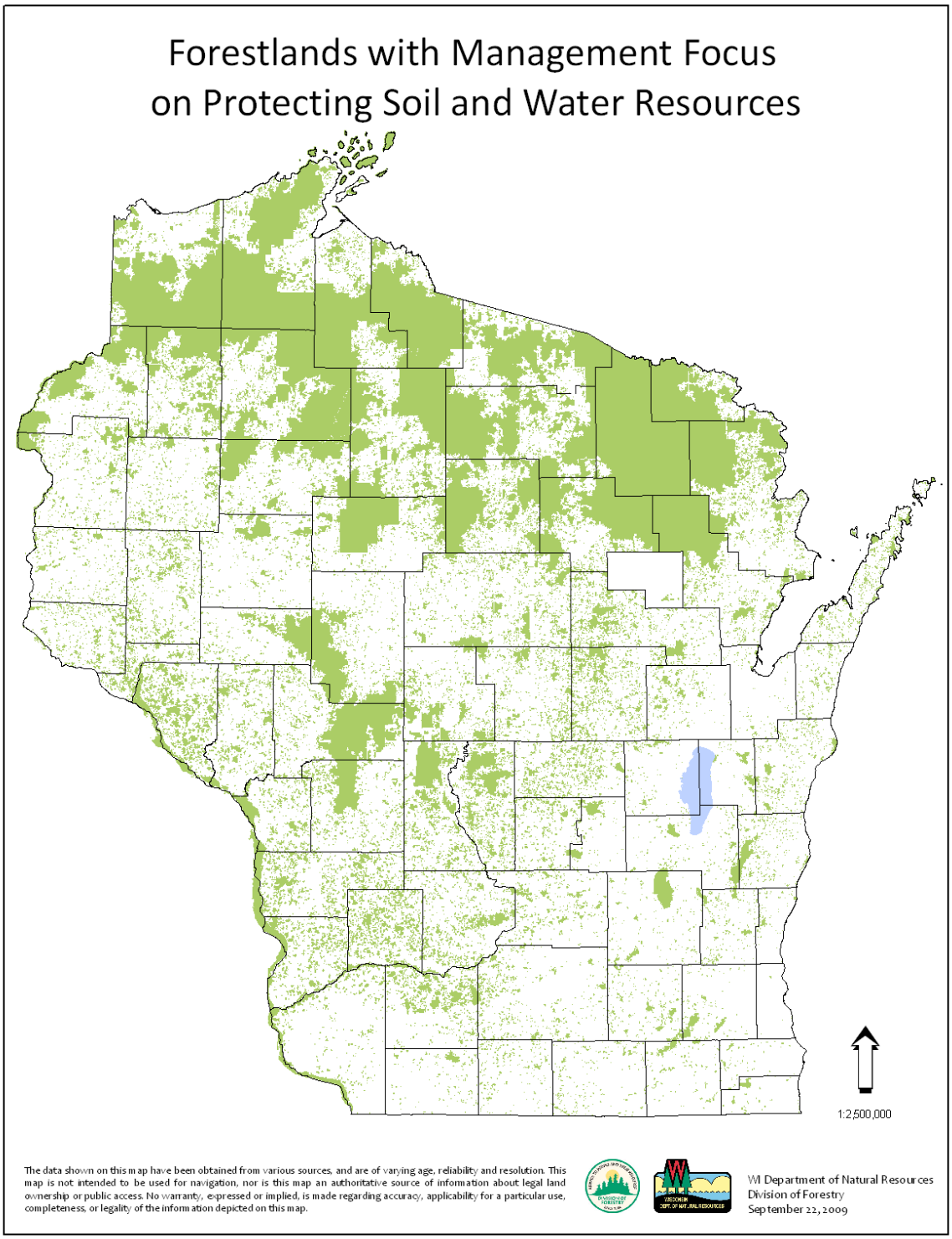
10. Soil and water quality in forested areas

11. Area of forest land adjacent to surface water and forest land by watershed

Indicators 10 and 11 provide a measure of forest, soil, and water quality by evaluating land management commitments, forest management activities, water quality designations, and land uses. Maintaining a watershed in a forested condition can help to protect both soil and water quality. Soil conditions influence forest composition, structure, and function, as well as the quality of water resources.

10.1 Management focus on protecting soil and water resources

These metrics measure the extent that management commitments recognize protection of soil and water resources in forested areas. Management commitments can be defined in land management designations, master plans, certification programs, participation in land conservation programs, or placement of conservation easements.



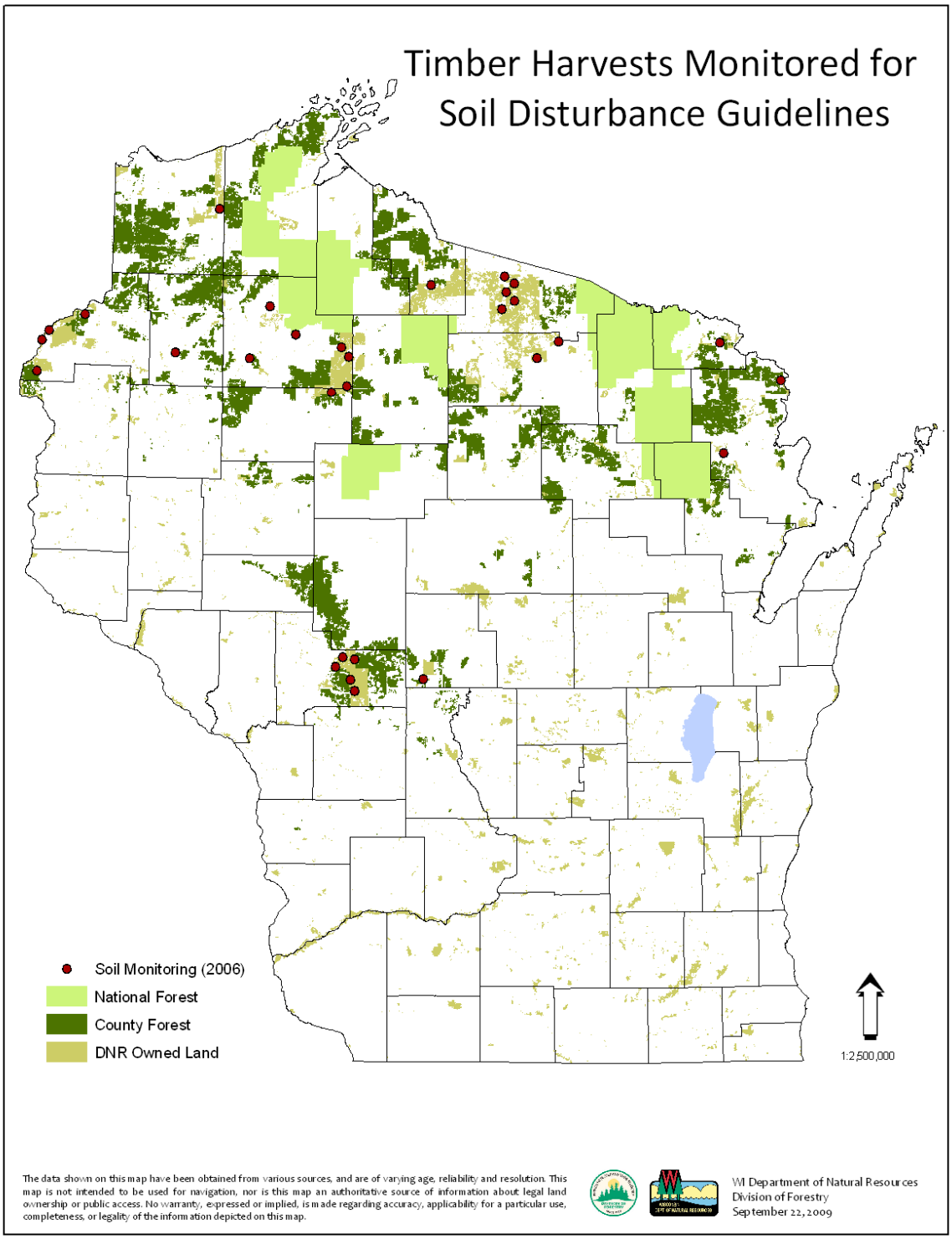
Map 10.a: Forest lands with a management focus on protecting soil and water resources
Source: DNR, 2009

In 2008, over 10 million acres of Wisconsin's 16 million acres of forest land had a management focus to protect soil and water resources (Map 10.a). These acres include DNR forests and managed lands, national forests, county forests, private forests enrolled in the Managed Forest Law, Forest Crop Law, State Natural Areas, federal lands from USGS Gap Dataset, BCPL lands and Forest Legacy Easement lands. When implemented, such designations or management commitments prevent the degradation of soil resources and maintain the quality of water resources.

10.2 Guidelines to protect resources: soil

Guidelines to protect soil resources are a set of preventive practices designed to limit degradation of soil resources and to control soil erosion caused by forest management activities. The goals of these practices are not only to avoid loss of productive soils, but also to protect lakes, streams, and wetlands from excessive sediment loads due to accelerated erosion.

Guidelines designed to protect soil resources can be found in Wisconsin Forest Management Guidelines (FMGs) and Wisconsin's Forestry Best Management Practices (BMPs) for Water Quality Field Manual. Since 1995, the Department has worked with its partners to monitor the application and effectiveness of forestry BMPs on nearly 600 timber harvests on federal, state, county, and private forest lands. Monitoring teams have found that soil and water resources are protected over 99% of the time when BMPs are used. However, if BMPs are not used, impacts to water quality, such as soil erosion and sedimentation, can be observed over 66% of the time. This demonstrates the value of following BMPs for water quality.



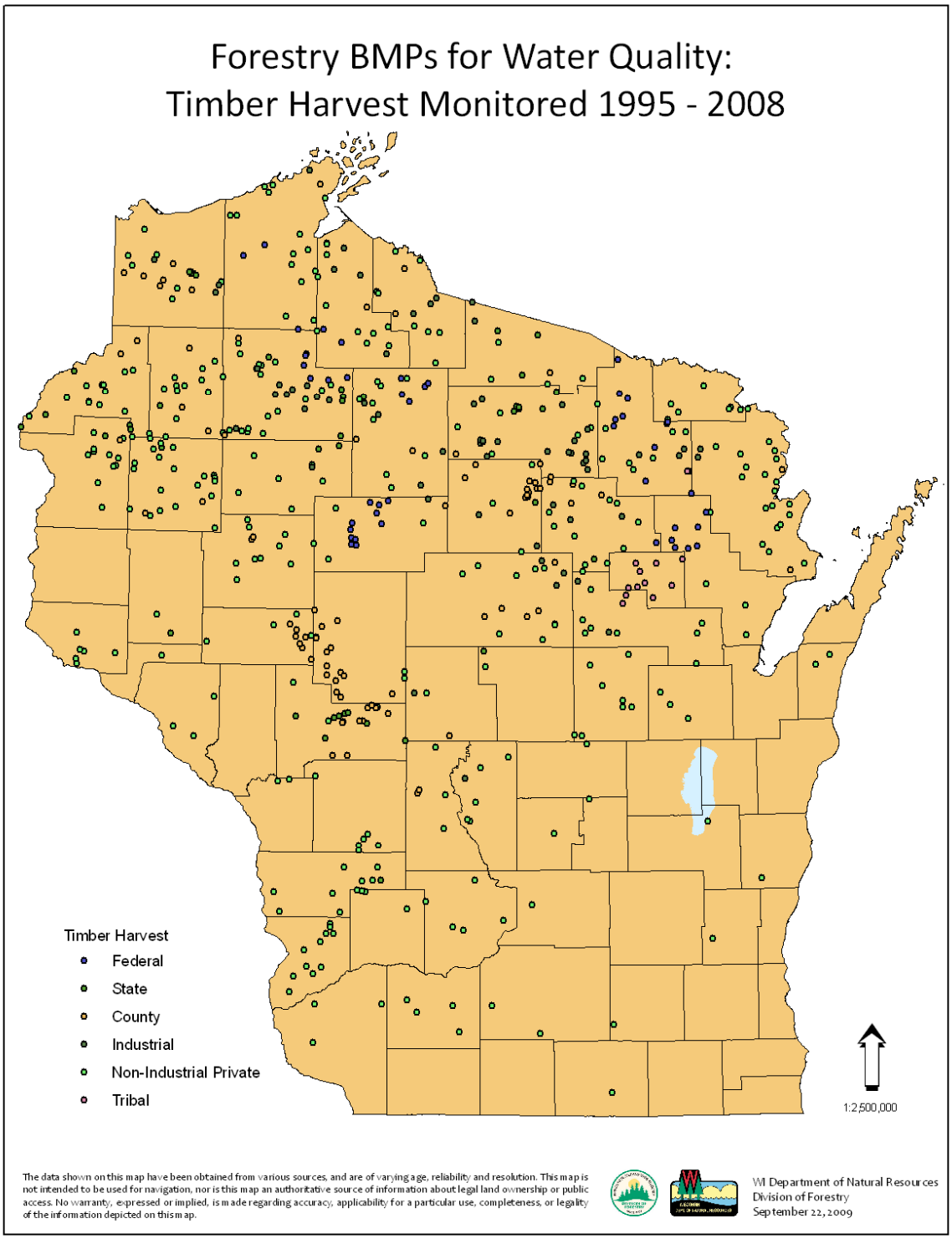
Map 10.b: Timber harvests monitored for soil disturbance guidelines
Source: DNR, 2009

In addition to BMP monitoring, in 2006 the Department checked the compliance of 30 randomly selected state land timber harvests with its soil disturbance policy (Map 10.b). The sales were on a variety of properties, including state forests, wildlife areas, state parks, and fishery areas. Twenty of the harvests were completed and
10 were in progress when the data was collected. On average, over 4.2% of the sale area was devoted to infrastructure, like roads, landings, and primary skid trails. The amount of sale area in infrastructure ranged from less than 1% to over 18%.

Ruts and/or gullies were observed on 20 of the 30 timber harvests, but excessive rutting was only documented on two harvests. In both cases, harvesting was completed prior to the soil disturbance policy being put in place. In one case, the rutting was caused by harvesting equipment. In the other case, the rutting was caused by a mix of harvesting equipment and later off-road recreational users. The road has since been closed to vehicular traffic.

Guidelines to protect resources: water

In 1995, foresters, loggers and landowners began using forestry BMPs to help prevent damage to soil and water resources. These practices outline different ways that forest management activities can be done to minimize impacts to soil and water quality while achieving forest management objectives. When the Forestry BMPs for Water Quality Program began, monitoring was recognized as a crucial component to demonstrate the success of these practices. Monitoring teams have evaluated nearly 600 timber harvests since 1995 (Map 10.c).



Map 10.c: Forestry BMPs for water quality: timber harvest monitored 1995-2008
Source: DNR, 2009

Looking at individual landowner categories, a general improvement is seen in the correct application of BMPs for water quality over time (Table 10.a). After the latest cycle of BMP monitoring, it was found that BMPs are being correctly implemented over 90% of the time when needed. This is significant accomplishment for a non-regulatory program.

Table 10.a: Correct application of BMPs for water quality by landowner category

Landowner Category	Monitoring Cycle		
	1995 - 1997	2002	2003 - 2008
Federal	92%	96%	95%
State	86%	100%	90%
County	86%	89%	93%
Industrial	91%	95%	94%
Non-Industrial Private	82%	81%	90%

Note: Shaded cells indicate a sufficient sample size for statistically valid results.
Source: WDNR, 2008

Based on the monitoring results, water quality is protected over 99% of the time if BMPs are used correctly. However, if BMPs are not used, impacts to water quality can be observed over 66% of time. This demonstrates the value of using BMPs for water quality.

Beyond individual landowner categories, BMPs were also evaluated to determine how effective they are in different regions of the state. Three BMP categories—wetlands, forest roads, and skid trails—showed differences from the statewide trends for 1995-2006.

When evaluating wetland BMPs, monitoring teams found that, on average, wetland BMPs are correctly applied 88% of the time when needed (Table 10.b). In the Superior-Ashland Clay Plain, however, monitoring teams observed impacts to wetlands more frequently than elsewhere. This indicates a need for additional review to evaluate why the wetland BMPs are not as effective in this region of the state versus elsewhere.

Table 10.b: Application and effectiveness rates for wetland BMPs

	Correct Application	Adverse Impact Observed if BMPs Are:		
		Applied Correctly	Applied Correctly of Incorrectly	Not Applied
Statewide (521 harvests)	88%	1%	2%	77%
Superior-Ashland Clay Plain (18 harvests)	88%	5%	10%	100%

Note: Values have been rounded to the nearest whole integer. The standard error and the half-width for the 95% confidence interval, although not included in the table, can be substantial. In addition, the results have not been analyzed to determine if there is statistical significance when comparing results.
Source: WDNR

For the forest road BMPs, similar trends were seen in the Mississippi-Wisconsin River Ravines sub-section (Table 10.c), highlighting another area where further investigation into BMPs may be warranted. Additional training may also be needed to improve the correct application of BMPs for water quality.

Table 10.c: Application and effectiveness rates for forest road BMPs

	Correct Application	Adverse Impact Observed if BMPs Are:		
		Applied Correctly	Applied Correctly or Incorrectly	Not Applied
Statewide (521 harvests)	82%	1%	3%	67%
Mississippi-Wisconsin River Ravines (30 harvests)	61%	2%	11%	93%

Note: Values have been rounded to the nearest whole integer. The standard error and the half-width for the 95% confidence interval, although not included in the table, can be substantial. In addition, the results have not been analyzed to determine if there is statistical significance when comparing results.

Source: WDNR

The last BMP category that presented differences was skid trail BMPs. Statewide, BMPs for skid trails are being applied correctly only 66% of the time (Table 10.d). This indicates a statewide training need. It is interesting to note in the St. Croix Moraine and the Athelstane Sandy Outwash and Moraine, when BMPs are not applied, there is less likely to be an impact on water quality than elsewhere. This may indicate the potential for more flexibility in determining when to implement the guidelines; however, more research into this trend would be beneficial before altering implementation recommendations.

Table 10.d: Application and effectiveness rates for skid trail BMPs

	Correct Application	Adverse Impact Observed if BMPs are:		
		Applied Correctly	Applied Correctly or Incorrectly	Not Applied
Statewide (521 harvests)	66%	2%	8%	63%
Mississippi-Wisconsin River Ravines (30 harvests)	30%	4%	26%	86%
St. Croix Moraine (27 harvests)	55%	4%	13%	37%
Athelstane Sandy Outwash and Moraine (21 harvests)	74%	0%	14%	33%
Neilsville Sandstone Plateau (30 harvests)	59%	8%	11%	87%

Note: Values have been rounded to the nearest whole integer. The standard error and the half-width for the 95% confidence interval, although not included in the table, can be substantial. In addition, the results have not been analyzed to determine if there is statistical significance when comparing results.

Source: WDNR

10.3 Soil properties

The USDA Forest Service, Forest Inventory and Analysis (FIA) Program monitors total soil carbon, estimated bare soil, bulk density, and calcium-aluminum ratio on a subset of the standard FIA plots. The scale of sampling limits the use of these data for state-level analysis, so no conclusions were drawn from the results. See Appendix F for data tables.

10.4 Mining activities

A description of mining activities in Wisconsin is located in Appendix F as a reference for the Forest Legacy Program assessment process. Potential Legacy tracts need to be assessed for potential mineral and mining activity.

10.5 Certified loggers and acres managed

This metric provides a measure of logger education and training. This is an important measure because loggers are the primary party responsible for implementing practices to protect soil and water quality. Without an intensive survey and monitoring, it is not possible to say how many acres certified loggers manage. At a minimum, most loggers in Wisconsin meet the Sustainable Forestry Initiative (SFI) training standard. This training requires 16 hours of core training, including 8 hours on forestry BMPs for water quality. An additional 8 hours of training is needed annually to maintain status as SFI trained.

Beyond SFI training, some loggers have chosen to become Master Loggers. Master Logger Certification (MLC©) is a third-party certification system that formally recognizes those loggers whose training, experience, and commitment to sound forest stewardship make them eligible for the highest form of professional recognition in the logging sector.

Master Loggers must meet or exceed strict performance standards that fall under seven distinct "Areas of Responsibility." The American Logging Council developed seven Areas of Responsibility for the nation-wide Master Logger Program. Any logger wishing to become a certified Master Logger must meet or exceed strict performance standards in each of the following seven areas:

- Water quality and soils protection
- Compliance with government regulations
- Compliance with acceptable silviculture and utilization standards
- Participation in an on-going training regimen
- Implementation of aesthetic management techniques
- Adherence to a site-specific management plan that is agreed to by the landowner
- Utilization of sound business management principles

Master Loggers must pass a rigorous field audit of their harvests and their operations must receive the unanimous approval of the Wisconsin MLC© Certification Board. In 2003, there were 21 Master Loggers in Wisconsin. By 2007, there were 52 Master Loggers (Table 10.e).

Table 10.e Wisconsin Certified Master Loggers

	2003	2004	2005	2006	2007
# Master Loggers	21	36	39	49	52
Source: Don Peterson, Coordinator GLR Michigan Master Logger Certification and the Sustainable Resources Institute, Inc. (2008)					

10.6 Impaired stream miles

Forests play an important role in protecting water quality and aquatic habitat. Water resources, including lakes, streams, and wetlands, are good indicators of forest health because the water that runs off of forest lands drains into them. Physical, chemical, and biological properties of water

resources can be measured and evaluated against a healthy baseline range. Monitoring water resources can provide evidence of change in forest and aquatic ecosystems and makes it possible to implement adaptive management strategies.

Impaired waters are those waters that do not meet state water quality standards as defined by Section 303(d) of the federal Clean Water Act. Chapter 281 of the Wisconsin Statutes further authorized the Department to establish water quality standards consistent with the Federal Clean Water Act (Public Law 92-500). These water quality standards are in Chapters NR 102, NR 103, NR 104, NR 105, and NR 207 of the Wisconsin Administrative Code.

Water quality standards are the foundation of Wisconsin's water quality management programs and define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. Every two years, states are required to submit a list of impaired waters to the United States Environmental Protection Agency (U.S. EPA) for approval. In submitting its 2006 list, the Department of Natural Resources followed guidance issued by U.S. EPA in July 2005 (the 2008 Impaired Waters List is currently under review by U.S. EPA). Waters not meeting water quality standards are included on the 2006 impaired waters list. A water quality standard is not met under two conditions—either the current water quality does not meet the numeric or narrative criteria, or the designated use that is described in the Wisconsin Administrative Code is not being achieved.

In 2006, over 15,000 miles of Wisconsin's nearly 85,000 miles of rivers and streams were assessed (Table 10.f). Over 9,000 miles or over 10% of all rivers and streams in Wisconsin were assessed as "impaired." Wisconsin also has over 1.8 million acres of lakes, ponds and reservoirs. Over one-third of these waters were assessed in 2006 and 485,387 acres (26%) of all lakes, ponds, and reservoirs were designated as "impaired". At this time, conclusions cannot be drawn about those waters which were not assessed.

Table 10.f: 2006 Assessment of rivers and streams, lakes, ponds, and reservoirs

	Total	Assessed	Assessed %	Assessed in Good Condition	Assessed in Impaired Condition
Rivers and Streams (miles)	84,919	15,131	18 %	5,929	9,119
Lakes, Ponds and Reservoirs (acres)	1,862,421	678,110	36 %	192,723	485,387

Source: WDNR, 2006

Table 10.g below lists the top ten probable sources of impairments in rivers and streams, and lakes, ponds, and reservoirs. Silviculture (forestry management practices) was not identified as one of the top sources of water quality impairment in Wisconsin.

Table 10.g: Ten top probable sources of water quality impairment

	Rivers and Streams		Lakes, Ponds, and Reserviors	
#	Source	Total Impaired Miles	Source	Total Impaired Acres
1	Atmospheric deposition - toxics	9,209	Atmospheric deposition - toxics	485,488
2	Non-point source	3,434	Non-point source	226,264
3	Streambank modifications / destabilization	1,669	Contaminated sediments	214,042
4	Livestock (grazing or feeding operations)	1,474	Source unknown	65,095
5	Loss of riparian habitat	1,458	Upstream source	44,386
6	Impacts from hydrostructure flow regulation / modification	1,312	Site clearance (land development or redevelopment)	22,052
7	Contaminated sediments	1,295	Crop production	22,014
8	Crop production	840	Flow alterations from water diversions	19,075
9	Non-irrigated crop production	834	Streambank modifications / destabilization	18,017
10	Animal feeding operations	784	Discharges from municipal separate storm sewer systems	14,940

Source: WDNR, 2006

Looking at where water quality is impaired, in conjunction with other information, such as the source and cause of the impairment and how much forest land is in a particular watershed, can help to determine where to focus reforestation or other efforts. It is important to note however, that simply increasing the amount of forest land in a watershed may not lead to improvements in water quality.

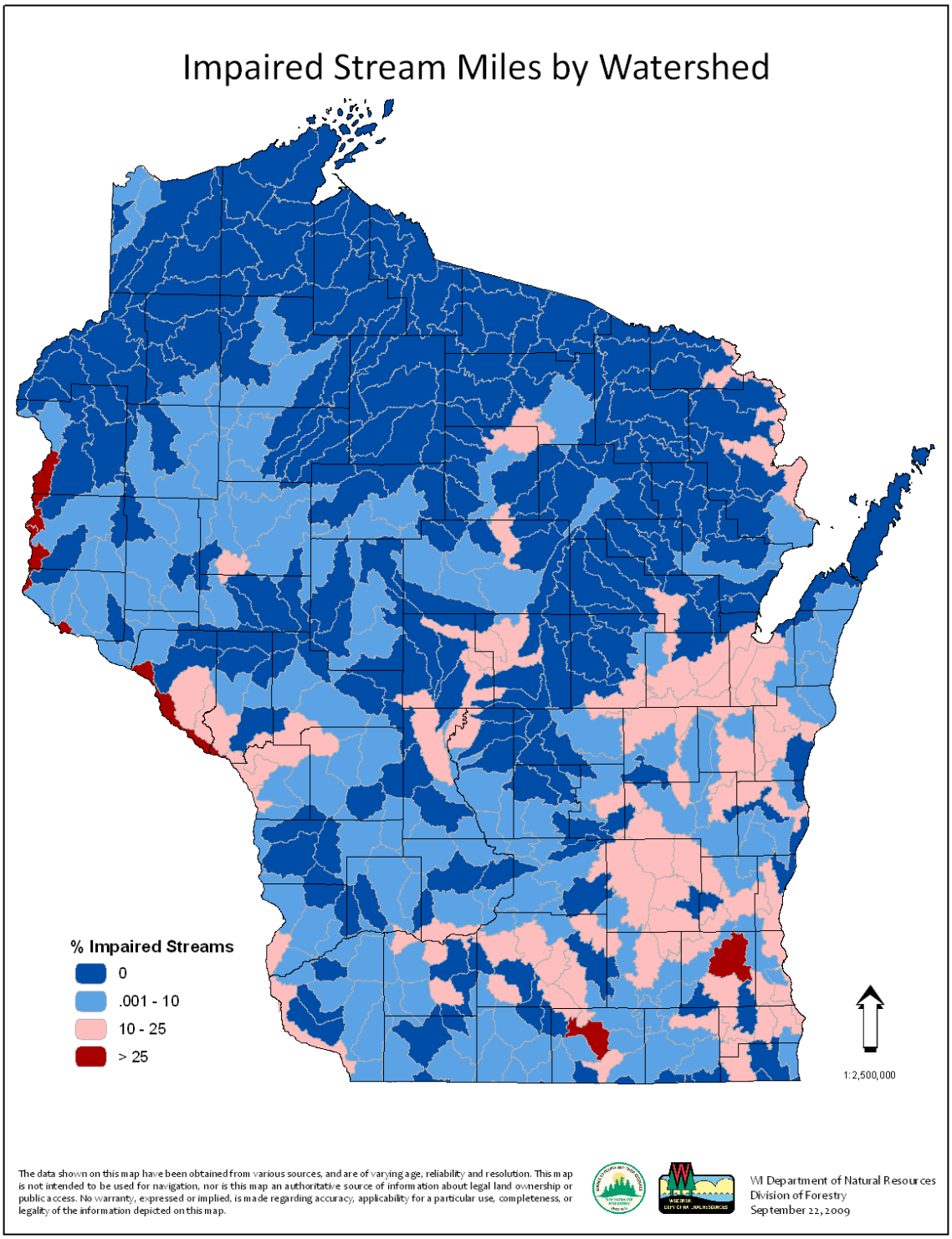
For instance, nearly 2,200 miles of rivers and streams are impaired by sediments and over 1,200 miles by phosphorus and temperature (Table 10.h). These impairments could be tied to failing septic systems or dams and their impoundments. Dams impound sediment behind them, leading to high phosphorous concentrations. Impoundments also raise water temperatures due to broad solar exposure that is difficult to shade. In such situations, it is unlikely planting more trees in the watershed would improve water quality. If, however, the percentage of unforested riparian buffers is high and the predominant land use is agriculture in a watershed, focusing efforts on reforesting riparian areas may have a significant impact on water quality.

Table 10.h: Impairment caused by various factors

	Impairment Caused by Sediment		Impairment Caused by Total Phosphorus		Impairment Caused by Temperature	
Rivers and Streams (miles)	2,197	24 %	1,244	14 %	1,288	14 %
Lakes, Ponds and Reservoirs (acres)	24,442	4 %	23,189	3 %	0	0 %

Source: WDNR, 2006

In addition, when prioritizing reforestation or other efforts, it would be helpful to look at miles of impaired streams as a percentage of the total streams in a watershed (Map 10.d). This analysis includes both perennial and intermittent streams, and may result in lower percentages in those counties with high numbers of intermittent streams because only perennial streams are assessed. Regardless, there are 6 watersheds in Wisconsin that have greater than 25% of their streams assessed as impaired and 55 watersheds with 10%-25% of their streams assessed as impaired.



Map 10.d: Impaired stream miles by watershed
Source: DNR, 2009

Identifying impairments is one way of determining water quality in Wisconsin. Another way water quality is assessed is by determining whether water resources are achieving the designated use standards for fish and aquatic life described in the Wisconsin Administrative Code. As reported in Wisconsin's 2006 Water Quality Report to Congress, 56% of the assessed rivers and streams and 71% of the assessed lakes, ponds and reservoirs were identified as impaired for the state designated use for fish and aquatic life (Table 10.i). However, of the water bodies that have been individually assessed and documented in the state's data system, the majority are perceived as the most degraded or impaired, thus skewing the overall picture of statewide river and stream conditions.

Table 10.i: Percent impaired water for fish and aquatic life state designated use

Rivers and Streams		**Lakes, Ponds, and Reservoirs.**	
Total Miles Assessed	Percent Impaired (of those assessed)	Total Acres Assessed	Percent Impaired (of those assessed)
14,978 (~18% of 85,000 river/stream miles)	56%	670,362 (~36% of 1.8 million lake acres)	71%

Source: Wisconsin 2006 Water Quality Report

11 Area of forest land adjacent to surface water and forest land by watershed

11.1 Percentage of forested riparian area

Riparian areas are lands next to lakes and streams. In a forested condition, these areas help to slow and filter runoff, regulate water temperatures, and provide habitat for wildlife. In watersheds dominated by agriculture, forested riparian areas are especially valuable in intercepting nonpoint source pollution (nutrients, sediments, chemicals, and pesticides) and reducing the input of these pollutants into water resources. Forested riparian zones also directly provide important food and habitat for aquatic systems, as well as indirect benefits like shade, which can aid in maintaining water temperature. Forested riparian areas are essential to wildlife habitat and provide corridors for resident and migratory wildlife movement.

Table 11.a: Watersheds per percentage of riparian area forested

Percentage of Riparian Area Forested	Watersheds
0% - 10%	19
11% - 20%	49
21% - 50%	168
51% - 100%	132

Source: WDNR