Monitoring Results • 1996-2021

Comprehensive Indiana Forestry Best Management Practices

DNR
Indiana Department
of Natural Resources

Forestry DNR

Comprehensive Forestry Best Management Practices

1996-2021

By: Jennifer Sobecki & Duane McCoy

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I. Introduction & Indiana Forestry BMP History

A. BMP Introduction

Indiana has 4.8 million acres of forestland, 21% of the state's land base, providing many benefits to Indiana residents and wildlife. Forestland is important to Hoosiers who frequent the woods for various forms of recreation, including hiking, biking, hunting, fishing, and wildlife watching. Even residents who don't partake in these activities benefit greatly from the clean air and water that our forests produce. Because forests are important to all citizens of our state, it is imperative that timber harvesting on all ownerships is done in a way that reduces or mitigates negative environmental impacts. Although forests are known to be the best way to reduce nonpoint source pollution (NPS) to waterways, they also can be a source of pollutants. When forest soils are bared, there is opportunity for NPS pollution to occur. Forestry BMPs are employed to protect forest soils and water quality during and after a harvest.

Forestry BMPs are a foundation for water quality protection and guidelines for protecting water quality during forest operations. The purpose of BMPs is to minimize the impact of forest activities that may negatively affect soil and water quality. This report is a summary of the application and effectiveness of BMPs for timber harvests conducted on forest properties statewide from 1996–2021 on all land ownership types. Data covers all BMP monitoring for 1,569 sites during those years, looking at time trends and making comparisons.

Drone photo of a pine harvest opening on state forest lands.

B. BMP History

In response to the Federal Clean Water Act amendments of 1987 and a request from Indiana's forest owners, the Department of Natural Resources Division of Forestry (DoF), in cooperation with the Woodland Steward Institute, took on a statewide project to develop a program to implement voluntary forestry BMPs. The Federal Clean Water Act amendments of 1987 prompted states to develop BMP guidelines to control the impacts of sivicultural practices, as well as the impacts of other land uses such as agriculture and development, which cause NPS pollution. In response, the Woodland Steward Institute took on the project called "The Forest Health Initiative". The forestry BMP guidelines were completed in 1995, the first round of BMP monitoring occurred in 1996, and the Forestry BMP Field Guide was published in 1998.

Table 1. Forestland ownership types in Indiana and the percentage of total area of forestland, percentage of state they make up, and the percentage of acres of each forest ownership type that has been monitored for forestry BMPs.

Forest Ownership	Acres	% of Forestland	% of state	% of ownership type acres monitored
Private	3,987,645	83.20	17.11	1.00%
Federal	399,244	8.33	1.71	0.09%
State/Local	405,954	8.47	1.74	15.40%

Table 2. Number of sites and acres monitored by ownership types in Indiana.

Landowner Type	# Sites Monitored	# Acres Monitored
State	721	62,625
Classified Forest & Wildland	716	35,671
NIPF	121	5410
Federal	6	355
County	2	100
Industrial	3	66
Totals	**1569**	**104,227**

In cooperation with the United States Environmental Protection Agency (EPA) and the Indiana Department of Environmental Management (IDEM) and the Woodland Steward Institute, the DoF facilitated a series of meetings that included individuals from many public agencies and private interests. In these meetings they set up committees that would, throughout the early 1990s, develop a set of forestry practices that would be designed to mitigate or minimize negative impacts of forest management activities on water quality, sometimes even enhancing water quality. This effort was designed under the auspices of the Clean Water Act, which directed the EPA to guide the states in developing BMPs for several land-use practices such as agriculture, urban development, and forestry. In forestry, the states were directed to establish BMPs but were given the option that they could be voluntary or regulatory.

The Indiana forestry BMP program was broken up into three main components. The first element was the BMP Guidelines themselves, which were the physical practices, such as water diversion spacing or seed mixture recommendations, and the publication that has been commonly known as the Indiana Forestry BMP Field Guide. This publication was most recently updated in 2022. https://www.in.gov/dnr/forestry/files/BMP.pdf

The second component was BMP training, which consisted of teaching the BMPs to the different parts of the Indiana forest products community, such as the loggers, landowners, and foresters. Since 1996, 1,057 loggers, foresters and landowners have been trained on maintaining the integrity of the soil and water on a timber harvest site using forestry BMPs.

The third part was BMP monitoring, which consisted of looking at how BMPs were applied in the field and how well those practices protected water quality.

BMP Training

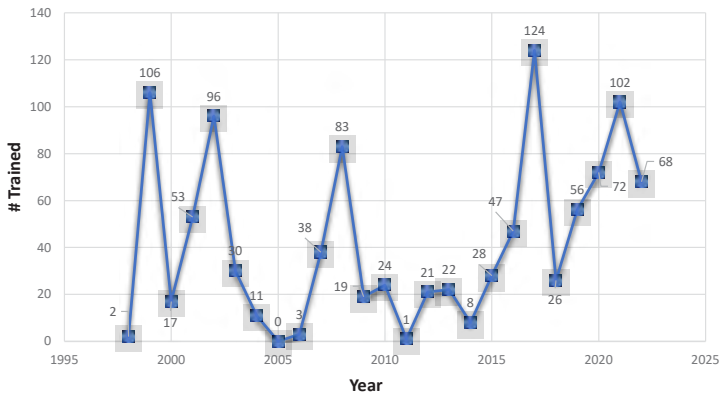


Figure 1. Number of persons per year trained since the beginning of the forestry BMP program.

By 1996, the BMP guidelines were constructed, and each program was ready to begin. Selected sites were predominately within the watershed of Monroe Lake, which is a reservoir serving many Hoosiers as a chief source of water and recreation. Additional sites were from adjoining Owen County and Morgan-Monroe State Forest. Only legitimate forest sites larger than 10 acres and logged within the last two years of the time of monitoring were considered for that round of monitoring. The identification of potential monitoring sites was accomplished by aerial reconnaissance and ground verification, licensed timber buyer records, district and consultant forester recommendations, and Monroe County logging permit records. Owners of prospective sites were contacted to seek permission to use their site as part of the study. Once sites were accepted for monitoring, teams were made up of people with diverse technical backgrounds. Each team was led by a DNR forester to provide technical and logistic support. Other team members came from the forest industry, environmental community, landowners, planning and development, wildlife biology, hydrology, and soil conservation. Team size was 4-5 individuals, often with team members possessing multiple areas of expertise.

All BMP monitoring since has followed the model that was set by the group in the mid-1990s, but it has changed and evolved over time by needed improvements. The first few rounds of monitoring were paid for through money from IDEM or the Great Lakes Commission under the Clean Water Act or some other federal program. On Indiana State Forest properties, all timber harvests are monitored after closeout for forestry BMP implementation and effectiveness.

Forestry BMP training for soil and water quality consists of classroom and field training. Above, loggers from around the state receiving classroom training for BMPs.

II. Methods

A. BMP Monitoring Objectives

The objectives of BMP monitoring are: 1) to assess the effectiveness of BMP guidelines in minimizing soil erosion and stream sedimentation; 2) to provide information on the extent of BMP implementation, past and current; 3) to identify areas to focus future program training and educational efforts to improve BMP implementation and effectiveness; 4) to identify BMP specifications that may need technical modification; and 5) to identify improvements needed in future monitoring efforts.

B. Site Selection

State Forest

Every timber harvest conducted on state forest property is monitored if the timber was sold after July 1, 1999, unless the harvest occurred in order to change the land use. For example, Ferdinand State Forest had a site where timber was harvested before the area was cleared for a pipeline right-of-way. This kind of land-use change makes it impossible to monitor for forestry BMPs.

Classified Forest and Wildland

Beginning in 2009 and henceforth, at least 10% of Classified Forest and Wildland (CFW) program sites reported as having a harvest the previous year will be monitored. CFW monitoring began to make CFW properties eligible for certification with the Forest Stewardship Council (FSC). The 10% of Classified harvests are randomly selected from the annual reports, stating there was a harvest during the year they are reporting. When the annual reports are in, each timber harvest in each district is given a number, and those are run through a random number generator. At least 10% of harvests reported annually by landowners in each district are monitored. For instance, if a district gets back 31 annual reports that said they had a harvest during that year, we will monitor the first four sites that come out of the random number generator.

DNR foresters learning about forestry BMPs. This training covers how to implement BMPs for maximum effectiveness in protecting water quality and reducing soil movement. The training also teaches how to monitor the site after a harvest for BMP application and effectiveness.

Random Forests

From 1996 through 2004, monitoring sites other than state forests were selected by their geographic position. The 1996 and 1997 rounds were in the counties that had land in the Monroe Lake watershed; the 1999 round was in five randomly selected counties throughout the state (Ohio, Jefferson, Clay, Martin and Steuben); and the 2000 round looked at sites in seven of the 13 counties that have watersheds flowing into the Great Lakes (Adams, Allen, Elkhart, LaGrange, LaPorte, Noble, Steuben). One site in 1996, six sites in 1997, and five sites in 1999 were recorded as being CFW. Other landowner types included non-industrial private forests (NIPF), county, federal, and industrial.

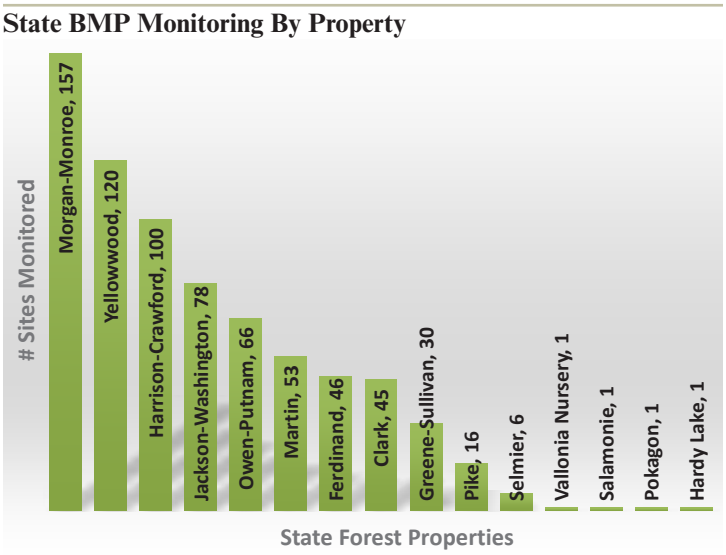


Figure 2. Timber harvests monitored for BMPs in Indiana State Forests by property.

Classified Forest Sites Monitored by District

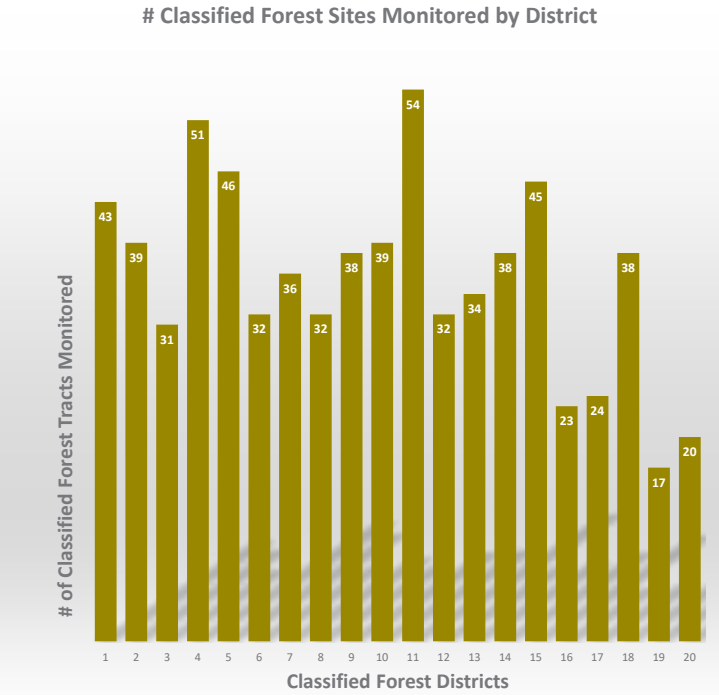


Figure 3. Number of classified forest timber harvest sites monitored for BMPs by district.

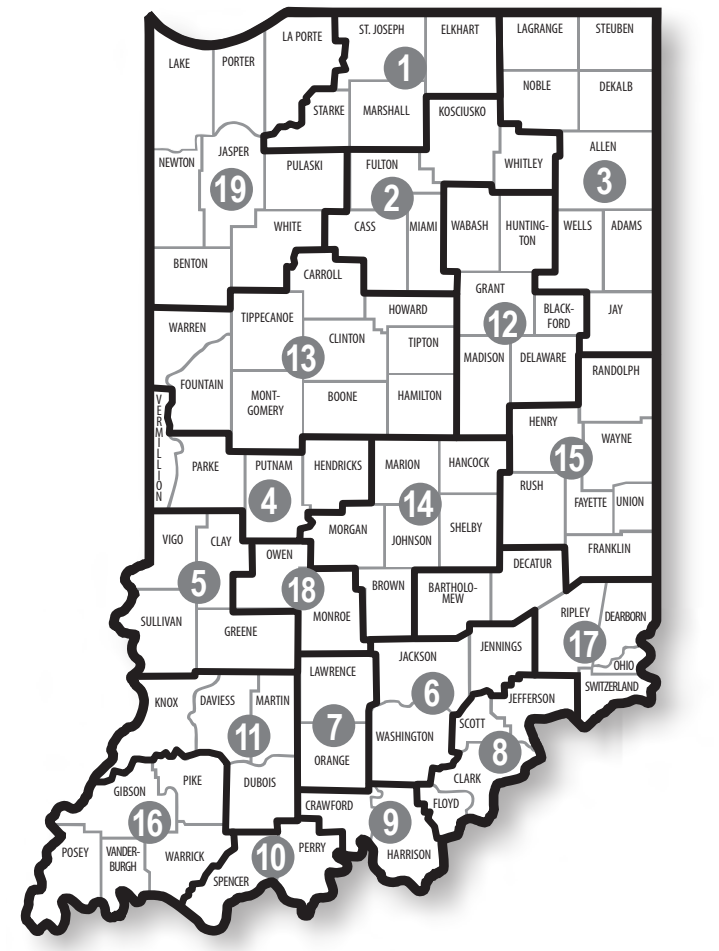


Figure 4. Classified Forest Districts

BMP Sites By Landowner Type

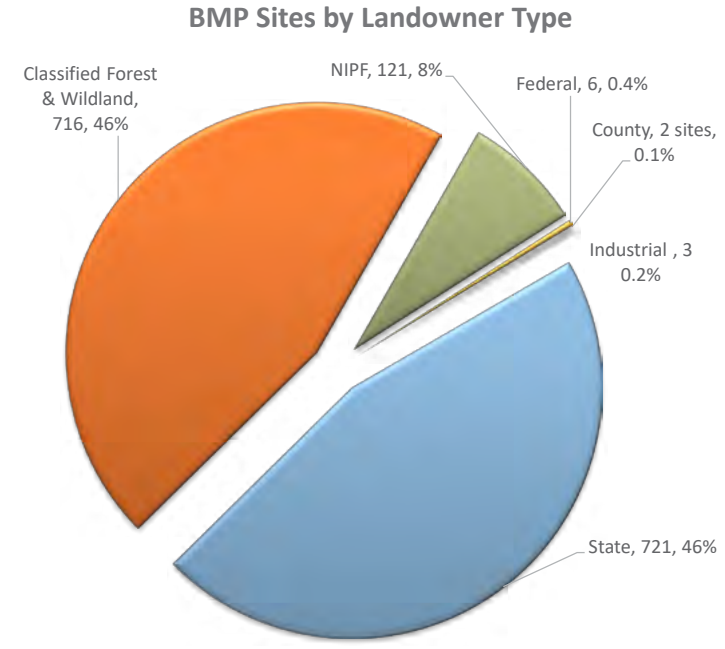


Figure 5. Proportion of land ownership type for total number of sites monitored.

Sites Monitored Per Year

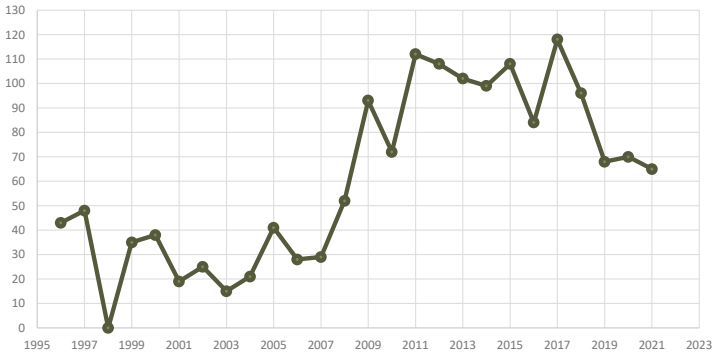


Figure 6. Total number of sites monitored each year since the program began 25 years ago.

C. Data Collection, Entry and Analysis

The BMP Monitoring Form is used to collect data both in the office and field. Much of the first page can be completed by consulting maps, harvest paperwork, and/or talking to the forester, timber buyer, or landowner. The remaining pages of the form are all completed in the field during and after the site evaluation. More details about that process can be found below in the Site Evaluation section.

These "raw" datasheets are then brought back to the office and given to a DoF employee to enter in the Indiana Forestry BMP database. Datasheets are "cleaned up", and copies are supplied to concerned parties: foresters, landowners, timber buyers, and managers. Data is entered and analyzed then used to generate state, classified and comprehensive reports.

D. Monitoring Team Selection

Selection of monitors has been modified over the course of forestry BMP monitoring in Indiana (1996 -2021). It has also varied based upon the landownership and monitoring objectives.

State Forests

Initially on state forests, either or both the Watershed Conservation (WC) and Licensed Timber Buyers (LTB) foresters came to every BMP monitoring site, which kept a good balance for consistency in the monitoring and resulting data. BMP monitoring staff now includes the LTB forester and one or two foresters whose positions' partial focus is BMP monitoring. The other participants are the administering forester, and at times, other foresters on the property. This provides balance in the monitoring process, provides good training, and allows discussion.

From July 1999 until 2003, the coordination of monitoring dates and people was carried out by the property specialist, who also attended the monitoring of every timber harvest. This practice was discontinued when administrative duties increased for that position and coordination of monitoring was passed to the LTB forester.

Ownership other than State

In the monitoring rounds from 1996–2004, an assortment of technical backgrounds was the basis for monitoring team selection. Each team was led by a DNR forester to provide technical and logistic support. Team members also included individuals from the forest industry and the environmental community; landowners, planning and development staff; and professionals in the fields of wildlife biology, hydrology, logging, and soil conservation. Team size was four or five individuals, often with team members possessing multiple areas of expertise.

Classified Forest

In the 2008-2021 monitoring of classified forest sites, the district forester and one or more of the BMP monitoring staff monitored each site. If the landowner or harvesting professional came too, they were included but did not participate in the monitoring process other than observing it.

E. Site Evaluation

BMP monitoring is based on the evaluation of each specific practice for application and effectiveness. Application is the installation of a practice and the condition of the practice at the time of monitoring. Effectiveness is the level of success a practice has in the prevention of pollutants entering a body of water or the level of impact the pollutant is having on the body of water at the time of monitoring. It is possible to apply all of the BMPs properly and get a good score in application but still have soil entering a stream, which would call for a lower score in effectiveness. The opposite may be possible as well.

There are 58 individual BMPs measured for application and effectiveness on each site evaluation. These individual BMPs are within five categories:

1. Access or Haul Roads
2. Log Landings or Yards
3. Skid Trails
4. Stream Crossings
5. Riparian Management Zones (RMZ)

The team inspects the harvest area, covering all access roads, log landings, skid trails, bodies of water, RMZs, and stream crossings as suggested in the Indiana BMP monitoring protocol, and comments on successes and departures from the BMP guidelines.

Once on the site, the monitoring team walks the area and its adjacent and interior intermittent or larger streams carrying maps of the site, the BMP monitoring form, and the BMP Field Guide. This allows each team member to evaluate the BMPs on the site. Once the team has walked the area, they come together to discuss each question and each team member's scores on the BMP monitoring form until they reach consensus as a team on scores for each question.

On state forests, between 1999 and 2010, the definition of large intermittent streams was focused on streams that were 4 feet wide at the bed of the stream or marked as mapped intermittent streams or larger on U.S. Geological Survey quadrangle maps. This was done to more easily determine what streams need to be monitored for the presence of large woody debris caused by the harvest that must be removed.

The "4-Foot Rule" was adopted as an automatic intermittent stream starting July 1, 1999, when BMPs officially were put in state timber sale contracts. On other forest ownership types, the definition of an intermittent was defined in the BMP Field Guide and how the monitoring crew interpreted what it saw on the site. As of July 1, 2010, the "4-Foot Rule" gave way to consistency with the other property ownership types as far as stream crossings were concerned. With this rule, there were streams on state forests that had woody debris in them that was required to be removed that would not have been counted against them on other ownership types. Now, all ownership types are consistent in this matter.

III. Results

A. Comprehensive BMP Application & Effectiveness

Comprehensive BMP Application

Figure 7. BMP Application for all 1,569 sites monitored from 1996 – 2021.

Comprehensive BMP Effectiveness

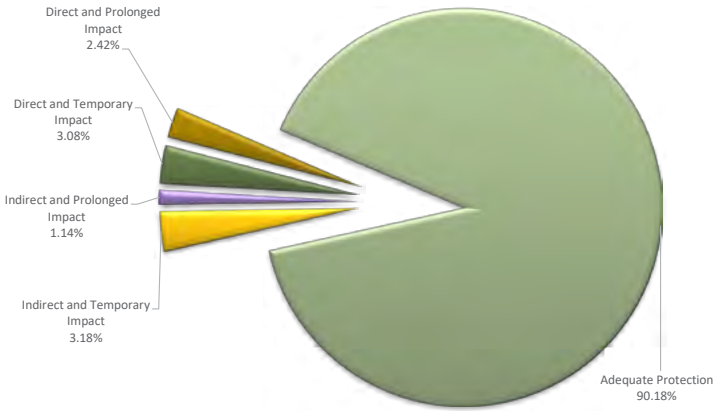


Figure 8. BMP Effectiveness for all 1,569 sites monitored from 1996 -2021.

The application and effectiveness rates for forestry BMPs used to protect sites after timber harvests are excellent for the 1,569 sites monitored since 1996. The overall application rate is 85.19%, and the overall effectiveness rate is 90.18%.

B. Application & Effectiveness of BMPs by Category

In the overall BMP application and effectiveness for the five categories, access roads and log landings were, again, the highest ranked, with access roads having a 94.7% application and 98.0% effectiveness rate. Log landing application rate was 92.2% and effectiveness 97.2%. The third highest category was RMZs, with 79.1% application most critical in this area. Small problems in application on stream crossings can lead to large-scale disturbance

BMP Application and Effectiveness Trends

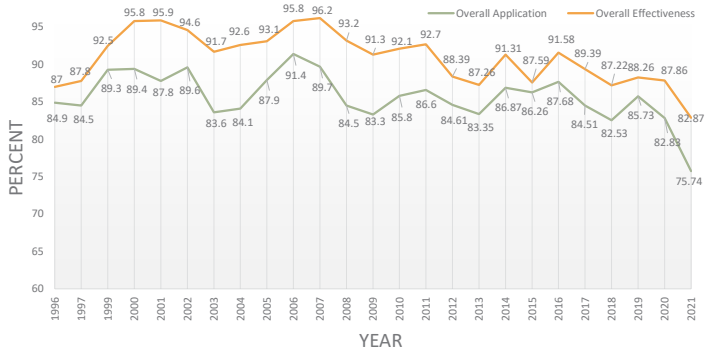


Figure 9. These are the application and effectiveness trends for each year, calculated separately to only account for each specific year's sites monitored.

Yearly BMP Application Trends by Category

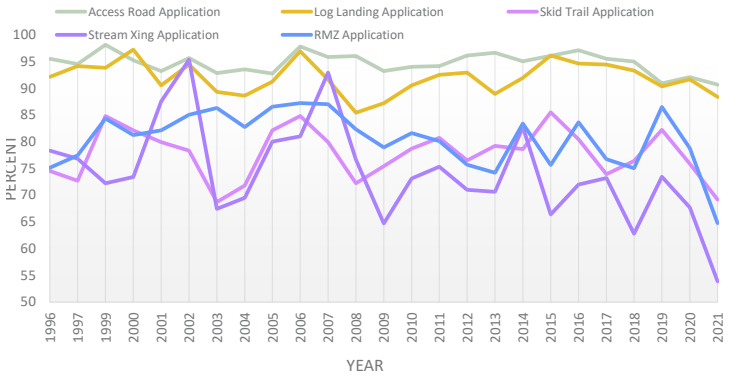


Figure 10. Yearly BMP application trends by BMP category. These are calculated separately as each year's monitoring sites.

to the streams, making this area the most critical and important BMP area. The application of stream crossings across the 25 years of monitoring, on all land ownerships, is 71.7% and 73.2% effectiveness.

BMP application trends remain consistently high for access roads and log landings through the 25 years of monitoring. RMZ application got off to a slow start the first two years of monitoring, staying between 75 -80%, but after that never dropped below 80%, except for 2009. The application rate for RMZs improved greatly in 2019 only to be followed with two sharp declines for 2020 and 2021. The 2021 RMZ application rate was 64.8%, the lowest on record. Skid trails and stream crossings are the most challenging part of the timber harvest. The application trend lines for both BMP categories fluctuate widely across the monitoring term, down-turning sharply the last two years. Stream crossings are the most erratic, fluctuating from 95.3% at their highest point in 2002, and 53.9% at their lowest point in 2021.

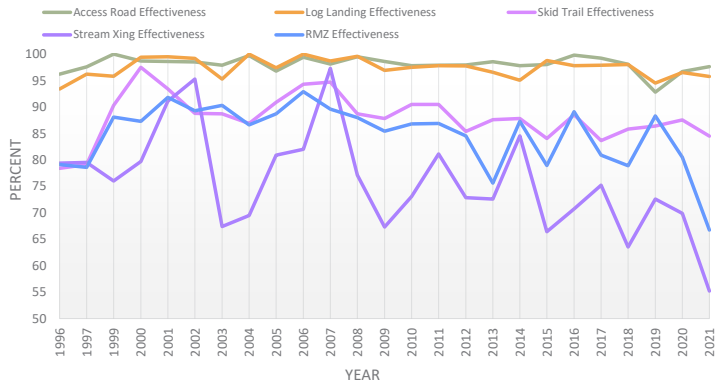


Figure 11. Overall BMP effectiveness yearly trends by BMP Category.

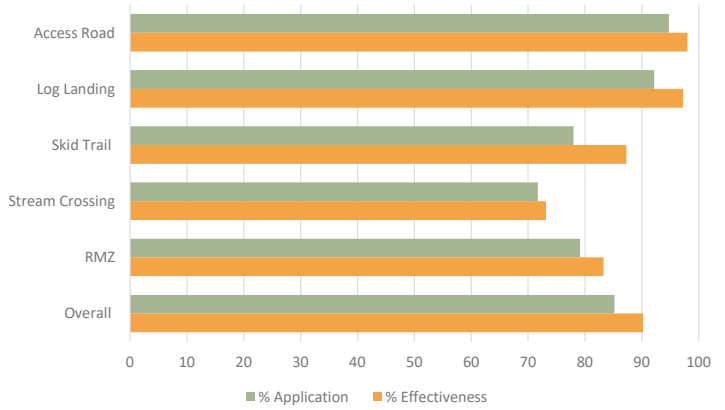


Figure 12. Application and Effectiveness percentages for all 1,569 sites monitored, grouped by BMP category.

The BMP effectiveness trends closely mimic the application trends; however, the effectiveness rates are generally higher than application rates. As with application, effectiveness rates for access roads and log landings are consistently high. Skid trails show the most variation between application and effectiveness. While application had many ups and downs, skid trail effectiveness is much more consistent. It seems after a bit of a learning curve of the first two years (78.4% and 79%, respectively), that effectiveness of skid trails became much improved, and percentages ranged from the mid 80s to the high 90s. RMZ effectiveness was similar to application, although it ranged a few percentage points higher. Stream effectiveness closely mirrored the application percentages and remained erratic. The last two years there has been a downturn on both RMZ (66.7% in 2021) and stream crossing (55.2% in 2021) effectiveness.

In the last 25 years of BMP monitoring, there have been drops in score. This has also happened in the past couple of years in application and effectiveness in the Skid Trails, Stream Crossings and RMZ categories. A number of variables can singly cause this issue. Examples are a wet year with high precipitation, or a combination of factors such as employee turnover and experience levels, the number of sites being monitored, weather extremes, and even the timing of the harvests that year. A more in-depth analysis is in the Discussion section of this report.

In the overall BMP application and effectiveness for the five categories, access roads and log landings were again the highest ranked, with access roads having a 94.7% application and 98.0% effectiveness. Log landing application rate was 92.2% and effectiveness 97.2%. Skid trails and RMZ are closely related, and the application and effectiveness reflect that. Skid trail application is 78.0% and RMZ is 79.1%. Effectiveness for skid trails is 87.3% with RMZ at 83.3%. The BMP area with the most difficulty was stream crossings. Because of the direct impact all crossings can have on water resources, BMPs application and effectiveness are most critical in this area. Small problems in application on stream crossings can lead to large-scale disturbance to the streams, making this area the most critical and important BMP area. The application of stream crossings across the 25 years of monitoring on all land ownerships is 71.7% and 73.2% effectiveness.

C. Application and Effectiveness by Landowner Type

While it is impossible to make any direct correlation between landowner types due to the different site selection methods used, there is still useful data from these sources. We can conclusively say that across all landownership types effectiveness rates are always higher than application rates. This indicates that although BMPs may not be applied perfectly, there is still a satisfactory safeguard being provided to the water resources of the site. Federal, industry and county ownerships only had six, three, and two monitored, respectively, and thus do not provide a clear picture of the status of BMPs on timber harvests of those ownerships (Figure 8). State, classified, and nonindustrial private forests had 721, 716, and 121 sites monitored. This number of sites gives a better snapshot of what the BMPs on timber harvests of these ownership types look like. Most of the following graphs will omit the three minor landowner types because they play a small role in this dataset. State forests have the highest overall application (86.0%) and effectiveness (91.9%) rates compared with classified and NIPF. Classified and NIPF have 83.8% and 84.6% application rates, respectively. Classified forest had higher effectiveness rates than NIPF at 88.5% compared to 87.5% for NIPF.

Overall BMP Application & Effectiveness by Landowner Type

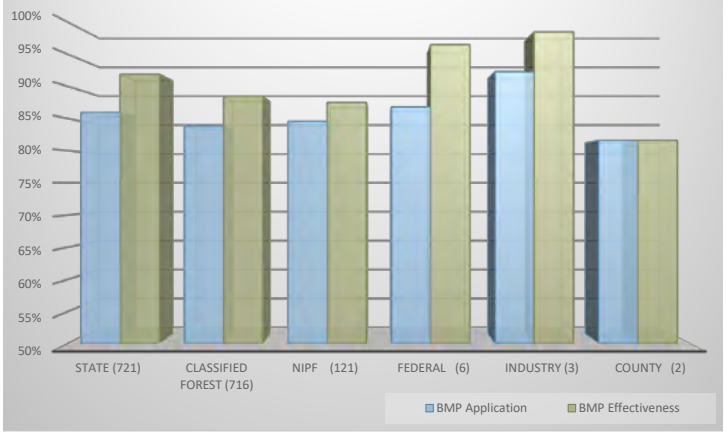


Figure 13. Overall application and effectiveness broken out by landowner types. Classified forest and state forest sites comprise the largest number of sites in the dataset at over 91% of the total sites monitored, combined.

Access Roads

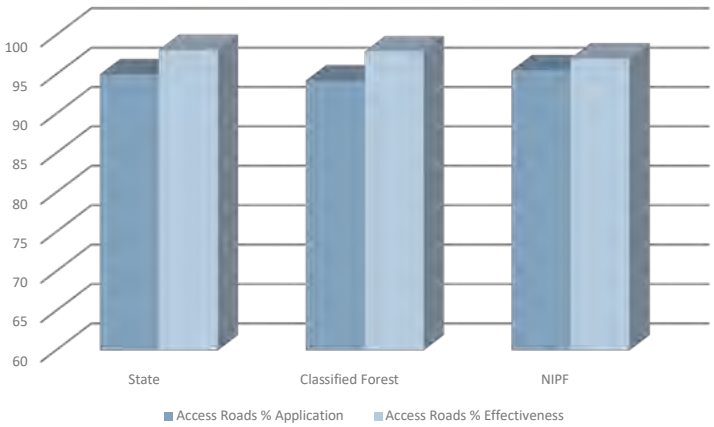


Figure 14. The three landowner types have similar application and effectiveness rates for access road.Access roads have the highest overall ratings for application and effectiveness of all five bmp categories.

Log Landings

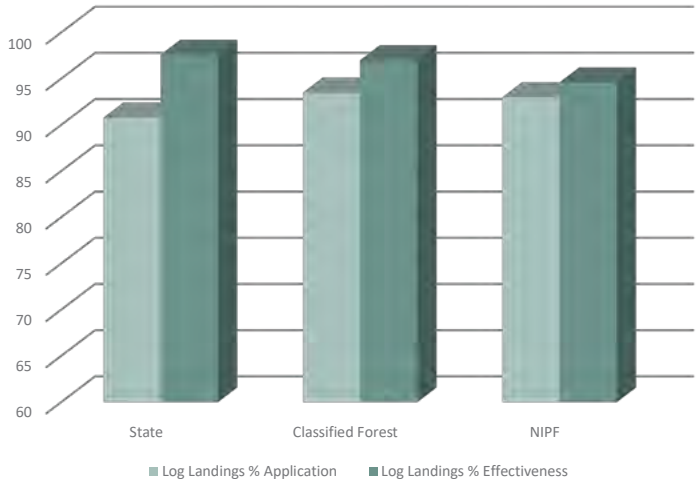


Figure 15. While state forests have the lowest log landing application implementation, they also have the highest effectiveness rate.

Skid Trails

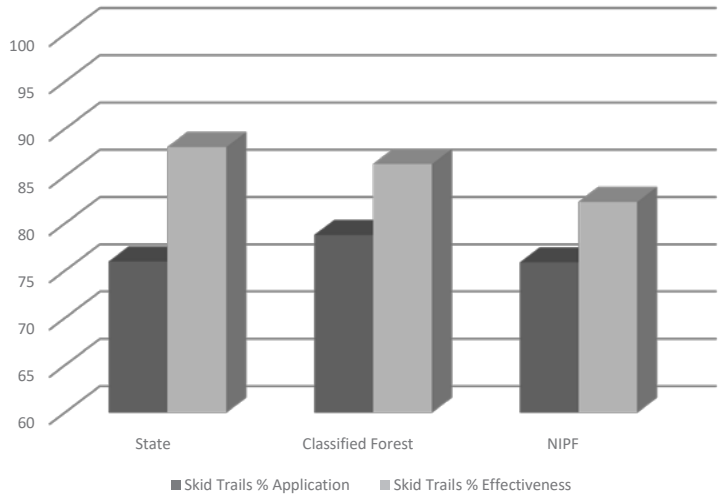


Figure 16. Skid trails have a larger gap between application and effectiveness than any other BMP category, with effectiveness ranging 6-12% higher than application rates.

Stream Crossings

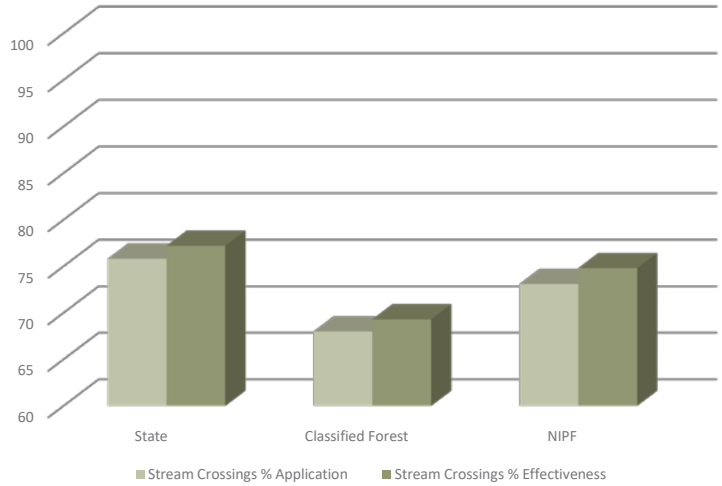


Figure 17. Stream crossings are the lowest rated category for application and effectiveness. State crossings fare much better than classified and NIPF crossings in general. State application and effectiveness is about 8% higher than on classified sites that were monitored.

The five BMP categories had many similarities between ownership types; there were also some notable differences. Similarities were access roads and log landings, which were areas of high implementation for all ownership types. Rates were almost identical for skid trails on state and classified forest at 76% and 78.8% application, respectively, and 88.1% and 86.3% effectiveness, respectively; however, skid trails for NIPF were 75.9% application and 82.3% effectiveness. Larger gaps in application and effectiveness among these three ownerships are seen in the stream crossing and RMZ categories. State forest application score for stream crossing was 75.8%, and effectiveness was 77.2%. Classified forest stream crossing had the lowest

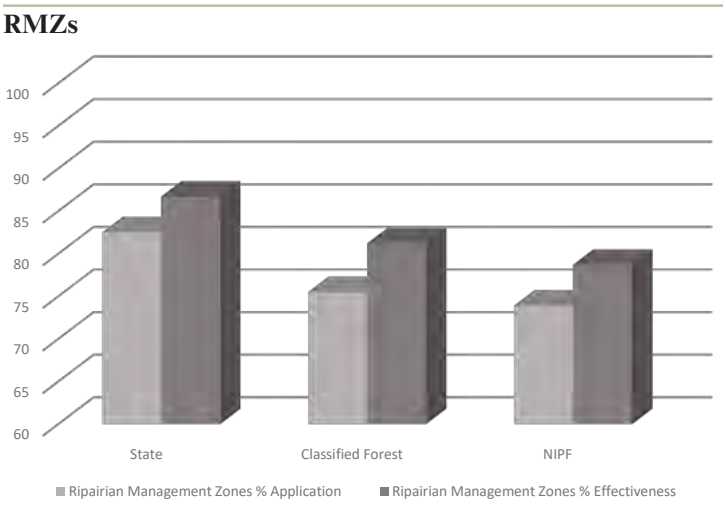


Figure 18. State RMZs are more than 7% higher in application and 5% in effectiveness than private lands.

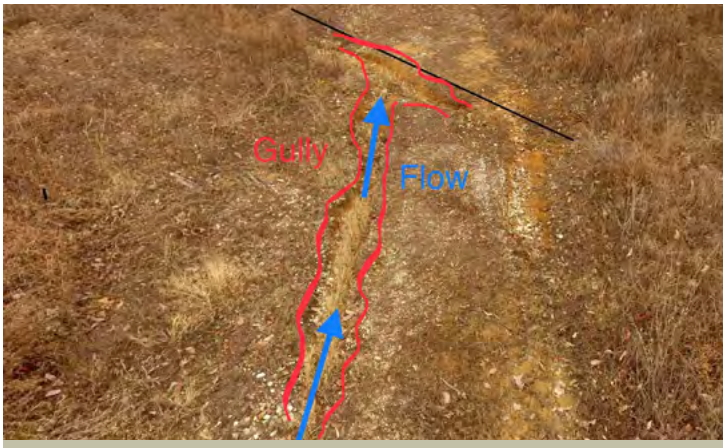
application and effectiveness rates at 68% and 69.3% effectiveness. NIPF stream crossings scored 73.1% application and 74.8% effectiveness. RMZs for these three ownerships followed a similar pattern, in that state forests had a higher application and effectiveness rate than classified or NIPF. RMZs were lowest for NIPF 73.9% application and 78.7% in effectiveness.

The remainder of this report will only look at information collected from the state and classified forest landowner types. These two comprise more than 91% of the data. State and classified forest reports are produced every year, with all the new data from sites collected that year included. These can be referenced at https://www.in.gov/dnr/forestry/files/fo-classified-forest-bmp-1996-2021-report.pdf & https://www.in.gov/dnr/forestry/files/fo-BMP-report1996-2021.pdf . This report will not rehash the material in those reports but compare the areas of differentiation between these two landowner types.

This gravel access has a well-armored and constructed waterbar to both allow movement of water off the road while still allowing the road to be functional.

Access Roads

Classified forests and state forests are closely matched on access road scores. BMP ratings for this category are high overall with application for access roads is 94.7% and effectiveness at 98%.



The diversion on this access road diverted flow off the trail; however, the gully prior to the water diversion indicates that more diversions may have improved this portion of the trail.

Log Landings

Log landings are where compaction is concentrated on a harvest. Most heavy equipment use the landing and the harvested trees are processed there. Therefore, it is imperative that landings be well-armored and water diverted to stable areas and not onto trails, roads, or bodies of water as the runoff rate is high due to soil compaction.

Log landings are fairly close in application and effectiveness rates for state and classified forests; however, there are three application areas where the two landowner types diverge. The good news is that this doesn't negatively impact the effectiveness percentages, with both having overall 97% or better for this category. The specific BMPs that differ are landings located outside of RMZ, landings avoid concentrating or collecting runoff, and landing runoff enters stable area. State forest

In this pine clearing, the smaller pine trees that were not marketable were used to stabilize the log landing area, as pine plantings can be quite wet. This allowed the landing to be stable even during wetter periods.

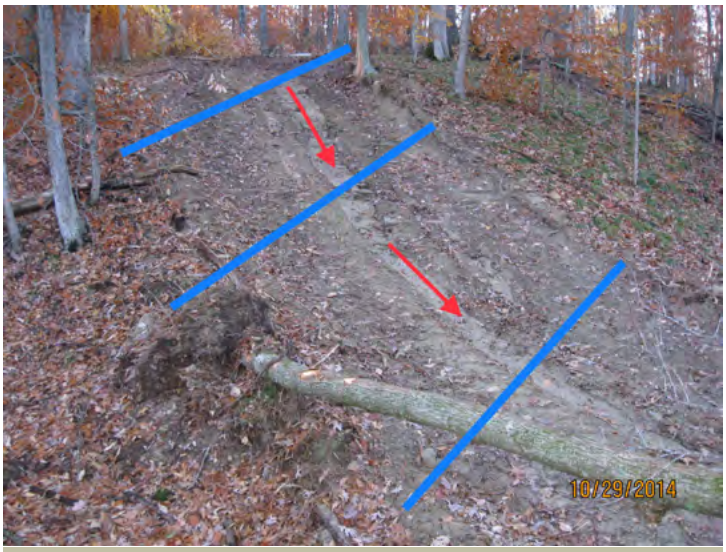
scored better on landings not being located in an RMZ, with a 95.5% application compared to 89.8 for classified; however, classified forest scored better on landings not collecting or concentrating runoff, with an 86% compared to 74.5% on state lands. Runoff entering stable areas was also applied at a higher rate on classified, at 89.5% compared to 83.3% for state properties.

A grassy field used as a log landing. Using existing grassed areas for log landing reduces damage to soil, runoff, and sedimentation to bodies of water and speeds recovery of the area.

Skid Trails

Skid trails also have three areas of divergence between state and classified, avoidance of steep and straight grades, skid trail minimization and installation of appropriate drainage and diversions. Classified forest was better at avoiding the long and steep grades, with an application rate of 85.3%, while state forests was 71.3%. Classified forests also performed better in minimizing skid trails, with an application score of 89.7% compared to 82%. Effectiveness rates for both practices was still high at more than 93% for both landowner types. Appropriate drainage and diversions installed was the weakest area of skid trail application and effectiveness for both landowner types. State forest had a 49.2% application rate compared to 44.3% on classified forests. Classified forest effectiveness for this specific BMP was lower than state, with a 62.3% and 78.2%, respectively.

This skid trail has been closed out properly, with waterbars diverting flow off the trail and seeded to expedite growth of vegetation that will stabilize the soil.



No water diversions were placed on this skid trail down a short but steep hill, resulting in a gully forming down the center of the trail. Waterbars placed where the blue lines are could have prevented this erosion.

Debris used to armor a skid trail.

Lack of water diversions on this trail is causing active erosion, leading to sediment-laden runoff reaching the stream.

Stream Crossings

Bridges to cross drainages both reduce the amount of sediment going into a drainage from equipment and protect the bed and banks of the stream so that there is minimal damage.

There is a fairly large gap between Classified Forest and State Forest on stream crossing BMPs. In general, the state forest BMPs for crossings score better than classified; however, there are a few practices that do not. Stream crossings and RMZ tables comparing the individual BMP scores for state and classified are included in these sections. The only area where classified forests sites significantly outperform state forest stream crossings is culverts cleared of significant flow obstructions. Overall application and effectiveness is 7.8% and 7.9% higher for state forest stream crossings.

Table 3. State and classified forest stream crossing BMPs compared side by side

Stream Crossing	Classified % Application	State Forest % Application	Classified % Effective	State Forest % Effective
X1. Number of crossings minimized	89.0	88.6	89.4	91.2
X2. Crossings minimize disturbance to the natural bed and banks	52.7	66.3	54.4	68.4
X3. Streambank approaches properly designed and stabilized	43.5	58.2	46.0	59.9
X4. Water runoff diverted from road prior to crossing	40.2	57.9	45.0	59.3
X5. Crossing as close to 90 degrees as practicable	89.9	87.9	91.3	92.2
X6. Crossing does not unduly restrict water flow	78.0	81.6	79.2	82.6
X7. Soil has not been used as fill in the stream (except culverts)	73.4	76.1	73.4	76.4
X8. Ford constructed of nonerosive materials	78.3	84.4	77.3	84.8
X9. Fords have stable banks and streambeds	50.3	62.2	50.7	61.4
X10. Culverts are properly sized and installed	75.8	73.2	80.3	75.6
X11. Culverts clear of significant flow obstructions	84.6	67.5	87.7	70.0
X12. Temporary structures properly anchored	89.1	98.1	87.0	96.3
X13. Temporary structures and resulting obstructions removed	60.6	80.0	60.6	76.9
Overall Stream Crossing	**68.0**	**75.8**	**69.3**	**77.2**

RMZs

Sinkholes generally lead directly to a water source, thus the area around them is an RMZ. See the 2022 Forestry Field Guide.

RMZs are the other BMP category most related to stream crossings and can have direct impacts to water quality. There are multiple individual BMPs within this category that have more than 5% separation in application and effectiveness between classified and state forest property sites monitored. The only BMP that was higher for classified forest is "ephemeral channels free of excavated material" (in red). Overall application and effectiveness for RMZ was 7% higher for state forests and 5.5% better for effectiveness.

A skid trail was constructed with soil and pushed into this ephemeral channel blocking the flow, causing the water back up and to go over the trail, eroding the trail and causing sediment deposition in the channel. This will also lead to the eventual failure of this skid trail.

Harvest debris was cleaned out of this drainage.

Table 4. State and classified forest RMZ BMPs compared sided by side

Riparian Management Zones	Classified Forest % Application	State Forest % Application	Classified Forest % Effective	State Forest % Effective
Z2. Perennial & large intermittent streams clear of obstructing debris	59.7	71.6	61.9	72.9
Z3. Tree tops and cutoffs placed back from water course to prevent movement into streams during floods	87.2	92.4	92.4	95.0
Z4. RMZ free of excavated material & debris (other than above)	92.6	94.9	95.5	97.2
Z5. Less than 10% bare mineral soil exposed within RMZ (not including crossings)	96.2	96.2	97.1	97.4
Z6. Adequate tree stocking in primary RMZ next to perennial streams	97.1	99.4	99.2	99.4
Z7. RMZ free of roads and landings (except crossing)	61.1	65.1	80.6	85.7
Z8. Water diverted from roads before entering RMZ	57.6	82.7	68.2	86.6
Z9. Water diverted onto stable areas of the forest floor	66.0	86.1	72.5	88.9
Z10. Road and trail surfaces stabilized as needed within RMZ	74.3	88.2	78.8	89.5
Z11. Ephemeral channels free of excavated material	69.7	62.6	71.4	64.4
Riparian Management Zones	**75.5**	**82.5**	**81.2**	**86.7**

IV. Discussion

The overall forestry BMP application rate is 85.2%, and overall effectiveness is 90.2%. The high application and effectiveness scores show there are many sound practices taking place throughout the state's forests harvest sites to maintain the integrity of the soil and water resources.

The highlight of Indiana's forestry BMPs in the last 25 years has been the high implementation and performance rates in the areas of access roads and log landings. Access road application and effectiveness rates were 94.7% and 98.0%, respectively. Log landings had a 92.2% application and 97.2% effectiveness rating. Access road runoff drainage and diversion was the only real issue of concern, all still having a more than 80% application rate overall and mid-90% effectiveness rates. Log landings' only problem areas were the concentration or collection of runoff and the runoff diverted onto stable areas of forest floor. These areas also had application rates in the low 80%, but effectiveness was more than 93%, showing that impacts to water quality were minimal. All ownerships performed well on both forestry BMP categories.

Skid trails are where much of the work of a harvest occurs, so it is no surprise that issues arise in this area. Skid trails had an overall application rate of 78.0% and effectiveness of 87.3%. The weakest individual BMP in this category is S7, appropriate drainage and diversions installed. Application is 46.5% and effectiveness is 69.8% for drainage and diversions on skid trials. This indicates that although there are some difficulties correctly implementing BMPs here, most do not result in impacts to water quality. Skid trails can have a spectrum of disturbance levels depending on how often equipment drives over a particular point on the ground. For instance, the main trail just off the landing would have a higher disturbance level because all harvested logs must be moved to the landing, while an area traveled over only twice – once to access trees and the other to pull out the logs – has a much lower level of disturbance. Also, skid trails go to areas that other equipment cannot access and cover more surface area across the harvest area, so they may cross drainages, travel down or across hill slopes, or go into areas that are wet. Therefore, most of the application and effectiveness issues of a site are from skid trails. Also, most closeout practices are put in place with limited space as landforms, and adjacent vegetation will often limit the equipment's ability to place structures where they would be most effective. This causes minor departures in application (20% of skid trail application scores are minor departures) with little to no effect on water quality.

Overall stream crossing BMP application is 71.7%, and overall effectiveness is 73.2%. Due to the nature of stream crossings, impacts to water quality are, at times, inevitable; however, the length and severity of impacts can be lessened if BMPs are applied properly. The best plan is to harvest in a way that avoids stream crossings; however, that is often not a viable option. The largest problem on stream crossings has been and continues to be the diversion of water before the stream crossing. This individual BMP (X4) had an overall application of 46.5% and effectiveness of 50.2%. Classified forests lagged behind state forests in this area by 17.7% in application and 14.3% in effectiveness. The proper design and stabilization of stream banks at crossings was also a problem area, with an overall application of 50.0% and effectiveness of 52.3%. This problem is also more pronounced on sites of private land ownership. The largest deviation between state and classified forests was in the removal of temporary structures (such as soil and pole fords) from stream crossings. Application was 20% lower on classified sites, and effectiveness was more than 16% lower for classified. Conversely, state forests lag behind classified forests on flow obstructions on culverts by over 17% in application and effectiveness.

RMZs are much like stream crossings in that they are in close to bodies of water. If there is a problem, it often leads to direct impacts to water quality, so managers often try to avoid placing high impact infrastructure like access roads or landings in RMZs unless they already exist. RMZs had a respectable application rate, at 79.1%. The effectiveness rate for overall RMZs was 83.3%. The two main problem areas for RMZs was the presence of obstructing debris in perennials and large intermittent streams and the presence of excavated materials in ephemeral channels. Z2, the RMZ BMP concerning obstructing debris, had an application rate of 67.2% and effectiveness of 68.9% overall. State forests performed about 11% better than classified forest on application and effectiveness of this BMP. Z11, BMP concerning excavated material in ephemeral channels, had an application of 66.8% and effectiveness rate of 67.8%. One RMZ BMP, Z8, had a large deviation of application and effectiveness rates between ownership types. Z8 is the BMP concerning water diversion before entry to the RMZ. On state lands this particular BMP was well implemented and performed, at 82.7% and 86.6% in application and effectiveness. On classified forest sites the application and effectiveness of this BMP was much lower, at 57.6% and 68.2%. It was even lower on NIPF sites, with a 29.8% application and 42.9% effectiveness rate. A similar pattern is noted on Z9, water diverted onto stable area of forest floor, with classified forests application at 20% lower than state forests, and effectiveness of more than 16% lower.

Fluctuation in scores being high or low can occur from year to year. There can be many factors that contribute to these fluctuations, sometimes individually, sometimes in combination, and other times they work against each other to negate any fluctuation. With a program that is now 25 years old, these fluctuations have happened repetitively. Often, these fluctuations are more drastic in the stream crossings, RMZ, and skid trail categories because they are the most dependent on topography and weather conditions. Employee turnover has been an issue during the last 25 years, but it has been exponentially high during the past three years for logging crews, foresters, and other professional groups. This can have a high impact on the BMPs from marking the timber and setting up the site through the people running the equipment closing out the harvest sites, as well as their experience level and the amount of training they have had concerning BMPs. Even the people who monitor the sites for BMPs has changed during the past four years. All of these factors can impact the final application and effectiveness scores for these critical portions of the harvest.

V. Recommendations

- Concentrate training, education, and implementation on areas where problems are more common, such as skid trails, RMZs, and stream crossings.
- Continue to emphasize importance of diverting water before it concentrates on roads, landings, skid trails and enters streams and RMZs. These types of BMPs were particularly challenging on private lands; therefore, continuing education for private lands managers, owners and contractors is of distinct importance.

VI. Conclusions

Since 1996 the Indiana Division of Forestry has provided forestry BMP leadership, training, and implementation for private, industry, federal, county, municipal and state forest lands. To date, 1,057 people have been trained on forestry BMPs to reduce soil and water impacts from timber harvesting. The division continues to hold itself and others to a high standard by continually monitoring timber harvests on state forest lands and other ownership types. A total of 1,569 sites have been monitored at the time of this report. The forestry BMP standards developed by the division and other stakeholders were revised in 2022 and updated to reflect the current science.

It is the desire of the Division of Forestry to use information that is found in reports such as this, and other similar reports, to raise awareness of the challenging areas of forestry BMPs, and to continue to improve in these areas. Managing Indiana's timberlands for forest production while maintaining the highest environmental quality is of the utmost importance.

Monitoring team discusses BMP application and effectiveness after closeout of this state forest harvest.

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