VOLUNTARY IMPLEMENTATION OF FORESTRY **BEST MANAGEMENT PRACTICES** IN TENNESSEE

Results from the 2010 Forestry BMP Implementation Survey

TENNESSEE DEPARTMENT OF AGRICULTURE
DIVISION OF FORESTRY, 2013

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EXECUTIVE SUMMARY

A survey was conducted in 2010 by the Tennessee Department of Agriculture, Division of Forestry in cooperation with the University of Tennessee, Department of Forestry, Wildlife and Fisheries to determine how frequently forestry Best Management Practices (BMPs) were implemented. The implementation survey was designed to be consistent with methodology as described in the Southern Group of State Forester's (SGSF) *Silvicultural Best Management Practices Implementation Monitoring Framework for State Forestry Agencies*.

A random sample of 205 harvest sites was distributed among Tennessee's Forest Inventory and Analysis (FIA) survey units based on the amount of timber harvested within each unit. Harvest sites were visited between spring 2010 and the end of winter 2011. Each site was evaluated for 53 individual BMPs that were categorized by haul roads, skid trails, log decks, streamside management zones (SMZs), stream crossings, debris and hazardous materials, site prep and planting, and applicable BMPs in wetlands.

The 2010 BMP implementation survey showed no significant change in overall BMP implementation rate (88.9 percent) when compared to the overall implementation rate from the 2007 Survey (89.2 percent). Substantial improvement in BMP implementation rate is evident when compared to the Division's first BMP implementation survey conducted in 1996 (62.9 percent).

In 2010, all BMP categories had implementation rates higher than 70 percent. Wetlands was the BMP category with the lowest implementation rate (70.4 percent). Site prep and tree planting was the BMP category with the highest implementation rate (97.1 percent).

All FIA survey units had implementation rates higher than 78 percent. The East survey unit had the lowest implementation rate (79 percent). The West Central survey unit had the highest implementation rate (92.5 percent).

As a result of the information obtained through the 2010 BMP implementation survey, the practices that will be the focus of BMP education and training for the next planning phase include: 1) installing sufficient water control structures, 2) problem areas not stabilized 3) improper materials left in streams and 4) wetland areas. These issues will be addressed through additional courtesy check site visits, logger contacts, educational materials, technical guides, and demonstrations. Special emphasis will also be given to highlight the importance of stabilizing disturbed areas.

Continuing educational programs, such as Tennessee's Master Logger Program, can increase logger's knowledge of BMPs as well as helping them understand the principles of forest management, logging safety, and business

2010 TENNESSEE FORESTRY BEST MANAGEMENT PRACTICES IMPLEMENTATION SURVEY REPORT

INTRODUCTION

Since the mid-1980's the State of Tennessee, Department of Agriculture, Division of Forestry (TDF) has been providing leadership in forestry Best Management Practices (BMPs). The Division's water quality program assists the forestry community with forestry BMP implementation through three major program areas: technical assistance, water quality complaint investigations, and forestry BMP implementation monitoring.

Technical assistance is provided through a partnership with the Tennessee Forestry Association and the University of Tennessee. TDF participates in the Tennessee Master Logger program and forestry BMP workshops and field days. TDF is also engaged in courtesy check site visits to active harvest sites, servicing requests for site-specific technical guidance, logger contacts, and providing educational materials.

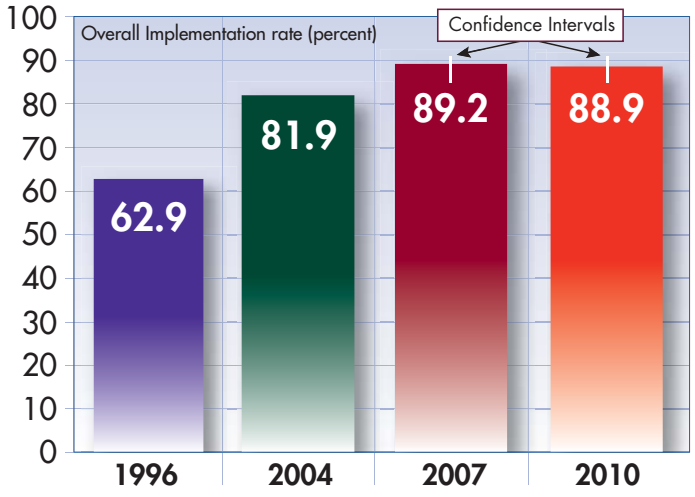
Water quality complaint investigations are handled through a memorandum of understanding (MOU) between the Department of Agriculture and the Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control (WPC). Upon receiving a complaint of a possible water quality violation caused by silvicultural practices, TDF performs an initial site visit to determine if the complaint is valid. TDF subsequently provides technical assistance when corrective actions are needed at these sites. Problem sites are referred to TDEC/WPC.

Forestry BMP implementation monitoring is achieved through logger contacts, courtesy check site visits, and periodic surveys. This report contains the results of the 2010 forestry BMP implementation survey. The purpose of the Tennessee forestry BMP implementation survey is to periodically ascertain and document the extent that forestry BMPs are being applied on-site. BMP guidelines for forestry practices allow normal forestry activities to be conducted while protecting water quality from degradation by point source pollution such as soil erosion. Periodic surveys allow TDF to objectively evaluate the utilization of BMPs and, of particular importance, where specific BMPs are not being implemented. This information is the basis for developing training and education priorities for TDF and its partners.

PREVIOUS FORESTRY BMP IMPLEMENTATION SURVEYS

The TDF conducted BMP implementation surveys in 1996, 2004, 2007 and 2010 (figure 1). Survey results indicate substantial improvement in BMP implementation between 1996 and 2007. Beginning in 2007, to facilitate more consistency between surveys and compatibility with other southern states, the Division implemented methodology as described in the Southern Group of State Foresters (SGSF) *Silvicultural Best Management Practices Implementation Monitoring Framework for State Forestry Agencies*. Future BMP implementation surveys will be conducted on a 5 year cycle.

FIGURE 1.
Overall Forestry BMP Implementation Survey Results for Tennessee



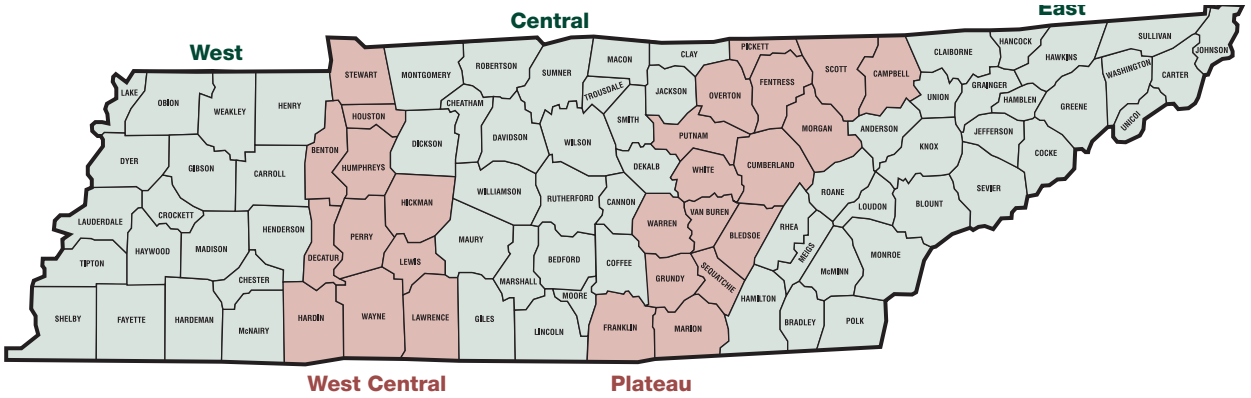
HARVEST SITE SAMPLE SIZE

Sample size (the number of harvest sites evaluated) was determined by UT for statistical validity. For a margin of error at the 5 percent level and a probability of 90 percent, the smallest plausible sample size was 96 A sample size of 205 was used so there was adequate representation of forestry activity statewide (Refer to Appendix C for details).

Specific harvest sites to evaluate were determined by dividing the State into a 4 mile by 7 mile grid. One grid was roughly the size of half of a 7.5 minute topographic map. Statewide, there were 1,445 grids. Grids that were not at least 50 percent forested were discarded.

Forested grids were numbered and catalogued by FIA survey unit and put together in a computer database. Grids for harvest sites were selected by

FIGURE 2.
Forest Inventory and Analysis Survey Units



FIA data were used to determine the volume of timber harvested statewide and within each FIA survey unit (figure 2). Sample size within each FIA unit was based on the proportion of statewide timber harvest occurring within a respective FIA unit. Thus, more plots were taken in units where more timber was harvested, and likewise, fewer plots were taken in survey units where less timber was harvested (table 1).

FIA survey unit by a computer random number generator. Thus, if a survey unit had a proposed sample size of 35 plots, the first 35 forested grids selected by the generator were used.

Grids were visited to locate a harvest site. If a grid had two or more harvest sites, the first site found was evaluated. If a harvest site was not found in a grid, that grid was omitted and another grid (next in order) was added from the computer generator selection. The only data taken at this

TABLE 1. STRATIFICATION OF HARVEST SITES BY FIA SURVEY UNIT BASED ON TIMBER HARVESTED, 2008 FIA DATA

REGION	HARVESTED ACRES (thousand acres)	PERCENT	# OF DESIRED SITES	ACTUAL SAMPLE SIZE
East	24.4	11	21	22
Plateau	59.3	26	52	53
Central	42.1	18	37	38
West Central	48.5	21	42	43
West	55.1	24	48	49

time were global positioning system (GPS) coordinates of the site and location directions. Steps were taken to assure the selection of evaluated harvest sites was not biased. The evaluators were unfamiliar with their assigned harvest sites prior to selection.

HARVEST SITE EVALUATION

Harvest sites were visited by an evaluator to observe forestry BMP implementation. Individual BMPs were evaluated by the following categories: haul roads, skid trails, log decks, streamside management zones (SMZs), stream crossings, debris / hazardous materials, site preparation / tree planting and applicable BMPs associated with wetlands (table 2). There existed a potential total of 10,865 observations on the 205 evaluated harvest sites. All the BMP survey categories were not present on every harvest site. For example, haul roads were not present on sites that could be accessed by existing public roads. The harvest sites sampled for the 2010 survey resulted in evaluation of 5,757 individual BMP observations.

TABLE 2. VARIABLES BY BMP CATEGORY

BMP CATEGORY	NUMBER OF INDIVIDUAL BMPS
Haul Roads	13
Skid Trails	6
Log Decks	5
SMZs	5
Stream Crossings	9
Debris & Haz Mat	2
Site Prep & Planting	4
Wetlands	9
Total	53
Potential total observations (Total x 205 sites)	10,865

Observations where individual BMPs were correctly applied were tallied as a “YES”. Observations where individual BMPs were absent but needed or incorrectly applied were tallied as a “NO”. Observations where individual BMPs were not needed were tallied as “NOT APPLICABLE”.

BMP implementation rates were calculated for individual BMPs, BMP categories, FIA survey units and overall implementation. Implementation rates for individual BMPs were calculated by dividing the number of observations where BMPs were correctly applied (YES) by the total number of observations [YES/(YES+NO)]. Individual harvest site implementation rates were calculated using the same formula as for individual BMPs. Implementation rates for BMP categories, FIA survey units and overall implementation rate were then calculated by averaging individual harvest site implementation rates for each respective variable.

Harvest sites were also evaluated to determine if “significant risks” to water quality existed. A significant risk is an existing on-the-ground condition resulting from failure to correctly implement BMPs, that, if left unmitigated, will likely result in an adverse change in the chemical, physical or biological condition of a water body.

A total of thirteen BMP evaluators were used for this survey, including eleven TDF employees from TDF’s four administrative districts, Mike Sherrill (TDF’s water quality program specialist) and Dr. Wayne Clatterbuck (Professor, University of Tennessee, Department of Forestry, Wildlife and Fisheries). Harvest site visits began in the spring of 2010 and were concluded by December 2011.

Site evaluation criteria included:

a. Harvest site must be at least five acres in size.

b. Land must have remained in a forested condition, i.e. harvest for change in land use such as development, agriculture, etc. was not included in the study.

c. Landowner consent.

d. Harvest must be completed and loggers gone from the site.

e. Harvest must have taken place after January 2008.

If an evaluator had prior knowledge about a harvest site that they were assigned to visit, they were urged to give that site to another evaluator to maintain objectivity during the evaluation process. Evaluators used in this study were the same used in previous studies. The dedication and consistency of the evaluators was determined to be very good. They took their judgments seriously and gave good written notes about the harvest sites.

RESULTS

BMP IMPLEMENTATION

The statewide average forestry BMP implementation rate for 2010 was determined to be 88.9 percent. Table 3 summarizes BMP implementation by BMP category. Table 4 summarizes BMP implementation by FIA survey unit. Tables 5 through 12 summarize BMP implementation by individual BMPs. Details on statistical calculations can be found in Appendix C.

BMP CATEGORIES (TABLE 3) – All BMP categories had implementation rates higher than 70 percent. Wetlands was the BMP category with the lowest implementation rate (70.4 percent). Site prep and tree planting was the BMP category with the highest implementation rate (97.1 percent).

FIA SURVEY UNITS (TABLE 4) – All FIA survey units had implementation rates higher than 78 percent. The East survey unit had the lowest implementation rate (79.0 percent). The West Central survey unit had the highest implementation rate (92.5 percent).

TABLE 3. BMP IMPLEMENTATION BY BMP CATEGORY

BMP CATEGORY OF SITES	NUMBER IMPLEMENTATION	AVERAGE %	NUMBER OF SIGNIFICANT RISKS[1]	MARGIN OF ERROR
Haul Roads	143	88.0	4	3.3
Skid Trails	205	85.0	14	3.3
Log Decks	205	92.1	4	2.3
SMZs	96	88.2	7	5.5
Stream Crossings	57	81.9	7	7.7
Debris & Haz Mat	205	96.3	0	2.1
Site Prep & Planting	20	97.1	0	4.1
Wetlands	18	70.4	10	15.0

[1] The 46 significant risks observed occurred on 5 of the 205 separate harvest sites.

TABLE 4. BMP IMPLEMENTATION BY FIA SURVEY UNIT

FIA SURVEY UNIT	NUMBER OF SITES	AVERAGE % IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS[1]	MARGIN OF ERROR
East	22	79.0	37	11.3
Plateau	53	92.2	0	3.9
Central	38	92.0	1	3.6
West Central	43	92.5	0	4.0
West	49	84.0	8	4.9

[1] The 46 significant risks observed occurred on 5 of the 205 separate harvest sites.

HAUL ROADS (TABLE 5) – The lowest implementation rate for individual haul road BMPs was associated with stabilizing problem areas with seed (57.9 percent). The highest rate was associated with existing roads utilized (99.3 percent).

TABLE 5. IMPLEMENTATION OF BMPS RELATING TO HAUL ROADS

BMP	YES	NO	N/A	% IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS	MARGIN OF ERROR
HAUL ROADS						
Broad Based Dips	53	24	66	68.8	0	10.6
Waterbars	41	22	80	65.1	0	12.0
Culverts	34	5	104	87.2	0	10.7
Turnouts (wing ditches)	80	19	44	80.8	0	7.9
Water Control Structures at Recommended Intervals	68	31	44	68.7	1	9.3
Crowned or Outsloped	91	16	36	84.0	1	6.9
Avoided Sensitive Areas & SMZs	123	5	15	96.1	1	3.4
Rock Used (BBD or other)	86	12	45	87.8	0	6.6
Problem Areas Stabilized with Seed	44	32	67	57.9	0	11.3
Follows Contour	137	4	2	97.2	1	2.8
Within Grade	135	5	3	96.4	0	3.1
Existing Roads Utilized	133	1	9	99.3	0	1.5
Located away from Water	122	6	15	95.3	0	3.7

Haul roads were correctly within grade 96.4% of the time.

SKID TRAILS (TABLE 6) – The lowest implementation rate for individual skid trail BMPs was associated with stabilizing problem areas with seed (51.9 percent). The highest rate was associated with maintaining an appropriate grade (94.5 percent).

TABLE 6. IMPLEMENTATION OF BMPS RELATING TO SKID TRAILS

BMP	YES	NO	N/A	% IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS	MARGIN OF ERROR
SKID TRAILS						
Grade	190	11	4	94.5	2	3.2
Water Control	119	60	26	66.5	2	7.1
Avoided Wet & Sensitive Areas	173	14	18	92.5	3	3.8
Equipment Use	131	11	63	92.3	2	4.5
Problem Areas Stabilized with Seed	54	50	101	51.9	1	9.8
Ruts do not Channel into Streams	155	14	36	91.7	4	4.2

LOGGING DECKS (TABLE 7) – The lowest implementation rate for individual logging deck BMPs was associated with stabilizing problem areas with seed (60.7 percent). The highest rate was associated with using existing decks (98.2 percent).

TABLE 7. IMPLEMENTATION OF BMPS RELATING TO LOGGING DECKS

BMP	YES	NO	N/A	% IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS	MARGIN OF ERROR
LOGGING DECKS						
Existing Decks Used	107	2	96	98.2	1	2.6
Location	198	6	1	97.1	1	2.4
Drainage	192	13	0	93.7	1	3.4
Hazardous Waste Management	196	7	2	96.6	0	2.6
Problem Areas Stabilized with Seed	71	46	88	60.7	1	9.0

STREAMSIDE MANAGEMENT ZONES (TABLE 8) – The lowest implementation rate for individual SMZ BMPs was associated with equipment use within the SMZ (84.4 percent). The highest rate was associated with SMZ matched to stream type and canopy cover intact (90.6 percent).

TABLE 8. IMPLEMENTATION OF BMPS RELATING TO STREAMSIDE MANAGEMENT ZONES

BMP	YES	NO	N/A	% IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS	MARGIN OF ERROR
STREAMSIDE MANAGEMENT ZONES						
SMZ matched to Stream Type	87	9	0	90.6	2	5.9
Canopy Cover Intact	87	9	0	90.6	1	5.9
Tree Felling	83	12	1	87.4	2	6.8
Equipment Use	81	15	0	84.4	1	7.4
Width	85	11	0	88.5	1	6.5

STREAM CROSSINGS (TABLE 9) – The lowest implementation rate for individual stream crossing BMPs was associated with water control structures (60.4 percent). The highest rate was associated with crossings minimized (91.2 percent).

TABLE 9. IMPLEMENTATION OF BMPS RELATING TO STREAM CROSSINGS

BMP	YES	NO	N/A	% IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS	MARGIN OF ERROR
STREAM CROSSINGS						
Crossings Minimized	52	5	0	91.2	1	7.5
Location	51	6	0	89.5	1	8.1
Aquatic Life Movement Disruption Low	49	5	3	90.7	2	7.9
Approaches	47	9	1	83.9	1	9.8
Water Control Structures	32	21	4	60.4	1	13.4
Crossings Appropriate & Properly Installed						
Ford	16	6	35	72.7	0	19.0
Culvert and Fill	19	7	31	73.1	1	17.4
Bridge	10	6	41	62.5	0	24.2
Temporary Structures Removed	33	10	14	76.7	0	12.9

DEBRIS & HAZARDOUS MATERIALS (TABLE 10) – The lowest implementation rate for individual debris and hazardous materials BMPs was associated with treetops and stumps (94.5 percent). The highest rate was associated with oil and fuel spills (97.0 percent).

TABLE 10. IMPLEMENTATION OF BMPS RELATING TO DEBRIS/HAZARD MATERIALS

BMP	YES	NO	N/A	% IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS	MARGIN OF ERROR
DEBRIS/HAZARD MATERIALS						
Treetops & Stumps	154	9	42	94.5	0	3.6
Oil & Fuel Spills	196	6	3	97.0	0	2.4

SITE PREPARATION (TABLE 11) – The lowest implementation rate for site preparation BMPs was associated with firelines (87.5 percent). The highest rates were associated with SMZs and slopes (100 percent).

TABLE 11. IMPLEMENTATION OF BMPS RELATING TO SITE PREPARATION

BMP	YES	NO	N/A	% IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS	MARGIN OF ERROR
SITE PREPARATION						
Method	19	1	0	95.0	0	9.7
SMZs	14	0	6	100	0	N/A
Slopes	18	0	2	100	0	N/A
Firelines	7	1	12	87.5	0	23.4

BMP evaluators seldom encountered situations where logging debris was left in streams.

WETLANDS (TABLE 12) – The lowest implementation rate for individual wetlands BMPs was associated with stabilizing problem areas with seed (33.3 percent). The highest rates were associated with log decks (81.3 percent).

TABLE 12. IMPLEMENTATION OF BMPS RELATING TO WETLANDS

BMP	YES	NO	N/A	% IMPLEMENTATION	NUMBER OF SIGNIFICANT RISKS	MARGIN OF ERROR
WETLANDS						
Roads	8	3	7	72.7	1	26.9
Drainage Structures	9	3	6	75.0	1	25.0
Fill Material	7	2	9	77.8	1	27.7
Stream Crossings	8	5	5	61.5	1	27.0
Problem Areas Stabilized with Seed	3	6	9	33.3	1	31.4
Treetops	11	6	1	64.7	2	23.2
Log Decks	13	3	2	81.3	1	19.5
SMZs	13	4	1	76.5	1	20.6
Equipment Use	11	6	1	64.7	1	23.2

SIGNIFICANT RISKS

There were a total of 46 Significant Risks observed statewide, or 0.8 percent of the 5,757 individual BMP observations that required BMPs. These significant risks were observed on 5 separate harvest sites, or 2.4 percent of the 205 harvest sites evaluated. The skid trail category of BMPs contained the most significant risks (14). Haul roads, Log decks, SMZs, Stream crossings, and Wetlands contained 69.6 percent (32) of the significant risks observed.

Tables 3 through 14, figures 3 and 4, and Appendix B provide additional details to characterize significant risks for this survey.

SIGNIFICANT RISKS BY BMP CATEGORY

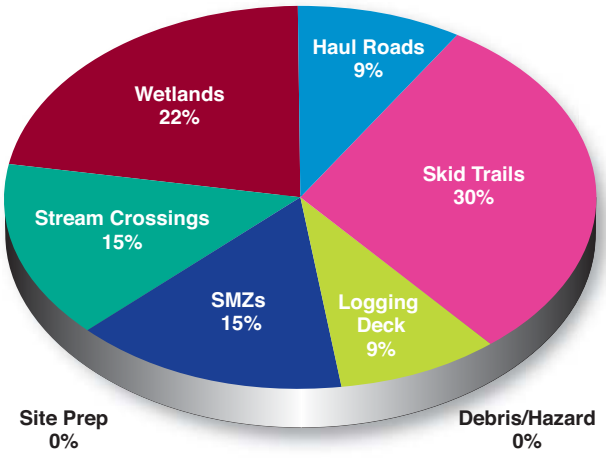
Table 13 and figure 3 present information on significant risks by BMP category. The skid trail category of BMPs had the greatest number of significant risks (14 significant risks on 4 harvest sites). The wetlands category of BMPs had the

An example of significant risk mitigation on a non-surveyed site.

second greatest number of significant risks (10 significant risks on 2 harvest sites). The debris/hazardous materials and site prep tree planting categories of BMPs had the least number of significant risks (0 significant risks for each respective category). Additional details concerning significant risks by individual BMPs are presented in Appendix B.

TABLE 13. SIGNIFICANT RISKS BY BMP CATEGORY	
Haul Roads	4
Skid Trails	14
Logging Deck	4
SMZs	7
Stream Crossings	7
Site Prep	0
Wetlands	10
Debris/Hazardous Materials	0
TOTAL	46

FIGURE 3.
SIGNIFICANT RISKS BY BMP CATEGORY

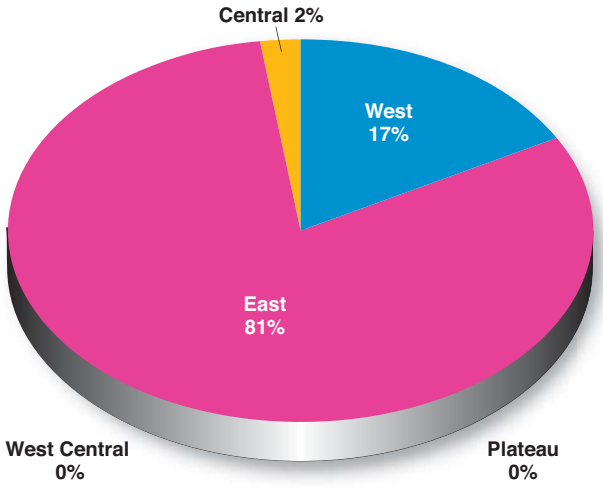


SIGNIFICANT RISKS BY FIA SURVEY UNIT

Table 14 and figure 4 present information on significant risks by FIA survey unit. The East Survey Unit had the highest level of significant risks (37 significant risks on 2 harvest sites). The West Survey Unit had the second highest level of significant risks (8 significant risks on 2 harvest sites). No significant risks were observed in the West Central or Plateau Survey Units.

TABLE 14. SIGNIFICANT RISKS BY FIA SURVEY UNIT	
East	37
Plateau	0
Central	1
West Central	0
West	8
TOTAL	46

FIGURE 4.
SIGNIFICANT RISKS BY FIA SURVEY UNIT



SUMMARY AND CONCLUSIONS

The 2010 BMP implementation survey revealed an average overall BMP implementation rate of 88.9 percent. There was little change in overall BMP implementation rate between the 2007 survey and the 2010 survey (89.2 percent). Substantial improvement in BMP implementation rate is evident when compared to the Division's first BMP implementation survey conducted in 1996 (62.9 percent). The improvement in implementation rates from 1996 to the present can be attributed to greater awareness of water quality issues associated with forest practices and improved understanding of correct BMP implementation. The resources invested over the past two decades to educate the forestry community about practices that protect water quality continue to show positive results.

The 2010 BMP implementation survey also represents the second cycle that utilized the methodology as described in the Southern Group of State Foresters (SGSF) *Silvicultural Best Management Practices Implementation Monitoring Framework for State Forestry Agencies*. Adoption of the SGSF methodology provides more consistency between surveys and compatibility with other southern states, resulting in a more objective and robust approach to BMP implementation monitoring.

The practices that will be the core items of BMP education and training for the next planning phase are 1) installing sufficient water control structures, 2) problem areas not stabilized 3) improper materials left in streams and 4) wetland areas. These issues will be addressed through additional courtesy check site visits, logger contacts, educational materials, technical guides, and demonstrations. Regardless of BMP category, special emphasis will also be given to highlight the importance of stabilizing disturbed areas.

The goal of the Division of Forestry's BMP implementation survey is to accurately evaluate BMP use and identify areas for continued improvement. Tennessee Forestry BMP implementation surveys are planned on a five-year cycle. This provides information for timely assessment of forestry BMP use in Tennessee.

Increasing demands for clean water are coming from every corner of our society. Utilization of the forest from which this clean water is derived is also important. Balancing the task of protecting the waters of Tennessee as well as maintaining the use of the forest is a priority for the Division of Forestry. This survey report is a tool that can be used to assure a proper course is chosen for the future of the Division's water quality program and position the Division to continue its leadership role in the forestry BMP arena.

Focused education and training on identified issues will be addressed through demonstrations, workshops, and additional courtesy check site visits.

GLOSSARY

IMPLEMENTATION MONITORING – The process used to determine the proper application of BMPs according to the specifications in *Tennessee Forestry Best Management Practices Guidelines*.

SIGNIFICANT RISK – An existing on-the-ground condition resulting from failure to correctly implement BMPs, that if left unmitigated will likely result in an adverse change in the chemical, physical or biological condition of a water body.

BEST MANAGEMENT PRACTICES (BMPS) – A practice or combination of practices which has been determined to be the most effective and practical means of preventing or reducing water pollution to a level compatible with water quality goals.

EROSION – The process by which soil particles are detached and transported by water, wind, and/or gravity.

HAUL ROAD – A permanent or temporary woods road over which timber is transported from a harvest site to a public road.

NONPOINT SOURCE POLLUTION – pollution of water which is:

- carried or conveyed by natural processes including precipitation, seepage, percolation, and runoff;
- not traceable to a distinct or identifiable source; and
- better controlled through the application of good management practices.

SILVICULTURE – The science and art of growing a forest. More particularly, the principles, theories and practices for protecting and enhancing the regeneration, growth and development and use of forests for multiple benefits.

STREAM – Includes perennial (continuous flowing) and intermittent (flows only during wet periods) streams that flow in well-defined channels. Streams as described require SMZs.

STREAMSIDE MANAGEMENT ZONES – A designated area that consists of the stream itself and an adjacent area of varying width where management practices that might affect water quality, fish, or other aquatic resources are modified. Streamside management zones are areas of closely managed activity, not areas of exclusion.

APPENDIX A

CLIMATOLOGICAL DATA (PRECIPITATION)

The following annual rainfall information is associated with selected climatological sites in Tennessee. This information is accessible from the National Oceanic and Atmospheric Administration's National Climatic Data Center web link (http://www.ncdc.noaa.gov/cdo-web).

During the timeframe of this report there were wide variations of precipitation. The below normal of 12.61 inches in Chattanooga and the above normal of 14.60 inches in Knoxville are the extremes. The annual precipitation does not reveal significant events such as the very high amounts of rain that occurred May 1- 2, 2010 causing widespread flooding.

LOCATION	INCHES OF PRECIPITATION					
	2008	Dep from normal	2009	Dep from normal	2010	Dep from normal
Kingsport	38.31	NA	51.81	NA	39.89	NA
Knoxville	50.96	-2.37	67.93	14.60	48.66	-4.67
Chattanooga	47.33	-7.19	62.59	8.07	41.91	-12.61
Ave.	**45.53**	**-4.78**	**60.78**	**11.34**	**43.49**	**-8.64**
Crossville	47.10	-10.00	67.63	10.53	49.40	-7.70
Jamestown	48.57	-8.28	66.24	9.39	59.33	2.48
Ave.	**47.84**	**-9.14**	**66.44**	**9.96**	**54.37**	**-2.61**
Nashville	48.17	0.06	57.87	9.76	59.08	10.97
Clarksville	54.82	3.04	60.39	8.61	39.54	2.65
Ave.	**51.50**	**1.55**	**59.13**	**9.19**	**49.31**	**6.81**
Jackson	59.24	4.38	58.60	3.74	63.17	8.31
Memphis	64.21	9.56	61.26	6.61	47.90	-6.75
Ave.	**61.73**	**6.97**	**59.93**	**5.18**	**55.54**	**0.78**

APPENDIX B

SUMMARY OF SIGNIFICANT RISKS BY CATEGORY, ITEM AND FIA SURVEY UNIT

HAUL ROADS	EAST	CENTRAL	PLATEAU	WC	WEST	TOTALS
1. Broad Based Dips						
2. Waterbars						
3. Culverts						
4. Turnouts (wing ditches)						
5. Water control structures	1					1
6. Crowned or Outsloped	1					1
7. Avoided sensitive areas & SMZs	1					1
8. Rock used (BBD or other)						
9. Problem areas stabilized with seed						
10. Follows contour	1					1
11. Within grade						
12. Existing roads utilized						
13. Located away from water						
TOTALS	4					4

SKID TRAILS	EAST	CENTRAL	PLATEAU	WC	WEST	TOTALS
1. Grade	1				1	2
2. Water control	1				1	2
3. Avoided wet & sensitive areas	2				1	3
4. Equipment use	1				1	2
5. Problem areas stabilized with seed	1					1
6. Ruts do not channel into stream	2				2	4
TOTALS	8				6	14

LOGGING DECKS	EAST	CENTRAL	PLATEAU	WC	WEST	TOTALS
1. Existing landings used	1					1
2. Location	1					1
3. Drainage	1					1
4. Hazardous waste management						
5. Problem areas stabilized with seed	1					1
TOTALS	4					4

STREAMSIDE MANAGEMENT ZONES	EAST	CENTRAL	PLATEAU	WC	WEST	TOTALS
1. SMZ matched to stream type	2					2
2. Canopy	1					1
3. Tree felling	1				1	2
4. Equipment use	1					1
5. Width	1					1
TOTALS	6				1	7

STREAM CROSSINGS	EAST	CENTRAL	PLATEAU	WC	WEST	TOTALS
1. Crossings minimized	1					1
2. Location	1					1
3. Aquatic life movement disruption low	1	1				2
4. Approaches	1					1
5. Water control structures	1					1
6. Crossing appropriate, properly installed						
A. Ford						
B. Culvert and fill	1					1
C. Bridge						
7. Temporary structures removed						
TOTALS	6	1				7

DEBRIS & HAZARDOUS MATERIALS	EAST	CENTRAL	PLATEAU	WC	WEST	TOTALS
1. Treetops & stumps						
2. Oil & fuel spills						
TOTALS						

**significant risks were not present for this category*

SITE PREPARATION & TREE PLANTING	EAST	CENTRAL	PLATEAU	WC	WEST	TOTALS
1. Method						
2. SMZs						
3. Slopes						
4. Firelines						
TOTALS						

**significant risks were not present for this category*

WETLANDS	EAST	CENTRAL	PLATEAU	WC	WEST	TOTALS
1. Roads	1					1
2. Drainage structures	1					1
3. Fill material	1					1
4. Stream crossings	1					1
5. Problem areas stabilized with seed	1					1
6. Treetops	1				1	2
7. Decks	1					1
8. SMZs	1					1
9. Equipment use	1					1
TOTAL	9				1	10

APPENDIX C

STATISTICAL ANALYSIS

SAMPLE SIZE

The formula for estimating sample size:

$$n = \left(\frac{t\ CV}{AE}\right)^2$$

Where n = the number of sites to evaluate
t = Student's t-value
CV = coefficient of variation
AE = allowable error

Thus given the following parameters:

t = 1.96 — as t at the .05 value approaches a degrees of freedom of infinity, the value is 1.96
CV = coefficient of variation – estimated to be 50% which means that the standard deviation is 50% of the mean
AE = 10% (90% probability)

These assumptions give the estimate for sample size as

$$n = \left(\frac{1.96*\ 50}{10}\right)^2 = 96$$

Sample size is 200+. There are sufficient samples to make good statistical comparisons depending whether our estimate of CV is close.

The statistical parameters for this study are:
Test of Significance at the .05 level — (95% accurate) with a probability of 90%, i.e., 10% allowable error

These procedures are from the following reference:

W.G. Cochran and G.M. Cox. 1957. Experimental Design. 2nd Edition, Wiley Publishing, New York. 611 p

MARGIN OF ERROR CALCULATIONS FOR INDIVIDUAL BMPS

The margin of error expresses the maximum likely difference observed between the sample mean and the true population mean with 95% probability. The formula used to calculate margin of error for individual BMPs is listed below. Refer to tables 5 through 12 for individual BMP margin of errors.

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

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

Note: If the value of P is 100%, the margin of error is not zero. No calculation can be made.

Example of calculation for BMP implementation for equipment use in SMZs:

Where P (% BMP implementation for equipment use in SMZs) was evaluated to be 84.4% on 96 sites.

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

$$m = 2\sqrt{\frac{84.4\ (100\text{-}84.4)}{96}}$$

$$m = 2\sqrt{\frac{1{,}316.6}{96}}$$

$$m = 2\sqrt{13.71}$$

$$\mathbf{m = 7.4}$$

MARGIN OF ERROR CALCULATIONS FOR BMP CATEGORIES AND FIA SURVEY UNITS

The margin of error expresses the maximum likely difference observed between the sample mean and the true population mean with 95% probability. The formula used to calculate margin of error by BMP category and FIA survey unit is listed below. Refer to Table 3 and Table 4 for BMP category and FIA survey unit margin of errors respectively.

$$\mathbf{m = \frac{2\ (SD)}{\sqrt{n}}}$$

Where m = margin of error for a BMP category or FIA survey unit
SD = the standard deviation for a BMP category or FIA survey unit
n = the number of sites evaluated

Note: If the value of P is 100%, the margin of error is not zero. No calculation can be made.

Example of calculation for BMP implementation for haul roads:

$$m = \frac{2\ (SD)}{\sqrt{n}}$$

$$m = \frac{2\ (19.7)}{\sqrt{143}}$$

$$m = \frac{39.4}{12}$$

$$\mathbf{m = 3.3}$$

CONFIDENCE INTERVAL FOR OVERALL AVERAGE BMP IMPLEMENTATION RATE

A confidence interval is a tool that statisticians use to demonstrate their confidence in the measured mean of a sample. For example, a 95% confidence interval provides a range for which you can be 95% confident (i.e. 19 times out of 20) that the actual mean will be found. To calculate the confidence interval, the mean, variance, standard deviation, standard error, and margin of error must also be calculated. The formula used to calculate the confidence interval is listed below. The 95% confidence interval for the 2010 BMP survey overall BMP implementation rate (88.9%) across all sites was 86.5% to 91.2%.

$$\mathbf{95\%\ CI = Mean \pm Margin\ of\ Error}$$

APPENDIX D

FORESTRY BMP IMPLEMENTATION SURVEY CHECKLIST

BMP IMPLEMENTATION STUDY ---- 2010

I. Identification

FIA Region _____ Date of Inspection _____

County _____ Date of Harvest _____ (if known)

GPS Coordinates Latitude _____

Longitude _____

Ownership _____ (if known) Industry, Public, NIPF, Corporate

Inspector: _____ Acreage _____ (estimated)

Harvest Number _____ Type of Cut _____ (partial or clearcut)

II. Site Characteristics

A. Physiographic Region

1. Blue Ridge _____
2. Southern Appalachians _____
3. Cumberland Plateau _____
4. Highland Rim _____
5. Central Basin _____
6. Southern Coastal Plain _____
7. Alluvial Plain _____

B. Terrain Type

1. Wetland _____
2. Stream Valley _____
3. Flatland _____
4. Rolling Hills _____
5. Steep Upland _____

C. Drainage Features

1. Perennial Stream _____
2. Intermittent Stream _____
3. Ephemeral Stream _____
4. Lake/Pond _____
5. Not Present _____

III. Haul Roads

_____ **NOT** Applicable ----- Haul Roads not present

	Correct	Incorrect	Not Used But Needed	Not Needed	Is Significant Risk	BMP Page
1. Broad Based Dips (BBDs)	_____	_____	_____	_____	_____	9-10
2. Waterbars (only on temporary roads)	_____	_____	_____	_____	_____	13
3. Culverts	_____	_____	_____	_____	_____	11-12
4. Turnouts (wing ditches)	_____	_____	_____	_____	_____	10
5. Water Control Structures at Recommended Intervals	_____	_____	_____	_____	_____	9-13
6. Crowned or Outsloped	_____	_____	_____	_____	_____	9
7. Avoided Sensitive Areas & SMZs	_____	_____	_____	_____	_____	7
8. Rock Used (BBD or other)	_____	_____	_____	_____	_____	10
9. Problem Areas Stabilized with Seed	_____	_____	_____	_____	_____	8,11
10. Follows Contour	_____	_____	_____	_____	_____	7
11. Within Grade (2 to 12%)	_____	_____	_____	_____	_____	7
12. Existing Roads Utilized	_____	_____	_____	_____	_____	7
13. Located Away from Water	_____	_____	_____	_____	_____	7

If answered **Incorrect** or **Significant Risk**, describe the problem(s) below.

IV. Skid Trails

	Correct	Incorrect	Not Used But Needed	Not Needed	Is Significant Risk	BMP Page
1. Grade (2 to 30%)	_____	_____	_____	_____	_____	21
2. Water Control	_____	_____	_____	_____	_____	21
3. Avoided Wet & Sensitive Areas	_____	_____	_____	_____	_____	21
4. Limit Equipment Use Near Streams	_____	_____	_____	_____	_____	21
5. Problem Areas Stabilized with Seed	_____	_____	_____	_____	_____	21
6. Ruts Do Not Channel Water Into Stream	_____	_____	_____	_____	_____	21

If answered **Incorrect** or **Significant Risk**, describe the problem(s) below.

V. Logging Decks

	Correct	Incorrect	Not Used But Needed	Not Needed	Is Significant Risk	BMP Page
1. Existing Landings Used (if applicable)	_____	_____	_____	_____	_____	20
2. Location	_____	_____	_____	_____	_____	20
3. Drainage	_____	_____	_____	_____	_____	20
4. Hazardous Waste Management	_____	_____	_____	_____	_____	20,23
5. Problem Areas Stabilized with Seed	_____	_____	_____	_____	_____	20

If answered **Incorrect** or **Significant Risk**, describe the problem(s) below.

VI. Streamside Management Zones

	Correct	Incorrect	Not Used But Needed	Not Needed	Is Significant Risk	BMP Page
1. SMZ matched to stream type	_____	_____	_____	_____	_____	14 - 15
2. Canopy	_____	_____	_____	_____	_____	15
3. Tree felling	_____	_____	_____	_____	_____	22
4. Equipment use	_____	_____	_____	_____	_____	15
5. Width	_____	_____	_____	_____	_____	15
Response totals:	_____	_____	_____	_____	_____	

If answered **Incorrect** or **Significant Risk**, describe the problem(s) below. See reverse.

VII. Stream Crossings

	Correct	Incorrect	Not Used But Needed	Not Needed	Is Significant Risk	BMP Page
1. Crossings minimized	_____	_____	_____	_____	_____	17
2. Location	_____	_____	_____	_____	_____	17,18,19
3. Aquatic life movement disruption minimized	_____	_____	_____	_____	_____	17
4. Approaches	_____	_____	_____	_____	_____	17
5. Water control structures	_____	_____	_____	_____	_____	17
6. Crossing appropriate, & properly installed						
A. Ford	_____	_____	_____	_____	_____	18
B. Culvert and Fill	_____	_____	_____	_____	_____	18
C. Bridge	_____	_____	_____	_____	_____	19
7. Temporary structures removed	_____	_____	_____	_____	_____	8,19,21
Response totals:	_____	_____	_____	_____	_____	

If answered **Incorrect** or **Significant Risk**, describe the problem(s) below.

VIII. Debris & Hazardous Materials

	Correct	Incorrect	Not Used But Needed	Not Needed	Is Significant Risk	BMP Page
1. Treetops & stumps	_____	_____	_____	_____	_____	22
2. Oil & fuel spills	_____	_____	_____	_____	_____	20 - 23
Response totals:	_____	_____	_____	_____	_____	

If answered **Incorrect** or **Significant Risk**, describe the problem(s) below. See reverse.

IX. Site Preparation & Tree Planting

	Correct	Incorrect	Not Used But Needed	Not Needed	Is Significant Risk	BMP Page
1. Method	_____	_____	_____	_____	_____	24
2. SMZs	_____	_____	_____	_____	_____	24
3. Slopes	_____	_____	_____	_____	_____	24, 25
4. Firelines	_____	_____	_____	_____	_____	25
Response totals:	_____	_____	_____	_____	_____	

If answered **Incorrect** or **Significant Risk**, describe the problem(s) below.

X. Wetlands

	Correct	Incorrect	Not Used But Needed	Not Needed	Is Significant Risk	BMP Page
1. Roads	_____	_____	_____	_____	_____	31, 32
2. Drainage structures	_____	_____	_____	_____	_____	31
3. Fill material	_____	_____	_____	_____	_____	31
4. Stream crossings	_____	_____	_____	_____	_____	31
5. Problem Areas Stabilized with Seed	_____	_____	_____	_____	_____	31, 32
6. Treetops	_____	_____	_____	_____	_____	32
7. Decks	_____	_____	_____	_____	_____	32
8. SMZs	_____	_____	_____	_____	_____	32
9. Equipment use	_____	_____	_____	_____	_____	32
Response totals:	_____	_____	_____	_____	_____	

If answered **Incorrect** or **Significant Risk**, describe the problem(s) below.