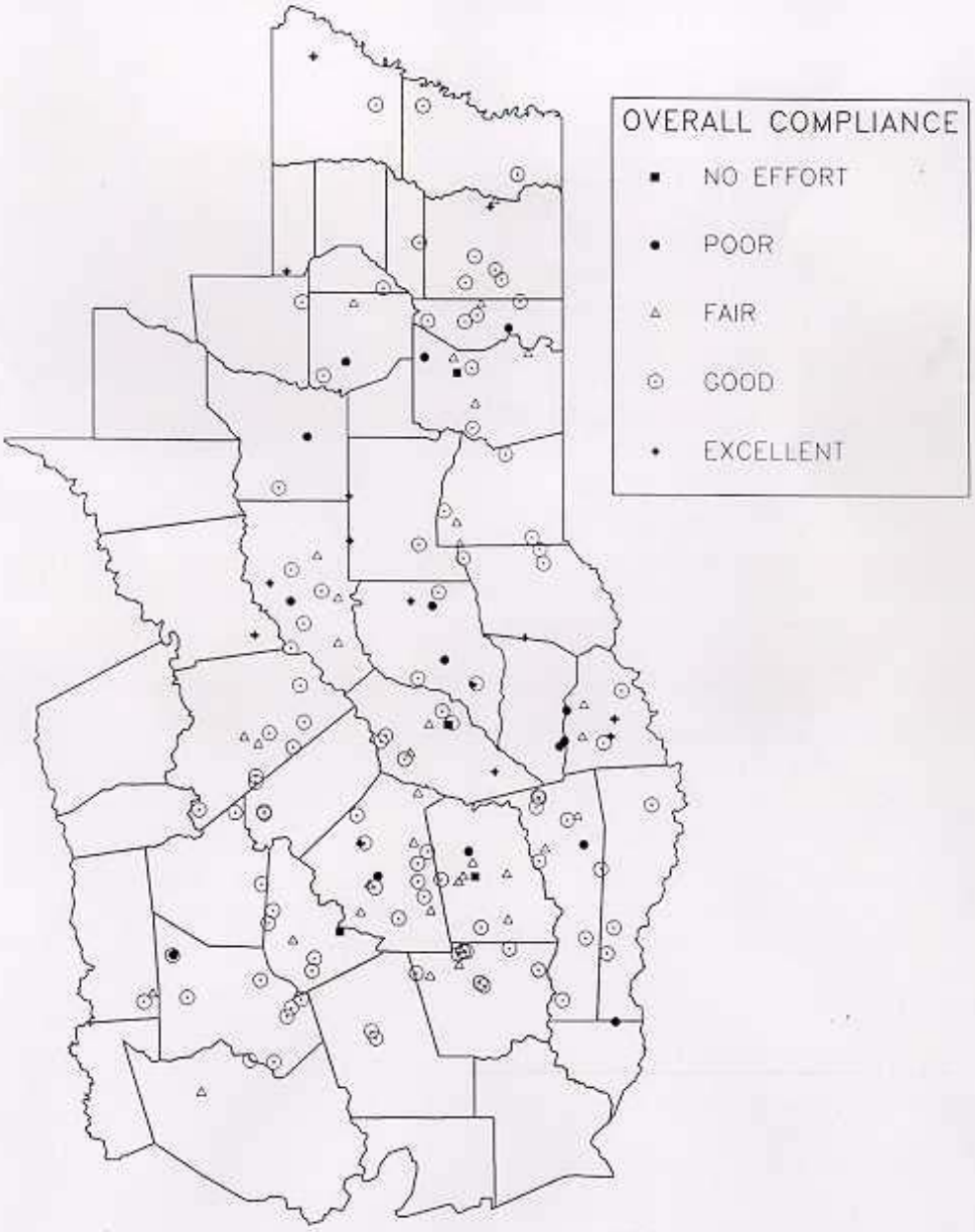


Figure 8
Overall Compliance

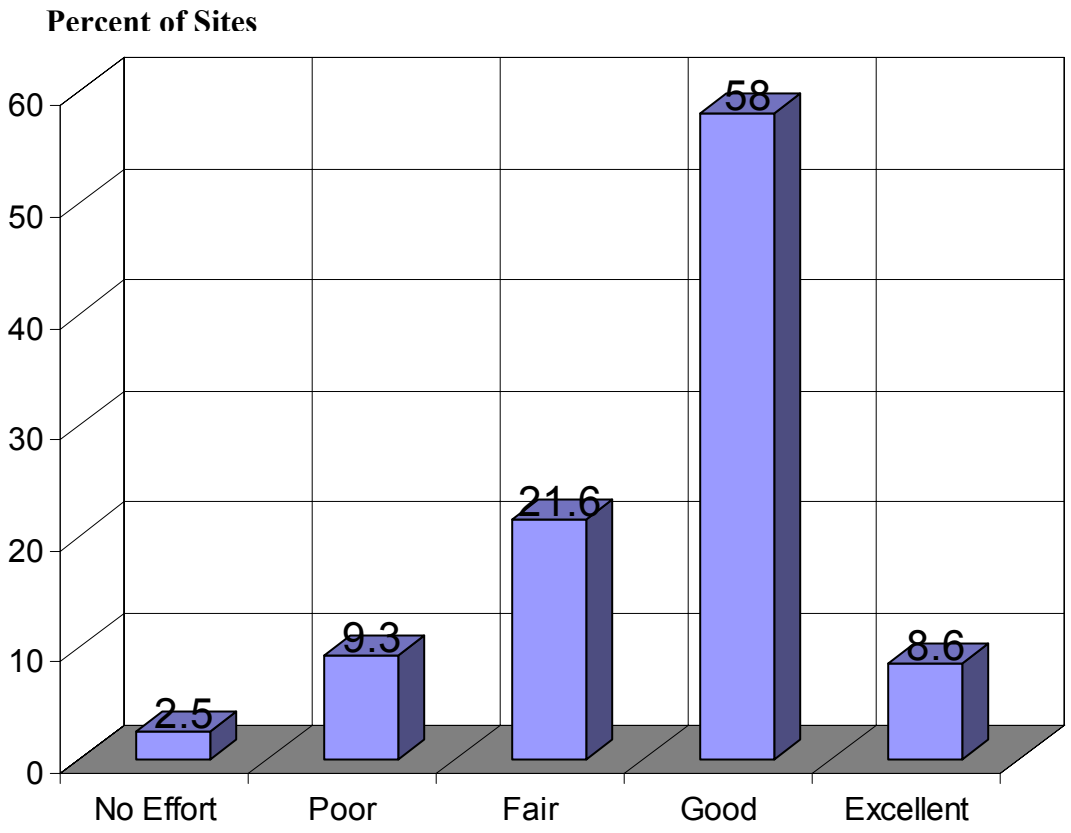


Figure 9
Overall Compliance by Ownership

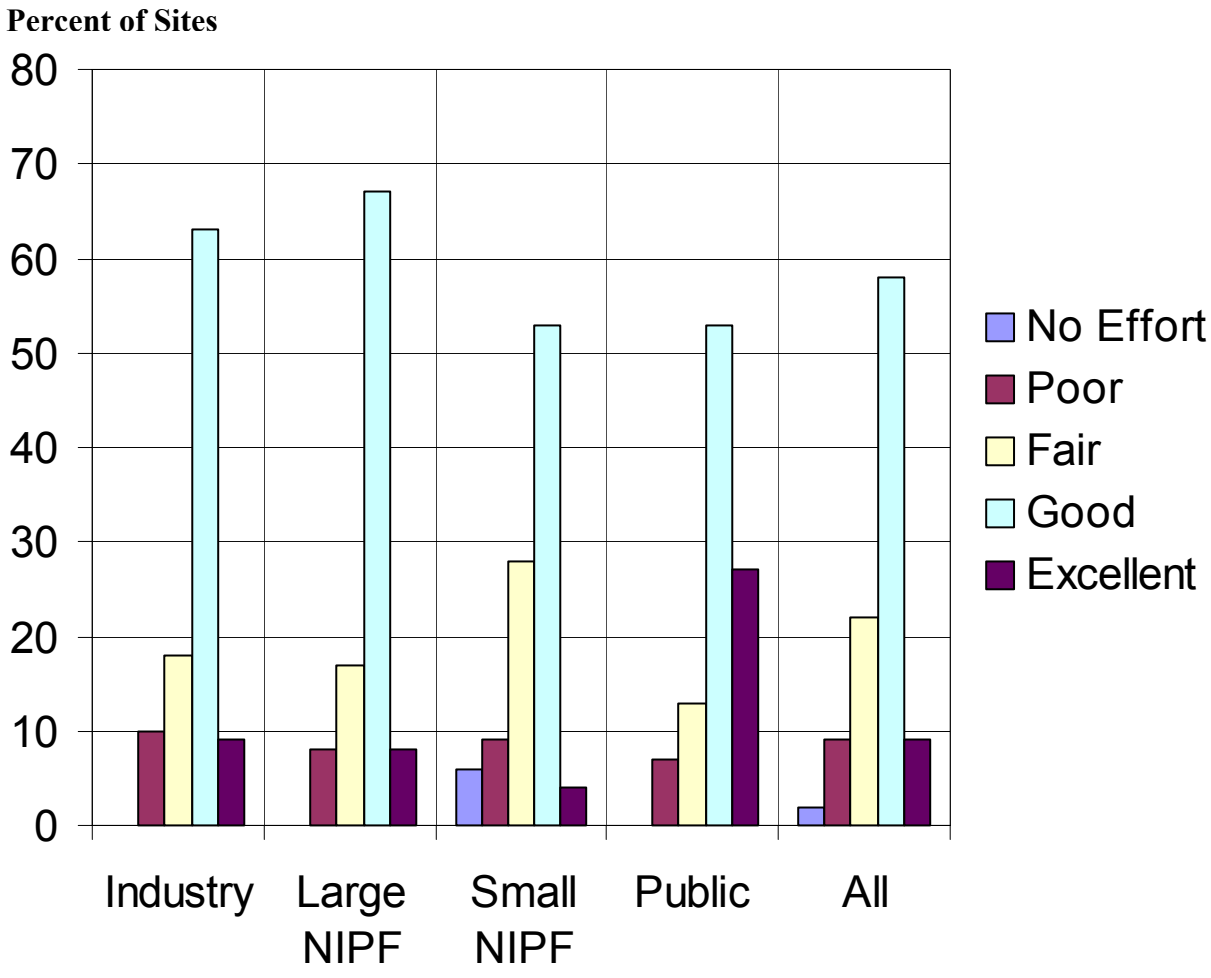


Figure 10
Overall Compliance by Year of Activity

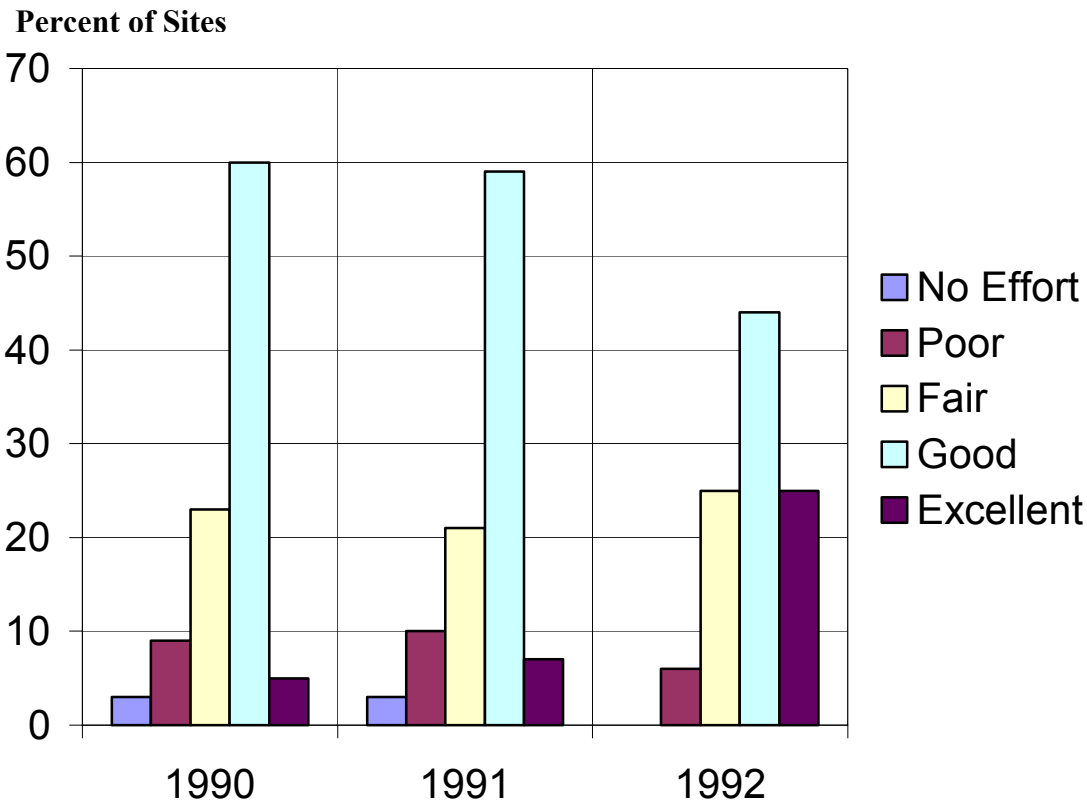


Figure 11
Overall Compliance by Region

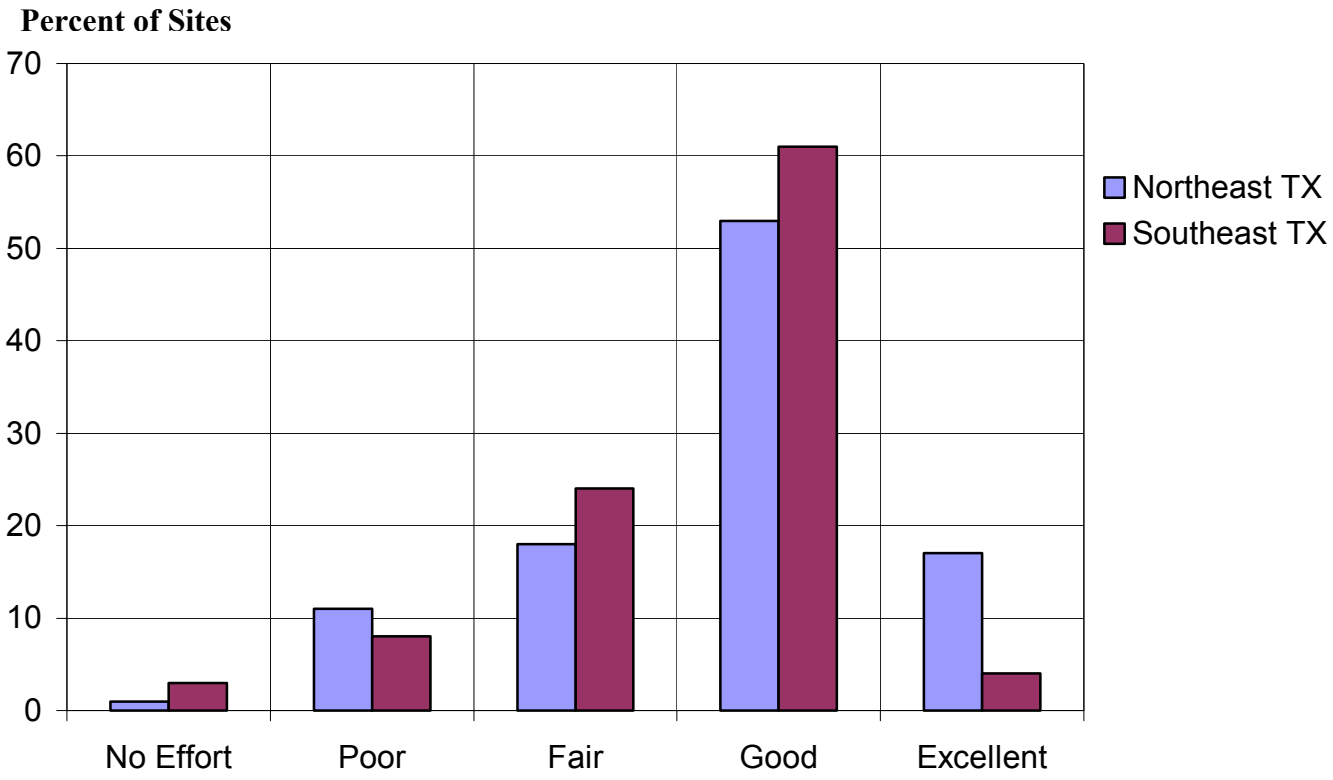


Figure 12
Overall Compliance by Forester Involvement

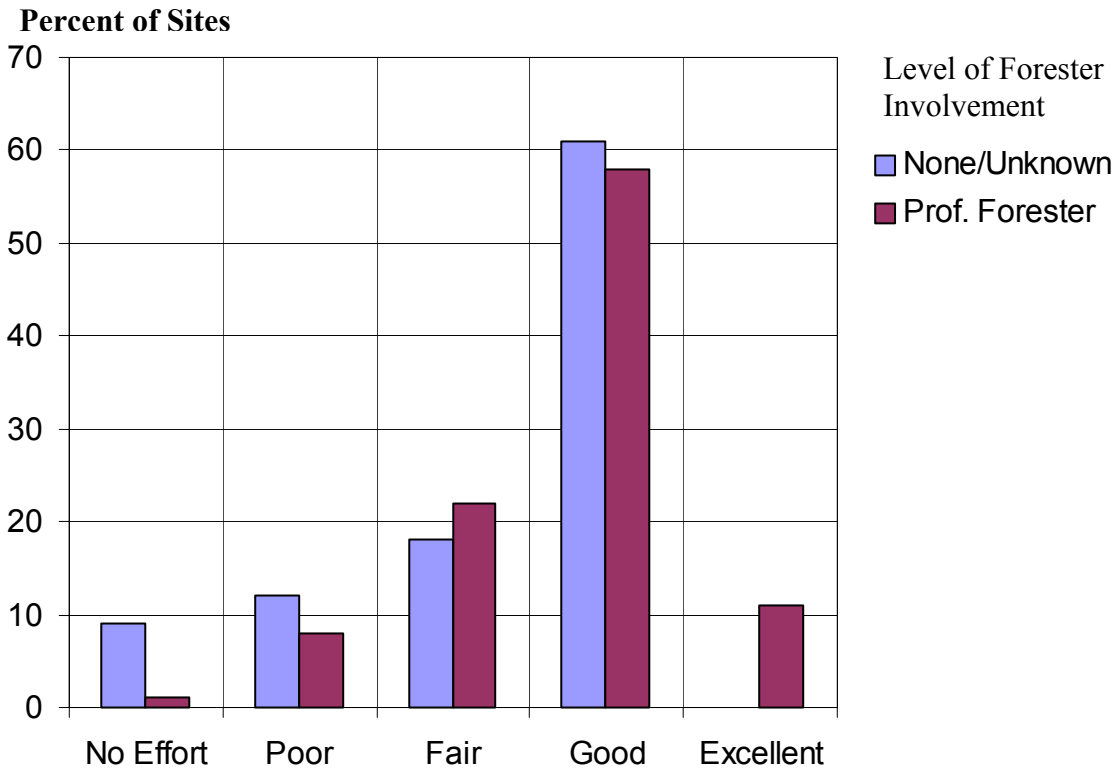


Figure 13
Overall Compliance by Type of Operation

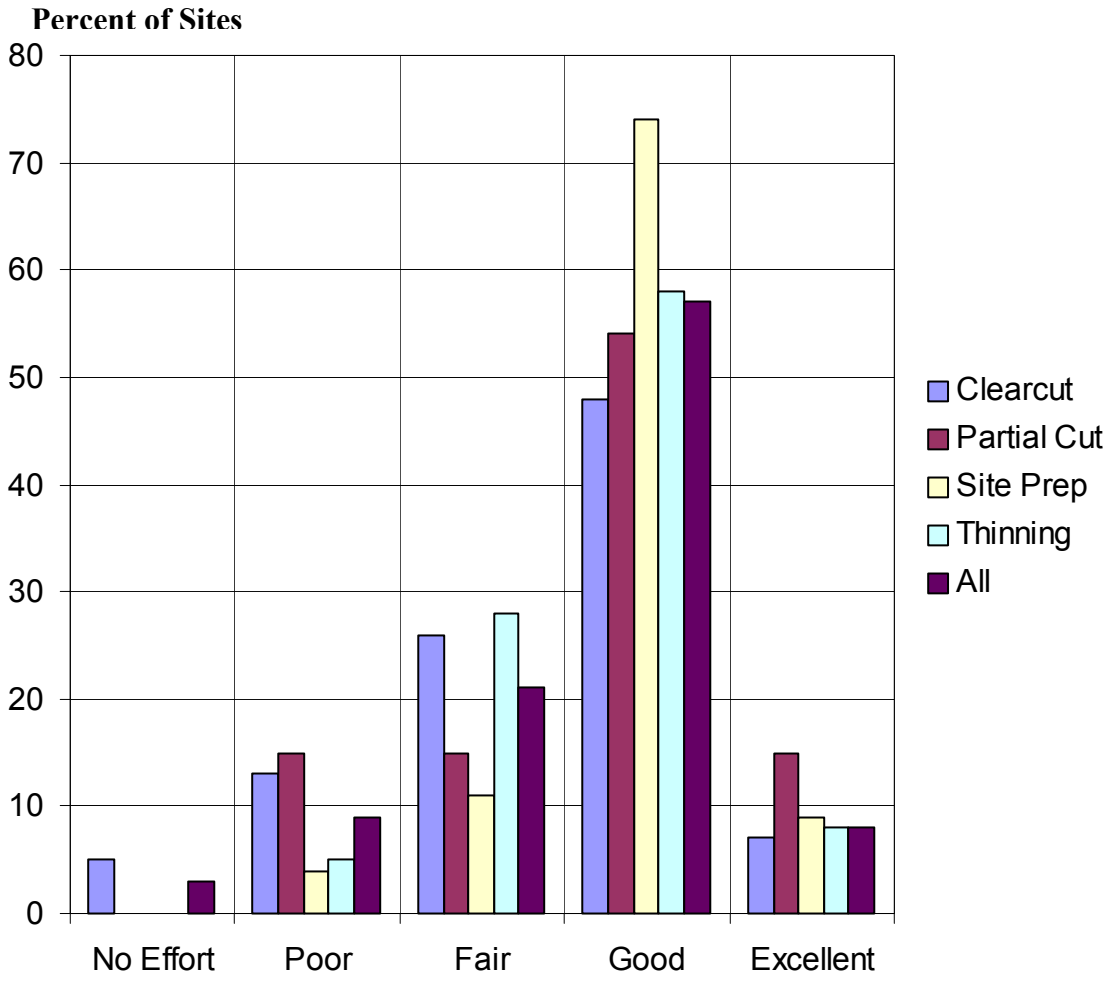
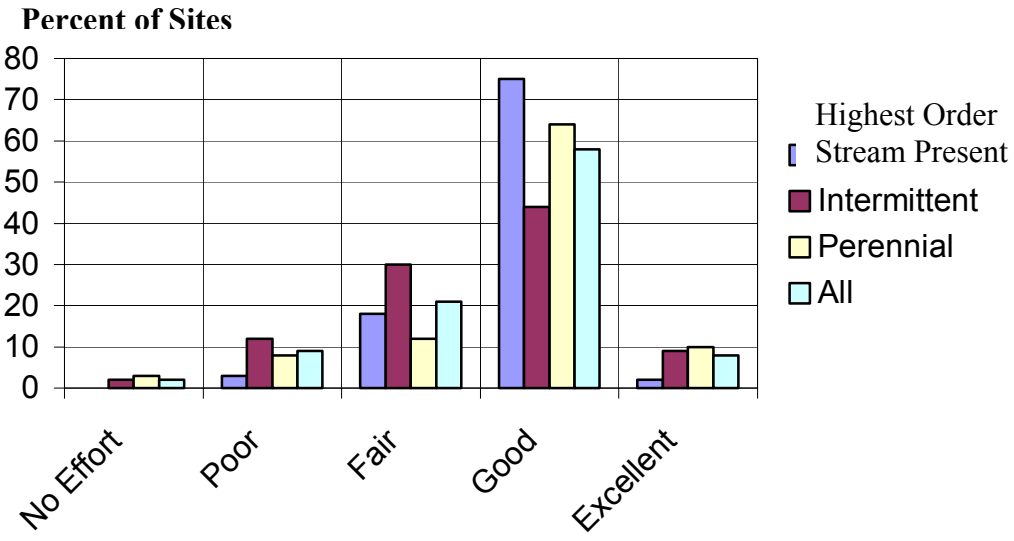


Figure 14
Overall Compliance By Proximity to Water



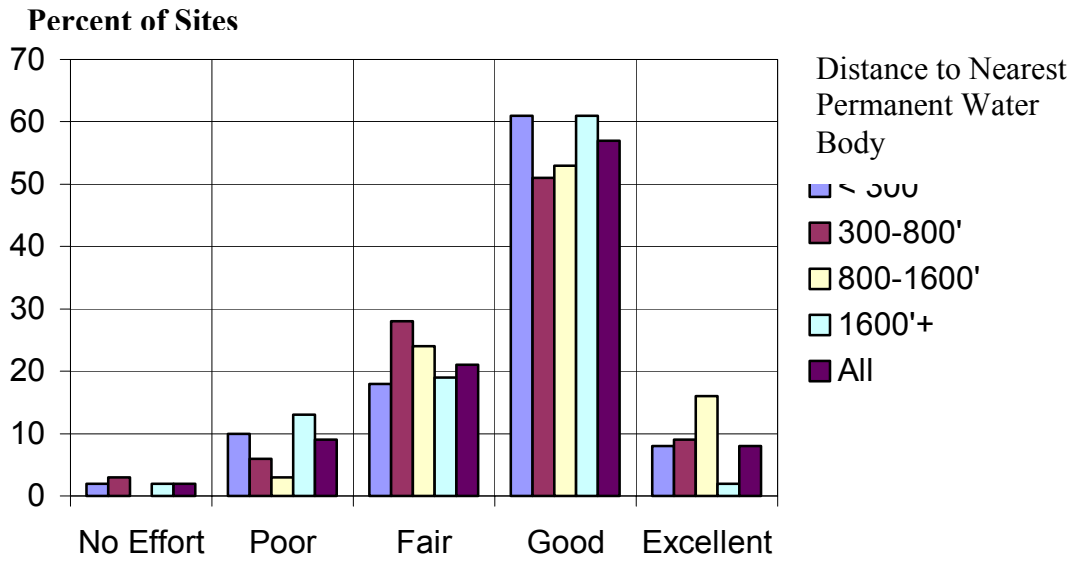
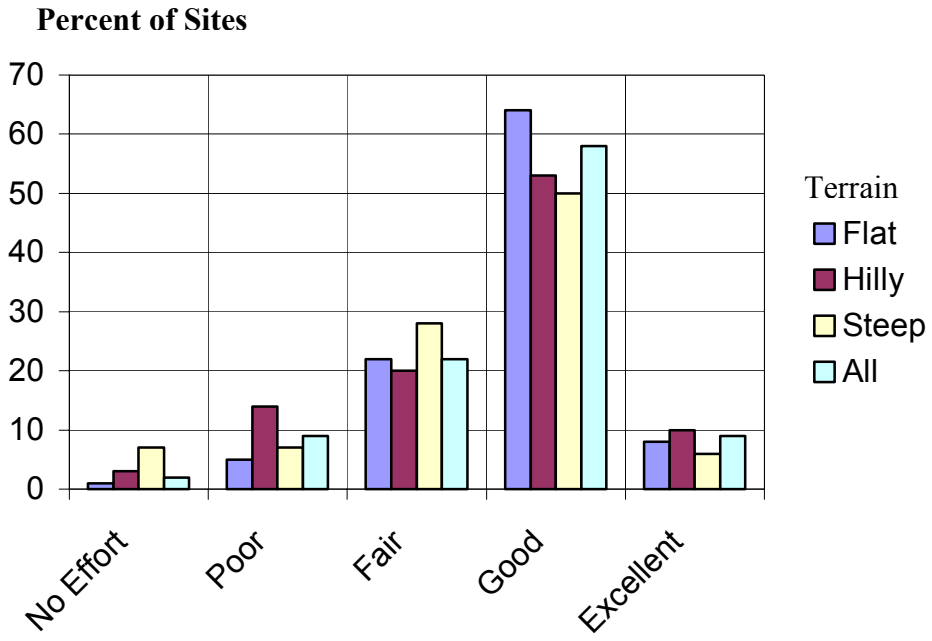


Figure 15
Overall Compliance by Eroadability & Terrain



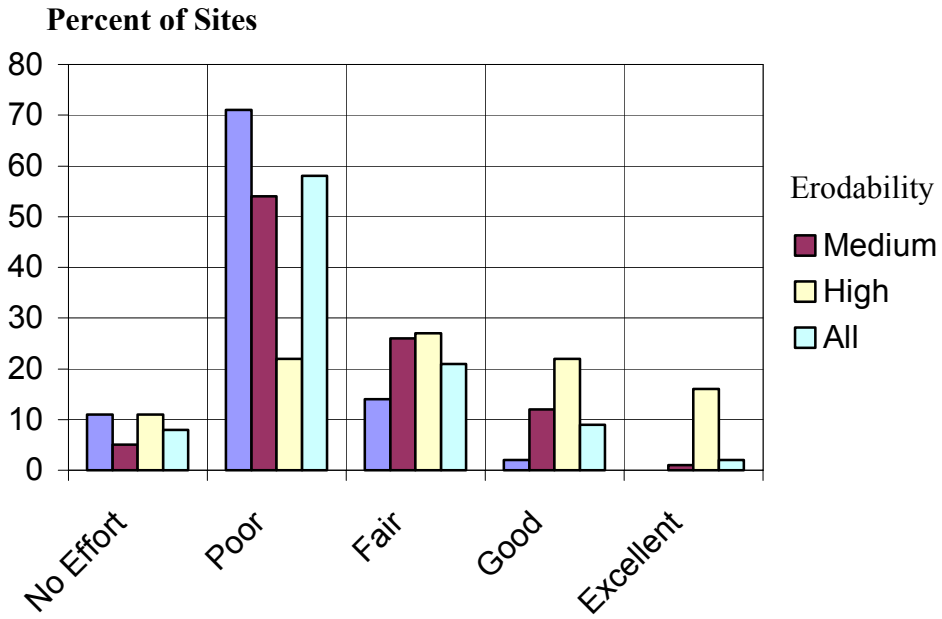
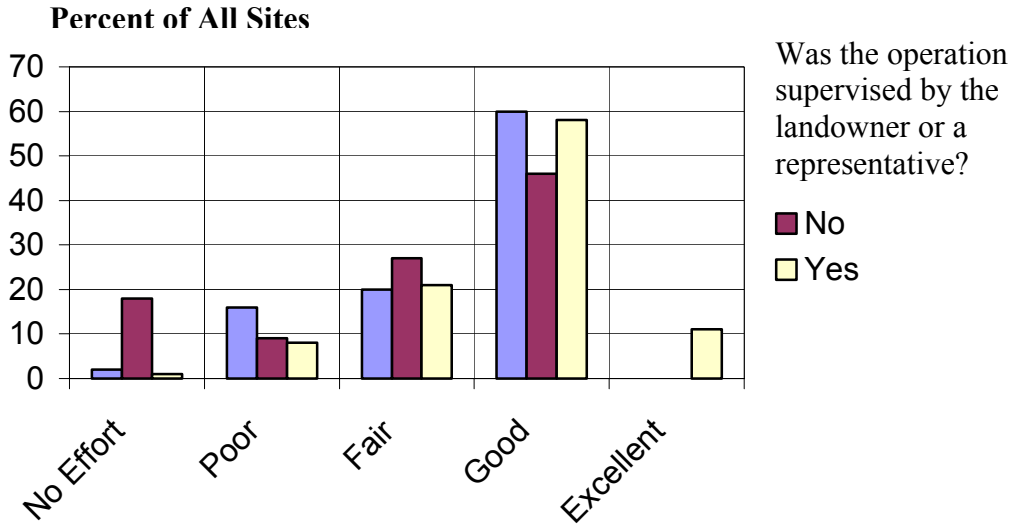


Figure 16
Overall Compliance by Level of Supervision



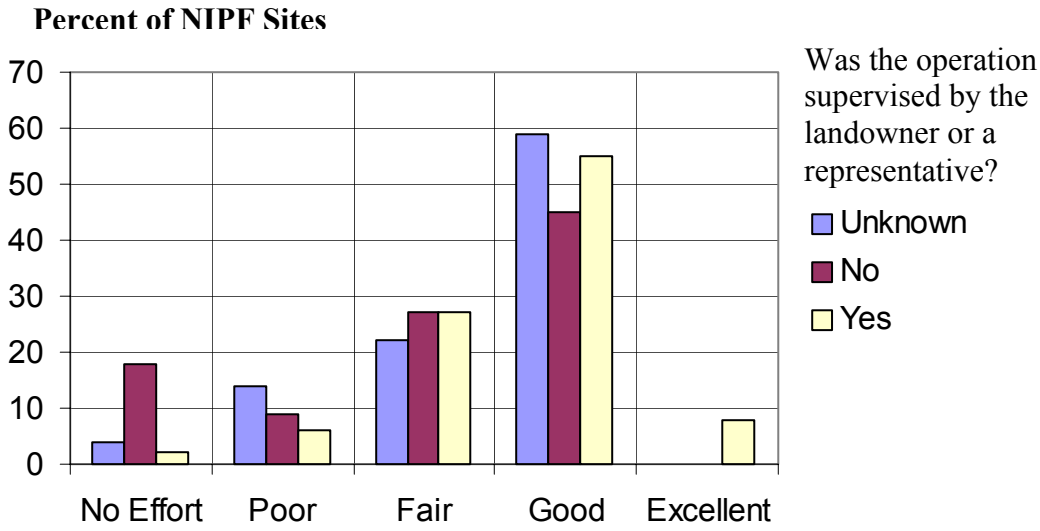
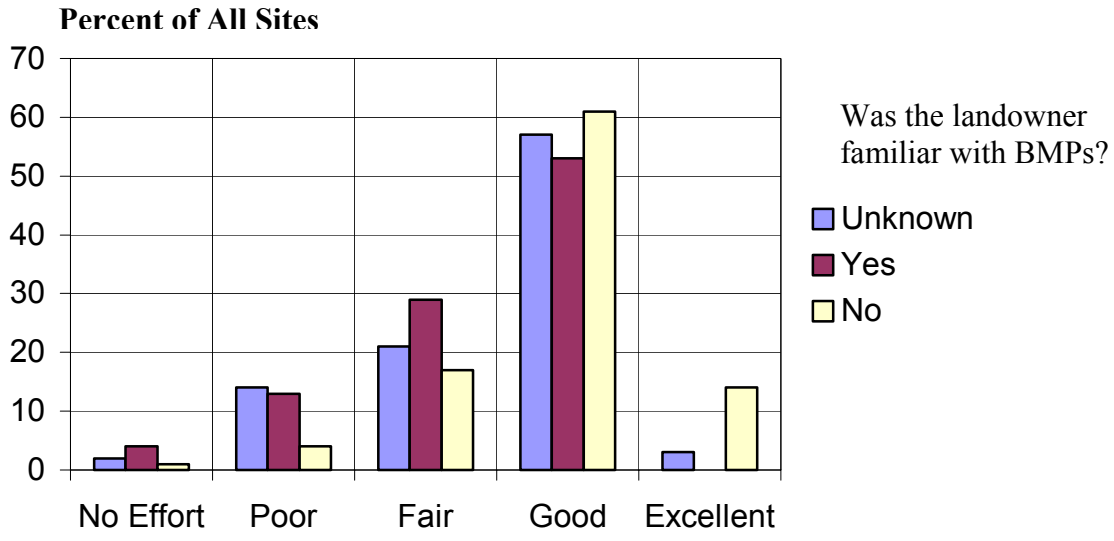


Figure 17
Overall Compliance by Landowner Knowledge



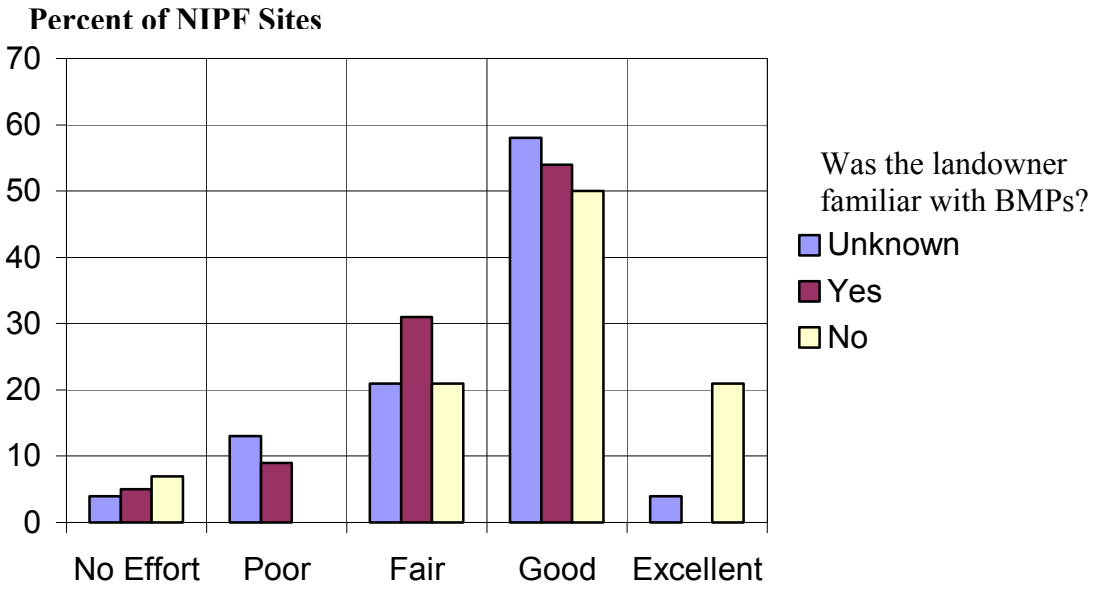
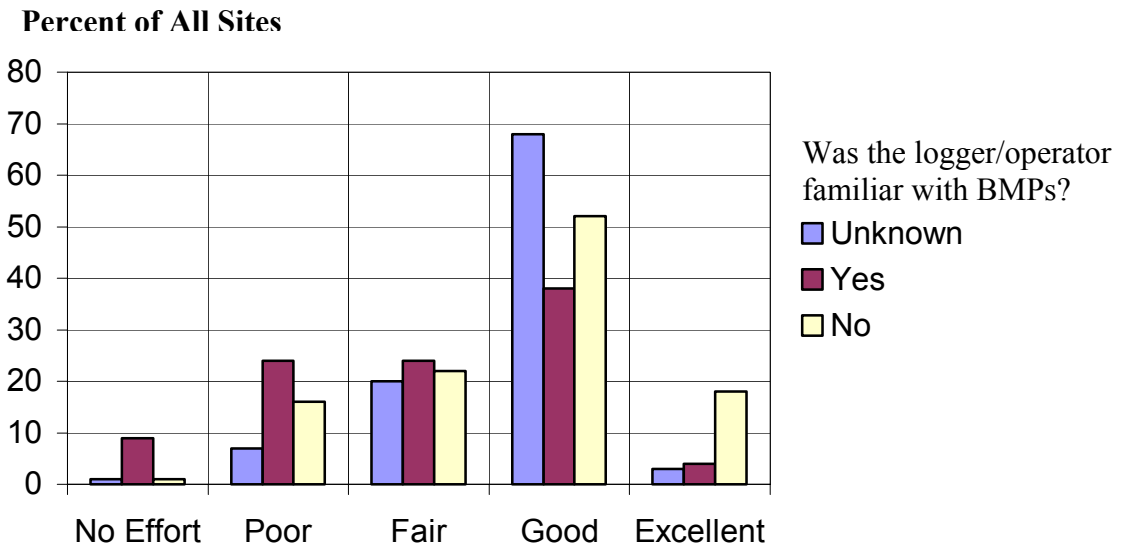


Figure 18
Overall Compliance by Logger/Operator Knowledge



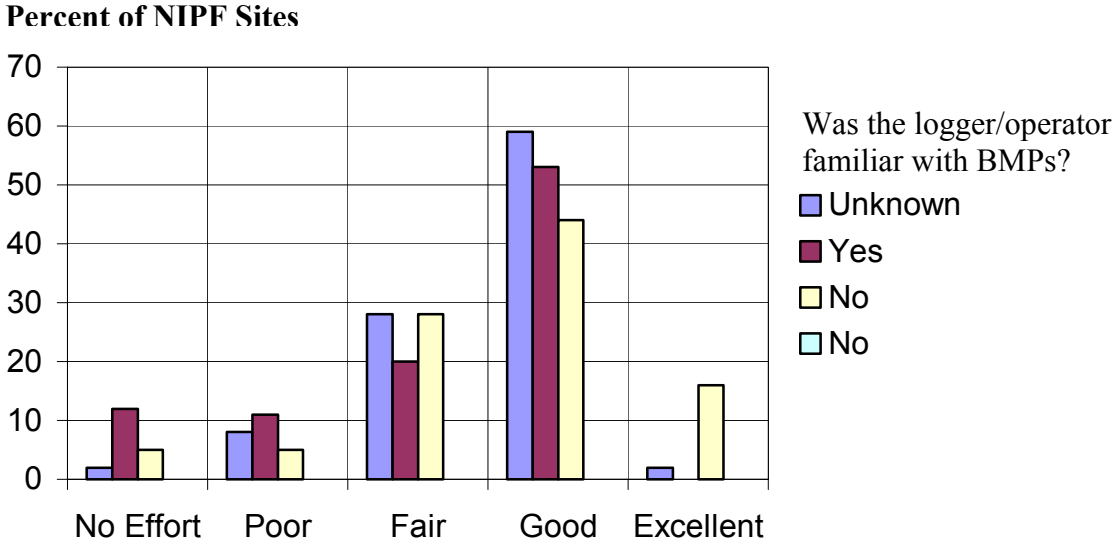


Figure 19
Overall Compliance by Inclusion of BMPs in Contract

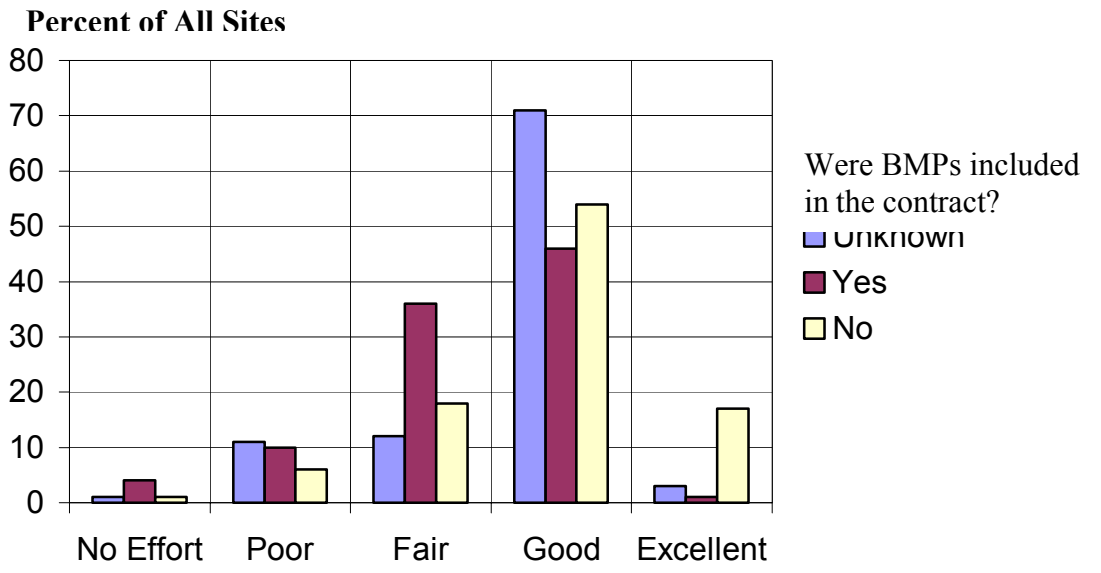


Figure 20
Overall Compliance by Forestry Organization Membership