WISCONSIN STATEWIDE FOREST ASSESSMENT
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The mission of the Division of Forestry is to work in partnership to protect and sustainably manage Wisconsin's forest ecosystems to supply a wide range of ecological, economic and social benefits for present and future generations.

Paul DeLong
Chief State Forester

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Introduction

Assessment Goal…
To assess the "state of affairs" of Wisconsin's public and private forests and analyze the sustainability of our forested ecosystems. This Assessment will identify trends and issues with the resource. This assessment will be used by (1) internal staff to conduct management and to design policy, (2) external partners who require statewide forestry data, and (3) as a requirement of the United States Forest Service, State & Private Forestry Program (S&PF).

In the ten years since the last statewide forest assessment (2000 Millennium Assessment), much has changed in Wisconsin forests. Emerald Ash Borer arrived, forest industries are using biomass and producing biofuels, and climate change is an increasing focus of management planning and conservation. The Statewide Forest Assessment 2010 (Assessment) helps to explain these trends, identify other issues, and present an updated view of the status of forests in Wisconsin; thus acting as a bellwether of the state's forest sustainability. It provides policymakers and the general public with a database of succinct, comprehensive, and scientifically sound data as well as professional experience. The Assessment does not set desired conditions; rather it provides the knowledge to set goals and strategies for sustainability.

The Assessment is based on Wisconsin's Forest Sustainability Framework (Framework). The Framework, which was approved by the Wisconsin Council on Forestry in December 2007, established a series of seven broad criteria intended to measure the sustainability of Wisconsin's forest resources. It represents the first attempt to organize data and trends into categories to evaluate the overall health and sustainability of our forests. It is a common set of indicators the forestry community can use to discuss the state of Wisconsin's forests.

Scope - statewide
The Assessment presents data and analysis of all forests—rural and urban, public and privately owned. Forest benefits and services (clean water, forest products, wildlife habitat, etc.) are produced by all forests, statewide. Risks to forests (fire, insects and disease, development, etc.) can occur anywhere and often spread across large areas affecting public and privately owned forests. Forests provide a complex set of benefits and services, and risks and threats affect forests statewide.

Format
Measuring sustainable forestry will be an evolving, iterative task. Over time, the forestry community may find the indicators in this Assessment are no longer appropriate or that new indicators should be added. Data was collected for the criteria and indicators identified in the Framework. Some of the data sources could not be collected or analyzed in the way the Framework proposes. Please consider this when comparing the Framework and the Assessment. This is the first time an Assessment is being conducted with the Framework as a model. It is appropriate to consider this a pilot project that upon completion will be reviewed and assessed for its effectiveness. Comments on the Assessment format, process, and efficacy are encouraged.

The analysis in the Assessment is organized into three levels: criteria, indicators, and metrics. This organization is based on established regional and national models using the criteria and indicators system. **Criteria** define broad categories of sustainability and are comparable to goals. Criteria included in this report address topics such as conservation of biological diversity, socio-economic benefits, and a variety of other issues. Associated with each criterion are a number of **indicators**, which provide specific measurements to assess the issue described in the criterion. Each indicator is, in turn, associated with a number of **metrics**, which are the specific data needed to measure indicators.

Forest Conditions and Trends -
Each criterion presents the conditions and trends of Wisconsin forests. A description of the criterion's importance begins each section followed by major conclusions and the findings. Many topics are discussed in multiple criteria. For example, wildland fire is presented in Criterion 3 (health), 6 (socio-economics), and 7 (planning). The index can be used to locate specific topics within the document.

Major Conclusions -
These are located at the beginning of each criterion. They are not in a ranked order. The conclusions are statements of informed opinion based on the findings. Findings are statements of fact drawn from the body of information and data in each criterion. Findings highlight and summarize the most critical and relevant elements in a discussion of a topic. The conclusions highlight threats to forest lands in the state, but also benefits they provide. The conclusions state the issue that will be the basis for the Statewide Forest Strategy. The strategies will address these issues and are consistent with the national priorities.

Data gaps
In attempting to measure something as all-encompassing as "sustainable forestry", the Framework occasionally concluded that existing data sources were inadequate (i.e., "data gaps" were present). In such situations, three alternatives were considered to address the gap: (1) use several metrics that when combined can measure an indicator, (2) select an imperfect metric noting its limitations, or (3) note that a data gap exists, and identify appropriate data and/or methods to address it. Throughout the Assessment, authors' note where these data gaps exist and to what degree it is an issue.

Scale – geographic
The intent of this Assessment is to understand the forest condition at the statewide scale. At a minimum, data is presented at the state level. When available and when it was valuable to do so, data is presented at the county level. Typically the USDA Forest Service, Forest Inventory and Analysis (FIA) data and socio-economic data is presented by county. Some of the biological data is presented by ecological subsection because it facilitates analysis. The value of analyzing several metrics together, a challenge when dealing with varying scales, was outweighed by the value of presenting certain types of data in the most appropriate scale for that topic. At times this meant not using valuable regional studies that directly address an indicator but instead using several proxy data sets to evaluate the indicator. The smaller scale studies were not disregarded but utilized to show what the state of knowledge on a topic is and to share tested methodology.

(See Wisconsin's Sustainability Framework for a complete discussion on the choice of data scales.)

A risk of using statewide data is that at times, a critical issue or threat in one region of the state may be masked by a stable condition statewide. When this became evident in the analysis, the authors assessed the regional threat and determined if it was great enough to highlight and evaluate.

Scale – time

The last statewide forest assessment was conducted in 2000. This assessment updates the data presented in the 2000 assessment and includes a whole new suite of data sets. Individual data sources may have been collected over different time periods. Some of the data such as from the FIA have reliable records back to the early 1950's. Others such as the Urban Forest Inventory only have baseline data for one year.

The authors decided to present data from different time periods in order to capture the most reliable data for the particular source. The reader should not infer that data presented with different dates is particularly relevant to the analysis. If it is, the author stated why they chose to present a particular date.

All effort was made to present the greatest range of dates—past to present—in order to identify any trends. Occasionally, the data and accepted knowledge allowed the author to forecast a future condition.

Perspective

The DNR, Division of Forestry was the primary author of this assessment in consultation with natural resource professionals across Wisconsin. Within the DNR, the bureaus of Wildlife, Endangered Resources, Water, Facilities and Lands, Air Management, Science Services, Parks, and Legal staff provided data and analysis. The authors have made every effort to not solely present data from the perspective of the DNR. Data sources are from a wide variety of agencies and organizations. The DNR recognizes the agency's influence and presence in many aspects of forestry, but strove to present unbiased findings and conclusions as a valuable source of information and research for others.

Reviewers are requested to provide alternative perspectives to make sure topics are discussed thoroughly. Please remember that the Assessment is based on scientific data and practical experience, and it strives to be as objective as possible. Opinions on the most important issues and ideas on how to address issues identified in the Assessment are addressed by the next step of the planning process – the Statewide Strategy.

Forest Conditions and Trends (by Sustainability Criteria)

Criterion 1:
Conservation of Biological Diversity

1. Area of total land, forestland, and reserved forestland
2. Forest type, size class, age class, and successional stage
3. Extent of forestland conversion, fragmentation, and parcelization
4. Status of forest communities and associated species of concern

Criterion 2:
Maintenance of Productive Capacity of Forest Ecosystems

5. Area of timberland
6. Annual growth and removals of forest products

Criterion 3:
Maintenance of Forest Ecosystem Health and Vitality

7. Area of forest land affected by potentially damaging agents
8. Area and percent of forest land subject to levels of specific air pollutants that may cause negative impacts on forest ecosystems
9. Wildfire Impacts on Forest Resource Sustainability

Criterion 4:
Conservation and Maintenance of Soil and Water Resources

10. Soil and water quality in forested areas
11. Area of forest land adjacent to surface water and forest land by watershed

Criterion 5:
Maintenance of Forest Contributions to Global Carbon Cycles

12. Forest ecosystem biomass and forest carbon pools

Criterion 6:
Maintenance of Socioeconomic Benefits and Ecosystem Services

13. Wood and wood products production, consumption, and trade
14. Outdoor recreational participation and facilities
15. Investments in forest health, management, research, education, and wood processing
16 Forest ownership, land use, and specially designated areas
17. Employment and wages in forest-related sectors

Criterion 7:
Legal and Institutional Framework for Forest Conservation and Sustainable Management

18. Extent to which the legal and institutional structure supports the sustainable management of forests
19. Forest-related planning and assessment

Criterion 1: Conservation of biological diversity

Overview

Sustainable forestry is defined as the practice of managing dynamic forest ecosystems to provide ecological, economic, social, and cultural benefits for present and future generations (Wisconsin Statutes Ch.28.04(1)e). Biological diversity is the entire spectrum of life forms and the many ecological processes that support them. Biodiversity occurs at four interacting levels: genetic, species, community, and ecosystem diversity. Biodiversity enhances the ability of an ecosystem to respond to external influences, to recover after disturbance, and to maintain essential ecological functions. Human benefits and values provided by the conservation of biodiversity include:

- Utilitarian benefits, including the needs of present and future human generations for food, chemicals, medicines, structural materials, energy savings, and genetic sources for plant and animal breeding, as well as indirect needs for ecosystem services like pollution mitigation, atmospheric balancing, water supply, maintenance of soil fertility, carbon storage, and flood control.
- Recreational, aesthetic, and spiritual values provided by a diverse and varied forest.
- Ethical values, for many people believe that other species have an intrinsic right to exist and that resource managers have a responsibility to ensure their survival.
- Traditional ecological knowledge and values. Indigenous peoples recognize forests and all their components as essential to their peoples' continued existence and perpetuation of their unique cultural identities.

Biodiversity is a fundamental component of forest sustainability and productivity.

Management for biodiversity conservation often focuses on the identification and protection of specific occurrences of rare species and exceptional examples of community types (element occurrences). To effectively conserve biodiversity, however, a wide array of species, sites, and landscapes must be assessed and managed to maintain viable populations and a balanced array of habitat conditions including well-distributed forest developmental and successional stages. Landscape level habitat considerations include patch size, spatial configuration, composition, ownership, and connectivity or isolation.

The indicators and metrics for Criterion One show the extent of forests and major forest types in Wisconsin. This criterion estimates trends in tree species abundance, size, and age; in forest developmental and successional processes; and in the general representation of forest habitat. The urban forest resource is described in this criterion as well. The abundance and paucity of some habitat elements can be evaluated, and trends can be interpreted. However, our knowledge of most plant and animal species' life history traits, habitat associations, population sizes, distributions, trends, and response to disturbance or environmental change is incomplete. Research in biodiversity is continually evolving and new data sources will be incorporated into this criterion as they become available.

Criterion 1 Indicators:

1. **Area of total land, forestland, and reserved forestland**
2. **Forest type, size class, age class, and successional stage**
3. **Extent of forestland conversion, fragmentation, and parcelization**
4. **Status of forest communities and associated species of concern**

Major Conclusions[1]

1) Wisconsin's forest composition and structure is evolving.

Wisconsin's forests are recovering from the Cutover that occurred between the mid-1800s and the early 1900s, but they are simplified compared to historical forests. Ongoing recovery cannot, however, be assumed due to new disturbance factors influencing forest progression. The relative abundances of species changed about five times as much in the 1800s as changed in the preceding 3,000 years (see Appendix A: *Ecological History of Wisconsin's Forests*). Logging, slash fires and agricultural expansion during the period known as the "Cutover" had a profound effect on Wisconsin's biological diversity. The state's forest resources have been characterized by nearly a century of recovery. Wisconsin's forests are now unquestionably of tremendous environmental, social and economic significance. They do not, however, possess the same complexity that forests had before Euro-American settlement. In addition, a new suite of disturbance factors such as deer browsing, climate change, invasive pests, and absence of fire increase the risk of prolonged ecological simplification. Continuing recovery of biological diversity cannot be assumed in the face of such challenges.

Ecological simplification (the reduction of species and structural diversity, and increased dominance of fewer species) limits the availability of diverse habitat. Simplification has been affected by:

- Loss of seed sources for trees such as pine, hemlock, yellow birch and cedar, countered by a prevalence of maples on many sites
- An onslaught of jack pine pests and difficulty regenerating jack pine, resulting in a 50% reduction in growing stock volume since the early 1980's
- Decrease in quality oaks on moderately moist and slightly dry sites
- Scarcity of large trees, cavity trees, snags, and coarse woody debris
- Loss of older forests (greater than 100-120 years old)
- Disturbances that hinder the development of complex structure in younger forests as they mature
- Reliance on maple and ash for the majority of trees in urban forests, exposing them to high risk of catastrophic loss from invasive pests

2) The composition of the large scale forest landscape is becoming fragmented and broken into small parcels.

Large expanses of working forests free of development pressure are decreasing. Anthropogenic factors such as housing and road development alter habitat, fragment landscapes and threaten biodiversity.

- Few large, remote interior forest patches (especially containing old forest) remain in Wisconsin. Adjacency of disturbed forests, development, and infrastructure impacts the values associated with interior forest patches. Many smaller patches are effectively all edge.
- Road and housing density and parcelization within forested landscapes continue to increase.

[1] (Items in bold are conclusions drawn by reviewing statements of finding from the Assessment. The bulleted items below each conclusion are the findings.)

- Increasing parcelization contributes to fragmentation and can be a barrier to coordinated landscape habitat management and the conservation of biodiversity.
- The best opportunities to manage forests on a broad scale occur in the north, although opportunities exist in select locations in the south. Southern forests retain important ecological functions and support many rare species.

3) Many native forest species are doing well, but the status of forest communities and species of concern is difficult to fully assess due to the lack of data and knowledge on life histories, habitat requirements, and population ecology of community types and rare species.

Although there are data gaps, current monitoring efforts show that forest habitat is critical for numerous rare species and that opportunities exist to enhance habitat and maintain biodiversity for forest species.

- Invasive plants and animals are a threat to the biodiversity of Wisconsin forests. Some infestations are out-of-control in the southern half of the state, and many undesirable species are taking hold in the north.
- Wisconsin forests provide habitat for numerous rare species including at least 15 rare vertebrates and numerous rare invertebrates and plants.
- Life history information is unavailable for many rare plant and animal species, and forestry professionals and other natural resource land managers want guidance on how to care for them.
- In general, neo-tropical migrant forest birds increased in Wisconsin over the last 40 years. This is especially true for birds that nest in middle-aged to older forests and for the wide range of conifer-dependent species. The status of some rare, forest obligate species like Red-shouldered Hawk, Cerulean Warbler, Northern Goshawk, and Spruce Grouse is not precisely known at a local scale.
- Habitat for American Marten appears limited and its persistence in the state is tenuous. Changing climate, increased competition with fishers and predation may be additional factors limiting population viability.
- Although the State Legislature authorizes DNR to update the Wisconsin Wetland Inventory on a 10 year cycle, but budget constraints and lack of staff have slowed this process to a 24 year cycle at best.

4) More data is needed to evaluate how effectively Wisconsin's forests are sustaining native biological diversity.

There are ongoing projects that track and monitor many species and communities, but projects that assess species habitat associations and develop modeling procedures to estimate biodiversity at larger scales would be beneficial for:

- Actual extent and impacts of identified concerns such as fragmentation
- Management regimes and impacts on community composition and structure
- Community type (e.g. old-growth pine forest) representation, composition, and structure
- Species of greatest conservation need and plant species
- Forest-based species' life histories, habitat requirements, and population ecology

- Indirect and cumulative effects (e.g. unintended consequences) of changes in biodiversity, habitat, and environment
- Acres and distribution of passively managed and older (>120 years) forest lands, and those adaptively managed to achieve native community habitat goals.

5) Wisconsin enjoys an exceptional State Natural Areas program protecting 607 reserves encompassing 326,000 acres in 70 counties.

The program, inspired by Wisconsin conservationist Aldo Leopold, began in 1951 and was the first State Natural Areas project in the country.

1. Area of total land, forest land, and reserved forest land
Tracking the total area of forest land demonstrates whether the state is gaining or losing overall forest cover. Forest extent can give a rough indication of the amount of habitat available to forest associated species. Knowing where forests are located and how dense the forest cover is indicates potential habitat and biodiversity management opportunities.

In the broadest sense, the area and proportion of protected forest ecosystems and native community management areas indicates the emphasis a society places on managing and preserving representative ecosystems for biodiversity conservation. Important forest management questions can be addressed by tracking a network of comprehensive and representative forest types within protected and adaptively managed areas. Traditionally, forests have been designated as protected areas for their conservation, scenic, and recreational values, but might not represent the full range of biodiversity. Over time, forest composition and structure within protected areas will change. Adequate management and protection of diverse ecosystems and species in native community management and reserved areas may provide more management flexibility in forests under more intensive management for timber production and other extractive purposes.

It is important to note the different definitions of forest. This assessment uses the following US Forest Service, Forest Inventory and Analysis (FIA) definitions.

Reserved forest land cannot be used for timber production due to legislation or administrative regulation.

Timberland is forest land that is not reserved and meets minimum requirements for productivity. (See Criterion 2 for a description of the amount and type of timberland.)

Forest land is the total amount of reserved forest, plus timberland, plus other forest land. In Criterion 1, the use of the term “forested” refers to forest land. This last category of “other” forest land is commonly found on low-lying sites with poor soils where the forest at its peak is incapable of producing 20 cubic feet per acre per year.

For other definitions of commonly used terms in this section, such as density, canopy, and cover type, please reference the glossary.

1.1 Forest and Total Land Area
1.2 Forest Density
1.3 Legally and Administratively Reserved Forest Land
1.4 Urban Forests

The amount of forest land in Wisconsin steadily increased over 24 years, from 14.7 million acres in 1983 to 16.4 million acres in 2007 (Table 1.a). Today, over 47% of the state is covered by forests. Based on estimates of vegetation type and cover in the mid-1800’s, forest area probably ranged from 22 to 26 million acres (not including barrens or savannas).

The northern third of the state is the most densely forested (Table 1.a and Map 1.a), whereas the southeast and south central regions are least forested. Northern forests represent nearly two-thirds of all forest land. Province 212 is approximately 62% forested, ranging from a high of 88% forested with 77% mean canopy cover in Subsection 212Jb (Gogebic-Penokee Iron Range), to a low of 11% forested with 8% mean canopy cover in Subsection 212Zb (Green Bay Clayey and Silty Lake Plain).

Southern forests represent about one-third of all forest land in the state. Province 222 is approximately 31% forested, ranging from a high of 66% forested with 52% mean canopy cover in Subsection 222Rb (Neilsville Sandstone Plateau), to a low of 9% forested with 5% mean canopy cover in Subsection 222Kh (Rock River Old Drift Country). (See Appendix E for a map of sections and subsections in Wisconsin.)

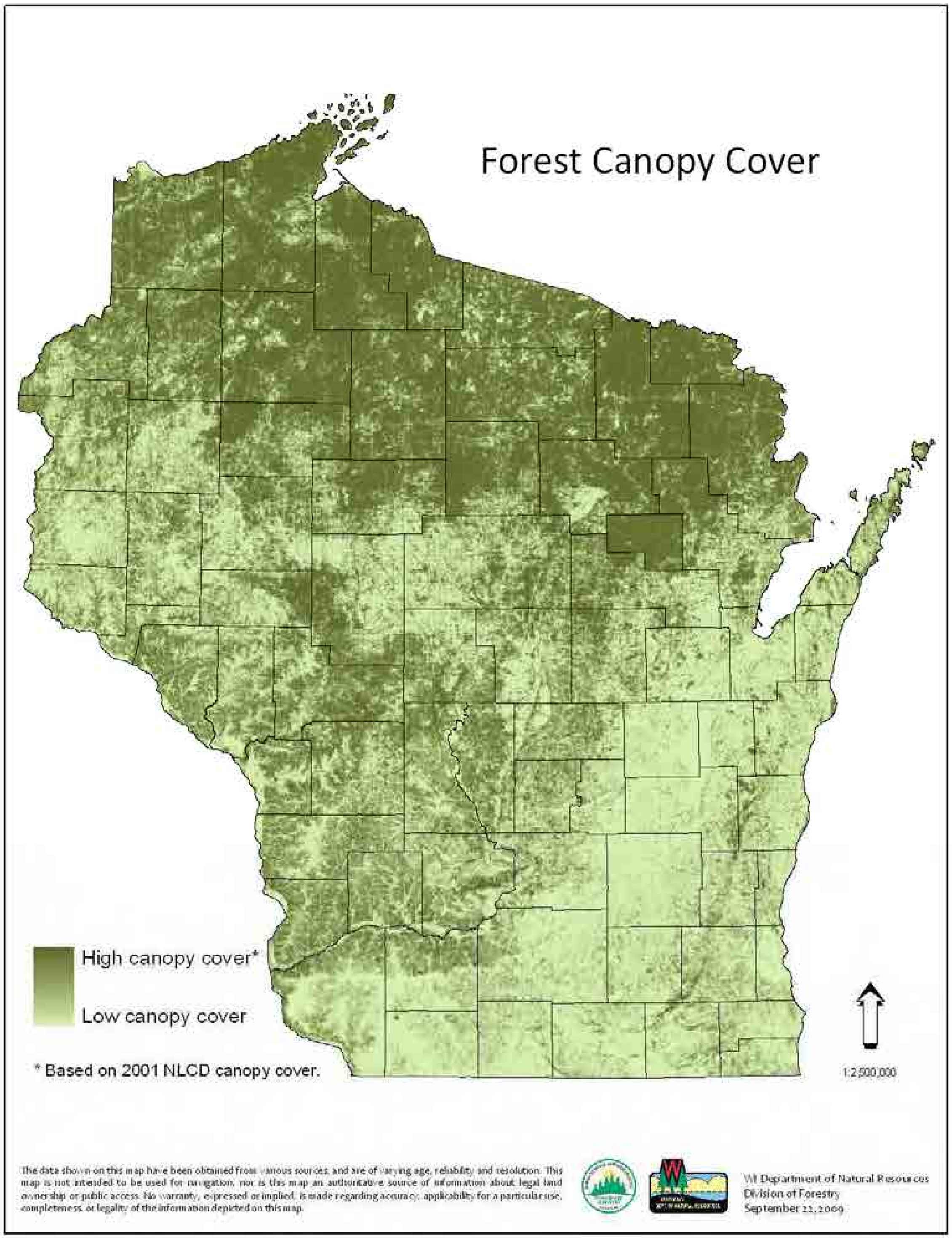
Based on FIA data, ninety-nine percent of all forest land in 2007 was productive timberland (Table 1.a). Only 1% of forests were classified non-productive or reserved. FIA restrictively defines reserved forest land as withdrawn by law(s) prohibiting the management of land for the production of wood products. Reserved forest land provides many benefits such as baselines for study and habitat for species that are sensitive to disturbance or that prefer the structural attributes that develop over time in passively managed forests. FIA data indicates a decline in reserved forest land acres, but classification definitions have changed over time, and sampling constraints can miss reserves like State Natural Areas and result in high estimation errors. In addition, this metric does not consider lands that, although not formally (legally) reserved, are not being actively managed (e.g. lands that are informally designated, inaccessible tracts, some wetlands, etc.) or are being managed by adaptive systems to promote habitat diversity (e.g. native community management areas). Better statewide estimations of acres and distribution of passively managed forest lands and those managed to achieve native community habitat goals would be helpful.

Table 1.a: Forest land area

Land use Type	**1983 acres**	**1996 acres**	**2007 acres**
Timberland	14,759,400	15,700,877	16,181,993
Reserved Forest Land	260,900	201,428	93,266
Other Forest Land	331,000	60,714	132,711
Total Forest Land	15,351,300	15,963,019	16,407,970
Province 212	10,652,700	11,011,850	11,129,800
Province 222	4,698,600	4,951,169	5,278,170

(USFS, FIA, 2007)

Wisconsin owes much to the state’s early conservationists of the 1930s, 40s, and 50s—including Aldo Leopold, botanists Norman Fassett and Albert Fuller, and plant ecologist John Curtis—who recognized the importance of reserves and the consequences of their loss. Under their guidance, Wisconsin created the nation’s first state-sponsored natural area protection program in 1951. The State Natural Areas (SNAs) program protects outstanding examples of native landscape, natural communities, significant geological formations and archeological sites. 607 State Natural Areas encompassing 326,000 acres are reserved for research and educational use, the preservation of genetic and biological diversity, and for providing benchmarks for determining the impact of use on managed lands. SNAs range in size from less than one acre to more than 7,700 acres. More than 90% of the plants and 75% of the animals on Wisconsin's list of endangered and threatened species are protected on SNAs located in 70 of Wisconsin's 72 counties.



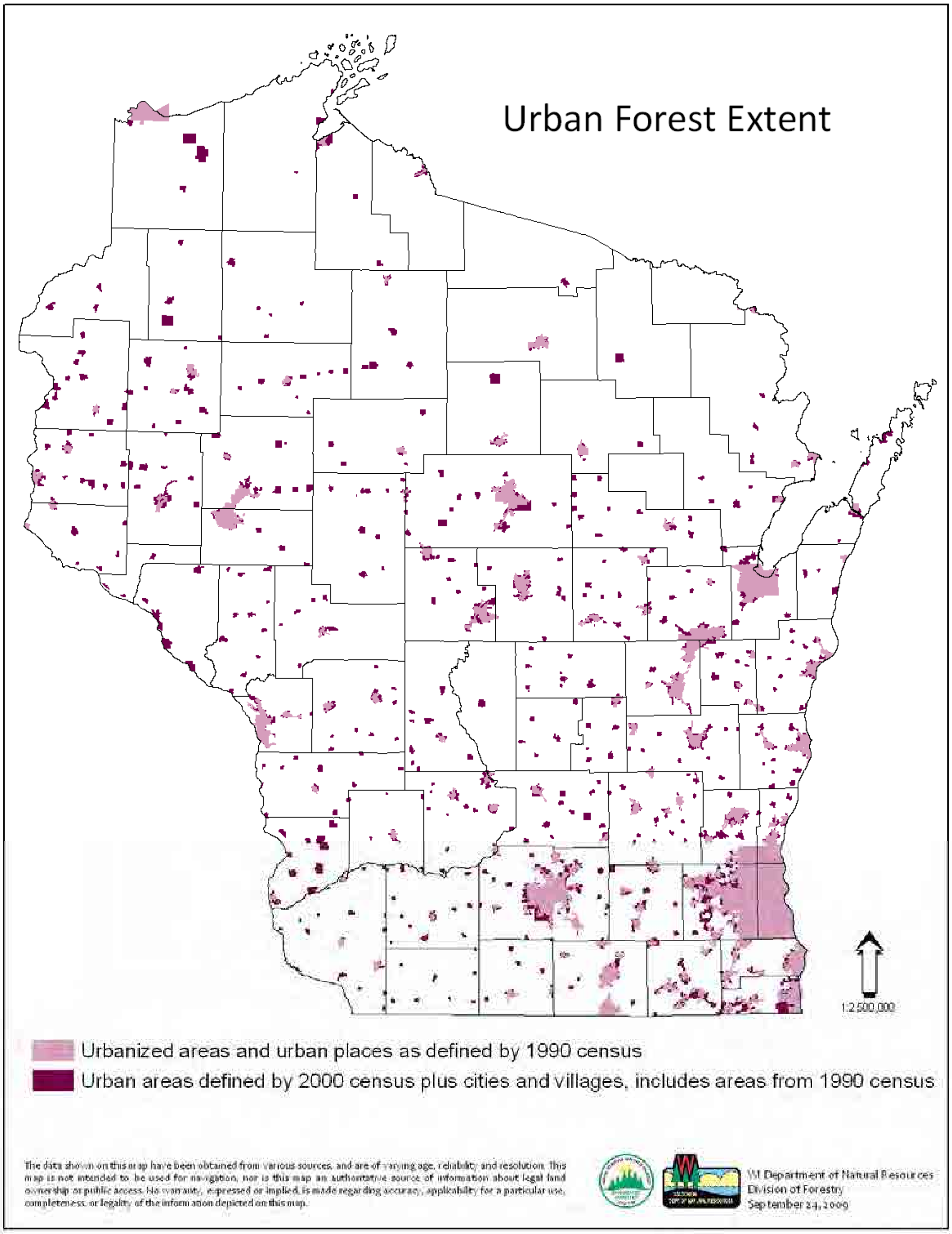
Map 1.a: Density of forest canopy cover

Source: National Land Cover Data 2001

1.4 Urban Forest

The urban forest is defined as the trees and associated vegetation in cities, villages, and other concentrated development. Defining this area spatially has been more problematic. The first detailed statewide assessment of Wisconsin's urban forests was performed in 2002 in a pilot Urban Forest Health Monitoring (UFHM) study (Cummings et al, 2007). This study defined the urban forest as that area with a population density of 1,000 people per square mile using 1990 US census data.

The census-based definition underreports the urban forest spatially, and so DNR undertook development of a spatial layer that more accurately reflects Wisconsin's urban forest on the ground (Map 1.b). This project compared combinations of available spatial data that encompassed the various national and programmatic definitions of urban forest to produce a layer that most closely delineates the extent of the urban forest as commonly accepted by practitioners. This layer is an overlay of city and village political boundaries and 2000 US census-based density of 500 people per square mile. While this layer may erroneously include some undeveloped land and exclude some developed land, it is the most accurate view of urban forests short of hand-digitized boundaries.



Map 1.b: Urban forest extent

Tree canopy cover in the urban forest is another metric whose methodology is still under development. In 1999, the DNR contracted a study to determine the canopy cover of Wisconsin communities using aerial photos and a 5% sample grid. In 2000 the Forest Service's Resources Planning Act (RPA) inventory analyzed LandSat imagery to estimate canopy. The 2002 Urban Forest Health Monitoring pilot used ground plot and FIA methodology to project canopy cover. Each of these methods produced different results. Currently, high-resolution multi-spectral satellite imagery and airplane-based hyper-spectral imagery with automated classification algorithms are under development which will provide more accurate and repeatable data for future trend analysis.

Table 1.b shows the results of the various urban forest assessment studies. For consistency, data from the 2002 UFHM pilot study of Wisconsin's urban forests will be used throughout the rest of the assessment since it is based on FIA methodology and is the most complete.

Table 1.b: Estimates of Wisconsin urban forest area, population, and canopy cover

	1999 DNR canopy	2000 Forest Service RPA	2002 UFHM pilot*	2007 DNR urban forest layer**
Area (acres)			729,270	1,847,308
Number of trees			26,934,000	
Number of trees per acre			37	
Tree canopy cover (percent)	28.9	25.8	14	

* 1990 Census definition of urban
** DNR's programmatic urban forest definition created by overlay of city and village political boundaries and 2000 Census definition of "urban"

Sources: DNR, 2007; Forest Service RPA, 2000; UFHM pilot, 2002

Wisconsin's urban forests are a significant resource. They cover about 5% of the state’s land area and are home to about 80% of the state's population (measured in 2002). The amount of urban forest is increasing as agricultural and forest land is converted to development. Forecasts predict urban land in the state will grow to 8.3% of the land area by 2050 (Cummings et al, 2007).

Regardless of the methodology, the average urban tree canopy statewide is low compared to many other states with similar ecotypes. There is an opportunity to fill vacant planting space and manage existing trees to increase canopy cover in urban forests. Conversion of agricultural land to urban forest initially decreases average canopy statewide, but will offer the greatest opportunity for planting and increasing overall tree canopy. Conversion of forest land to urban forest will increase overall average urban tree canopy at the expense of rural forests. When forest land becomes developed, this new urban forest will require more management to maintain the existing tree canopy and retain as much of the biodiversity as possible.

<u>Urban forest species composition and frequency</u>
As with native forests, urban forest composition is dynamic and influenced by similar variables

including climate and soil, and natural disturbances such as storms, insects, and diseases. In the urban forest, however, human disturbances and influences such as construction, maintenance of infrastructure, pollution, and landscape management practices play a much more significant role.

Two urban forest studies provide a picture of the species composition of the urban forest. The 2002 UFHM pilot study examined 111 plots statewide in an FIA grid and footprint that crossed all property boundaries. In addition, from 2002-2003 a second study of community rights of way established 900 plots statewide and examined only the publicly owned street trees. Tables 1.c and 1.d show the results.

Table 1.c: Urban forest species composition and frequency

Scientific name	Common name	Population estimate	Population (%)
Acer negundo	Boxelder	3,723,600	13.8
Fraxinus americana	White ash	3,640,800	13.5
Pinus strobus	Eastern white pine	1,530,800	5.7
Fraxinus pennsylvanica	Green ash	1,530,800	5.7
Acer rubrum	Red maple	1,406,700	5.2
Picea glauca	White spruce	1,199,800	4.5
Ulmus rubra	Slippery elm	1,034,300	3.8
Acer platanoides	Norway maple	827,500	3.1
Populus tremuloides	Quaking aspen	827,500	3.1
Thuja occidentalis	Northern whitecedar	744,700	2.8
Other 46 species			38.9
(Source Cumming et al, 2007)			

Table 1.d: Street tree species composition and frequency

Scientific name	Common name	Population estimate	Population (%)
Acer platanoides	Norway maple	310,600	30.5
Fraxinus pennsylvanica	Green ash	154,791	15.2
Gleditsia triacanthos	Honeylocust	85,542	8.4
Tilia cordata	Littleleaf linden	67,212	6.6
Acer saccharinum	Silver maple	64,157	6.3
Fraxinus americana	White ash	39,716	3.9
Acer saccharum	Sugar maple	37,679	3.7
Malus species	Crabapple	32,588	3.2

Ulmus thomasii	Rock elm	23,422	2.3
Acer rubrum	Red maple	21,386	2.1
Other 78 species			17.8
(Source: Cumming, et al, 2008)			

In both street trees and the overall urban forest composition, species richness (the number of species) is high—88 tree species were found on streets and 56 tree species were found in the overall urban forest. The difference in these results is due to the studies' different sampling densities of 900 plots for street trees and 111 plots for the overall urban forest, as well as the number of different species planted, particularly on streets.

On the other hand, tree species evenness (the relative abundance of each species) is low. In street trees, two species, Norway maple and green ash, make up 46% of all trees and their genera, *Acer* and *Fraxinus*, make up 63% of all trees. The evenness of the overall urban forest is somewhat better, but again, the top two species, boxelder and white ash, make up 27% of all trees and their genera make up 43% of all trees. While species richness and structural diversity contribute to overall population diversity and resilience, the uneven species distribution puts the population as a whole at a high risk for catastrophic impacts such as species-specific pests, in this case Asian longhorned beetle and emerald ash borer.

Urban forest tree size

Figure 1.a illustrates the diameter distribution of urban trees in Wisconsin. Urban forest trees (UFIA+) had a greater percentage of their population in larger tree diameters than those found in adjacent forested areas (UFIAf). On a per tree basis, larger trees can provide more services, such as air pollution removal and storm water mitigation, than smaller trees can. Understanding size distribution allows managers to account for both larger and smaller maturing trees in planting and management regimes.

Basal area and diameter at breast height (dbh) can be used as a surrogate for tree canopy size, so managers can understand the cumulative impact of particular species on environmental services. Species that dominate Wisconsin's urban land in terms of overall basal area are *Pinus strobus*, *Acer platanoides*, and *Salix babylonica* as shown in Table 1.e. Unfortunately, *Acer platanoides* is a non-native invasive species and *Salix babylonica* is a non-native from China.

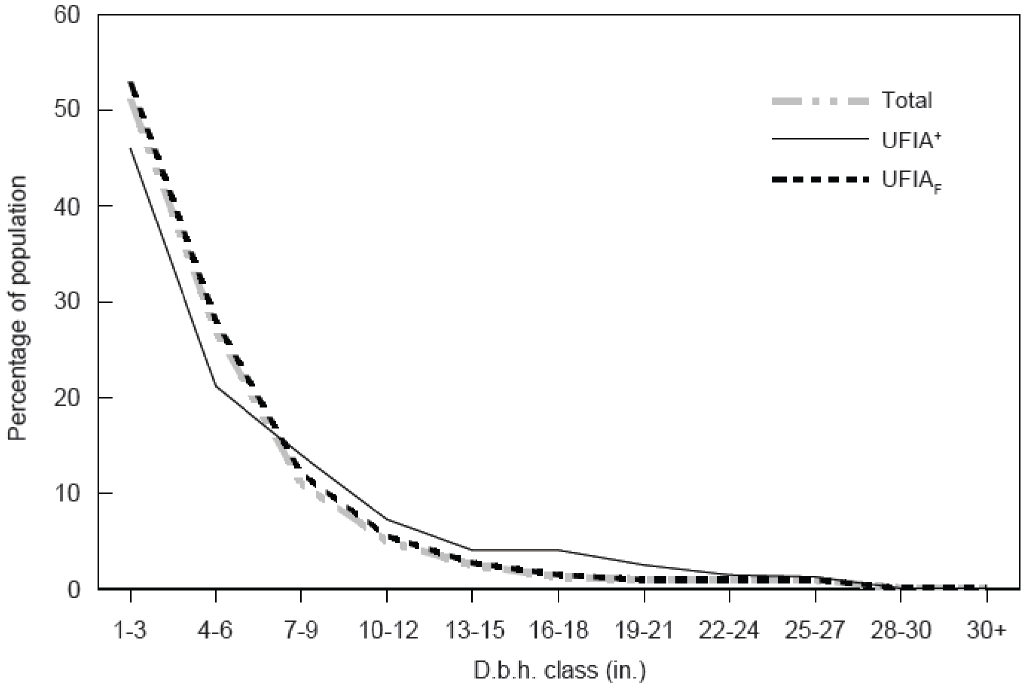


Figure 1.a: DBH distribution of urban trees in Wisconsin
(Cumming, et al, 2007)

Table 1.e: Top 10 urban forest species by basal area					
Genus Species	Common name	Number	% Basal Area	Average dbh	Median dbh
Pinus strobus	Eastern white pine	1,530,800	11.7	8.8	7
Acer platanoides	Norway maple	827,500	9.1	11.4	12
Salix babylonica	Weeping willow	82,700	6.7	30.5	29
Fraxinus americana	White ash	3,640,800	6.1	3.5	2
Quercus rubra	Northern red oak	620,600	5.6	9.4	6
Acer saccharinum	Silver maple	165,500	5.4	20.2	22
Fraxinus pennsylvanica	Green ash	1,530,800	4.9	5.6	5
Acer negundo	Boxelder	3,723,600	4.5	3	2
Picea glauca	White spruce	1,199,800	4.2	5.8	5
Ulmus americana	American elm	579,200	4.1	7.7	3
All others (46)		13,032,500	37.6		
(Cumming et al, 2007)					

<u>Street tree size</u>
Tree size, often considered a proxy for age, is a useful metric for street tree managers. Because street trees are within the public right-of-way, proper management of these trees, especially large and mature trees, is essential to public safety. A stable street tree population is most dependent upon age (size) diversity. Inadequate tree replacement is a greater threat to future street tree population stability than is low species diversity. Urban street trees in Wisconsin averaged 12.8 inches diameter at breast height (dbh) and are considered well-established, "midsized" trees (Cummings et al, 2008). Managers will be contending with many mature trees within the next 10 to 20 years, depending on species and site characteristics. Figure 1.b shows the dbh distribution within the 10 most common species.

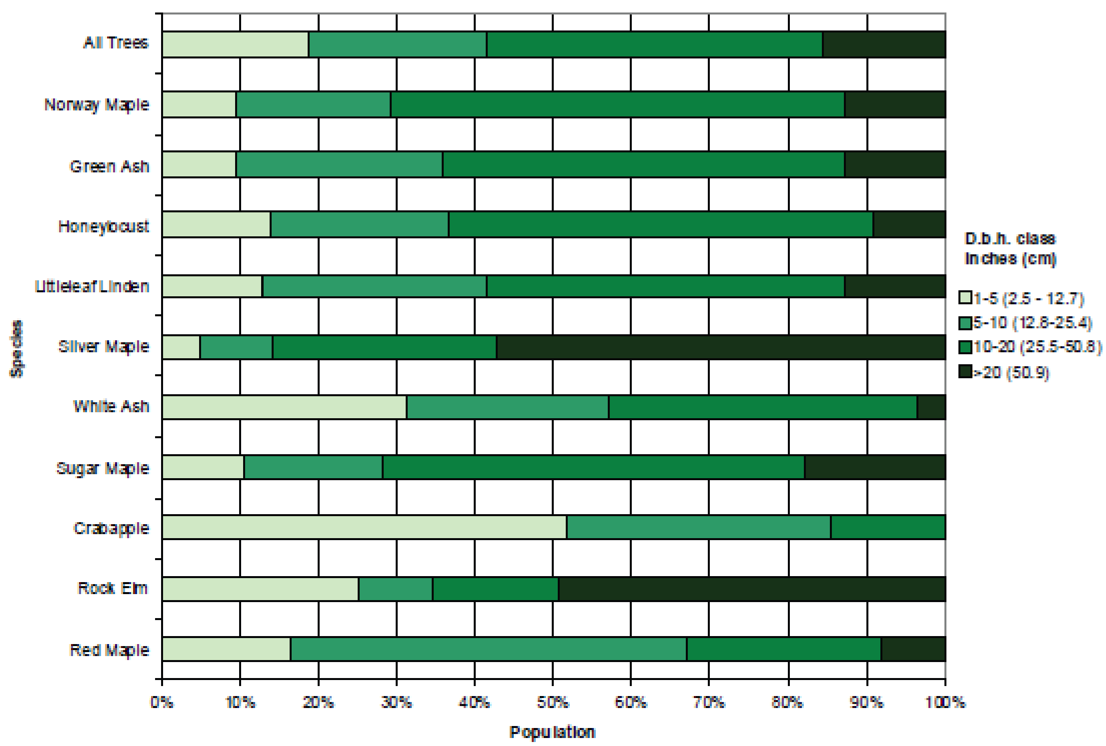


Figure 1.b: Diameter distribution within the 10 most common street tree species (Cumming et al, 2008)

2. Forest type, size class, age class, and successional stage
This indicator interprets successional and structural development trends based on characteristics and changes in forest cover types, size class, and age class.

Many native forest associated species prefer habitat characteristics that vary with forest composition and structure. The mix of successional and developmental stages across forested landscapes indicates potential habitat and biodiversity. A landscape management approach that accounts for all characteristic successional and developmental stages with forest stands ranging from small to large will facilitate biodiversity conservation. Silvicultural systems that more closely emulate natural disturbance and stand development processes are more likely to sustain ecological complexity and biodiversity (Crow et al. 1994, Niemela 1997, Seymour and Hunter 1999, OMNR 2002, Franklin et al. 2007, MFRC 2007, National Commission on Science for Sustainable Forestry 2007).

Ecological simplification of forest ecosystems refers to the loss of species and structural diversity, and increased dominance of fewer species. At the landscape scale, simplification and homogenization occur when forest patches become similar in size, shape, and composition, providing less habitat diversity. Traditional forest management systems risk creating simplified ecosystems unless mitigating measures are taken. Even-aged rotational harvest methods might not include the retention of significant structural legacies that typically persisted following natural stand replacement disturbances. For these even-aged management systems, the retention of compositional and structural legacies is critical to the development and implementation of adaptive silvicultural methods that strive to integrate the conservation of biodiversity (Crow et al. 1994, Seymour and Hunter 1999, Hammond et al. 2004, Franklin et al. 2007, MFRC 2007).

In forests managed for timber production, variable retention harvesting retains biological legacies from the harvested stand for integration into the new stand to achieve ecological objectives (Helms 1998). Structural legacies selected for retention may include large reserve trees, large snags, and large down logs that provide refugia and structurally enrich the new stand (Crow et al. 1994, Christensen et al.1996, Fridman and Walheim 2000, OMNR 2002, Hammond et al. 2004, Hyvarinen et al. 2006, Franklin et al. 2007). Large structures take time to develop and are not easily replaced. Important characteristics of reserve trees selected as biological legacies are: species diversity; size class representation, especially very large trees; tree health, including both healthy and decadent trees; and heterogeneous distribution as dispersed individuals and aggregated patches.

Silvicultural practices are designed to manipulate vegetation to achieve management objectives (Smith 1962, WDNR 1990, Nyland 1996). At its foundation, silviculture is based on understanding and working with ecological processes. Most natural disturbance regimes and events retain compositional and structural legacies in heterogeneous patterns and create ecological complexity. Adaptive silvicultural methods in managed stands can promote stand level heterogeneity, compositional and structural complexity, and the conservation of biological diversity.

2.1 Forest cover type
Forest land area slowly increased from 1983 to 2007 (Table 2.a and Table 2.b). During this same period, timber growing stock volumes increased by over 30% (Table 2.c).

Forest tree composition is dynamic, changing over time within stands and across landscapes. Forest change often is slow, but can also be abrupt and drastic. Some important factors that influence changing forest composition include environmental variables such as climate and soil; forest disturbances such as fires, storms, insects, diseases, and tree cutting; regenerative strategies of nearby tree species; and forest management practices. Tree composition influences the composition of other plants and animals and how the forest ecosystem functions, thereby influencing biodiversity.

Maple-beech-birch is the most common forest cover type in Wisconsin, representing over a quarter (27%) of all forest land. Total acreage of this type increased significantly in the 1980's and 1990's, but leveled off in the last decade. The maple-beech-birch type (roughly analogous to maple-basswood and northern hardwood cover type classifications) is characterized by the dominance of sugar maple. Hard maple (mostly sugar maple) accounts for 11% of statewide growing stock volume. Soft maple (mostly red maple with some silver maple) accounts for 12%. Both sugar and red maple have shown significant increases in volume since the 1980's, with red maple increasing most steadily and dramatically. Red maple gains are related to its occurrence within other forest types. A major change in overstory composition is the reduction in the representation of hemlock, white pine and yellow birch. (Although the growing stock volume of hemlock reported in Table 2.c is going up, that is attributed to small trees growing larger, not to an increase in hemlock acreage.)

Maple-beech-birch is a late-successional forest type, but most Wisconsin stands are in the early stages of stand development and recovery from the Cutover. Structurally, they are comparatively simple. Most are even-aged, in the stem exclusion stage, lack large structures (trees, snags, woody debris), and exhibit relatively homogeneous canopies. Few maple-beech-birch forests possess the ecological complexity of pre-settlement forests.

Oak-hickory is the second most common forest cover type in Wisconsin, representing about one-fifth (21%) of all forest land. Total acreage of this type has remained relatively stable since the 1980's. In Wisconsin, the oak-hickory type is characterized by the dominance of oaks. Northern red oak accounts for about 8% of statewide volume. Since the 1980's, volume first increased somewhat but then declined. The number of red oak trees has been declining more rapidly than volume. Declines have been greatest on mesic and dry-mesic sites.

Historically, forests dominated by oak occupied about 5.0 million acres or 20% of forest land area. These forests occurred almost entirely in southern Wisconsin (Province 222) and were fire driven systems, largely intermingled with oak savannas. Current oak-hickory forests are distributed somewhat more widely and characterized by the passage of older oaks and absence of renewal with the cessation of fire as a natural process, the in-growth of shade tolerant trees like red maple or invasive shrubs, and excessive animal browsing.

Aspen-birch is the third most common forest cover type in Wisconsin, representing about one-fifth (20%) of all forest land. Based on Public Land Survey data from the mid-to-late 1800s, aspen- and white birch-dominated forests occupied about 0.4 million acres or 2% of forest land area historically. The aspen-birch type expanded dramatically after the Cutover, but today the total acreage is slowly and steadily declining. About 8% of the total acres present in the early 1980's have converted to other vegetation types.

Aspen (including cottonwood, a relatively minor species in the state) accounts for about 12% of statewide volume. Since the early 1980's, volume has declined slowly and steadily, at a rate similar to the decline in type acres. White birch is also declining in volume. These species are primarily associated with fire driven disturbance regimes. Current aspen-birch forests are mostly coppice origin from commercial timber harvests and no longer associated with fire.

The aspen-birch type has many associated wildlife and economic benefits. It is, for example, favored habitat by ruffed grouse and woodcock and is a mainstay of the state paper industry. The expansion of aspen-birch following the Cutover demonstrates that site conditions in Wisconsin can support more of the type than was present in pre-settlement times. The degree and extent of active management (involving fairly intensive harvest techniques) to promote aspen-birch is a public policy question to be addressed in the broader forestry community.

Pine (white, red, jack) is dominant on about 9% of all forest land. Total acreage has remained relatively stable since the 1980's. Historically, white pine and red pine dominated forests occupied about 1.9 million acres or 8% of forest land area. Since the early 1980's, the volume of white and red pine has steadily and significantly increased, more than doubling. Most red pine is grown in plantations. Natural white pine regeneration is advancing due to its shade tolerance and the absence of fires. The volume of fire-dependent jack pine, on the other hand, has decreased dramatically since the early 1980's, with over one-half of its acres converting to other forest types.

Historically, pinelands were most common on dry outwash sands landscapes. Jack pine-scrub oak forests and barrens often occurred within the most droughty or fire prone portions of these landscapes. These pine forests were compositionally and structurally complex because of variable, natural fire patterns and species adaptations. Today, plantations are common but have simple composition and structure. Older stages of pine forests are poorly represented, and fire has been removed as a natural process.

Elm-Ash-Cottonwood dominated forests represent about 9% of all forest land, compared to1% historically. Total acreage has been steadily increasing in the absence of fires that once prevented encroachment of trees into more open wetlands. This forest type is highly variable with mostly hardwoods growing on floodplains, and wet soils. Ash is a dominant species in this forest type and its volume has been steadily and significantly increasing. That trend could be upset by emerald ash borer, an exotic, invasive insect expected to sweep up river corridors killing ash trees. Red and silver maples are important species in this forest type and have shown steady and significant increases in volume sine the 1980's. Elms are also present, but the exotic Dutch elm disease has curtailed their development and dominance. Cottonwood is an uncommon type component in

Wisconsin.

Spruce-Fir dominated forests are a northern type that represent about 9% of all forest land in Wisconsin. Total acreage remained relatively stable since the 1980's, but is down from historical levels and could be further threatened in a warming climate. In the mid-to-late 1800s, swamp conifers occupied about 13% of the forest land area and boreal forest occupied about 2%. Since the 1800s, some stands have converted to aspen-birch, lowland hardwoods, and lowland brush.

Table 2.a: Forest land area by forest type, 1996 and 2007

Forest Cover Type Group	1996 acres	2007 acres
Maple-Beech-Birch	4,694,776	4,501,073
Oak-Hickory	3,519,328	3,500,645
Aspen-Birch	3,442,490	3,244,378
White-Red-Jack Pine	1,479,033	1,532,014
Elm-Ash-Cottonwood	996,835	1,443,141
Spruce-Fir	1,319,605	1,398,094
Oak-Pine	332,100	588,820
Nonstocked	156,493	153,262
Exotic Softwoods	10,343	24,154
Pinyon-Juniper	8,718	17,829
Exotic Hardwoods	998	4,562
Oak-Gum-Cypress	2,300	0
Total	15,963,019	16,407,970

(USFS FIA, 2007) This table reflects the most recent forest cover type groups that FIA uses. This is a change from the 1983 cover types. 1996 acres were adjusted in table 2.a to match cover types used in 2007.

Table 2.b: Forest land area by forest type, 1983 and 1996

Forest Cover Type Group	1983 acres	1996 acres
Maple-Basswood	4,052,200	5,348,592
Aspen-Birch	3,988,700	3,440,750
Oak-Hickory	2,904,600	2,927,863
Bottomland Hardwood	1,318,700	1,558,713
Pine	1,281,300	1,187,591
Spruce-Fir	991,900	729,456
Other Softwoods	638,400	650,230

Nonstocked	175,500	119,824
Total	15,351,300	15,963,019
(USFS FIA, 2007) 1996 acres in Table 2.b reflect the same cover types as 1983.		

Table 2.c: Growing stock volume by species group on forest land (Growing stock volume is the net volume in cubic feet of growing stock trees 5.0 inches DBH and over, from 1 foot above the ground to a minimum 4.0-inch top diameter)			
Species Group	**1983**	**1996**	**2007**
White and Red Pine	1,338,559,042	1,938,290,578	2,842,867,878
Aspen and Cottonwood	2,726,931,006	2,611,712,484	2,485,668,933
Soft Maple	1,231,201,714	1,937,001,241	2,448,877,831
Hard Maple	1,513,617,899	2,189,431,303	2,270,873,673
Select Red Oaks	1,437,153,202	1,772,161,629	1,717,657,267
Ash	748,298,152	1,002,936,127	1,247,113,898
Basswood	848,732,720	1,108,647,394	1,105,217,255
Select White Oaks	647,968,694	937,787,616	1,044,283,683
Other Red Oaks	638,147,621	662,332,274	891,170,596
Spruce and Fir	883,334,967	880,520,703	858,087,747
Hemlock	290,338,433	411,735,400	435,094,216
Jack Pine	632,104,349	385,159,336	293,083,752
Yellow Birch	209,518,111	269,772,710	278,586,799
Hickory	196,038,054	220,523,339	267,459,080
Black Walnut	23,131,967	48,496,739	89,447,969
Beech	28,704,134	49,088,414	31,997,093
Other Yellow Pines	3,044,078	7,088,194	17,714,340
Other Eastern Hardwoods	1,770,088,265	1,463,970,146	1,479,099,696
Other Eastern Softwoods	615,053,264	905,249,148	1,035,945,335
Total	15,781,965,672	18,801,904,775	20,840,247,041
(USFS FIA, 2007)			

Aquatic Resources

Trees and forests are critical to the health and proper function of watersheds. Clean water is one of our most important and valuable forest products. Forests protect municipal water supplies, reduce flooding, replenish groundwater aquifers, and provide critical aquatic fish and wildlife habitat.

Today, Wisconsin enjoys 84,919 miles of rivers and streams plus 1,862,421 acres of lakes, ponds and reservoirs. In respect to wetlands, DNR estimates that Wisconsin has only about half of the 10 million acres that were present in 1848 due to farm drainage and filling for development and roads. Laws have slowed their loss, but wetlands continue to be destroyed and degraded. Invasive plants, like purple loosestrife and reed canary grass, are crowding out native plants and harming habitat. Overuse of groundwater and increasing storm water from development can also either starve or drown wetlands plants.

As the case for historic forest cover, the earliest information available on Wisconsin's wetlands comes from the original government land survey of the state that occurred between 1832 and 1866 (see Appendix A). The surveyors mapped about 5 million acres of wetland. Although the survey gives a good distribution and extent of Wisconsin's original wetlands, it does not provide accurate statistics. Survey methods and mapping were primitive and different surveyors had different interpretations of what constituted a wetland. Some of the work was done in the winter when wetlands were covered by ice and snow. Wetland boundaries were mapped more accurately along survey section lines, and when survey maps were drawn the land cover between the section lines was only estimated.

An analysis of wet soils in Wisconsin provides a more accurate image of the state's original wetland acreage. Soil scientists estimate that Wisconsin has approximately 10 million acres of wet soils (somewhat poorly, poorly and very poorly drained), which is a much more accurate approximation of Wisconsin's pre-settlement wetland acreage. A Wisconsin Wetland Inventory was completed for the state in 1985. Based on aerial photography from 1978-79, it shows approximately 5.3 million acres of wetlands remaining in the state representing a loss of about 47% of original wetland acreage. This figure does not include wetlands less than 2 or 5 acres in size, which are the smallest mapping units used by various counties. (Simon, 2008)

Wetland areas continue to change, and so the State Legislature authorized the DNR to update the Wisconsin Wetland Inventory on a 10 year cycle. Budget constraints and lack of staff have, however, slowed the process to a 24 year cycle at best. Changes related to wetland losses controlled by permits in recent times are tracked under Section 404 of the Clean Water Act, which establishes a program to regulate the discharge of dredged and fill material. A DNR review of U.S. Army Corps of Engineers (COE) individual permit decisions from 1982 - August, 1991 showed wetland losses of approximately 10,800 acres statewide (1,200 acres/year average). Another DNR review of COE individual and nationwide permit decisions from August, 1991 - April, 1998 revealed wetland losses of approximately 2,053 acres statewide (312 acres/year average). The second review showed that permitted wetland losses declined by 460% (1,128 acres/year average). The marked improvement is attributed to the adoption of state wetland water quality standards on August 1, 1991. These wetland acreage loss figures are estimates only and do not reflect total wetland acreage changes. Wetland losses due to illegal wetland filling and wetland drainage are not known. New wetlands have also been created under efforts of the federal Wetland Preserve and Conservation Reserve Programs, state Department of Transportation wetland mitigation projects, and restoration work under the North American Waterfowl Management Program. (Simon, 2008)

Additional details about Wisconsin’s aquatic resources can be found under Criterion Four: Conservation & Maintenance of Soil and Water Resources.

2.2 Size class

Most forests in Wisconsin are comprised of trees of medium diameter (poletimber) to large diameter (sawtimber), although stands of small diameter trees are also abundant (Table 2.d). Acreage with 5-17 inches diameter trees is most prevalent. Spruce-fir and aspen-birch types have the most small-medium sized trees. Maple-beech-birch, oak-hickory, and pine types have the most large trees. During the last decade, the proportion of large diameter stands increased, and the proportion of small diameter stands decreased. Wisconsin's forests are maturing, but are still relatively simple structurally, as most are in the stem exclusion stage of stand development.

Table 2.d: Forest type group timberland acres, % by size class 1996 and 2007

Forest Cover Type Group	Small Diameter (<5" dbh)		Medium Diameter (5-9/11" dbh)		Large Diameter (>9/11" dbh)	
	1996	2007	1996	2007	1996	2007
Maple-Beech-Birch	19	10	48	42	33	48
Oak-Hickory	20	12	36	28	43	61
Aspen-Birch	49	40	41	46	10	15
White-Red-Jack Pine	23	18	34	26	43	56
Elm-Ash-Cottonwood	32	21	44	49	24	30
Spruce-Fir	53	44	31	38	15	18
Oak-Pine	52	25	29	32	19	43
Exotic Softwoods	59	27	25	27	15	46
Pinyon-Juniper	100	17	0	60	0	23
Exotic Hardwoods	100	100	0	0	0	0
Oak-Gum-Cypress	0	0	0	0	100	0
Total	31	22	41	38	29	40
(USFS FIA, 2007)						

2.3 Age group

Forest trees and stands regenerate, grow and mature, and senesce. As forests mature they change structurally (e.g. stand initiation, stem exclusion, demographic transition, old multi-aged) and develop different attributes (e.g. age structure, tree density, tree size). Successional changes in tree composition often occur as forests mature. Some tree species like aspen grow rapidly and typically live less than a century. Others, such as sugar maple, grow more slowly and can live for several centuries.

In Wisconsin, most forests were cut over and many acres burned in the late 1800's and early 1900's. Following the Cutover, many areas were temporarily farmed and pastured. Most of today's forest originated on open land and developed into even-aged stands with all trees at about the same age. Some of these stands, particularly those dominated by shorter lived and faster growing tree species, have been harvested for timber and regenerated. Many stands continue to grow and age—most are still even-aged and maturing within the stem exclusion stage of structural development, but some are approaching old age (senescence) and demographic transition.

Current forests are homogeneous (simplified) in terms of age class diversity. Most forests in Wisconsin are 40-80 years old and even-aged (Table 2.e and 2.f). Approximately 10% of Wisconsin forests are under 20 years of age, and 4% are over 100 years of age. Average forest age is slowly increasing as predominantly young forests mature. The forest types proportionally best represented in the younger age classes are aspen, pine, and oak-pine, with the latter two predominantly associated with dry sites.

Older forests (greater than 100-120 years old) that were more common prior to the Cutover are rare and continue to decline in extent due to type succession, age-related mortality, pests, invasive species, herbivory, the lack of seed sources, harvesting and other factors. This decline has continued from earlier inventories. The forest types proportionally best represented in the over 100 age classes are spruce-fir, pine, and oak-hickory. These older forests offer unique habitat, including compositional, structural, and functional attributes. Better data on acres, distribution, and types of older forests would be helpful.

Table 2.e: Forest type group timberland acres, % by age class, 2007

Forest Cover Type Group	Age Class (years)						
	≤19	20-39	40-59	60-79	80-99	100-119	≥120
Maple-Beech-Birch	4	8	26	41	17	3	1
Oak-Hickory	5	8	24	38	18	5	2
Aspen-Birch	22	30	29	16	3	<1	<1
White-Red-Jack Pine	15	28	31	13	6	3	4
Elm-Ash-Cottonwood	5	15	32	28	15	4	1
Spruce-Fir	4	12	29	31	16	5	3
Oak-Pine	16	19	36	22	5	1	1
Exotic Softwoods	24	29	38	9	0	0	0
Pinyon-Juniper	0	14	75	11	0	0	0
Exotic Hardwoods	100	0	0	0	0	0	0
Total	10	16	28	30	13	3	1
(USFS FIA, 2007)							

Table 2.f: Forest type group timberland acres, % by age class, 1996

Forest Cover Type Group	Age Class (years)						
	≤19	20-39	40-59	60-79	80-99	100-119	≥120
Maple-Beech-Birch	9	12	31	30	12	4	2
Oak-Hickory	9	14	24	31	13	6	3
Aspen-Birch	28	25	31	13	2	<1	<1
White-Red-Jack Pine	15	29	30	9	9	5	2
Elm-Ash-Cottonwood	10	22	35	19	12	2	1
Spruce-Fir	6	15	33	26	8	7	5
Oak-Pine	36	21	25	12	2	2	2
Total	15	18	29	23	9	4	2

(USFS FIA, 2007)

Vegetation present at the time of Euro-American settlement (mid-to-late 1800's)

Studies of Wisconsin's pre-settlement vegetation including *Ecological History of Wisconsin's Forests* (Appendix A) provide a useful picture of what vegetative types different parts of the state were capable of supporting. The purpose in presenting pre-settlement vegetation information is not to suggest that Wisconsin's forests should be restored to those historic conditions. Rather, management efforts will be most effective when they consider the natural variability that climate, soils, wildlife and Native American culture (including use fire) defined in the absence of logging, farming, urban expansion and other disturbances brought by settlers.

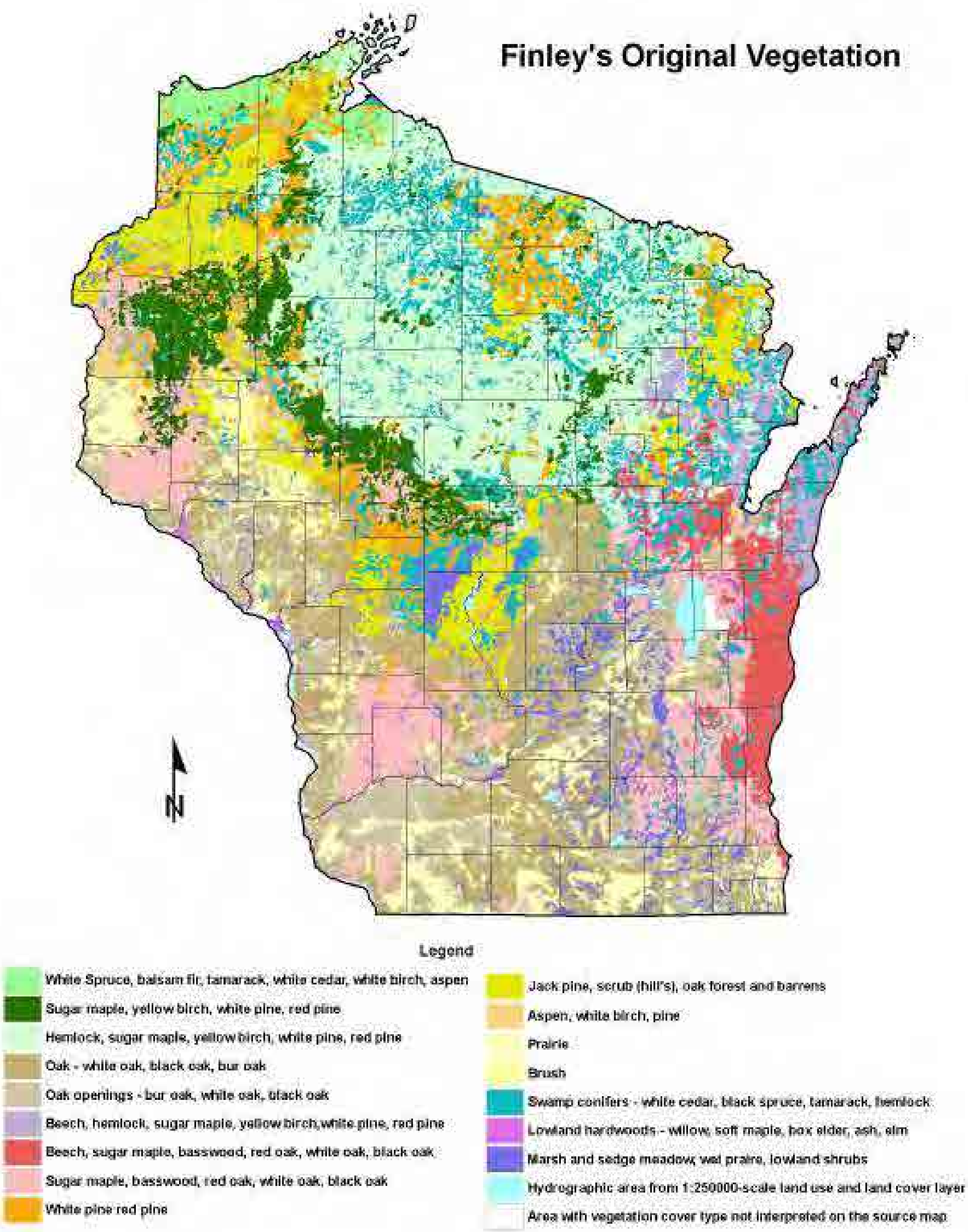
An interpretation of pre-settlement vegetation cover by Robert Finley, which preceded the spatial model in Appendix A, is presented in Table 2.g. It shows that forest land covered about 25.5 million acres or 73% of the total land area in Wisconsin. Jack pine-scrub oak forests and barrens, and oak openings (savannas) represented another 17% of land area. Open land represented about 10% of statewide land area.

Forests dominated by hemlock, sugar maple, beech, and yellow birch occupied about 13.9 million acres or 54% of forest land area. About two-thirds of these forests occurred in northern Wisconsin (Province 212). Here, conifers played a dominant role, particularly hemlock. Most stands were old and multi-aged, and compositionally and structurally complex. In southern Wisconsin, these forests were mostly dominated by hardwoods (maple, basswood, oak). See Map 2.a for a visual representation of Finley's original vegetation.

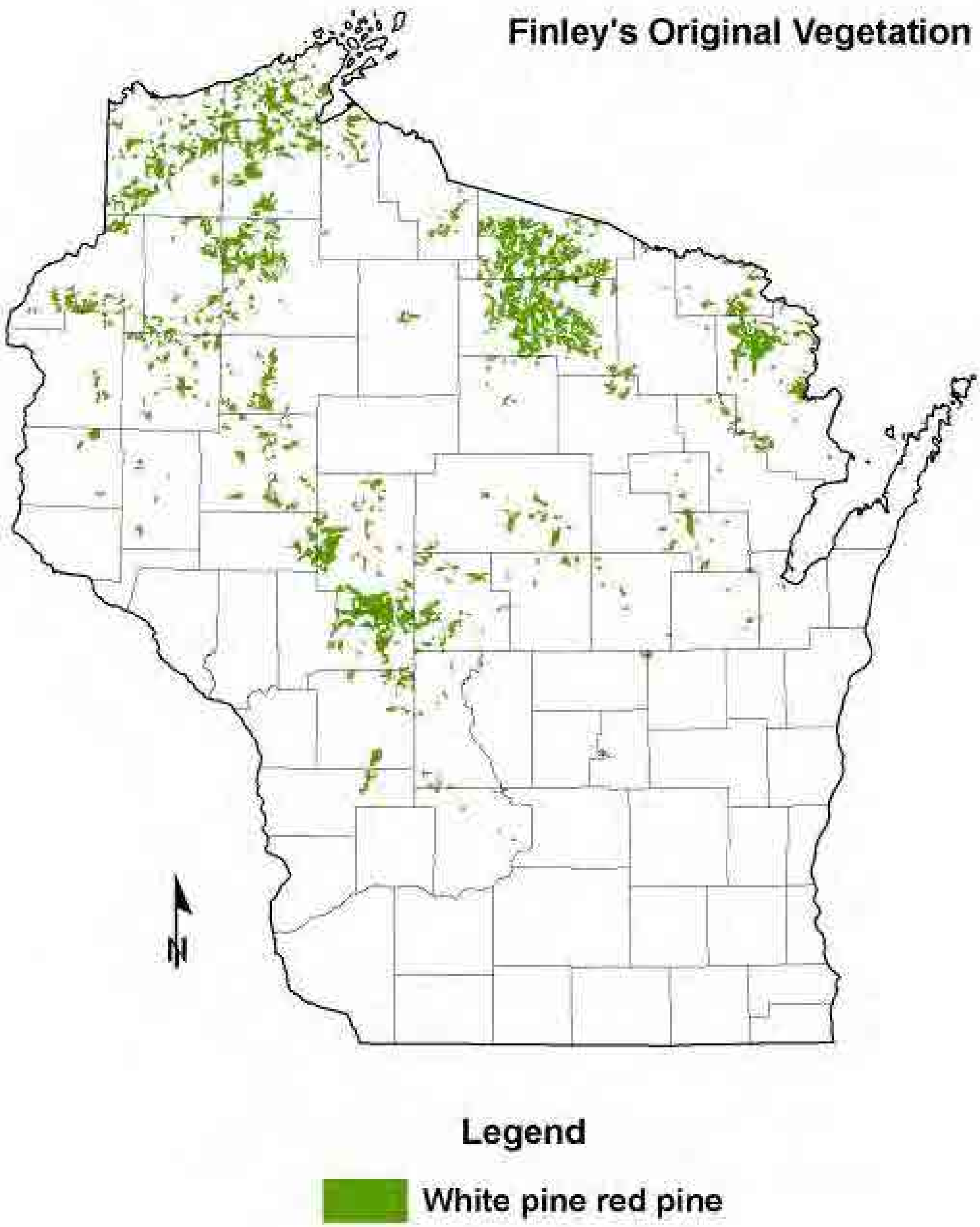
Table 2.g: Land area by vegetation cover type and ecological province

Vegetation Cover Types	Total Acres	% of Total Acres	% of Cover Type Acres by Province	
			Prov. 212	Prov. 222
Boreal Forest: White Spruce, Black Fir, Tamarack, White Cedar, White Birch, Aspen	547,549	2	100	0
Beech, Hemlock, Sugar Maple, Yellow Birch, Pine	959,320	3	100	0
Hemlock, Sugar Maple, Yellow Birch, Pine	6,250,578	18	99	1
Sugar Maple, Yellow Birch, Pine	2,207,300	6	89	11
White Pine, Red Pine	1,946,337	6	83	17
Aspen, White Birch, Pine	397,426	1	67	33
Jack Pine-Scrub Oak Forests and Barrens	2,388,105	7	64	36
Beech, Sugar Maple, Basswood, Oaks	1,305,995	4	74	26

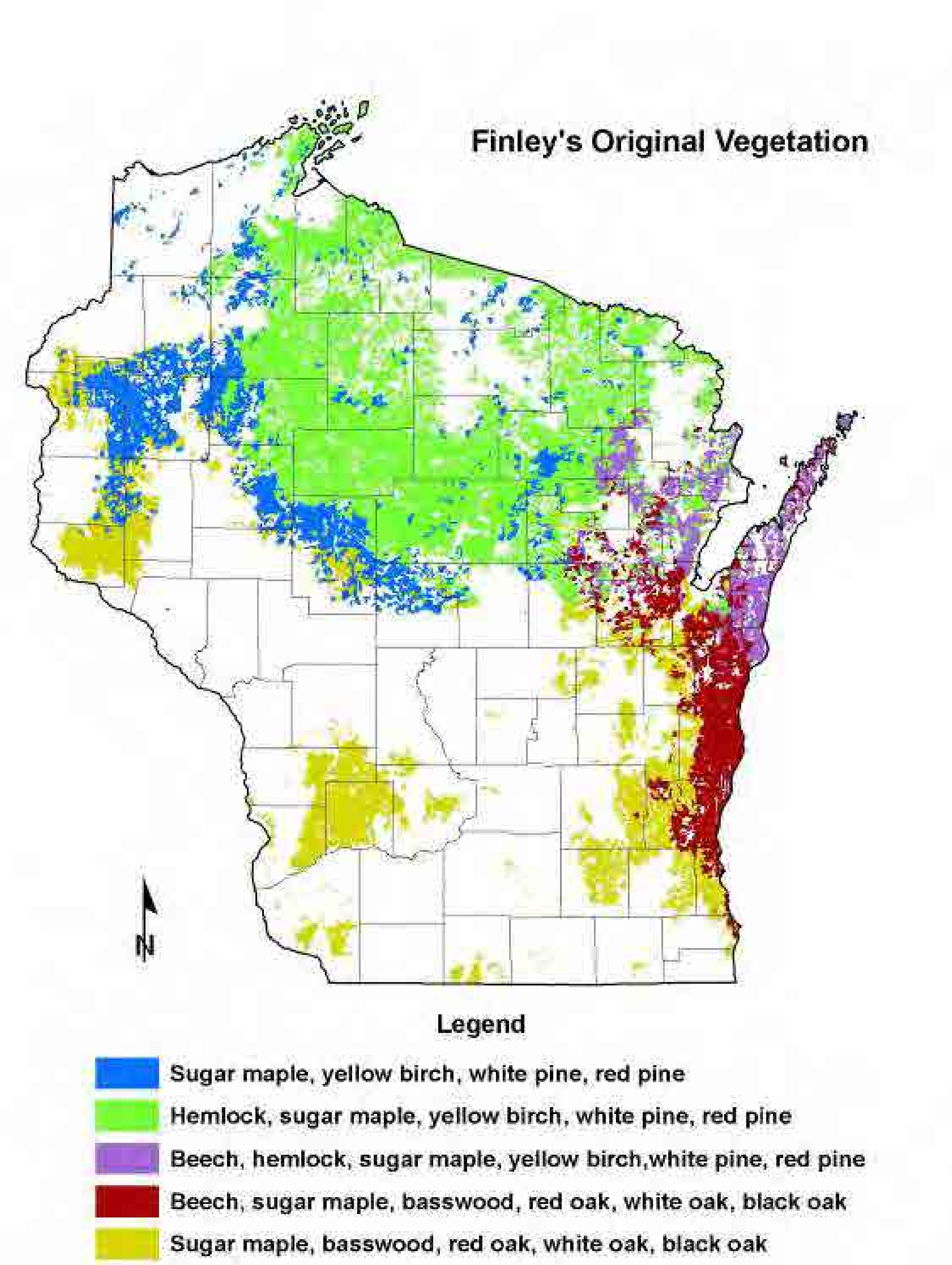
Sugar Maple, Basswood, Oaks	3,130,531	9	22	78
Oak – White, Black, Burr	5,030,763	14	6	94
Oak Openings	3,439,484	10	1	99
Swamp Conifers	3,398,502	10	80	20
Lowland Hardwoods	312,743	1	28	72
Brush	806,602	2	10	90
Marsh and Sedge Meadow, Wet Prairie, Lowland Shrubs	1,193,673	3	6	94
Prairie	1,691,625	5	1	99
Total	35,006,536		52	48
Source: Finley, 1976				



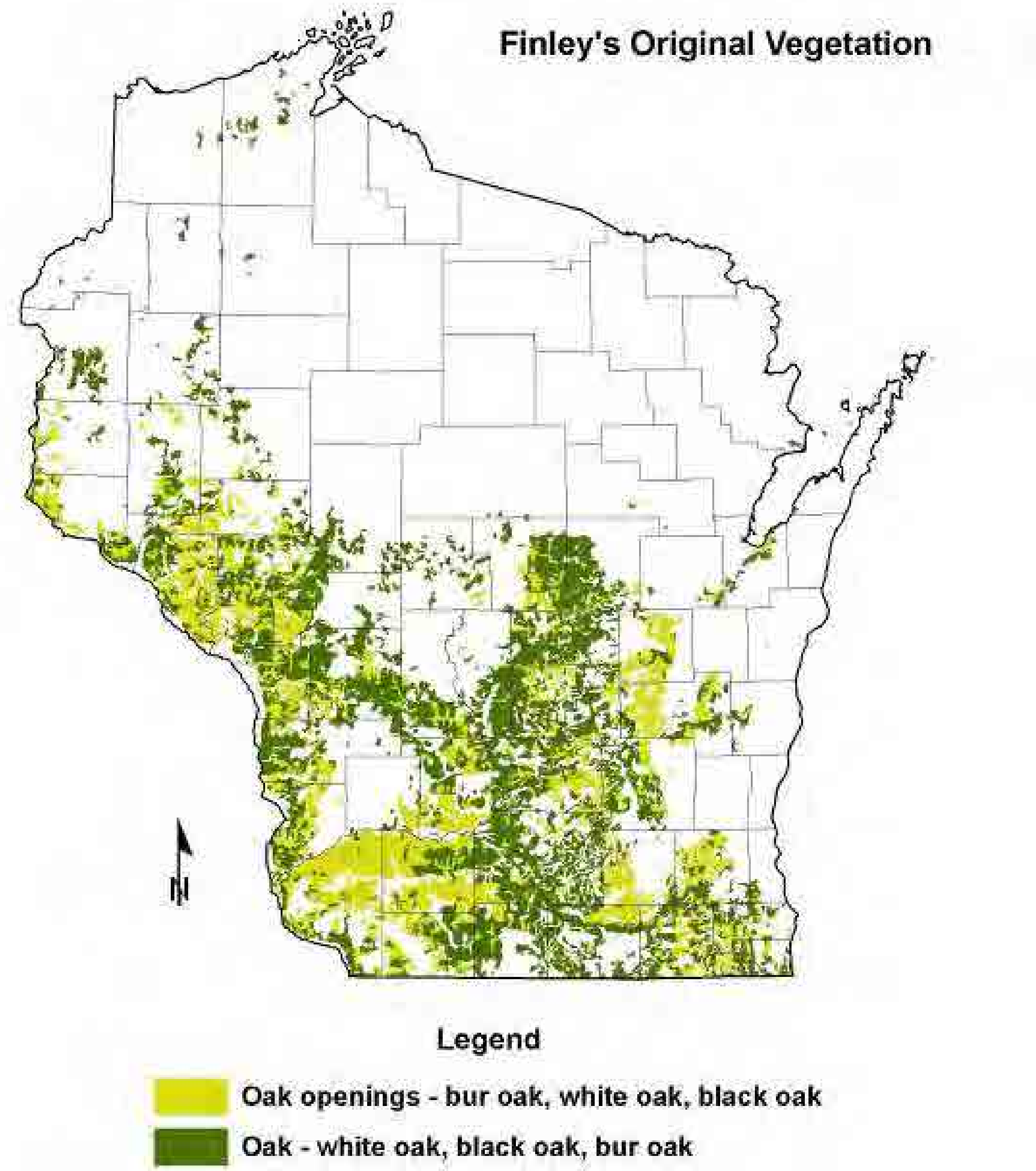
Map 2.a: Original vegetation cover of Wisconsin
Source: Finley, 1976



Map 2.b: Original vegetation of Wisconsin: northern hardwoods (maple/beech/birch) and hemlock
Source: Finley, 1976



Map 2.c: Original vegetation of Wisconsin: oak
Source: Finley, 1976



Map 2.d: Original vegetation of Wisconsin: pine
Source: Finley, 1976

3. Extent of forest land conversion, fragmentation, and parcelization
Fragmentation is a term used to describe certain kinds of landscape structures. Common measures of fragmentation are patch size, isolation (distance between patches), and edge (cumulative length of patch edges). "Permanent fragmentation" refers to long-term conversion of forest to urban, residential, agricultural, or other non-forest uses. Roads and utility corridors can also create permanent fragmentation. Permanent fragmentation is a permanent loss of habitat and alters some ecological processes. Permanent fragmentation therefore has the greatest negative impact on forest biodiversity.

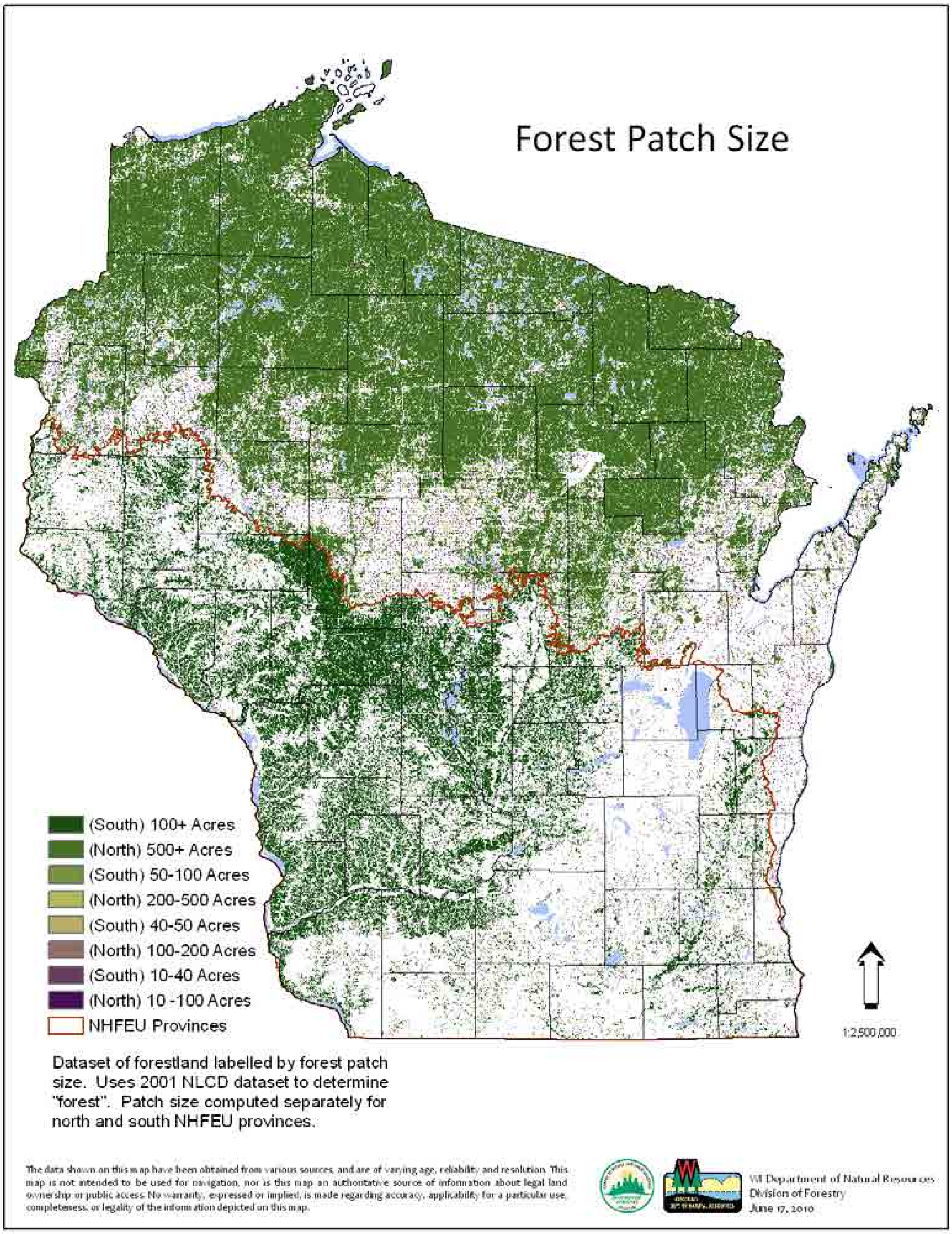
"Habitat fragmentation" is defined as a disruption of habitat continuity caused by human or natural disturbance, which creates a mosaic of successional and developmental stages within a forested tract. At a landscape scale, aggregated continuing human disturbance may result in relatively high levels of habitat fragmentation with negative impacts. Dispersal can be affected if species or their propagules cannot cross a disturbed area, find suitable habitat within it, or successfully compete with disturbance adapted species.

Parcelization is the subdivision of a single forest ownership into two or more ownerships. The forest land itself may not change immediately when broken up into separate tracts, but it becomes more susceptible to fragmentation (e.g. some tracts may be sold for development). With multiple landowners, coordinated landscape scale management becomes increasingly difficult to implement due to landowners with diverse objectives. Parcelization can be a barrier to the successful conservation of biodiversity.

3.1 Forest land developed
3.2 Net change in forest land
3.3 Additions to and conversions from forest land
There are currently 16.4 million acres of forest land in Wisconsin, up from 14.7 million acres in 1983 (Table 1.a). Based on estimations of vegetation type and cover in the mid-1800's, forest area ranged from 22 to 26 million acres (not including barrens or savannas).

Each year some forest land is converted to non-forest land uses (developed), and some non-forest land is regenerated to forest. Criterion 6, Metric 16; and Criterion 7, Metric 19 provide additional assessments regarding land ownership, land use, management designations and limitations, and legal and institutional frameworks. More specifically, Metrics 3.4, 16.2, and 19.3 provide discussions of ownership trends and parcelization.

Metric 1.2, Map 1.a provides a statewide depiction of the density of forest canopy cover (National Land Cover Data 2001). Spatial models to evaluate forest fragmentation are being developed and refined to improve accuracy. Map 3.a showing forest patch size is such a GIS product, more of which will be available as this type of research progresses.



Map 3.a: Fragmentation: forest patch size
Source: U.S. Forest Service, Rachel Riemann

3.4 Forest Parcel Size

Parcelization is occurring in Wisconsin as evidenced by the increased number of landowners and smaller average parcel sizes. Most forest land (66%) in Wisconsin is privately owned. The average parcel size owned by a private landowner is 30 acres, a decrease from 41 acres in 1997 (Table 3.a). During this same period, the number of landowners increased from 263,000 to 362,000 (Table 3.b and Metric 16.2). The number of large scale forest owners (owning 200 acres or more) has remained stable since 1997, but the acreage of parcels owned by these large scale forest owners has decreased. The most dramatic change in acreage occurred with owners of parcels 5,000 acres and greater. Most likely these lands have been sold off in smaller parcels resulting in the increase in owners of less than 100 acres. Large forest landholdings in amenity rich areas are particularly at risk of being split as landowners can sell smaller parcels at a higher price.

In a study on what factors contribute to forest parcelization, Mehmood and Zhang (2001) found urbanization, income, regulation uncertainty, death, and financial assistance for landowners to have significant impacts on the change in average parcel size. The proximity of urban development and higher densities are correlated with reduced rates of timber harvest on private forests (Barlow et al, 1998). As forest parcels decrease, loggers may find the small sale sizes too small to bid on (Kittredge et al, 1996) and therefore more difficult for landowners to manage economically.

Table 3.a: Average parcel size of privately owned forest lands

Ownership Category	Average Parcel Size (acres)	
	1997	2006
Private Forest Ownership	41	30
Non-Industrial Private Forest (NIPF) Ownership	37	28
(USDA, FIA, NWOS, 2006)		

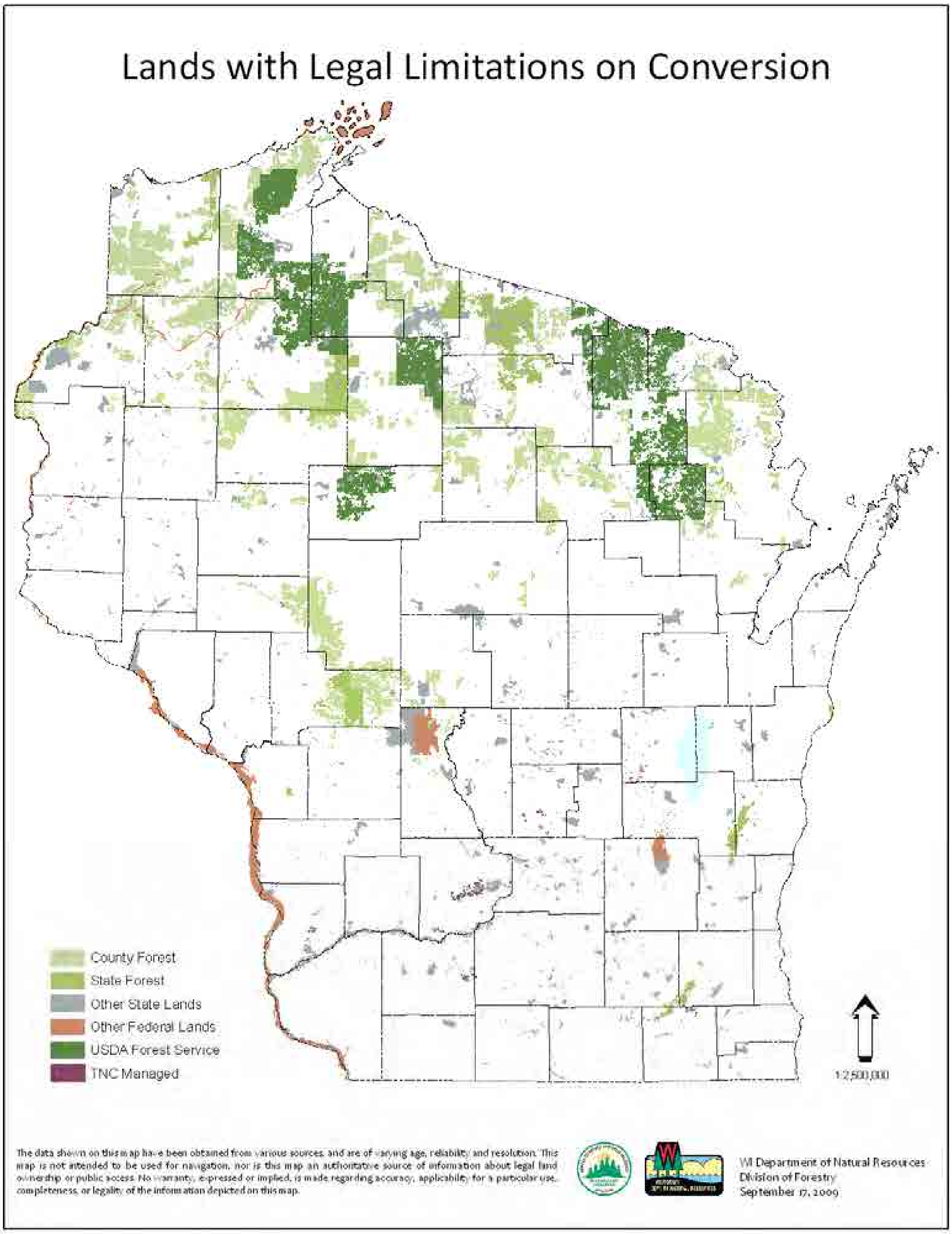
Table 3.b: Number of owners and acres of private forest in Wisconsin by parcel size class

Ownership Parcel Size Class	**# Owners (thousands)**			**# Acres (thousands)**		
	1997	2006	Change from 1997 to 2006	1997	2006	Change from 1997 to 2006
1-9	92	176	84	339	529	190
10-19	40	46	6	518	575	57

20-49	69	77	8	2157	2204	47
50-99	37	36	-1	2290	2411	121
100-199	17	19	2	2111	1996	-115
200-499	7	7	0	1569	1496	-73
500-999	1	1	0	435	423	-12
1000-4999	<1	<1	0	316	304	-12
≥5000	<1	<1	0	1077	810	-267
Total	263	362	99	10,812	10,479	-64
(USDA, FIA, NWOS, 2006)						

3.5 Lands with Various Legal Limitations on Conversion
Maintaining forest land contributes to the conservation of forest biodiversity. One method is public ownership. The vast majority of public land occurs in northern and west-central Wisconsin (Map 3.b). Public and tribal forest land ownership is slowly increasing and represents about 34% of Wisconsin forest land (Table 3.c). About 66% of forest land is privately owned, in large part as non-industrial private forests (NIPF). On private forest lands, conservation easements may help ensure long-term retention of forested conditions. In Wisconsin, statutory incentives like the Managed Forest Law (MFL) and regulations like county zoning ordinances are additional methods to encourage maintenance of private forested lands. Criterion 6, Metric 16; and Criterion 7, Metric 19 provide related information about land ownership, land use, management designations and limitations, and legal and institutional frameworks.

Legal limitations on conversion help to reduce permanent fragmentation. However, they do not address habitat fragmentation. If legal limitations on conversion incorporate forestry practices guidelines, then some aspects of habitat fragmentation could be addressed.



Map 3.b: Lands with legal limitations on conversion (this map does not include private conservation easements other than The Nature Conservancy) Source: DNR, 2009

Table 3.c: Area of forest land in Wisconsin by ownership category				
Ownership Category	**1968 Thousand acres**	**1983 Thousand acres**	**1996 Thousand acres**	**2006 Thousand acres**
Total Private	10,216	10,426	10,812	10,749
NIPF	8,816	9,252	9,710	10,070
Forest Industry	1,400	1,174	1,102	679
Tribal	157	358	347	368
Total Public	4,573	4,568	4,745	5,157
Federal	1,485	1,621	1,629	1,576
State	723	707	823	1,075
Local	2,366	2,240	2,293	2,506
Total	**14,945**	**15,351**	**15,904**	**16,274**
(USDA, FIA, NWOS, 2006)				

3.6 Road Density
3.7 Housing density

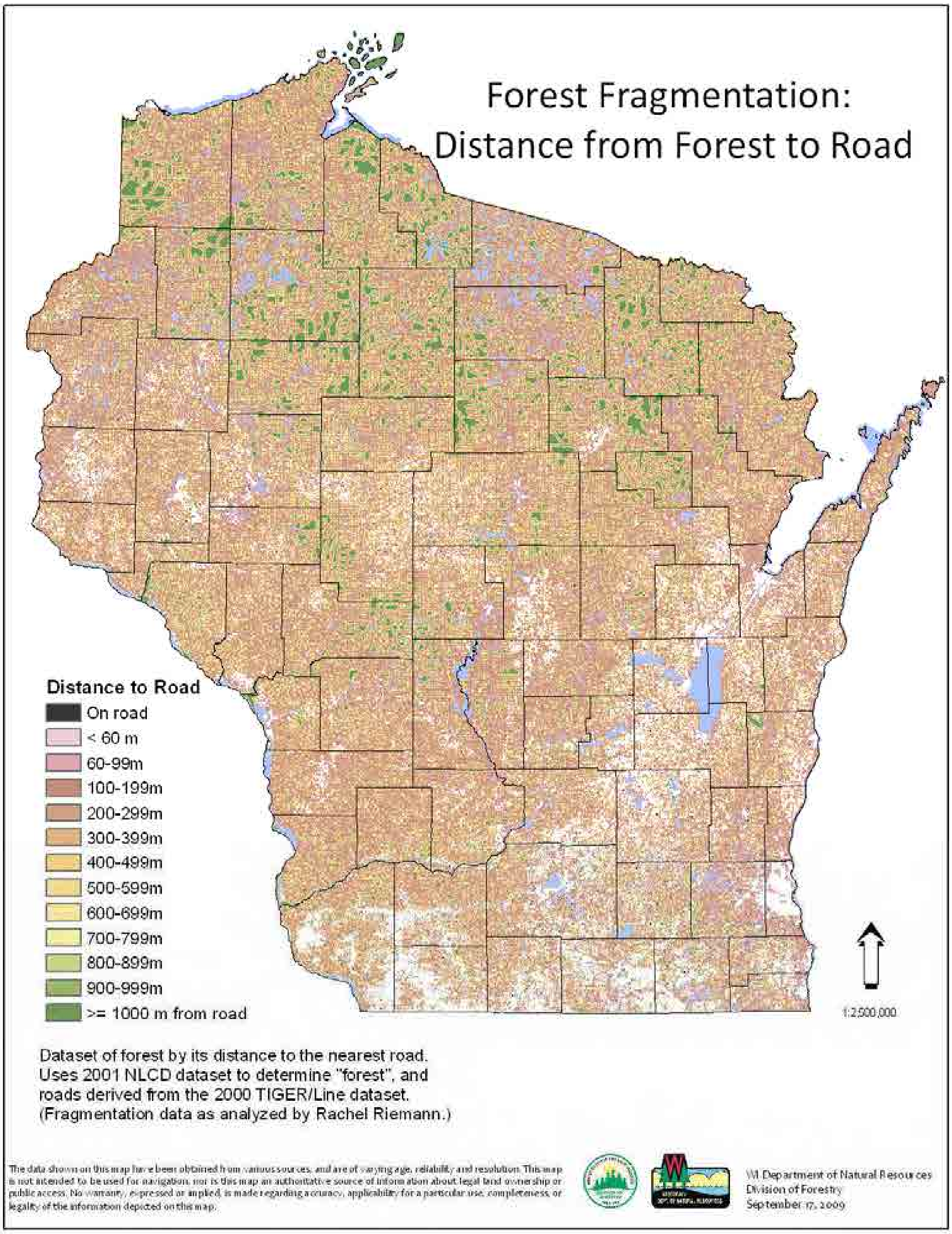
Roads are a vital component of our society and the management of forests. They provide access for housing, recreational activities, hunting and fishing, research, fire control, forest improvement activities, timber harvesting, and other uses. Roads also have well-documented, short and long-term effects on the environment and can be highly controversial as society balances the benefits of biodiversity including human social and economic needs. One size road may have a significant effect in one location and not in another. Road density and housing density are related. Roads fragment landscapes and facilitate the development of housing; as road and housing density increases, forest landscapes become increasingly fragmented and interior forest patch sizes become smaller. An effective synthesis of roads and related housing issues draws people together to thoroughly evaluate access benefits, problems and risks, and to inform managers about what roads may be needed, for how long, for what purposes, and at what benefits and costs (Gucinski, 2001).

In general, increased road and housing density threaten the conservation of biodiversity by:

- Altering composition, structure, and function of adjacent ecosystems
- Changing land use through development (removing habitat)
- Increasing edge and decreasing interior forest
- Providing avenues and sources of invasion for exotic species
- Causing air and water pollution
- Altering hydrological networks
- Increasing ecosystem disturbance through increased human access and activity; impacts are both direct (e.g. road kills, potential overhunting) and indirect (e.g. habitat alteration, wildlife behavioral changes)
- Limiting management alternatives

Many of these impacts can be mitigated by techniques such as road design, routing to avoid critical habitats, warning signs, seasonal road closures, fencing, vegetative buffers, etc. Housing impacts may also be regulated through appropriate zoning and land use planning. All such measures, however, involve tradeoffs balancing social and economic benefits with diversity critical for sensitive species.

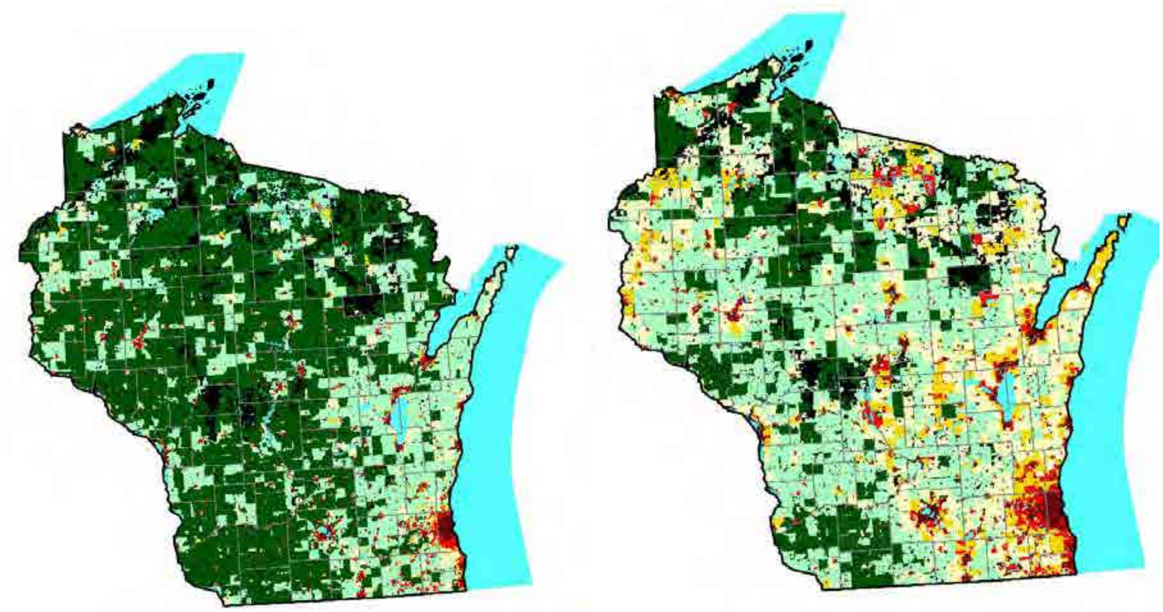
Road densities for the state represented in Map 3.c were calculated using TIGER data (US Census Bureau). In Province 212, the mean road density was 1.3 km^2 with a maximum of 19.5 km^2. In Province 222, the mean road density was 1.6 km^2 and the maximum 20.8 km^2.

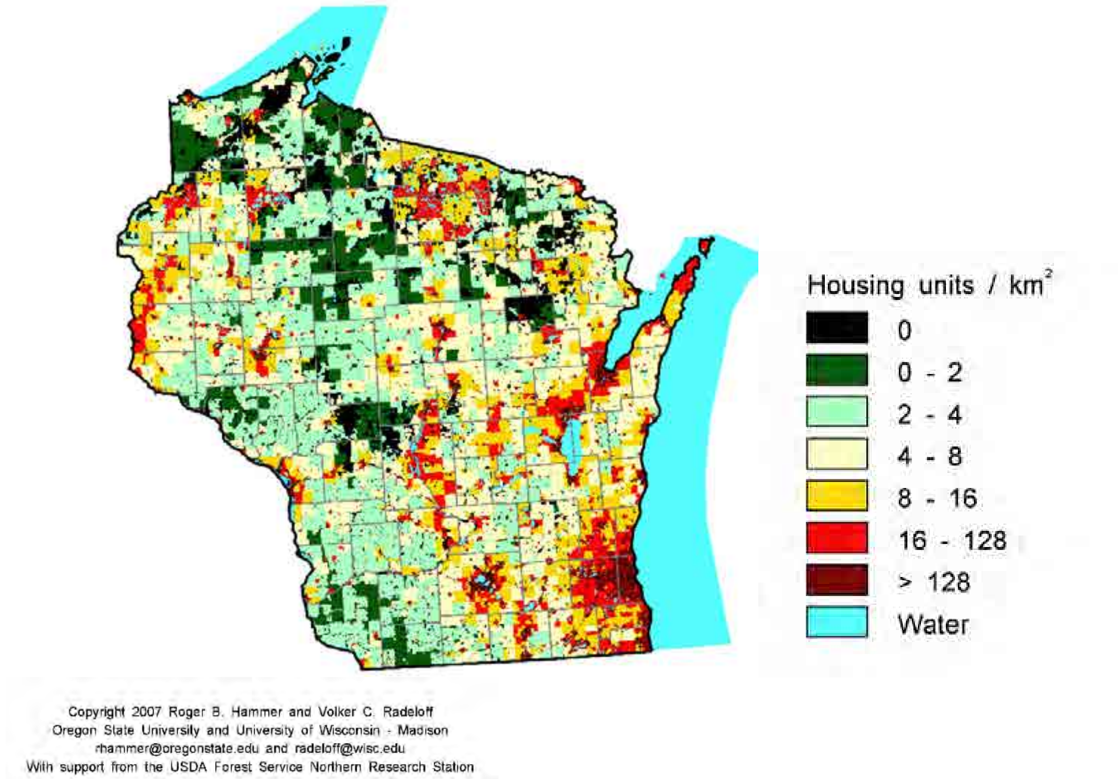


Map 3.c: Fragmentation: distance from forest to road
Source: US Forest Service, Rachel Riemann

In a study of three ecoregions in northern Wisconsin, there was a substantial increase in road density and landscape fragmentation from 1937 to 1999 (Hawbaker et al. 2006). Road density more than doubled from 1.7 to 3.5 km/km^2. Roads were mapped from aerial photographs and any linear feature that was clearly visible in the photo and connected to another road or building was considered a road. Typical roadless patch size was greatly reduced. (See Hawbaker and Radeloff, 2004 for a discussion on road density and landscape pattern.)

Housing density is increasing across most forested regions within Wisconsin (Map 3.d). In northern Wisconsin, there was a 6% increase in population and a 113% increase in the number of housing units between 1940 and 1990; much of this housing development was concentrated along lakeshores (Hawbaker et al. 2006). The majority of forests either contains or is near housing (Radeloff 2005). Few large, remote interior forest patches remain in Wisconsin.





Map 3.d: Housing density changes 1940, 1990, 2030
Source: Hammer, Radeloff, 2007

4. Status of forest communities and associated species of concern
This indicator focuses on elements of biological diversity of conservation concern. Although all species are important, some are of greater conservation concern than others because of their sensitivity to management, regional scarcity, or past declines. Some characteristics of species that warrant special concern are those with: 1) low population densities that require large territories or home ranges (e.g. large-bodied animals), 2) poor dispersal and colonizing abilities, 3) local endemism or restricted geographic distributions, 4) specialized habitat requirements, 5) migratory species, and 6) rare species (Crow 1990).

This indicator discusses the occurrence of high quality community types and habitat availability for some habitat specialists. It references rare and uncommon species, including endangered and threatened species, and species of greatest conservation need. This indicator uses the population trends of selected species as a surrogate measure of the biological diversity supported by Wisconsin's forests. Changes in these species' abundance can indicate environmental stress, including unfavorable changes in forest habitat.

In general, data that directly address Indicator 4 are lacking. Monitoring of forest associated animal and plant populations and knowledge concerning responses to habitat changes are limited. Population monitoring and research that links species population changes directly to changes in forest composition and structure are needed. Population viability and response to environmental change provide direct measures and interpretation of potential trends in biodiversity.

4.1 Forest and woodland communities
Three major biomes—temperate grasslands, temperate broadleaf and mixed forests, and boreal forests—converge in Wisconsin, and conditions here allow for a diverse set of natural community types, or plant species assemblages, including several forested types. The Wisconsin Natural Heritage Inventory (NHI) program tracks high-quality examples of communities using a system derived from work by John Curtis in 1959. This system was recently used for both the Wisconsin Wildlife Action Plan and the Ecological Landscapes of Wisconsin Handbook, two sources that provide extensive information for the material covered in this metric.

It is difficult to assess the statewide condition of forested communities, as they are not represented by any comprehensive statewide maps or spatial data sets. In addition, although we can examine very broadly where forests occur in the state and use extrapolated data to assess general trends, several important metrics of community structure and function are unavailable. For example, data related to trends in understory composition are notably lacking, and these data are routinely collected for only a very small portion of the forests in the state.

Several of Wisconsin's key trends described in Indicators 1-3 impact forested communities including changes in overstory species composition, lack of older forests, forest simplification, lack of certain structural features in many forests, forest fragmentation, invasive species, intense deer herbivory, and expected climate change effects. All of these factors play a significant role in the structure and function of Wisconsin's forested communities. Also, there have been significant changes to the understory composition of many forested communities in the state. Studies examining over 150 forest sites in northern (Wiegmann and Waller 2006) and southern (Rogers et al. 2008) Wisconsin highlight significant changes to our flora over the last 50 years. These studies found overall decreases in understory species richness with rates of species loss in the south almost double those in the north. Both studies cite general losses in native species and increases in exotic species. Plant species faring best in these studies were often known to be regionally common and widespread, and in some cases grasses and sedges were “winners” over many of the less common forbs. It is unclear how these changes to species composition will affect overall ecosystem function.

The Wisconsin NHI Program recognizes 22 natural community types that can be broadly categorized as either upland or wetland forests. It is important to note that many of these communities often occur in close association with non-forested types, forming continuums, rather than discrete, definable units. Therefore, although we focus on forested types in this chapter, their use by animal and plant species may be influenced by other related communities. For example, a Northern Dry Forest could be closely linked to an adjacent Pine Barrens community, a globally rare and dynamic type that would fall under a barrens or savanna group, rather than a forest group. These associated communities often provide important, sometimes essential, rare species habitat.

Forested communities in Wisconsin can be separated into northern and southern groups, roughly corresponding to the location of the Tension Zone (Curtis 1959) and the two Ecological Provinces discussed earlier. However, some parts of the state contain both northern and southern types; the Central Sands Ecological Landscape is a notable example where both groups co-occur along with numerous plant and animal species near the northern or southern edges of their ranges.

Northern forests

Northern Wisconsin once contained the largest and most contiguous expanse of hemlock-hardwood forest in the Lake States (WDNR in prep). Although there have been many changes to the composition, structure, and function of these forests (e.g., see Indicator 2), the northern half of the state continues to provide excellent opportunities for maintaining large patches of interior forest used by numerous animals such as large predators and forest interior raptors and songbirds. Northern Wisconsin forests sometimes contain specialized microhabitats such as Ephemeral Ponds, Forested Seeps, and cliffs supporting significant plant and animal diversity including several rare species. Forests also provide important buffers for numerous high-quality lakes, streams and other aquatic features and wetlands. Wet forest types are abundant in the north, including extensive conifer swamps harboring specialized groups of plant and animal species. Relatively large acreages of public lands and larger private ownerships exist in the north, although the recent trend toward parcelization of larger tracts is a concern.

Reducing fragmentation and invasive species effects, improving forest species composition, developing more complex structure, developing old-growth forests, reducing the impacts of deer herbivory, and identifying areas in which to manage across broad ecologically-based landscapes are all examples of important opportunities for maintaining biodiversity in the northern forest. Table 4.a summarizes the natural community types identified by NHI for the Northern Forest group.

Table 4.a: Northern forest community types recognized by the Wisconsin Natural Heritage Inventory (NHI) program	State Rank	Global Rank	Related Forest Habitat Types (Kotar et al. 2002)
Upland Forests			
Boreal Forest	S2	G3?	ArAbSn; ArAbVCo; ASnMi
Mesic Cedar Forest	S1	G3?	n/a
Mesic Floodplain Terrace	S2	GNR	n/a
Northern Dry Forest	S3	G3?	PArV; PArVAm; PArVAo; PArVHa; PArVPo; PArV-U; PEu; PQE; PQG; PQGCe; PVG; PVGy; QAp
Northern Dry-mesic Forest	S3	G4	AAt; ACl; AFVb; AVb; AVb-V; AVCl; AVDe; AVVb; PArVAa; PArVAa-Po; PArVAa-Vb; PArVAm; PArVHa; PArVPo; QAp; TFAa
Northern Mesic Forest	S4	G4	AAs; AAt; AAtRp; ACaCi; ACaI; ACl; AFAd; AFAl; AFAs; AFAs-O; AFH; AFTD; AFVb; AH; AHI; AHVb; AOCa; ASaI; ATAtOn; ATD; ATDH; ATFD; ATFPo; ATFSt; ATiCa-La; ATiSa-De; ATM; ATTr; TMC
Wetland Forests			
Black Spruce Swamp	S3?	G5	n/a
Forested Seep	S2	GNR	n/a
Hardwood Swamp	S3	G4	n/a
Northern Wet Forest	S4	G4	n/a
Northern Wet-mesic Forest	S3S4	G3?	n/a
Tamarack (Poor) Swamp	S3	G4	n/a
See the NHI Working List (*dnr.wi.gov/org/land/er/wlist/*) for more information about state and global ranks.			

The following examples highlight two of Wisconsin's northern forest communities. See the Wisconsin DNR Web for more information about each of the forested community types (*dnr.wi.gov/org/land/er/communities/*), including rare animals associated with each of the types and areas of the state with the best opportunities to maintain them.

<u>Northern Mesic Forest:</u>

- Classic "northern hardwood" and "hemlock hardwood" forests once covering the largest acreage of any Wisconsin community; they are still widespread and both ecologically and economically important
- A very broadly-defined community type with more or less distinct variants. Floral and faunal composition can vary significantly among examples and across landscapes in different ecological settings
- Provides habitat for many common and some rare species. Some notable rare species

examples are the Northern Goshawk, American marten, Black-throated Blue Warbler, and four-toed salamander
- Structure and species composition are greatly simplified from pre-European settlement conditions. Overall, forests are younger, and conifers such as hemlock and white pine are greatly reduced (see Indicator 2). Many historic mesic forests were replaced by aspen forests and now exhibit reduced structural and species diversity.
- Examples of current issues include: lack of older forest and associated structural attributes, intense deer herbivory, impacts of exotic earthworms, declining conifer component now lacking in many stands (particularly in smaller size classes), parcelization, and major threats from invasive plants.
- Major opportunities exist in some areas to develop old-growth forests at a landscape scale.

<u>Northern Wet-mesic Forest</u>
- Familiar "cedar swamps" of the north providing habitat for numerous plant and animal species
- One of a handful of forested peatland types in the state, they occur on richer, less acidic environments than the other forested peatlands and are often fed by nutrient-rich groundwater providing specialized habitats
- Cedar swamps are especially notable for the many rare plant species they support. Several rare plants occur most frequently in these communities, utilizing the numerous microhabitats present
- Although many examples have been logged, there are comparatively more old-growth or old examples of this type compared with most other forest communities. Many examples still retain a complex structure and mostly intact groundlayer and hydrology
- Examples of current issues: the future of these forests is uncertain as cedar regeneration is almost non-existent in most cases. Deer browse can be extremely heavy as deer often "yard" in these swamps, invasives such as glossy buckthorn and Eurasian swamp thistle are a significant threat in many areas, and fragmentation can greatly diminish ecosystem function. Maintaining hydrology is critical to maintaining this community.

<u>Southern Forests</u>

The forests of the southern half of the state differ in many ways from their northern counterparts. Conifers, although locally abundant in certain community types, play a much smaller role in the south. Oaks are currently widespread, and a number of other deciduous trees found here are rare north of the Tension Zone. Species composition is shifting away from oaks, as oak regeneration on all but the more xeric sites has proven quite difficult.

In general, southern forests have experienced more dramatic changes following European settlement than the forests of the north due to the effects of human disturbances such as land conversion to agriculture, fragmentation, and persistent grazing. Many southern forests were former savanna communities that succeeded to forests through many decades of fire suppression. Lack of fire impacted many otherwise intact dry and dry-mesic oak forests, as well. Rich mesic forests were often converted to agriculture, and most remaining examples are small patches in highly fragmented areas. Old-growth forests, while very rare in the north are almost completely absent in the south. Similarly, invasive species, while a threat in many parts of the north, are quite widespread in much of the south and can be extremely difficult to control and virtually impossible to eradicate.

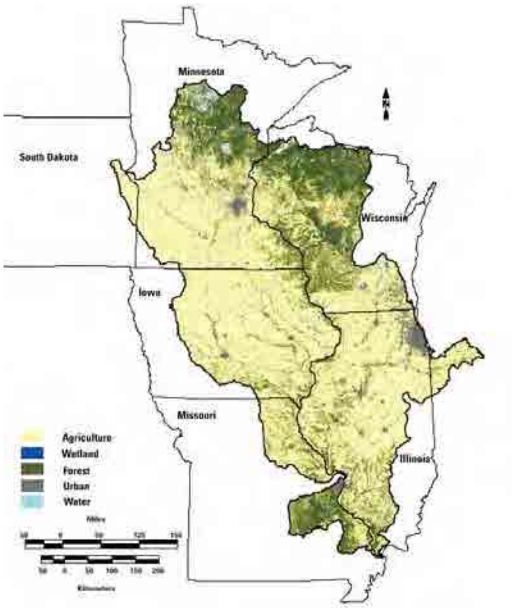


Figure 4.a: Forest cover of the Upper Mississippi watershed
Source: DNR, 2009

Public lands are much less abundant in the southern half of the state, with the exception of the Central Sand Plains Ecological Landscape, and many of the heavily forested areas are comprised of smaller landholdings than those found in the north with several notable exceptions such as the Black River State Forest, the Kettle Moraine State Forest, the Kickapoo Valley Reserve, and the Lower Wisconsin State Riverway. These properties provide essential habitat for a large suite of plant and animal species and will become increasingly important for maintaining biological diversity as future ecological impacts continue to decrease other opportunities in much of the south.

Many generalist species such as white-tailed deer, Brown-headed Cowbird, raccoon, and Wild Turkey have thrived in the modern landscape of southern Wisconsin which is now composed of a mosaic of agricultural lands, forest fragments, and urban-industrial areas. Most of the large herbivores (bison, elk) and carnivores (gray wolf, cougar) are gone. Some area-sensitive birds successfully reproduce, and can even be locally abundant in parts of southern Wisconsin, but others have shown population declines. As with the northern forests, many rare plants and animals utilize specific microsites within the forest, such as cliffs, seeps, and springs.

Despite numerous ecological perturbations, southern Wisconsin forests are important for the state’s biodiversity and provide habitat largely absent from much of the surrounding areas in adjacent states or from most other areas in southern Wisconsin. For example, a large portion of the “Driftless Area” forests occur in Wisconsin and harbor numerous rare birds and many other species. For southern forest types, this area offers one of the best opportunities in the Upper Midwest for conserving forest interior habitats (Wilson 2008). Figure 4.a illustrates the forest cover of the Upper Mississippi Watershed, highlighting the importance of the forests in

Wisconsin's "Driftless Area" in a landscape that is largely dominated by agriculture. Table 4.b summarizes the natural community types identified by NHI for the Northern Forest group.

Table 4.b: Southern forest community types recognized by the Wisconsin Natural Heritage Inventory (NHI) program

	State Rank	Global Rank	Related Forest Habitat Types
Upland Forests			
Central Sands Pine-Oak Forest	S3	G3	PEu; PVCr; PVG; PVGy; PVHa; PVRh
Hemlock Relict	S2	G2Q	ATTr
Pine Relict	S2	G4	PVCr; PVGy; PVHa
Southern Dry Forest	S3	G4	PEu; PVCr; PVG; PVGy; PVHa; PVRh
Southern Dry-mesic Forest	S3	G4	AArL; AArVb; AFrDe(Vb); AQVb-Gr; ArCi; ArCi-Ph; ArDe; ArDe-V; ATiAs(De); ATiCr(As); ATiCr(O); ATiDe; ATiDe(Pr); ATiDe-As; ATiFrCa(O); ATiFrCi; ATiFrVb; ATiFrVb(Cr); ATiH; ATiSa
Southern Mesic Forest	S3	G3?	ACaCi; AFAs; AFAs-O; AFH; AFrDe; AFrDeO; ATiAs(De); ATiCa; ATiCa-Al; ATiCa-La; ATiDe; ATiFrCa; ATiFrCa(O); ATiFrVb; ATiH; ATiSa; ATiSa-De
Wetland Forests			
Floodplain Forest	S3	G3?	n/a
Southern Hardwood Swamp	S2	G4?	n/a
Southern Tamarack Swamp (Rich)	S3	G3	n/a
White Pine-Red Maple Swamp	S2	G3G4	PArVRh; PVRh
See the NHI Working List (*dnr.wi.gov/org/land/er/wlist/*) for more information about state and global ranks.			

The following examples highlight two of Wisconsin's southern forest communities. See the Wisconsin DNR Web for more information about each of the forested community types (*dnr.wi.gov/org/land/er/communities/*), including rare animals associated with each of the types and areas of the state with the best opportunities to maintain them.

<u>Southern Dry-mesic Forest</u>

- Oak forests, most often dominated by red and white oak with numerous tree associates and historically common. This continues to be one of the more common

forest types in the south.
- Provides important habitat for numerous rare species including forest interior birds such as Cerulean Warbler, Acadian Flycatcher, and Hooded Warbler, all State Threatened species
- Species composition is shifting away from oaks and toward more shade-tolerant deciduous species such as sugar maple, red maple, and the "central hardwood" species. Oaks are getting older on average, but are often lacking in both the smallest and largest size classes.
- Examples of current issues: lack of large contiguous blocks, increased fragmentation, oak regeneration is very difficult on most sites, deer herbivory impacts are high, high-grading often accelerates shift in species composition, invasive species threats include potential impacts from gypsy moths, as well as from many already established invasive plants.
- Select areas may still provide opportunities for landscape-scale planning and large-scale management

Floodplain Forest
- Wetland forests occurring most commonly along major river systems; most of the large examples are south of the Tension Zone. This type has never been widespread due to the specialized conditions needed to create and maintain it. Relative to upland types, a higher proportion of these forests have persisted to modern times but species composition changed including the loss of mature American elm trees.
- A regionally important community; some of the best and most extensive examples in the Upper Midwest occur in Wisconsin.
- Provides habitat for many rare species, including the most SGCN of any forested community type (See Figure 4.b). Species utilizing Floodplain Forests include specialists such as Prothonotary Warbler. Other rare species can often be found here in high numbers including wood turtle and Red-shouldered Hawk (both state threatened).
- Examples of current issues: many of these forests are compromised by invasive plants, and regeneration can be difficult in part due to reed canary grass infestations. Hydrological alterations have had dramatic impacts, and future successional patterns in some areas are uncertain, as large dams influence both flood timing and magnitude. This community will likely be further impacted by exotic insects and diseases (Dutch elm disease, Emerald ash borer).

4.2 Forest Associated Species of Concern

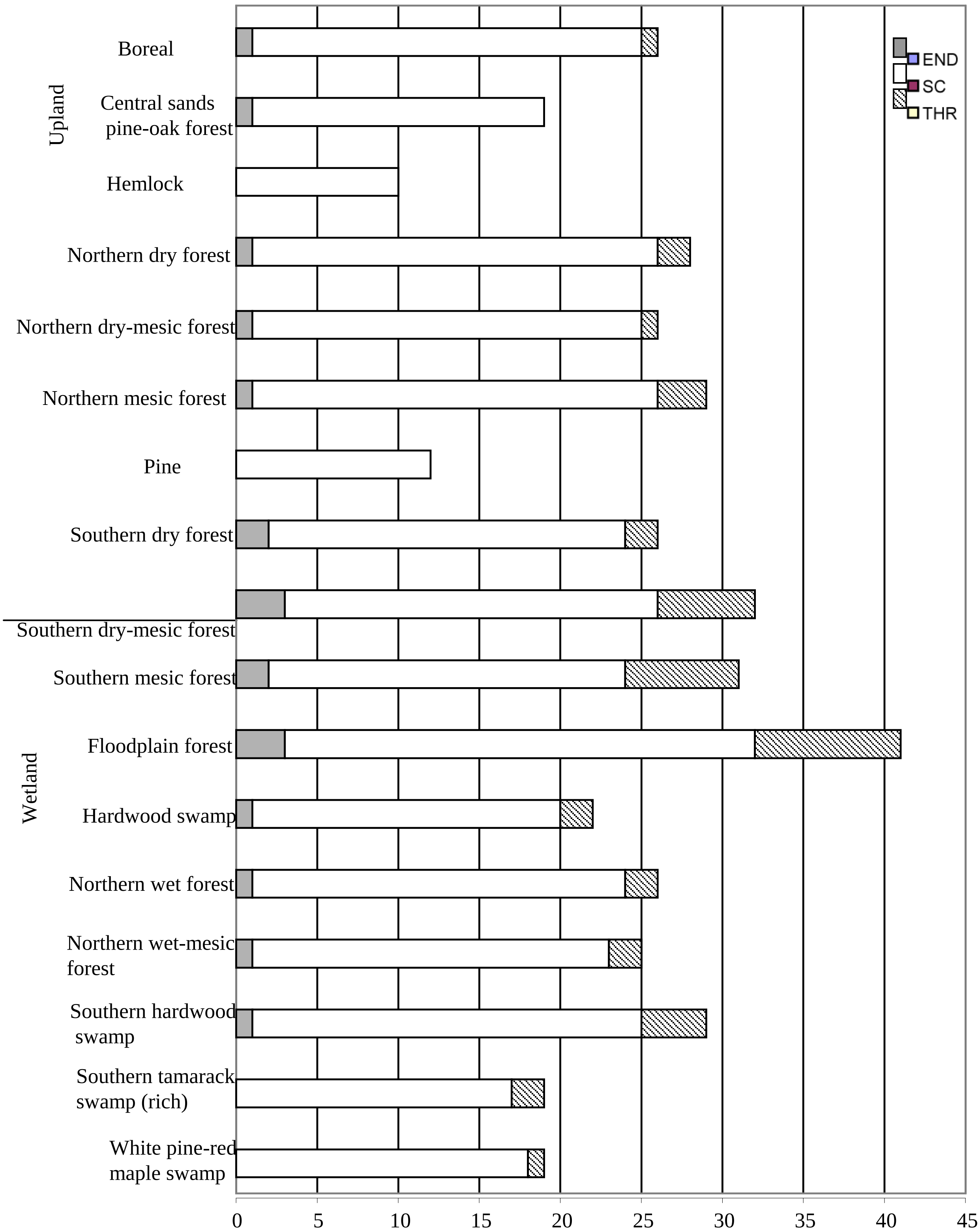
Wisconsin supports almost 700 species of vertebrates, well over 2000 native plant taxa, and tens of thousands of invertebrates, along with numerous lichens and non-vascular plant species. Although not all of these organisms use forested habitats, Wisconsin forests provide important, sometimes critical, habitat for many of them.

Rare plant and animal species, as described in this Indicator, are those found on the NHI Working List (*dnr.wi.gov/org/land/er/wlist/*). The Working List includes those species "listed" by state and/or federal laws as threatened or endangered, as well as "special concern" species that may be at risk of becoming threatened or endangered in the future. For animals, the Working List species closely correspond to the Species of Greatest Conservation Need (SGCN) described in the Wildlife Action Plan.

Wisconsin has 15 species that are federally threatened or endangered, and 3 species that are candidates for federal listing. State threatened or endangered species include 139 plants, 40 invertebrates, 25 birds, 21 fish, 10 herptiles, and one mammal. Some species have recovered sufficiently in Wisconsin to be removed from state and/or federal listing in recent years, including Bald Eagle, Osprey, Trumpeter Swan, and gray wolf. Others not yet listed as threatened or endangered have experienced substantial declines in numbers, either locally or across their ranges, and may require future protection; for animals, the Wisconsin Wildlife Action Plan is designed to outline steps to conserve these species before this happens.

The Wisconsin Wildlife Action Plan identifies 152 vertebrate and 530 invertebrate SGCN. Of these, 63 vertebrates are associated with the 17 forested community types described in the plan. All but two of the forested community types are used by at least 15 vertebrate SGCN, and some SGCN are limited to only a single forested community type. Of these forested communities, Floodplain Forests support the highest number of rare vertebrates, based on Wildlife Action Plan data. Over 40 vertebrate SGCN (11 of these state threatened or endangered) are known to be associated with Floodplain Forest habitats in Wisconsin. Figure 4.b illustrates the number of SGCN associated with each of Wisconsin's forested communities. Table 4.c shows individual vertebrate SGCN associated with each Wisconsin forested community. Natural community associations are not available for invertebrates at this time.

In general, there is a lack of detailed life history information for many rare species, so planning forest management activities to best conserve biodiversity can be a challenge. There is a need to develop this information, as the majority of the forested communities in the state are actively managed through timber harvest. The Wildlife Action Plan identifies 200 vertebrates and 420 invertebrates as "Species of Information Need," i.e., species lacking the basic inventory and/or life history information needed to determine their conservation needs in the state. For some species, life history and status information exists, but there is much uncertainty regarding the impacts of various management activities. This uncertainty is often compounded by local landscape factors, as management activities often focus on small areas, sometimes out of necessity, rather than considering the larger landscape. Finally, although they play integral roles in every community type and support many ecosystem-level biological processes, detailed information is particularly lacking for the invertebrates. Although some groups of invertebrates are better understood as a result of modern efforts, proper identification of others can be a challenge, and it may not even be possible to create a comprehensive species list for certain groups due to the paucity of information.



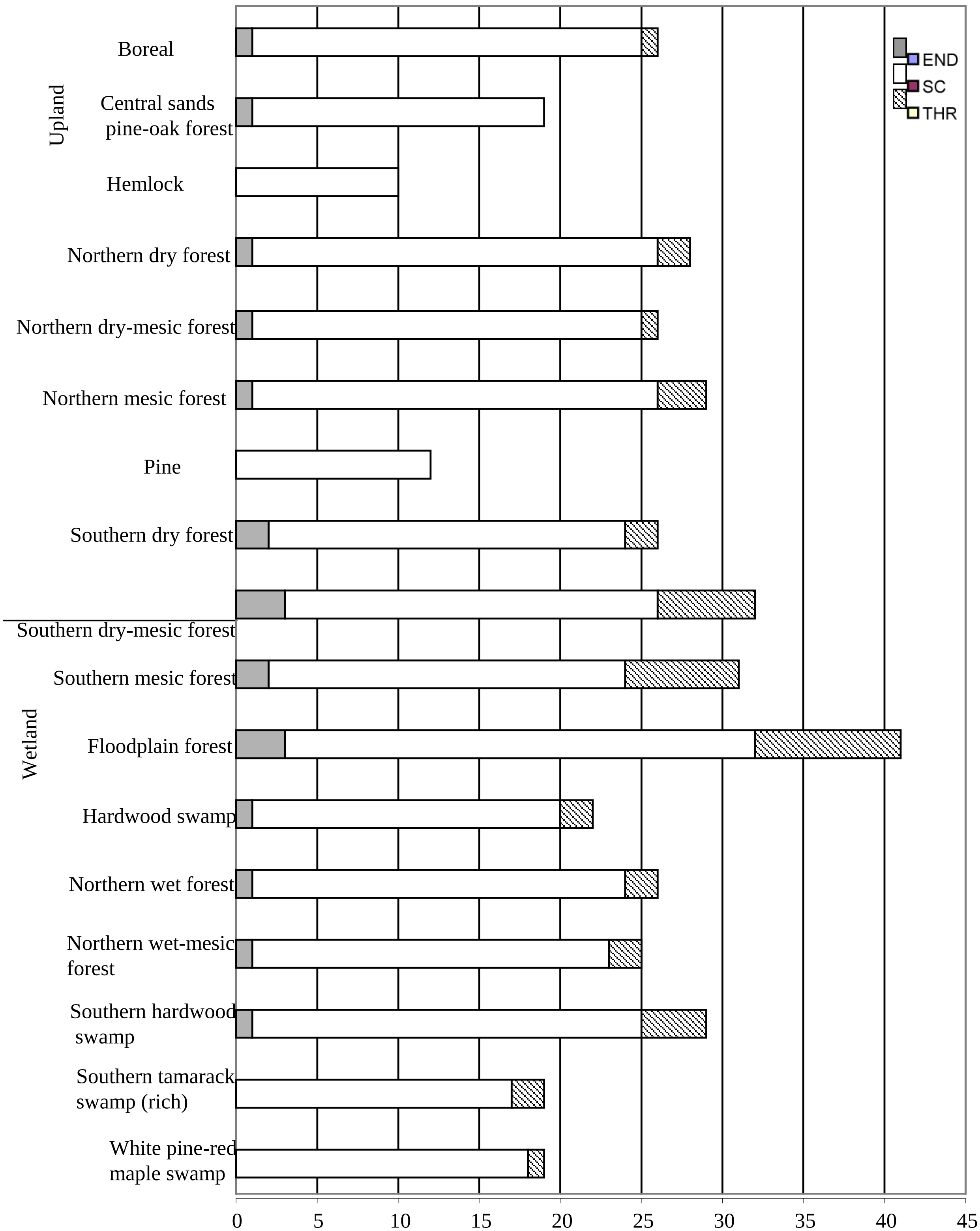


Figure 4.b: Numbers of Species of Greatest Conservation Need (SGCN) that are State Endangered, State Threatened, or Special Concern
Source: DNR, 2005

4. Status of forest communities and species of concern

Data are from the Wildlife Action Plan, and only the 17 forested natural communities included in the plan are shown, as some NHI communities were lumped together. Data may be incomplete for some uncommon relict types such as Hemlock Relict and Pine Relict. See *dnr.wi.gov/org/land/er/wwap* for more information.

Table 4.c: Vertebrate Species of Greatest Conservation Need (SGCN) associated with forested communities in Wisconsin

Numbers shown are degrees of association between each species and a particular community type (3=significant association, 2=moderate association, and 1=low association). Where no number is shown, a species is not known to use a particular community type.

	Upland Forests										Wetland Forests						
	Northern				Southern						Northern			Southern			
Common Name (State Status)*	Boreal forest	Northern dry forest	Northern dry-mesic forest	Northern mesic forest	Central sands pine-oak forest	Hemlock relict	Pine relict	Southern dry forest	Southern dry-mesic forest	Southern mesic forest	Hardwood swamp	Northern wet forest	Northern wet-mesic forest	Floodplain forest	Southern hardwood swamp	Southern tamarack swamp (rich)	White pine-red maple swamp
Acadian Flycatcher (THR)								1	3	3				2			
American Marten (END)	3	1	3	3							1	1	1	1			
American Woodcock (SC)	1	1	1	2	1			1			2	1	1	1	1	2	1
Bald Eagle (SC)														1			
Black Rat Snake (SC)							3	3	3	3				2	2		
Black-backed Woodpecker (SC)	2	2	1	1								3	1				
Black-billed Cuckoo (SC)	1	1	1	2							1	1		2	1	2	
Black-throated Blue Warbler (SC)	1		2	3													
Blanding's Turtle (THR)									2	2				2	2	2	
Blue-winged Teal (SC)														2	1		
Blue-winged Warbler (SC)		1			1			2	2	2				2	1	2	1
Boreal Chickadee (SC)	2											3	1				
Brown Thrasher (SC)		1															
Bullsnake (SC)					2		2	2	2	2							
Butler's Garter Snake (THR)														2			
Canada Warbler (SC)	3	1	2	2	1	2	2				3	2	3			1	2
Cerulean Warbler (THR)				1				1	3	2				3			
Connecticut Warbler (SC)	1	3	1									2					
Eastern Massasauga Rattlesnake (END) (and a federal candidate)														3	2		

Eastern Red Bat (SC)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2
Four-toed Salamander (SC)	2			3						3	2	2	3	3	3	2	
Golden-winged Warbler (SC)	1	2	2	2	1			1	1	1	2	2	1		1	1	1
Gray Wolf (SC)	3	2	3	3	3	1	1	2	2	2	2	3	3	2	1	1	1
Great Egret (THR)														2			
Hoary Bat (SC)	2	2	2	2	2	2	2	1	1	1	2	2	2	2	1	1	2
Hooded Warbler (THR)									3	3							
Kentucky Warbler (THR)									2	3				3			
Kirtland's Warbler (SC) (and Federally Endangered)		3															
Least Flycatcher (SC)	2	2	2	3	1			1	1	1	2		1	2	1		1
Louisiana Waterthrush (SC)									3	3							
Mink Frog (SC)	1			1							1	1	1				
Moose (SC)	3	1	1	2							3	2	3	2			
Northern Flying Squirrel (SC)	3	2	3	3	1	2	2	1	1	1	2	3	3	2	1	1	1
Northern Goshawk (SC)	2	1	2	3							1		1				2
Northern Long-eared Bat (SC)	1	2	2	2	2	2	1	2	2	2	2	1	1	2	2		2
Northern Prairie Skink (SC)		2	2					2	2								
Olive-sided Flycatcher (SC)	2	1	1									3	2				
Ornate Box Turtle (END)					3			3	3	2							
Pickerel Frog (SC)				2						2		2	2	2	2		
Prairie Ringneck Snake (SC)					2			2	2								
Prothonotary Warbler (SC)														3			
Red Crossbill (SC)	1	3	3	1	1	1	2					1					
Red-headed Woodpecker (SC)		1	1		2			2	2					2			
Red-shouldered Hawk (THR)		1	2	2					2	2	1		1	3	1	1	2
Rusty Blackbird (SC)														3	3	2	1
Silver-haired Bat (SC)	2	2	2	2	2	2		1	1	1	2	2	2	2	1	1	2
Solitary Sandpiper (SC)														3	1		
Spruce Grouse (THR)	2	2										3					
Timber Rattlesnake (SC)							3	3	3	3				2	2		
Veery (SC)	3	1	2	2		2	2		2	2	3	2	1	2	1	1	3
Water Shrew (SC)	3			2						2	3	3	3	2	2	1	1
Western Worm Snake (SC)								2	2								
Whip-poor-will (SC)		2	2	1	3	1	2	3	3	1				1			
Willow Flycatcher (SC)														1	1	1	
Wood Thrush (SC)			1	2	1			2	3	3	1	1	1	2	1	1	1
Wood Turtle (THR)				3						2	2	2	2	3	2		
Woodland Jumping Mouse (SC)	2	1	1	3						2	2	2	2	2	2		1
Woodland Vole (SC)					2			3	3	1				1			
Worm-eating Warbler (END)								2	3	2							
Yellow-bellied Racer (SC)								2	2								

Yellow-billed Cuckoo (SC)				1				1	2	2				3	2	1	1
Yellow-crowned Night-Heron (THR)														3	2		
Yellow-throated Warbler (END)									2					3			

* END = State Endangered, THR = State Threatened, SC = special concern. Note that some special concern species are protected by other state and federal laws. See the NHI Working List (*dnr.wi.gov/org/land/er/wlist/*) for more information. Data are from the Wildlife Action Plan - see *dnr.wi.gov/org/land/er/wwap*.

4.3 Bird Populations

This section uses a selection of common or uncommon forest birds as indicators of broad-scale habitat changes in northern and southern forest ecosystems of Wisconsin. Birds were selected that have a narrow niche breadth relative to different forest habitats and were common enough to generate population trends at the state level. Note that these aren't necessarily the most abundant birds in that habitat type, but rather, the majority of their breeding habitat was contained in a specific forest habitat type. Forest bird information was gathered from sources cited in the Wisconsin All-bird Plan species accounts for each individual species and was largely dependent on data gathered from the Federal Breeding Bird Survey.

Using forest breeding birds as indicators requires a number of assumptions about their populations and the impacts of forest change. These assumptions include: (1) Changes in forest types and amounts on a coarse scale will result in changes in forest breeding bird populations (2) changes in bird populations are due principally to the amount of breeding habitat acreage and not to changes in migratory stopover or wintering ground habitat and (3) coarse scale forest acreages are more important than site-level habitat quality factors or landscape structure, quantified by metrics like patch size distribution, area of edge, etc. These are all very tenuous assumptions and the information presented here should be used cautiously. Surprisingly, despite the wealth of bird survey information over many different forested areas in Wisconsin, there is a lack of coordinated information relating bird species abundances to different forest habitats or cover types.

Future revisions to this assessment process would be greatly assisted through additional monitoring efforts suggested in the text below. In addition, efforts to better correlate bird counts to a common forest habitat "language" would offer additional insights on forest bird habitat selection and value as forest indicators.

<u>Statewide Trends in Forest Birds</u>

In general, forest birds increased in Wisconsin over the last 40 years based on Federal Breeding Bird Survey data. This is especially true for birds that nest in middle-aged to older forests and for the wide range of conifer-dependent species. There are exceptions, including some birds that are associated with a declining habitat type (i.e. Connecticut Warbler - Jack Pine) or are sensitive to forest fragmentation (i.e. Least Flycatcher). The status of some of our rare, forest obligate species like Red-shouldered Hawk, Cerulean Warbler, Northern Goshawk, and Spruce Grouse is not precisely known. Data on these species exists at a statewide scale, but finer scale data is often unavailable. Efforts are underway to gather more data. This result is expected as forested acreage increased in Wisconsin and the average age of conifers and forests increased over the last half of the last century. There are still forest birds that are declining and are of high concern, but there is no apparent pattern based on habitat type that can explain these declines. Reasons for these declines are not always well understood but may be related to any of the following:

- *Gross habitat changes* – Large-scale loss of habitat quality through conversion, succession, or fragmentation. Examples include Connecticut Warbler declines and the loss of jack pine acreage.
- *Loss of habitat on non-breeding habitat* – The vast majority of Wisconsin's forest birds migrate to areas south of the United States during the non-breeding season. Land use changes and habitat conversion place them under stress during those periods.
- *Lowered survival rates during migration* – many long-distance migrants are under increasing stress from a loss of migratory stopover habitat or increased mortality risk from tall towers or windows. Changes in adult survival rates are especially detrimental to this group of birds.

Maple-Beech-Birch: Overall, birds that use the generalized maple-hardwood-hemlock forest types are stable or increasing (Figure 4.c). The one exception is Least Flycatcher. This species is declining range-wide but less rapidly than it is in Wisconsin and the other Western Great Lakes states. It appears to be sensitive to fragmentation from temporary or permanent creation of hard edges. Future iterations of this assessment could include some measure of fragmentation at various spatial scales. Blackburnian Warbler was included as it is very abundant in hardwoods stands that retain hemlock. Red-shouldered Hawk is not well monitored at a statewide level, but offers a species that would track older hardwood forests as a monitoring program is established into the future.

Black-throated Blue Warblers offer a species that might serve as a valuable ecological indicator for this forest type over the life of the assessment and an appropriate conservation target. This species prefers mature hardwood forests with a strong shrub understory. This species should respond positively to efforts to move the resource base to an un-even aged or more structurally complex forest stand. The slow increase in Black-throated Blue Warbler populations since the early 1980's probably generally reflects the recovery of this forest type from the Cutover over a century ago across the western Great Lakes.

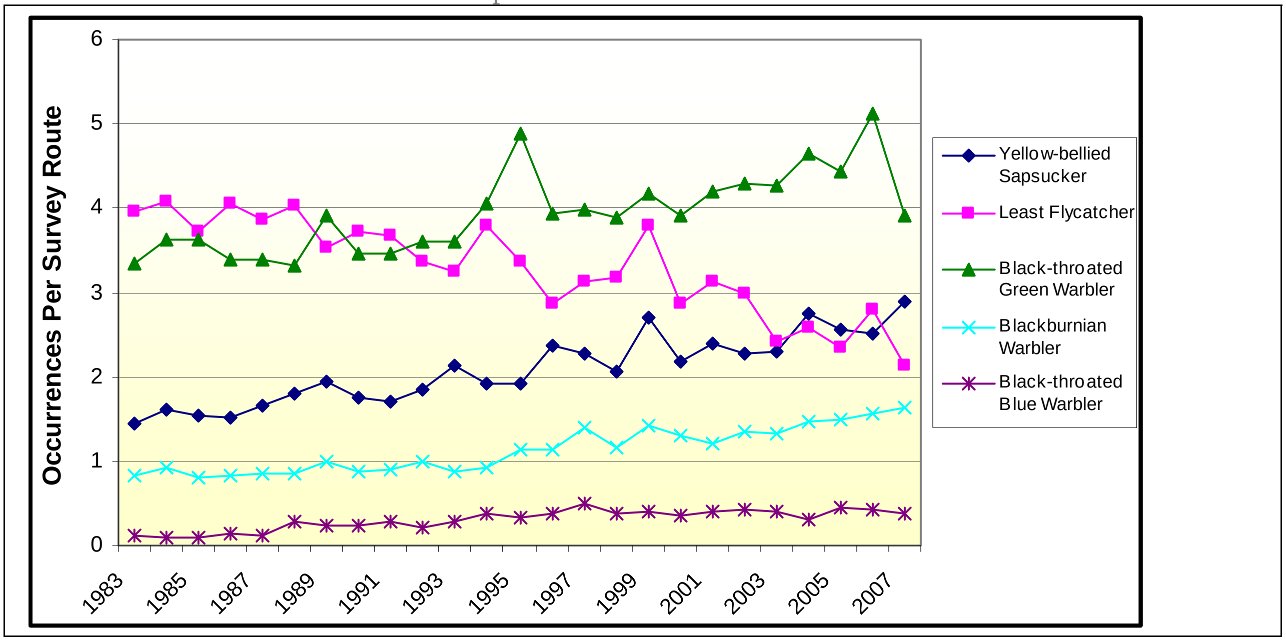


Figure 4.c: Population trends of birds associated with northern hardwood forests (1983-2007)

Source: Sauer, Hines, Fallon, 2008

Oak-Hickory: Bird species that utilize young oak/hickory forests show a mixed set of population trends (Figure 4.d). Brown Thrasher and other grass-shrub birds that prefer open oak barrens, shrub rows in agricultural landscapes or scattered shrubs within a grassy matrix are all declining. This is consistent with land use trends away from hedgerows in agricultural landscapes, forest succession, and a lack of forest management on the drier oak types in sandy northern forest landscapes which is allowing stands to age and reducing the amount of early successional habitat.

Eastern Towhee, Blue-winged Warbler and other forest edge/shrub birds are increasing or remaining relatively stable over time. It remains to be seen if this trend will hold as these forests age or succeed to other types.

Bird species that utilize more mature oak/hickory forests are stable or increasing during the forest assessment time period (Figure 4.e). Cavity nesters such as White-breasted Nuthatch and forest canopy breeders like Scarlet Tanager and Yellow-throated Vireo are stable or increasing over this time period. Many species that use older, structurally complex oak-hickory forests are not well monitored by the Federal Breeding Bird Survey in Wisconsin due to their limited distribution south of the tension zone. These include Cerulean Warbler, Kentucky Warbler, Hooded Warbler, Acadian Flycatcher and other high priority species. Forests south of the Tension Zone are heavily impacted by fragmentation and resulting edge effects. Future assessments would benefit from a monitoring program that targets existing and potential habitat for this suite of forest birds.

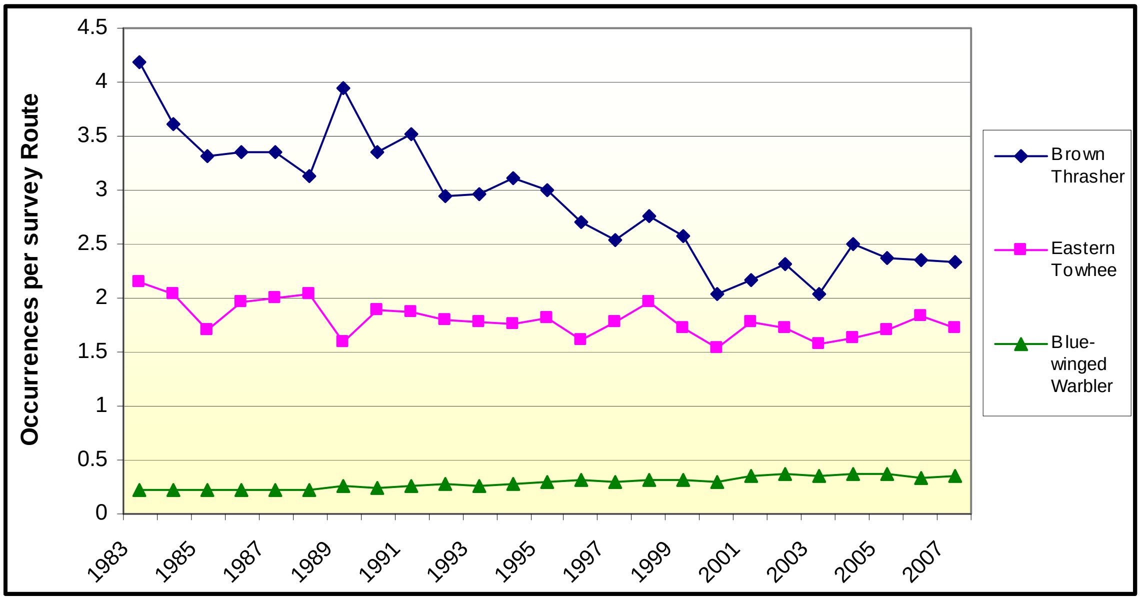


Figure 4.d: Population trends associated with early successional oak/hickory forests (1983-2007).
Source: Sauer, Hines, Fallon, 2008

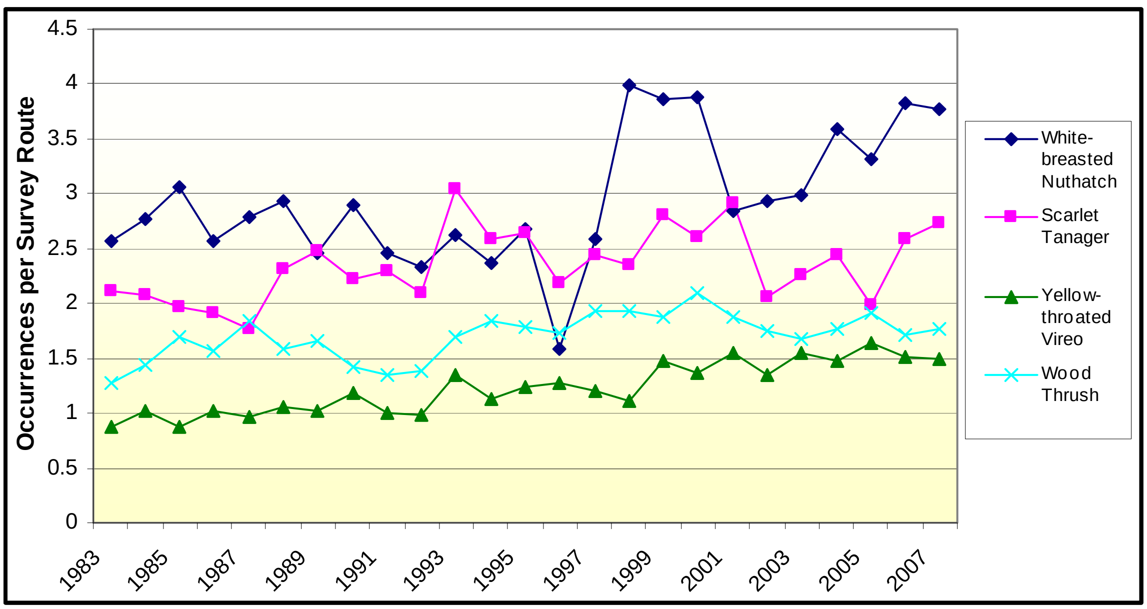


Figure 4.e: Population trends of bird species associated with mature oak/hickory forests (1983-2007)
Source: Sauer, Hines, Fallon, 2008

<u>Aspen-Birch:</u> Golden-winged Warbler, Chestnut-sided Warbler, Mourning Warbler and other early successional birds experienced a peak in the mid 1990's and have since declined (Figure 4.f). This is consistent with declines in the amount of young, high stem-density aspen forests over the same time period. These species also utilize shrub wetlands and other early seral deciduous habitats, but the changes in aspen-birch forests will probably be the primary influence on their populations over the short-term.

Species that utilize older aspen forests including those with higher amounts of conifer inclusions have increased since the early 1980's (Figure 4.g). These species also utilize other deciduous forest types and are less sensitive to changes in the amount of older aspen-birch than the species listed above. Maintaining conifer within aspen-birch stands appears to have positively impacted Black-throated Green Warbler and many of the other spruce-fir birds graphed in Figure 4.g.

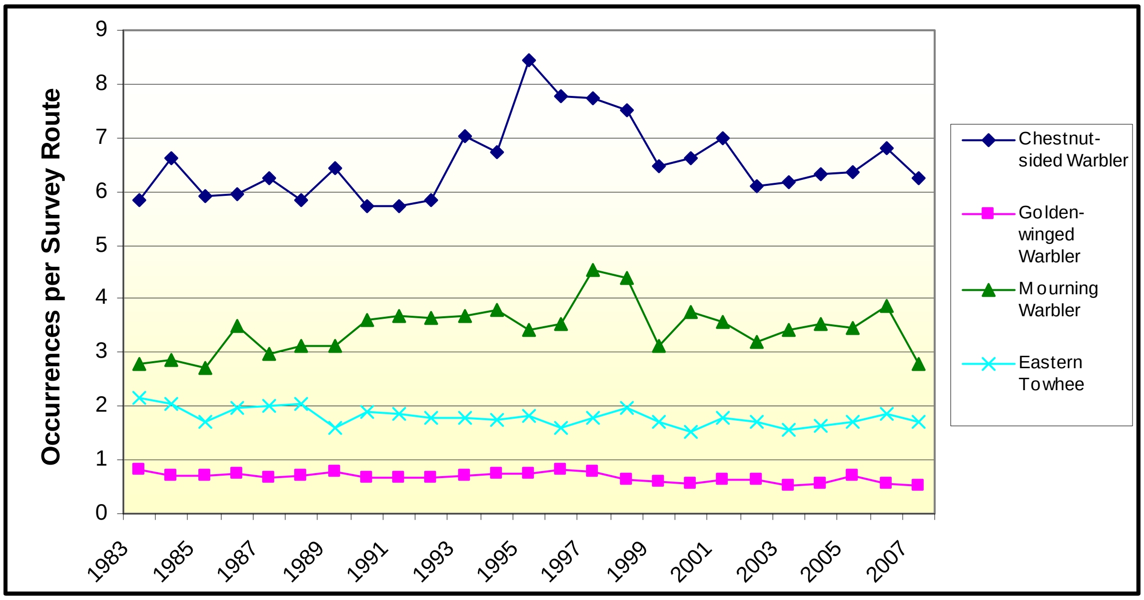


Figure 4.f: Population trends of bird species associated with early seral aspen-birch forests (1983-2007)
Source: Sauer, Hines, Fallon, 2008

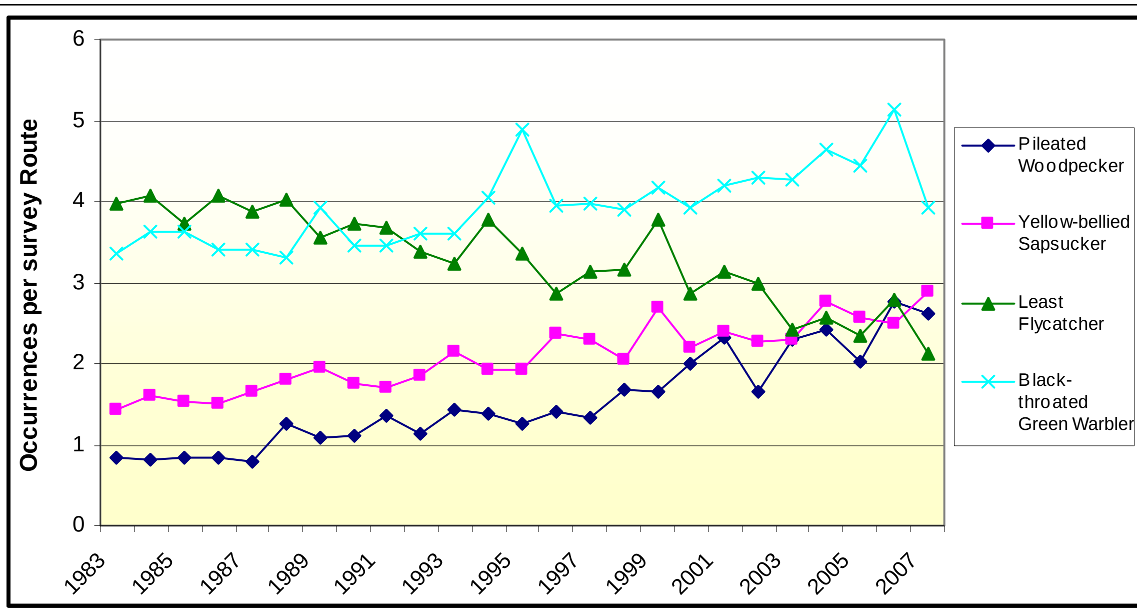


Figure 4.g: Population trends of bird species associated with older aspen-birch forests (1983-2007)
Source: Sauer, Hines, Fallon, 2008

Pine (white, red, jack): The jack pine cover type declined substantially in Wisconsin over the past 50 years. Bird species that utilize the early seral stages of this cover type have also declined including Brown Thrasher and Vesper Sparrow (Figure 4.h). This cover type is very important for Jack Pine specialists like Kirtland's Warbler and Connecticut Warbler and for the suite of species that prefer open barrens including Sharp-tailed Grouse, Vesper Sparrow, Clay-colored Sparrow and Upland Sandpiper.
In contrast to the early seral jack pine species, bird species that utilize mature coniferous forests have increased rapidly in response to large-scale pine plantings and conifer regeneration since the Cutover. This is most easily seen by looking at the population trend of Pine Warbler (Figure 4.i). Pine Warblers nest in the canopy of mature pines. Since 1983 this species has increased by 8%/yr and is one of the fastest increasing species in Wisconsin. In contrast, Connecticut Warblers have declined rapidly due to their preference for older Jack Pine forests. Canada Warblers and other forest gap specialists have remained stable or are increasing due to the aging of many of these pine forests allowing more light to penetrate the canopy and subsequent understory development. These species will all benefit from management that allows for more complexity in pine plantations or mimics disturbance patterns in natural stands.

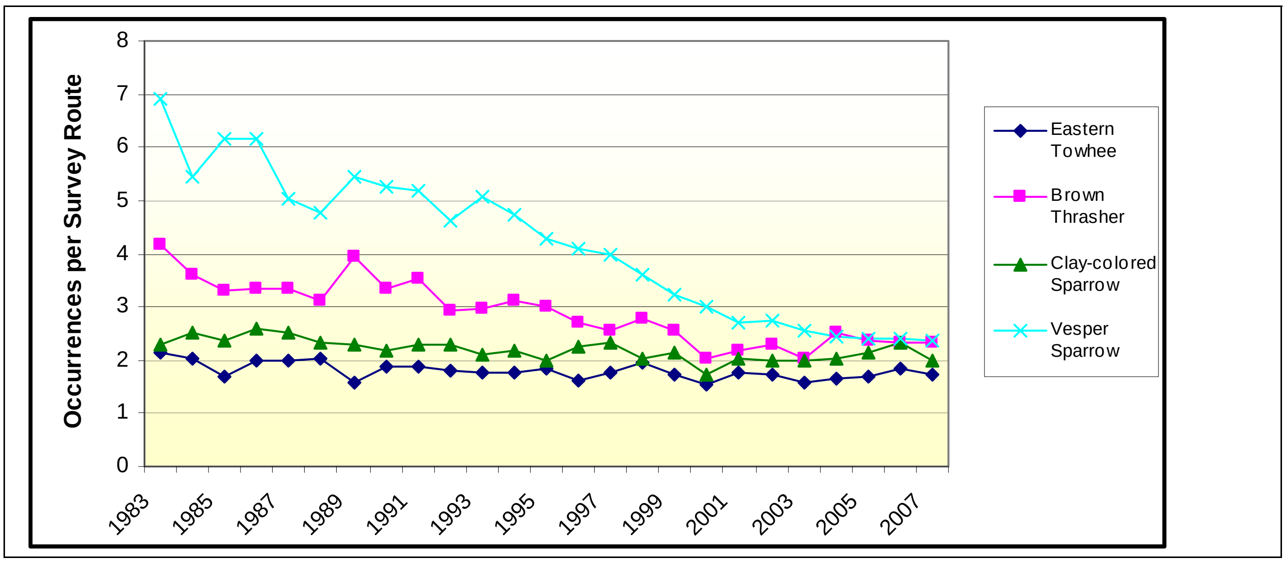


Figure 4.h: Population trends of bird species associated with young pine forests (1983-2007)
Source: Sauer, Hines, Fallon, 2008

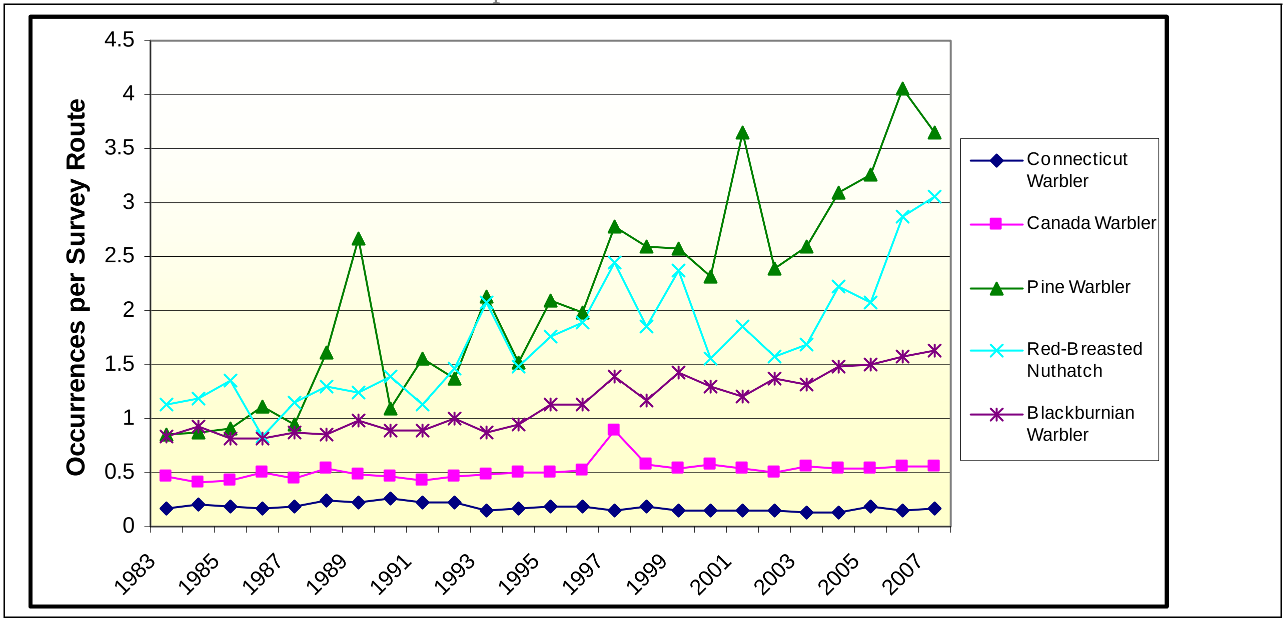


Figure 4.i: Population trends of bird species associated with older pine forests (1983-2007)
Source: Sauer, Hines, Fallon, 2008

Elm-Ash-Cottonwood: This class was split into a floodplain forest (bottomland hardwoods) type and a northern ash swamp type. Both of these communities have distinctive bird communities. Because both types are wetlands, road-based breeding bird surveys do not monitor bird species dependent on this type well overall.

Black ash swamps, or hardwood swamps, have a distinctive bird community but few birds that specialize in this type (Figure 4.j). Species listed (Veery, Canada Warbler, Black-and-white Warbler) are abundant in ash swamps but also are found in a number of other habitat types that might regulate their overall population trend. Birds that nest in this type are attracted to multi-layered forests with significant wetness. Species in this type are largely stable with the exception of Veery. The Veery prefers wet forests with high stem densities and the general trend across this type and the aspen-birch type for older forests would likely explain some of these declines. It's not clear how the emerald ash borer invasion will impact birds in this habitat type over the long-term. It may be necessary to set up wetland forest bird surveys to augment the lack of data from the Federal Breeding Bird Survey.

The floodplain forest birds are not well monitored by the Federal BBS. In order to properly use this indicator a monitoring program should be established specific to this habitat type. There are a number of birds that are restricted to this habitat type or are most abundant in this type. These include Prothonotary Warbler, Red-shouldered Hawk, Cerulean Warbler, Yellow-crowned Night Heron and others. Since these species are not well monitored and most are species of greatest conservation need (SGCN) in the Wisconsin Widlife Action Plan (WAP) a habitat-based monitoring program that evaluates the status of these species relative to short-term and long-term habitat change is warranted.

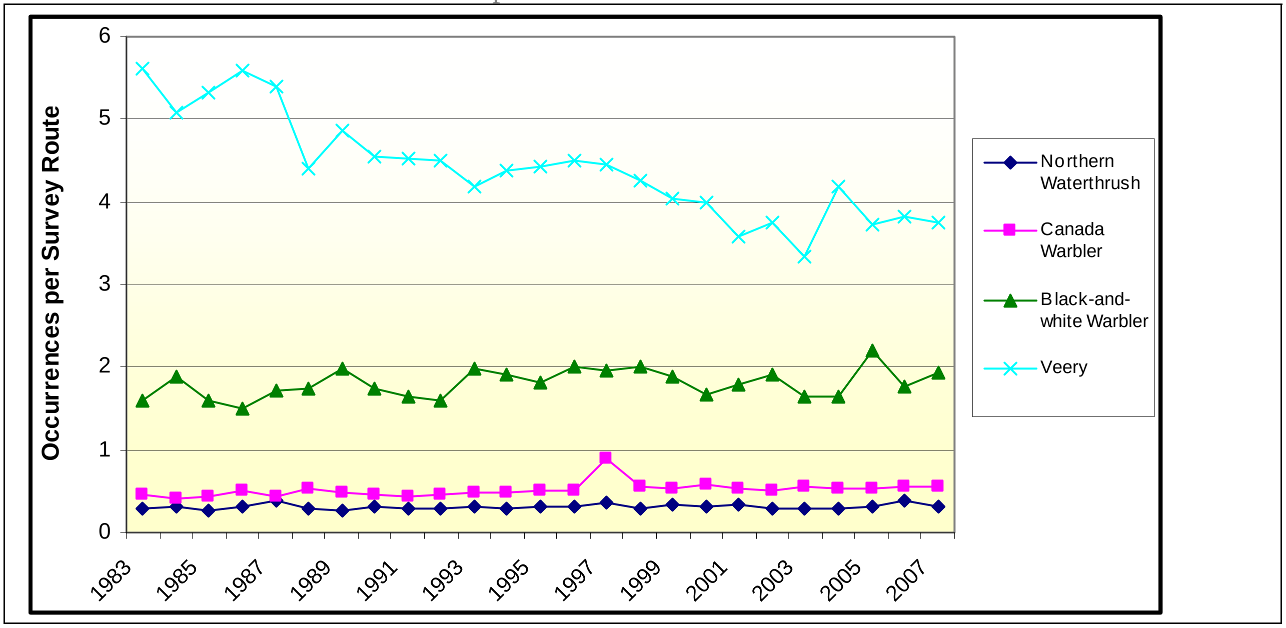


Figure 4.j: Population trends of bird species associated with northern hardwood swamps (1983-2007)
Source: Sauer, Hines, Fallon, 2008

Spruce-Fir: For the purposes of this indicator, the spruce/fir forest type was split into lowland and upland ecological groups. Upland white spruce-fir forests and lowland swamp conifer stands contain a number of conifer dependent birds that add a substantial amount of diversity to Wisconsin's avifauna. Picking indicator species for the type is somewhat difficult due to the road-based surveys not sampling wetlands and the general rarity of many of these species due to edge-of-range issues. Other characteristic species like Black-backed Woodpecker, Gray Jay, and Spruce Grouse are early breeders and should be incorporated into an indicator in the long-term due to their non-migratory status and use of the system as a whole.

Lowland coniferous forests contain a distinctive "boreal" assemblage of bird species. Most of these species are at the southern edge of their range in the Western Great Lakes. This type has probably been the least impacted by wide-scale timber management or conversion and has probably served as refugia for many species of conifer dependent birds. The Federal Breeding Bird Survey does not monitor many of these species well enough to say much about the long-term status of these species. Some, like the Yellow-bellied Flycatcher and Blue-headed Vireo appear to be more abundant today than they were in the early 1980's (Figure 4.k). Others, like the Ruby-crowned Kinglet and Olive-sided Flycatcher, have declined significantly despite no apparent gross habitat changes within the past few decades. This forest type would be a good candidate for a habitat-based bird monitoring program that generates status and trends for many under sampled species as well as providing information on these species response to management and climate change.

Upland spruce-fir forests are similar to lowland coniferous forests in that they have a unique assemblage of largely boreal birds. These include Cape May Warbler, Golden-crowned Kinglet, Magnolia Warbler and others. Many of these species are at the edge of their range in Wisconsin and are not well monitored as a group due to species rarity. However; based on available data

(Figure 4.l) many of these species are increasing as these forests age and become more structurally complex. Since many of these older spruce-fir forests are the result of deliberate planting, it's unclear if this trend will continue. In addition, these forests may be under pressure from climate change over the coming decades. This group of birds would offer good candidates for evaluating the impacts of climate change on Wisconsin's avifauna.

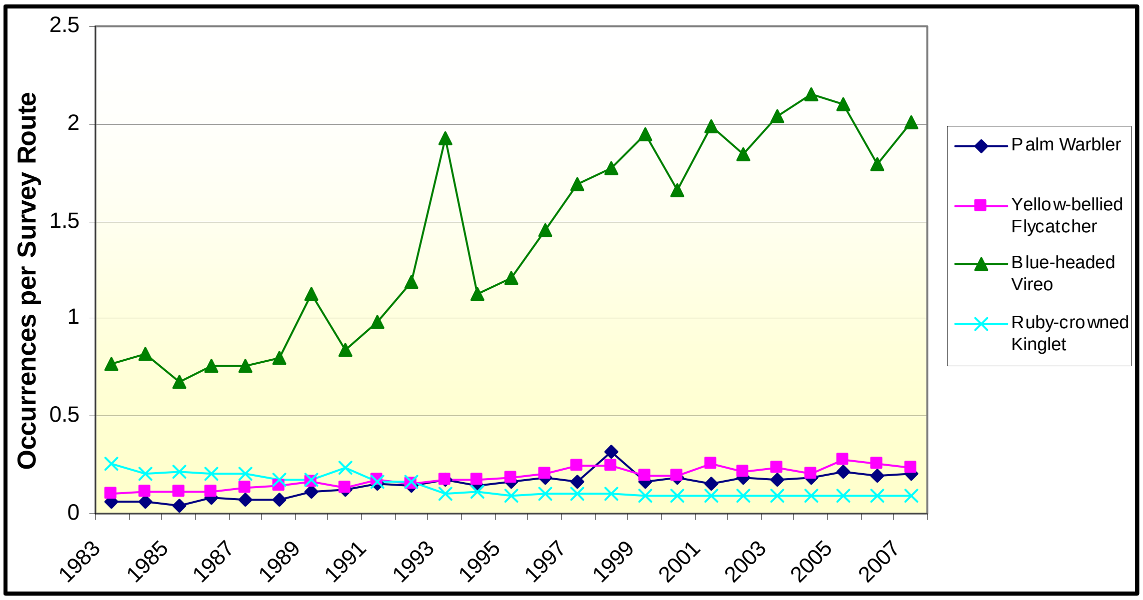


Figure 4.k: Population trends of bird species associated with lowland coniferous forests (1983-2007)
Source: Sauer, Hines, Fallon, 2008

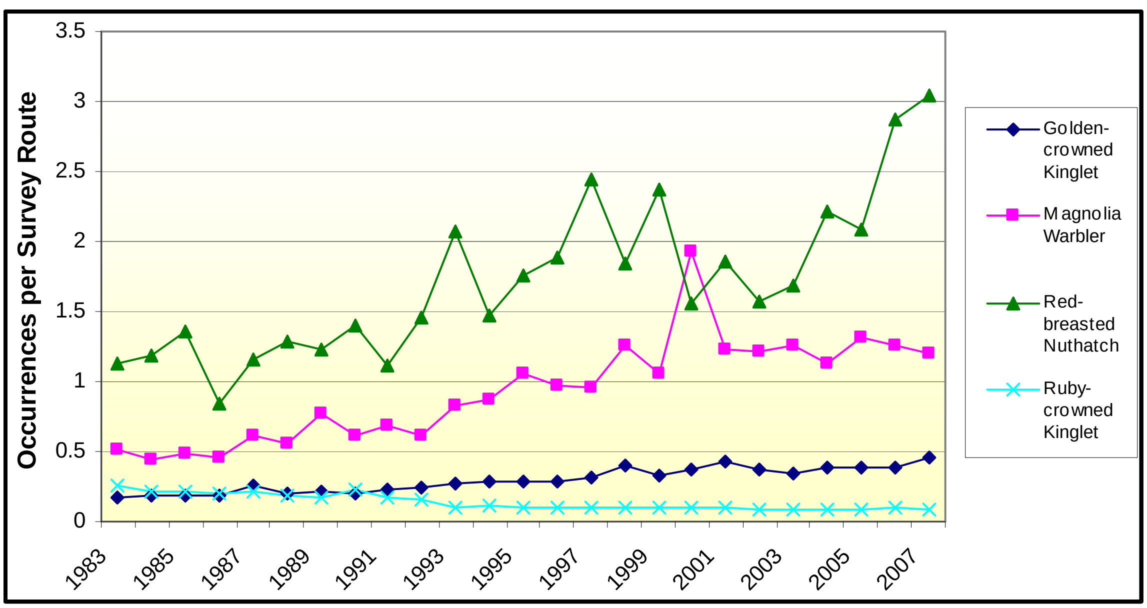


Figure 4.l: Population trends of bird species associated with upland spruce-fir forests (1983-2007)
Source: Sauer, Hines, Fallon, 2008

Based on Federal Breeding Bird Survey data, most forest birds have been stable or increasing in Wisconsin during the last 40 years. This is especially true for birds that nest in mid- to older-aged forests and for conifer-dependent species. However, it is difficult to link population changes to specific types of forest management, or to determine whether birds are responding to forest changes or some other factor.

Species utilizing deciduous and mixed-deciduous forests were stable or increasing over the 40 years reported, except for Least Flycatcher. Birds associated with younger oak-hickory forests showed mixed trends, while those associated with older oak forests were stable or increasing. Birds which utilize early-seral aspen exhibited population peaks in the 1990's, and have since returned to levels similar to the 1980s, except for Golden-winged Warbler which has gradually declined over the 40 year time period. Species of older aspen forests have increased, although this may not be due to changes in the aspen forest. An increase in the conifer component of aspen forests appears to have positively impacted Black-throated Green Warbler. Bird species associated with young jack pine have followed the decreasing trend of the extent of these forests, while those associated with older conifer forests have increased, apparently due to the widespread planting and recovery of conifers since the Cutover. Trends for birds of lowland forests, both deciduous and conifer are poorly estimated by existing surveys.

4.4 Mammal Populations

In general, data that directly address Indicator 4 and Metric 4.4 are lacking. Forest associated mammal population monitoring and knowledge concerning responses to habitat changes are limited. Population monitoring and research that links species population changes directly to changes in forest composition and structure are needed.

The forest associated mammal species included here—American marten, fisher, bobcat, wolf, and deer—do have relatively consistent, long-term, statewide population data, and habitat preferences are relatively well understood. However, many different factors can cause animal populations to fluctuate, and it is difficult to directly link population change with specific changes in forest habitat (cause and effect). These five species are top-level carnivores and/or keystone species; they can strongly influence the composition, structure, and function of their communities and habitats. Their populations and habits influence the populations and habits of many other species. Their population status and trends can indicate habitat suitability for a range of associated species, and thus provide a surrogate measure of some components of biological diversity supported by Wisconsin's forests.

American (Pine) Marten

In northern Wisconsin forests, American marten were abundant prior to Euro-American settlement. The species was extirpated from Wisconsin by the 1920's, due to loss of habitat and unregulated harvest. Marten were reintroduced into the Nicolet National Forest from 1975-1983 (N = 172 animals), and the Chequamegon National Forest from 1987-1990 (N = 139 animals). Subsequent estimates for the Nicolet population were approximately 100-150 animals in 1985 and 221 (160-280) animals in 2005. No population estimate has occurred for the Chequamegon population. Current marten distribution in Wisconsin (Figure 4.m) includes much of the original reintroduction areas (called marten restoration areas) along with portions of central Iron and western Douglas Counties. Currently, American marten are rare and their persistence is tenuous.

Two major issues that may be limiting the viability of American marten are competition from fisher and habitat suitability. Where snow depth is not limiting, fisher may outcompete marten through occupation of habitat (food and space) and direct predation. Marten are probably associated with forest landscapes containing mature forests that are structurally complex; important habitat features include: closed canopy, conifer dominated forest or hardwood forest with patches of conifers, coniferous understory, cavity trees greater than 22 inches dbh, large coarse woody debris, fine woody debris piles, and abundant prey (small mammals). These habitat features, occurring in concert, are uncommon in northern Wisconsin.

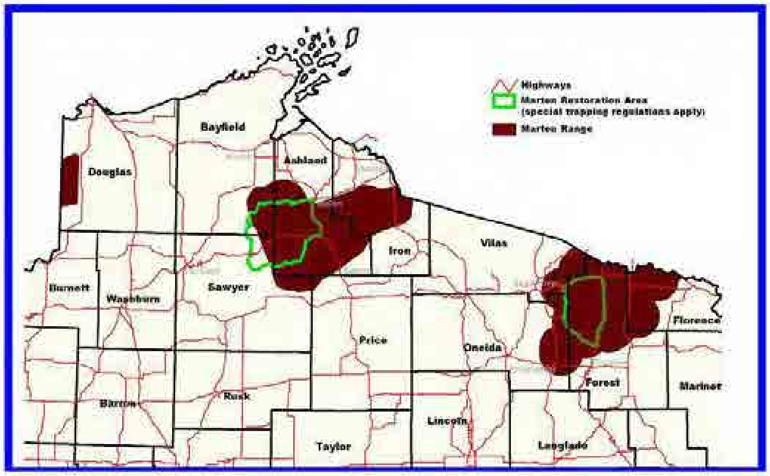


Figure 4.m: American marten distribution in Wisconsin, 2008
Source: DNR, 2008

Fisher
In Wisconsin, fisher mostly live in heavily forested northern and central regions, preferring large areas of contiguous forest cover. Dense, mostly mature forests comprised of interspersed patches of conifers, hardwoods, uplands, and lowlands can provide a diversity of resources and high quality habitat. The inclusion of dense mature conifer patches provides a preferred habitat element. Well developed structural characteristics improve habitat quality; large diameter cavity trees, snags, and coarse woody debris are important habitat elements. Maternity dens are usually located in large cavity trees and snags (mostly hardwoods). Den sites and temporary shelters include cavity trees, snags, coarse woody debris (e.g. hollow logs), brush piles, rock crevices, burrows of other animals, and temporary snow dens. Fisher are predominantly carnivorous, consuming a wide variety of prey; principal prey species are porcupine, snowshoe hare, grouse, squirrels, mice, voles, and shrews. Winter conditions characterized by extended periods of deep snow are a limiting factor for suitable fisher habitat.

In Wisconsin forests, fisher were common prior to Euro-American settlement. They were extirpated by the mid-1900’s. Beginning in the 1950’s, fisher were reintroduced on national forests in northeastern and north-central Wisconsin. Reintroductions were successful and populations expanded; once again, fisher are common in the forests of northern Wisconsin. Winter track surveys, harvest registration, and carcass collections have provided data and information concerning fisher population trends and ecology. Annual population estimates are modeled based on survey data (Figure 4.n).

Annual, regulated harvests of fisher began in 1985 and have continued since. In 2004, all of Wisconsin was opened to regulated harvests. The annual harvest of fisher has fluctuated over the years, due to population fluctuations and weather conditions during the harvest seasons (Figure 4.n).

In general, the statewide fisher population is viable and expanding (Figure 4.o). Prey is abundant. Relatively mild winter conditions have facilitated over-winter survival of both fisher and prey populations, particularly in the more northern reaches of the state. Northern forests are expansive and current conditions provide acceptable (although probably not optimal) habitat for fisher. As forests continue to mature habitat should improve; habitat elements that could be encouraged include increased landscape representation of conifers, large trees and cavity trees, and large snags and coarse woody debris. Forest fragmentation and parcelization are concerns owing to potential impacts on interior forest conditions. In southern Wisconsin, large areas providing interior forest conditions will probably remain a limiting factor.

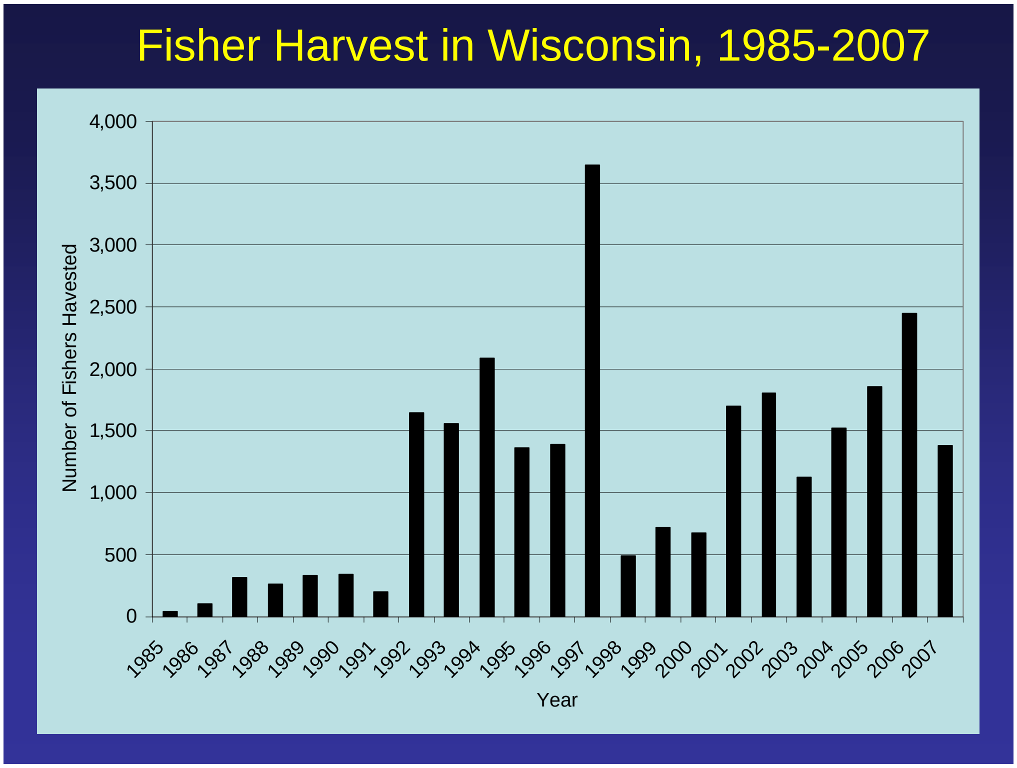


Figure 4.n: Fisher harvest in Wisconsin 1985-2007
Source: DNR, 2007

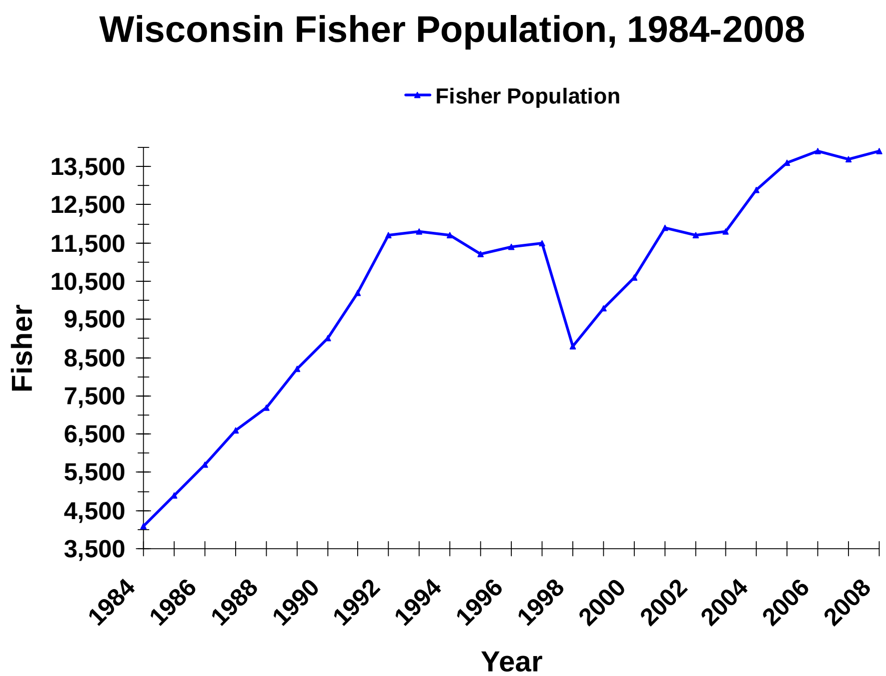


Figure 4.o: Wisconsin fisher population 1984-2008
Source: DNR, 2008

Bobcat
In Wisconsin, bobcats mostly live in the heavily forested northern regions. Coniferous forests, particularly conifer swamps, provide preferred habitat, with shelter, cover, and prey. Alder thickets and swamp hardwoods are also frequently used. Upland hardwood forests are sometimes used as primary habitat, particularly in more southern areas where conifers are sparse. Long-distance dispersal sometimes follows river corridors. Preferred den sites include caves, rock crevices, hollow trees, hollow logs, beneath large downed trees, and brush piles. Bobcat are carnivores; preferred prey species are snowshoe hare, cottontail rabbit, squirrel, porcupine, and white-tailed deer, but they will also consume woodchucks, birds, bats, mice, voles, shrews, reptiles, and insects.

Wisconsin is on the northern edge of bobcat range in North America, and historic populations ranged from low to common. Climate is a limiting factor for bobcat habitat, particularly snow duration and depth; winter weather impacts bobcat survival and population dynamics. However, since the mid-1990’s, bobcat populations have been increasing (Figure 4.p). Relatively mild winter conditions have facilitated over-winter survival of predator and prey populations including bobcats, fishers, raccoons, coyotes, wolves, white-tailed deer, and small mammals. The concurrent increase in deer populations may provide a more stable food supply, through direct predation on fawns and indirectly through the use of carrion.

Traditionally, bobcat population management in Wisconsin has been somewhat conservative, because climate was a limiting factor. Harvest seasons have been structured to only occur in northern Wisconsin, where a sustainable population exists. As the bobcat population began to grow, harvests were structured to maintain an overall harvest level of 15-17% of the population. In 2008, the bobcat management population goal was increased from 1,800 to 2,500 north of Highway 64 (Figure 4.p). Bobcat populations and annual harvests have increased over time (Figure 4.q). However, there has been a recent decline in bobcat populations in the North, and management strategies will probably remain cautious and conservative. Management of bobcats in Wisconsin will require additional ecological research and monitoring to facilitate understanding of behavior, population dynamics (e.g. reproduction and survival), and responses to changing habitat conditions (e.g. possible range expansion into central Wisconsin).

The northern Wisconsin bobcat population is small, but apparently viable and expanding. Prey is abundant. Relatively mild winter conditions have facilitated over-winter survival of both bobcat and prey populations. Northern forests are expansive and current conditions provide acceptable (although probably not optimal) habitat for bobcat. As forests continue to mature habitat should improve; habitat elements that could be encouraged include increased landscape representation of conifers, large trees and cavity trees, and large snags and coarse woody debris. Forest fragmentation and parcelization are concerns owing to potential impacts on interior forest conditions. In southern Wisconsin, large areas providing interior forest conditions with interspersed conifer patches will probably remain a limiting factor.

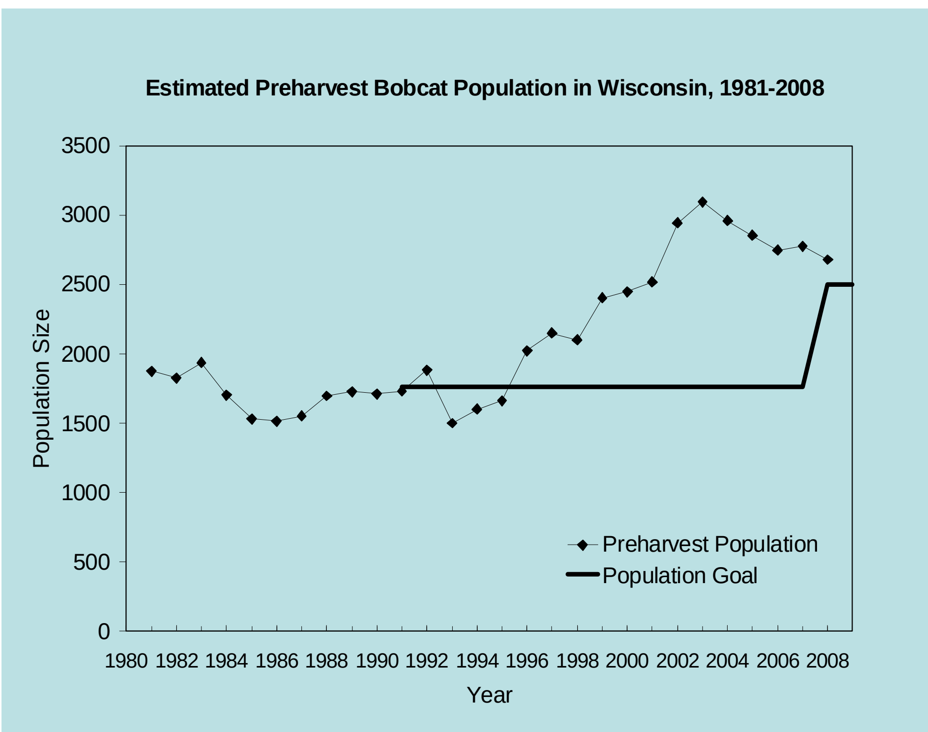


Figure 4.p: Bobcat populations and management goals
Source: DNR, 2008

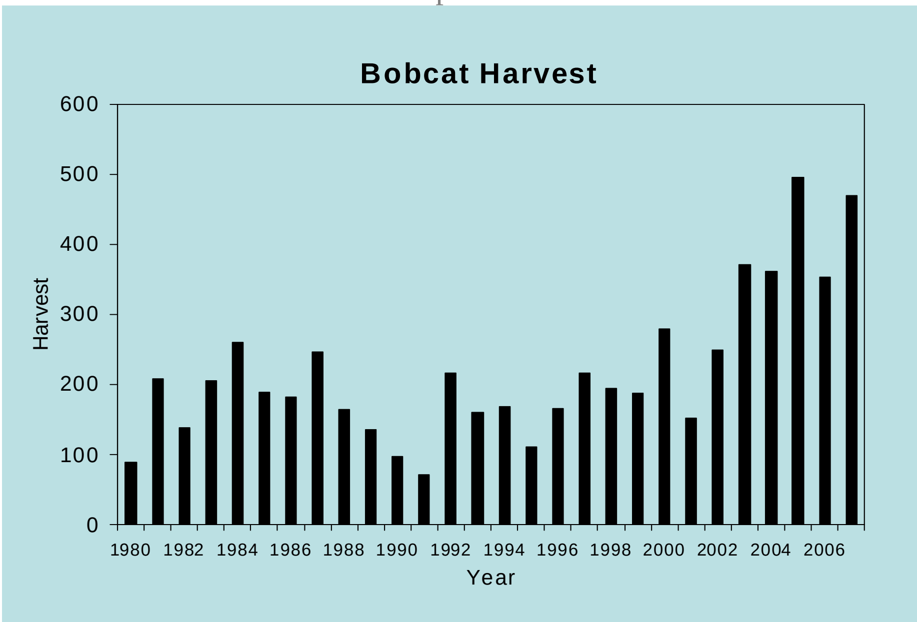


Figure 4.q: Bobcat harvests 1980-2007
Source: DNR, 2007

Timber (Gray) Wolf
Wisconsin wolves mostly live in the heavily forested northern and central sands regions. These large, wide-ranging carnivores have large home ranges and can inhabit most native ecosystems. Prey, principally deer, is abundant. The principle limiting factor for wolf populations in Wisconsin is intentional and accidental killing by humans; wolves require refuge from human contact. The best predictors of suitable wolf habitat are the lack of agricultural land and low road density; road densities <1 km/km^2 may provide suitable habitat, but densities <0.45 km/km^2 are preferred. Wisconsin offers extensive areas of suitable habitat, but core habitat is fragmented.

In Wisconsin, wolves were common prior to Euro-American settlement, and inhabited most major ecosystems. They were extirpated from the state by the mid-1900's. Wolves recolonized Wisconsin in the mid-1970's, and populations have been monitored since 1979 (Figure 4.r). As of late winter 2008, the statewide wolf population was 537 to 564 wolves in 144 packs and 24 loners. At least 520 wolves occurred outside of Indian reservations; the 2008 population exceeded the management goal of 350 wolves outside of Indian reservations by at least 170 wolves. Wolves were reported in 44 counties, and packs occurred in 34 counties in Wisconsin. Based on 2007 data, mean territory size was 30.5 square miles for adult wolves, and 6499 square miles of the state were estimated to be occupied by territorial wolves (Figure 4.s).

In 1975, The Wisconsin DNR listed the gray wolf as a state endangered species. In 1999, the wolf was downlisted to threatened status. In 2004, the gray wolf was removed from the list of threatened species and re-classified as a state protected wild animal.

In 1967 and 1974, the U.S, Fish and Wildlife Service listed gray wolves in the eastern U.S. as endangered. In 2003, the eastern gray wolf was downlisted to threatened status. In 2005, the wolf was relisted as endangered. Although the Western Great Lakes Distinct Population Segment of the eastern gray wolf was temporarily delisted in March of 2007, it is again listed at endangered in Wisconsin.

Following federal delisting, the state now has full management authority. However, intensive population surveys are required for the first five years following delisting; these surveys will provide data for future management decisions by the state. Currently, the 1999 Wisconsin Wolf Management Plan and the 2007 Wolf Plan Addendum guide wolf management in Wisconsin.

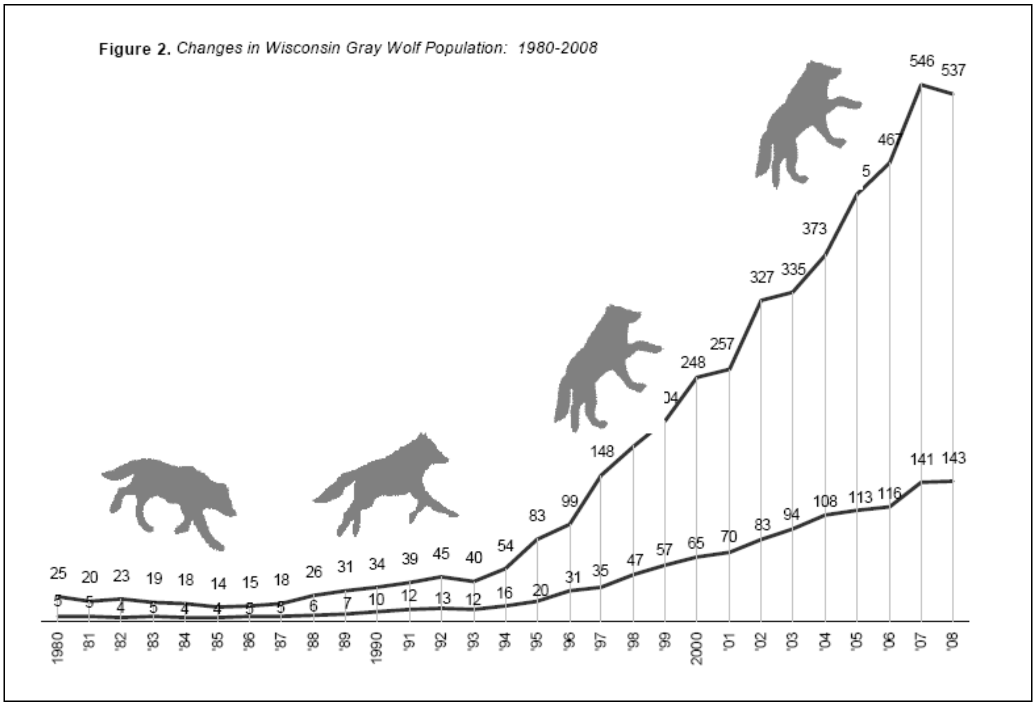


Figure 4.r: Changes in Wisconsin gray wolf population and number of wolf packs 1980-2008
Source: DNR, 2008

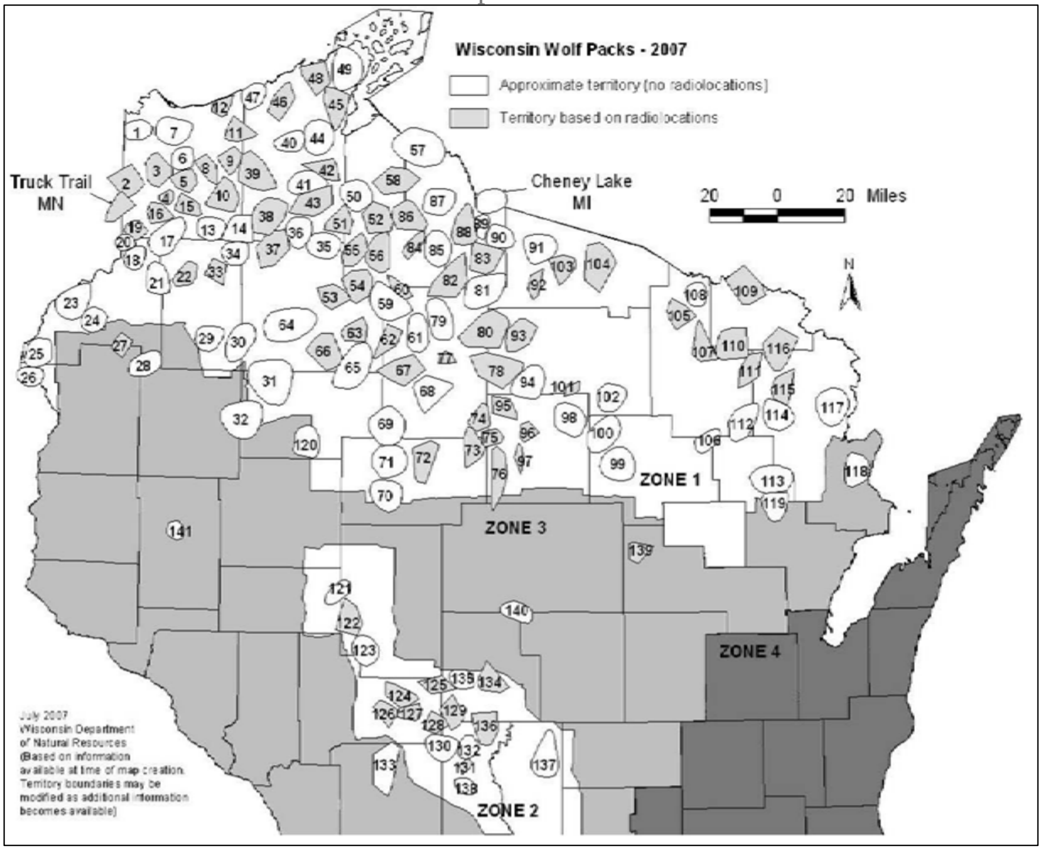


Figure 4.s: Gray wolf distribution in Wisconsin (winter 2006-2007)
Source: DNR, 2007

White-tailed Deer

In northern forests in Wisconsin, deer occurred at low relative abundance prior to Euro-American settlement; deer were much more common in the southern savannas and prairies. Following the Cutover, deer became abundant in the mid-1900's. The statewide deer population exploded in the 1980's (Figure 4.t). Statewide deer populations over the last twenty-five years have been historically unprecedented and are causing significant negative impacts to biodiversity, forest ecosystems, and sustainable forest management efforts.

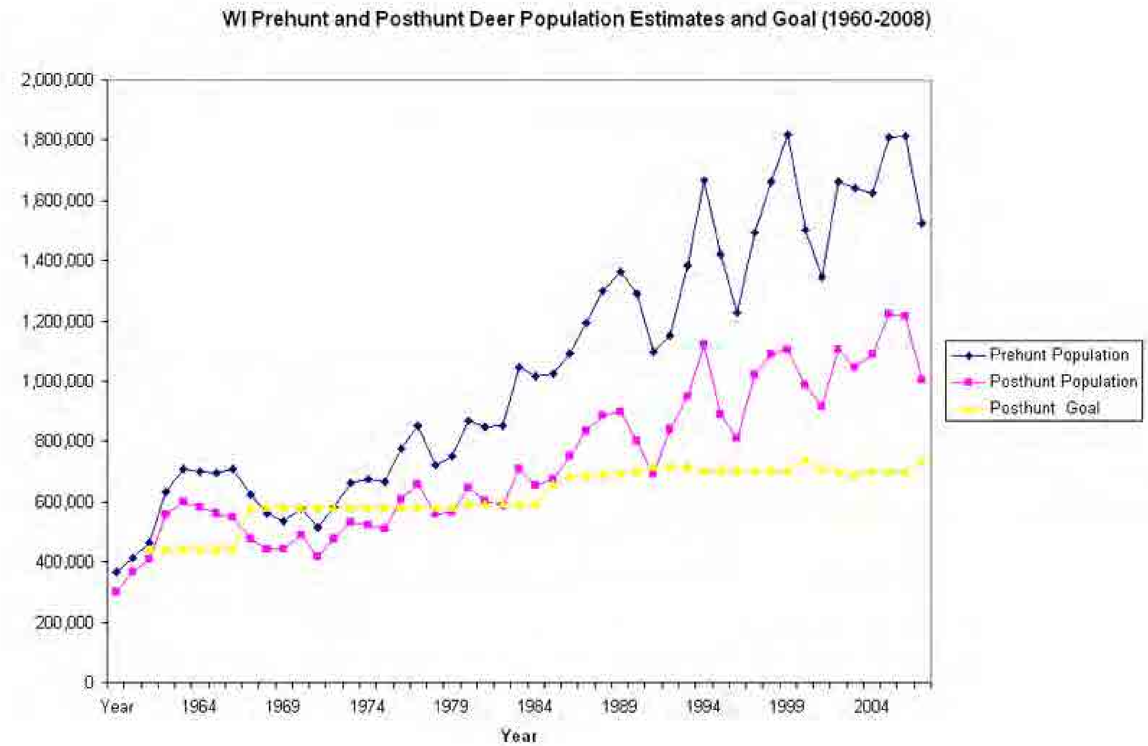


Figure 4.t: Wisconsin deer populations and goals, 1960-2008
Source: DNR, 2008

Table 4.d: Deer population and harvest data highlights since 1960

Year	Estimated population	Total kill	Comments
1962	400,000		
1970		73,000	
1981-1991		167,000 to 352,000	eight record kills
1992-1993	populations decline		deer control relaxed
1995		398,000	record harvest
1999	>1.5 million	402,000	record harvest
2000		615,000	national record
2001-2007	1.4-1.7 million	gun harvests vary 278,000-414,000	
2007		519,000	
2008		453,000	
2009	990,000 statewide post hunt population estimate	329,103	

Source: DNR, 2009

Since 1960, biologists have used hunter harvest and population modeling techniques to estimate herd size. Population goals were first established in 1962. Deer Management Unit population goals are determined by a variety of factors associated with biological and social carrying capacity. Approximately every 3 years deer population goals are reviewed through a collaborative process between stakeholders, public input and the DNR.

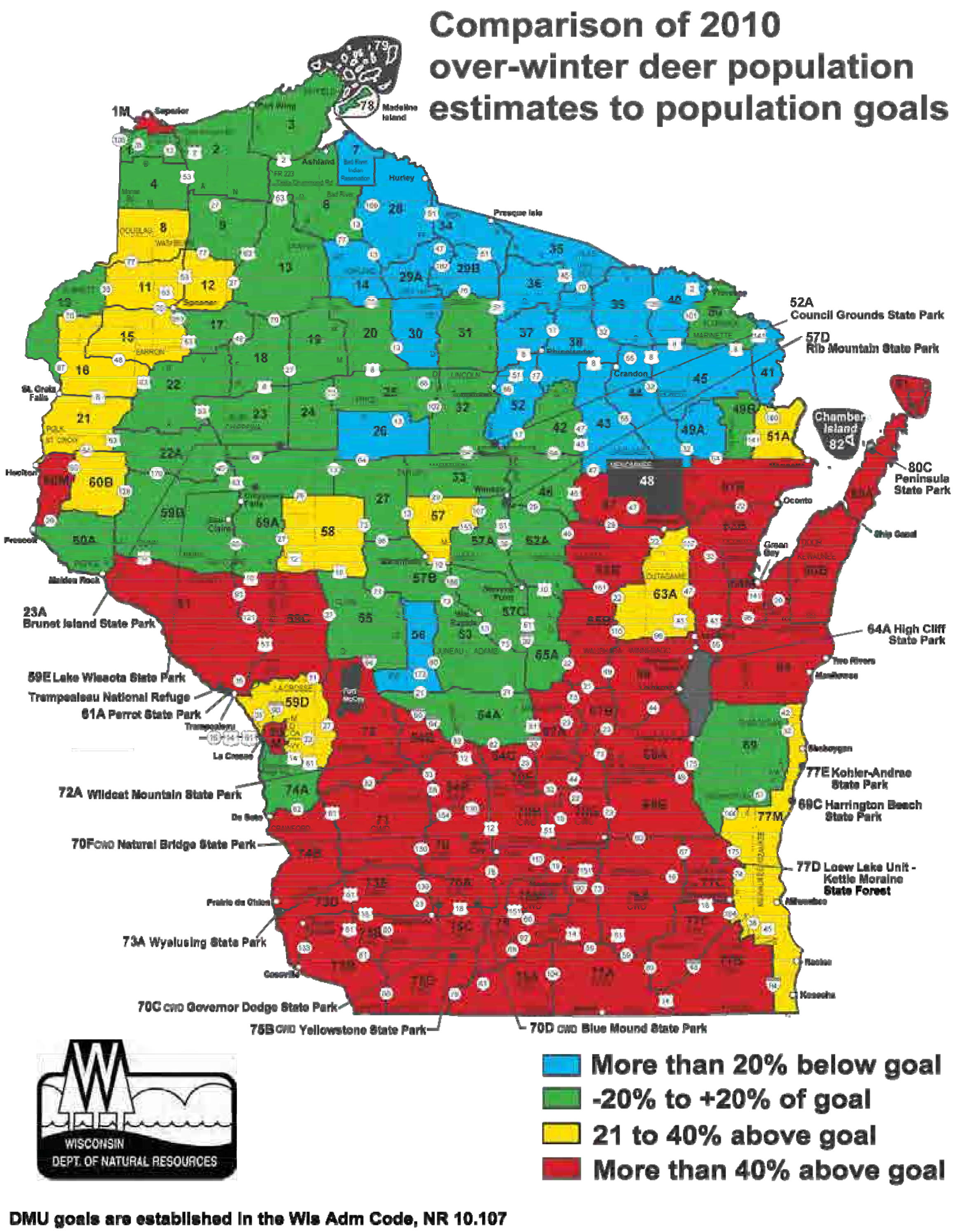
Biological carrying capacity (K) is the maximum number of deer the landscape can support over a prolonged period of time. A deer herd managed at “K” will result in heavy competition between deer, over browsing, and a high percentage of winter mortality. Generally, population goals in forested units are set about 60-65% of K. A deer population managed at these levels has shown to result in a long-term sustainable harvest and a healthy deer herd.

In units that are more agricultural or urbanized, social carrying capacity is usually a bigger factor in determining deer goals. The social carrying capacity is the number of deer that is less likely to cause excessive property damage, while still providing good recreational opportunities for hunting and viewing deer. Generally these units have more nutritional resources which create a higher K. However, if these units were managed at 60-65% of K, controlling the herd would be very difficult and the level of damage caused would be intolerable to many property owners. The goals in these units are set significantly below K to maintain this balance.

Between 1962 and 1984, the post-hunt estimate averaged 1% over goal. Between 1985 and 1994, the post-hunt estimate averaged 16% above goal, and between 1995 and 2009 the average was 47% over goal. The post-hunt estimate indicates that the statewide deer herd has been at or within 5% of goal only once in the last 20 years.

Overall, Wisconsin’s estimated post-hunt deer population is above goal. At the end of the 2009 deer season, however, statewide harvest data suggests progress toward goal. Most units within farmland regions are still above goal, while most units in the north are currently near or below goal (Figure 4.u).

The original over winter (1960 - post hunting season) goal for the Wisconsin deer herd was 441,900 deer. As deer range expanded and hunting interest increased, the post-hunt goal grew until it stood at 794,000 in 2010, an increase of approximately 80% from the original goal and 8% higher than in 2009. Overwinter goals were raised by 10-67% in 43 deer management units, and lowered 17-20% in 2 deer management units around the state. The last time deer populations were near goal (early 90's), hunter pressure resulted in the relaxing of herd control, which was followed by an exploding population and soon thereafter a national record deer harvest.



Map 4.a: Comparison of 2010 over-winter deer population estimates to goals
Source: DNR, 2010

Deer damage to forest regeneration and forest ecosystems has been in evidence since at least the 1950's. Over time and with exploding deer populations, negative impacts have increased, effects continue to accumulate over time and space, and some effects are becoming difficult, if not impossible, to reverse. Sustained high deer populations, particularly over the past twenty-five years (with only brief intermittent population declines), are significantly impacting ecosystem processes and the practice of sustainable forestry, causing ecological and economic losses. Deer browsing of forest vegetation can alter community composition and structure, change habitat, and reduce or eliminate populations of plants and animals. Deer browsing of tree regeneration can cause regeneration failures, increase regeneration costs, and reduce timber productivity. These losses affect most citizens of Wisconsin through impacts on ecosystem services, recreation, and economics. Overabundant deer in some zones will continue to be a significant barrier to sustainable forest management and the conservation of biodiversity.

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Criterion 2: Maintenance of Productive Capacity of Forest Ecosystems

Overview

Forests, directly or indirectly, provide a wide range of goods and services. The nature of these goods and services change over time as a consequence of natural causes and changes in social and economic demands, technology, and actions taken in the forest. Changes in productivity of forests, either positive or negative, could be a result of these factors, changing forest management, or unforeseen agents affecting ecosystems.

This criterion has two indicators and five metrics for evaluating the productive capacity of forest ecosystems. The first four metrics track traditional measures related to status and trends in forests available for wood supplies. Metric 5.1: Amount of timberland, shows how much forest is potentially available for wood production, compared with total forest area. Within the context of this report, timberland is defined as forest available for wood production not precluded by law or regulation from commercial harvesting of trees. Metric 6.1: Net growth and removals, compares net growth with wood harvest (removals) for products on timberland. This is a frequently-used method of assessing whether or not wood harvesting is reducing the total volume of trees on forest available for wood production. Metric 6.2: Type of removals, includes the volume lost from the resource through land use change and conversion to a reserved status. Metric 6.3: Total growing stock and tree grade of both merchantable timber and non-merchantable tree species on forest land available for timber production, explores the amount of growing stock in the state. Growing stock is a fundamental element in determining the productive capacity of the area identified as forest available for wood production. Metric 6.4: Annual removal of non-timber forest products (NTFP), addresses trends in non-wood related goods from the forest.

The USDA Forest Service, Forest Inventory and Analysis (FIA) program conducted periodic inventories of traditional forest resources on U. S. forests in 1936, 1956, 1968, 1983 and 1996. Beginning in 2000, inventories have been conducted every year on a continuous basis. Data from the first three inventories is available in hardcopy only, making some comparisons to later data unavailable. For inventory years 1983 and 1996 and from 2003 on, data is available electronically on-line and is updated annually with the most recent data from 2007. As a result, data from the inventory years 1983, 1996 and 2007 is presented because it is readily available for all of the traditional forest indicators in Criteria 2 and provides a consistent basis of comparison.

The information in Criterion 2 also builds on the analysis from Criterion 1. As noted there, Wisconsin's forest composition and structure are recovering from the Cutover that occurred between the mid-1800s and the early 1900s. Current forests are, however, simplified compared to historical forests, which are described in *Ecological History of Wisconsin's Forests* (Appendix A) and Criterion 1, Indicator 2.

Criterion 2 Indicators:

5. Area of timberland

6. Annual growth and removals of forest products

Major Conclusions

1) Wisconsin has the capacity to sustain present levels of timber harvest if it remains an important objective of landowners.

On a statewide basis, there is capacity to sustain, and in some cases increase, present levels of timber harvest from a purely wood volume standpoint at current growth, mortality, and removals rates. This potential may not be achieved, however, primarily due to the diverse objectives of the many different public and private owners of Wisconsin's forest land. A growing number of family forest land owners manage for non-timber purposes.

- Growth exceeded removals by at least 30% on Wisconsin timberlands from 1983 to 2007.
- 50 of the 55 commercial species in Wisconsin have a growth rate greater than their removal rate. Their growing stock volume is increasing.
- Overall, private timberlands account for 11.4 million acres, or about 70 percent of all timberland available for wood production in Wisconsin. The majority of wood harvested is from private lands.
- Private forest parcels are decreasing in size and the number of small forest owners (1-9 acres) increased by 84,000 owners (91%) between 1997 and 2006. Forest operations are more difficult on small parcels because they may be more difficult to access, they may have fewer bids due to small quantities, and non-commercial practices may be more expensive because the benefit of economies of scale are not there. This is all in addition to the decreasing amount of family forest owners who want to harvest.
- Federal National Forests are unable to sell the Allowable Sale Quantity (ASQ) in their approved plans. Many smaller DNR properties do not have master plans that establish a harvest objective.

2) Timberland and growing stock volume as a whole is increasing, but improving tree quality will require ongoing cultivation and precautions against destructive cutting practices.

Wisconsin's timberland acres and growing stock volume are increasing. This trend is of benefit to not only the forest products industry and their access to the wood supply but non-consumptive uses that improve with greater acreage such as carbon sequestration and increased habitat for animals. This growth affords a greater potential to manage lands for diverse purposes; the option for reserving lands improves.

- Wisconsin timberland totals 16.3 million acres and increased by 1.4 million acres between 1983 and 2007.
- Growing stock volume increased steadily from 15.5 billion cubic feet in 1983 to 20.5 billion cubic feet in 2007.
- Growing stock volume has been changing in quality, overall tree size, and quantity. Poletimber volume declined from 1983 to 2007. Sawtimber volume increased in all tree grades from 1983 to 2007.
- The volume of higher grade trees (1 and 2) has increased at a slower rate since 1996 whereas grade 3 and poorer increased at a much faster rate since 1996 (Figure 6.c).

3) Decline in growing stock of four high volume commercial species is of concern.

The decline in growing stock of high volume commercial species, mainly early successional species, is of concern. These trends are likely to continue. Species that are being replaced or converted include jack pine, paper birch, and quaking aspen that are maturing with high mortality rates (all over 2%) and are heavily utilized (over 100% removals to growth ratio).

Due to the low availability of these species, forest industry will likely need to pay more for these or find substitutes. As these species decline, animals and plants that require these cover types may be adversely affected. Several game bird species prefer early successional habitat. It will be more difficult to regenerate some of these species, such as jack pine, because their acreage has decreased as well.

- Four major commercial species have declined significantly in growing stock volume since 1983. These species include: jack pine (45% decline), paper birch (40% decline), balsam fir (27% decline) and quaking aspen (14% decline).
- Balsam fir (found mainly in the northern third of the state) is not an early successional species, but its mortality rate is over 4% and its removals to growth ratio is over 100%.

4) Generally across the state, the oak resource has remained fairly stable over the last ten years. However, there are concerns in specific regions regarding the change in oak volume and regeneration.

- The major oak species, other than Northern red oak, increased in volume and have a lower than average mortality rate on a statewide basis between 1996 and 2007.
- Thirty-four of the 72 counties in Wisconsin saw a decline in northern red oak growing stock volume between 1996 to 2007, however, the volume still increased from 1983 to 2007.
- All oak species in Wisconsin, with the exception of northern pin oak (1.4%), have mortality rates that are equal to or less than the 1% average mortality rate for all species combined.
- Black oak, northern red oak and white oak had removals to net growth ratios higher than the average for all species (59%). This appears to indicate that oak harvest intensity is variable in different areas of the state.

5. Area of timberland

5.1 Amount of timberland

This indicator calculates the wood production capacity of existing forests and shows how much forest is potentially available for wood production compared with total forest area. In practice, the area available for wood production at any given time will always be a value less than total timberland. The amount of the area adjustment that would be required to determine the actual availability of timberland depends on the ownership mix, accessibility, and management practices in place at the time of analysis. This adjustment would affect all other indicators in Criterion two as well.

Forest land in Wisconsin, totaling 16.4 million acres, is primarily in the northern half of the state. Timberland, including natural/semi-natural stands and planted forests comprise the largest category of forest (Figure 5.a) with 16.3 million acres. Timberland increased by 1.4 million acres (9.6%) in Wisconsin between 1983 and 2007 (Figure 5.b).

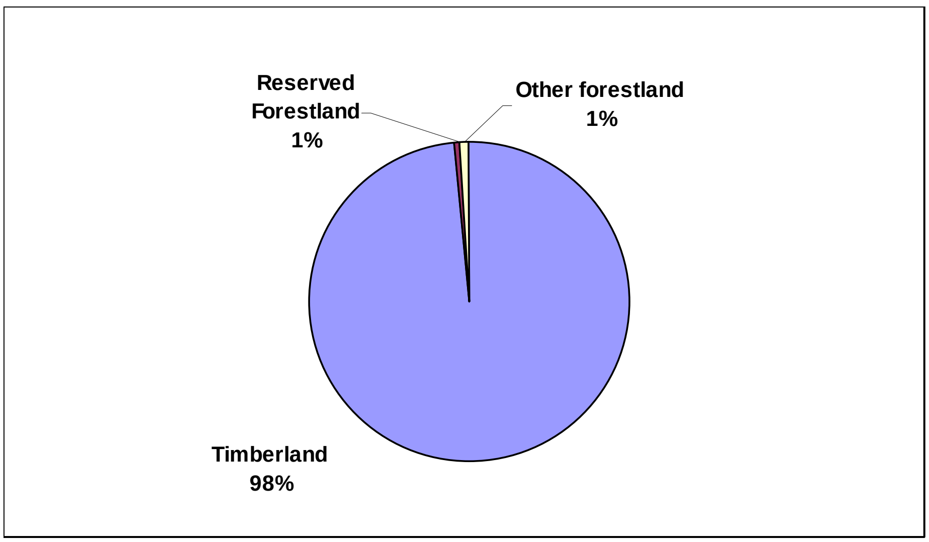

Figure 5.a: Percentage of forest land categorized as timberland compared to reserved and other forest land in Wisconsin, 2007
Source: FIA, 2007

5. Area of timberland

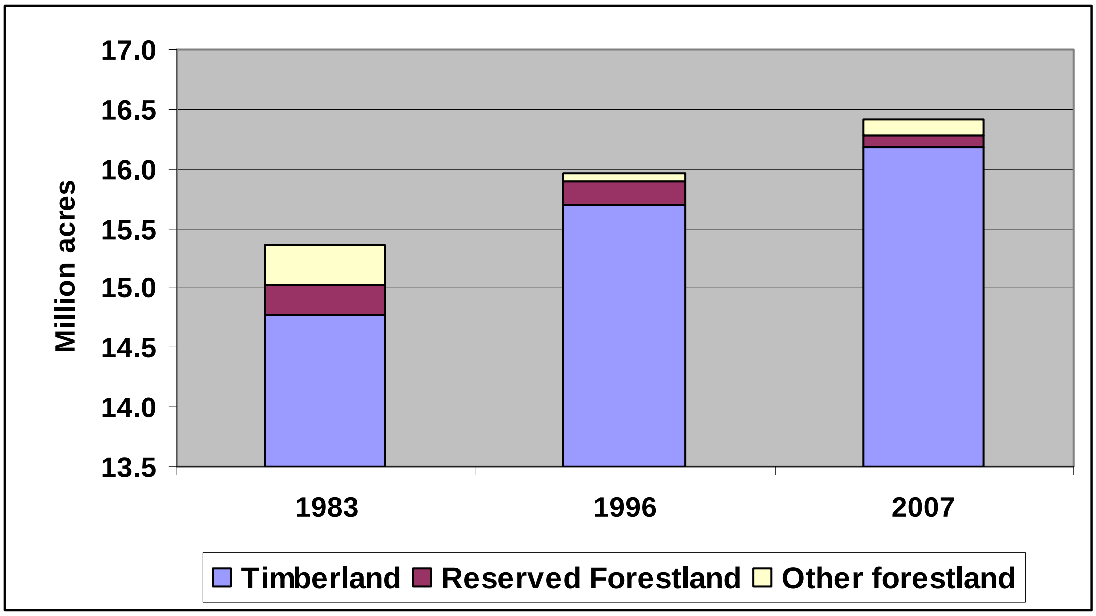

Figure 5.b: Amount of forest land categorized as timberland compared to reserved and other forest land in Wisconsin
Source: FIA, 2007

Ownership also plays a key role in the area available for the state's wood production. Timberland is concentrated on private lands in Wisconsin. Overall, private timberlands account for 11.4 million acres, or about 70 percent of all timberland available for wood production in Wisconsin. Private timberland includes all industry, non-industrial private, and Native American owned lands. Parcelization and housing development on private lands negatively impact wood utilization on timberland.

Timberland in Wisconsin has increased since 1983 with no sign of changing in the near future (Figure 5.b). Much of the increase likely came from the reforestation of marginal agricultural lands. The quality of the new timberland will slowly become evident as it grows to a large enough size to measure in the following metrics. The increase occurred in all Wisconsin counties except eight. Five of those eight counties are in the eastern part, which is more populated. Changes in timberland across the state ranged from a decrease of 17% in Fond du Lac County to an increase of 90% in Rock County over the 24 years.

The apparent decline in reserved forest land between 1983 and 2007 is likely due to the change in interpretation of the definition of reserved forest land. In the past, the definition of reserved forest land was based on land use. Reserved forest land was generally defined as land that excluded harvest but had no legal status specifically stating so. This more general definition allowed more land to be included in the reserved forest land category. Today, reserved forest land is considered a legal status in which harvesting is excluded specifically by law; fewer forest lands meet this more strict definition.

The availability of forest land for wood production is linked to the demand for these lands for other uses. Natural events and competing societal forces can also affect availability. Fire, weather, and insect and disease outbreaks can seriously impact supplies at any given time. Forest productivity can also be altered by pollution and human-caused degradation.

6. Annual growth and removals of forest products

6.1 Net growth and removals

This indicator compares net growth with wood harvest (removals) for products on timberland. This is a frequently-used method of assessing whether or not wood harvesting is reducing the total volume of trees on forest available for wood production. Net growth is defined as the net annual increase in the volume of growing stock between FIA inventories after accounting for effects of mortality, but before accounting for the effects of harvest. Removals are a measure of the average annual volume of growing stock trees harvested between inventories. Timberland is assumed to be the subset of forest land on which some level of wood harvesting is potentially allowed. So long as growth (net of mortality) exceeds removals, the volume of trees on timberland is considered sustainable. This measure, however, conveys no information about quality, biodiversity, other attributes of ecology, or management objectives, and so it should be considered in conjunction with other indicators.

Net growth exceeded removals by 30% or more on Wisconsin timberlands from 1983 to 2007, and the area of timberland increased. The result has been a substantial increase in the volume of growing stock on Wisconsin timberlands. A removals to net growth ratio of 100% means that removals are equal to net growth. A removals to net growth ratio over 100% indicates that more wood volume is being removed each year than grows in to replace it. Conversely, a removals to net growth ratio less than 100% indicates that more wood volume is growing in to the forest than is being removed. The removals/net growth ratio increased from 48% to 59% between 1983 and 2007. Between 1996 and 2007, net annual growth increased by 102 million cubic feet, while annual removals increased by only 17 million cubic feet (Figure 6.a).

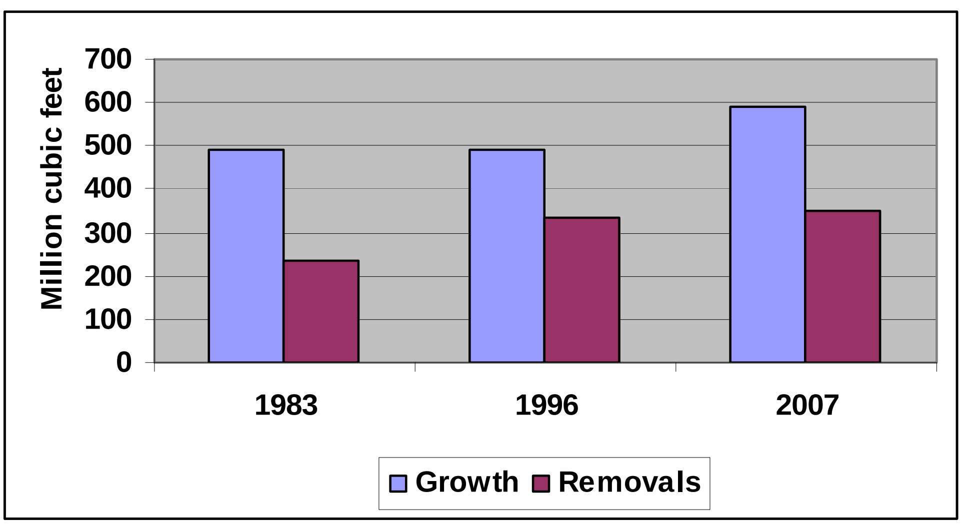

Figure 6.a: Net annual growth and removals of growing stock on timberland in Wisconsin
Source: FIA, 2007

Five of the 55 commercial species in Wisconsin have a removals/net growth ratio higher than 100% and also showed a significant decline in growing stock volume between 1996 and 2007 at the 68% confidence level. Softwood species included in this group are jack pine and balsam fir. Hardwood species included paper birch, American beech, and balsam poplar.

Four of the five species (except American beech) also have higher mortality rates than the average for all species in Wisconsin. This effects net growth volume negatively since net growth equals gross (or total) growth minus mortality. American beech may actually have a higher than average mortality rate as well since the data showed zero mortality, which is obviously questionable. However, four of the five species (except balsam fir) have higher removals to gross growth ratios than the average so they do have high real removal rates as well as relative to mortality. Balsam fir has a very high (75%) mortality to gross growth ratio. It appears that as a result of high expected mortality among these species that the older and larger trees are being utilized to salvage the value of the timber before they pass from natural causes.

The jack pine trend is of particular concern. It was severely hit by jack pine bud worm (see Criterion 3, Indicator 7). As a result, a larger proportion of the jack pine forest type currently is in the youngest age class and smallest stand size class as it regenerates. This helps to explain some of the decline in growing stock volume but more importantly, over one-half of jack pine forest type acres have converted to other forest types since 1983 (see Criterion 1, Indicator 2).

Clearly, on a statewide basis, there is capacity to sustain, and in some cases increase, present levels of timber harvest from a purely wood volume standpoint at current growth, mortality and removals rates. However, there are many reasons why potential increase in harvests may not be achieved. The main reason is that the diverse objectives of the many different owners of Wisconsin's timberlands may not have the maximization of wood fiber production as their primary objective.

6.2. Type of removals

FIA defines average annual removals to include: (1) net growing-stock volume harvested or killed in logging, (2) cultural operations (such as timber stand improvement) or land clearing, and (3) the net growing-stock volume not harvested but growing on land that was reclassified from timberland to non-commercial forest land or non-forest land during the period between FIA inventories. This volume is divided by the number of growing seasons to produce average annual removals.

The smaller component of removals other than harvests is defined as "other removals." This includes the volume lost from the resource through land use change and conversion to a reserved status. Forest land that is cleared for roads, industrial expansion, home construction, and development of rights-of-way all contribute to other removals.

Removals for harvest accounted for 88% of all growing stock removals in Wisconsin in 2007. Removals due to land change accounted for 12% of all growing stock removals during the same time period (Figure 6.b). Other removals from past forest inventories are erratic and show no defined trend. Since 2005 the rate of other removals has been consistent. Other removals may affect future harvest volumes if the forest land base has been reduced. These losses to forest land could be short or long term depending on future land use changes.

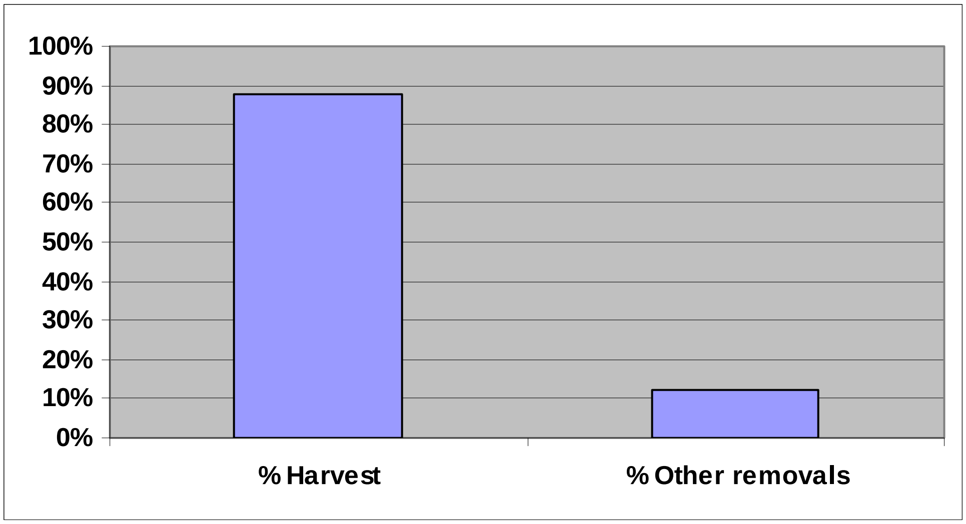

Figure 6.b: Type of growing stock removals on timberland in Wisconsin, 2007
(Sampling errors for harvest removals is 11% and for other removals 29%.)
Source: FIA, 2007

6.3. Total growing stock and tree grade of both merchantable timber and non-merchantable tree species on forest land available for timber production
Growing stock is a fundamental element in determining the productive capacity of the area identified as forest land available for wood production. Knowledge of growing stock and how it changes over time in both quantity and quality is central to considerations of a sustainable supply of wood for products. Growing stock is the volume, in cubic feet, of growing-stock trees 5.0 inches dbh and larger. Quality of growing stock is measured in grades 1, 2, 3 or greater than 3 with 1 being the best (see Glossary for complete description). Small diameter trees, called poletimber (conifers under 9-inch dbh and hardwoods under 11-inch dbh), are too small to be graded. Larger diameter trees, called sawtimber (conifers at least 9-inches dbh and hardwoods 11-inches dbh), can be graded.

Variability in the size and quality of trees has considerable bearing on their value in wood products. Generally speaking, about 89% of all live tree volume on timberland in Wisconsin is considered to be growing stock or wood capable of being used for traditional commercial products. The remaining 11% are trees of poor form, small stature, or otherwise unsuited for traditional wood products, but can be harvested for biomass or left in the forest for diverse structure and habitat. Given the minor influence of non-merchantable volume relative to total live volume of timber on forests available for wood production, the remainder of the discussion for this indicator will focus on merchantable or growing stock volume. As biomass/bio-energy markets develop, however, closer analysis of currently non-merchantable volume and net unutilized growth will be of greater future significance.

Overall, growing stock volume (Figure 6.c) increased in Wisconsin between 1983 and 2007. With a stable base of forest land available for timber production or timberland (Indicator 5.1) and a historic pattern of growth exceeding removals (Indicator 6.1), the volume of growing stock in Wisconsin has been rising steadily for more than 50 years. The current total of 20.5 billion cubic feet of growing stock is 33% higher than the volume in 1983 (15.5 billion cubic feet). Hardwood volume totals about 75% of growing stock volume on Wisconsin timberland.

Growing stock volume has been changing in quality, overall tree size, and quantity. Poletimber volume (which is ungraded) declined from 1983 to 2007. Sawtimber volume increased in all tree grades from 1983 to 2007. The volume of higher grade trees (1 and 2) has increased at a slower rate since 1996 whereas grade 3 and poorer increased at a much faster rate since 1996 (Figure 6.c). Timber grading rules have remained the same from 1983 to the present.

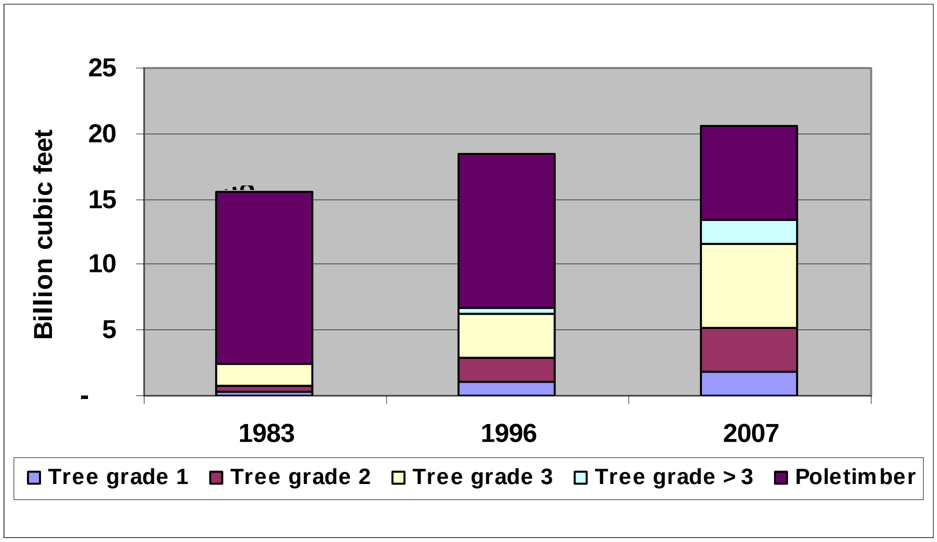

Figure 6.c: Volume of growing stock on timberland by tree grade, 1983-2007
Source: FIA, 2007

The highest growing stock volume species are sugar maple, red maple, northern red oak, red pine, and quaking aspen. All of these species but quaking aspen increased in growing stock volume between 1983 and 2007. Only quaking aspen declined during this period. Northern red oak volume did decline by 2% between 1996 and 2007, however. Thirty-four of the 72 counties in Wisconsin saw a decline in northern red oak growing stock volume from 1996 to 2007.

Four major commercial species have declined significantly in growing stock volume since 1983. These species include: jack pine (45% decline), paper birch (40% decline), balsam fir (27% decline) and quaking aspen (14% decline). All four declined from 1983 to 1996 and again from 1996 to 2007. Bigtooth aspen increased in volume between 1983 and 1996; however, it declined between 1996 and 2007 by 7%.

Two other lower volume commercial species declined significantly in growing stock volume between 1996 and 2007. Butternut and American beech declined by 50% and 34%, respectively.

Total growing stock volume has increased over the past 50 years and there is no reason to think this trend will not continue since net annual growth continues to exceed removals by a wide margin (Indicator 6.1). Although all grades of sawtimber have increased, lower quality sawtimber volume has increased at a faster rate than higher quality sawtimber. The larger rate of increase in the lower grade volume is likely due to three factors. First, the large volume of poletimber that grew into sawtimber size class since 1983 is likely a large percentage of the current grade 3 and poorer. Intermediate and selection harvests in the new sawtimber stands could improve the quality of the residual sawtimber over time. Second, a higher percentage of sawtimber that could be graded at 1 or 2 is of lower quality than previous years. Third, there may be an increase in harvesting higher grade timber rather than lower grade. This is often called high-grading as these types of harvests leave low quality trees and only harvest the highest quality, and the problem merits research to determine the extent to which the practice is occurring. We would expect the total growing stock volume to keep growing even though demand increased in recent years, especially for high quality hardwood sawtimber.

Most of the more important commercial species also increased in growing stock volume over the past 25 years. The exceptions are generally early successional species that are generally replaced by more shade tolerant species or are converted to other species such as red pine. Species that are being replaced or converted include jack pine, paper birch, and quaking aspen that are maturing with high mortality rates (all over 2%) and are heavily utilized (over 100% removals to growth ratio). Balsam fir is not an early successional species but its mortality rate is over 4% and its removals to growth ratio is over 100%. As a result, these species are declining in Wisconsin's forests. The decline in butternut and American beech can be attributed to Butternut Canker mortality and removals to growth ratio over 200%, respectively. These trends are likely to continue.

Northern red oak is an exception to the high mortality rate with a recent decline in growing stock volume. This species had a mortality rate (0.7%) that is less than the 1% average rate for all species in the state. The highest significant northern red oak volume losses at the 68% confidence level were in Burnett, Washburn, Monroe and Jackson counties. Considering the lower than average mortality rate, it appears that the northern red oak decline in these counties is due to high harvest levels relative to the standing volume and/or low in-growth of young stock.

All oak species in Wisconsin, with the exception of northern pin oak (1.4%), have mortality rates that are equal to or less than the 1% average mortality rate for all species combined. All oak species except Northern red oak and swamp white oak increased in growing stock volume statewide between 1996 and 2007. Black oak, northern red oak and white oak had removals to net growth ratios higher than the average for all species (59%). The major oak species, other than Northern red oak, increased in volume and have a lower than average mortality rate on a statewide basis. While the oak species are generally doing well across the state, it does vary by county. This appears to indicate that oak harvest intensity is variable in different areas of the state. The last statewide forest assessment (2000) showed a trend of limited oak regeneration in southern Wisconsin due to aging forests with heavy selection harvests which increase the rate of succession to elm-ash-soft maple and maple-basswood types. Northern red oak is the primary oak species of concern in Wisconsin.

6.4. Annual removal of non-timber forest products (NTFP)

Non-timber forest products (NTFP) include medicinal plants, food and forage, floral and horticultural products, resins and oils, arts and crafts materials, and game animals (National Report 2010). The various types, uses, and growing locations of these products make tracking the amount of removal challenging. Many of these products do not have a commercial market, but are of greatest importance to specific people for individual use. For instance, Native Americans harvest birch bark and medicinal plants for cultural traditions and applications. Many woodland owners state one of the reasons they own forest is for the enjoyment from non-timber forest products they harvest such as mushrooms, berries, and wild game. Some NTFPs have a commercial market; balsam and pine boughs, sphagnum moss, and princess pine (*Lycopodium*, or club moss, which is fairly common in northern hardwood forests) are typically harvested by the floral industry to use in products. NTFP reflect the biodiversity of forest ecosystems. Many species with commercial value can be culturally and ecologically sensitive.

As demand for these products grows, it becomes increasingly important to monitor the removal of products from forests, and the effects of their removal on the viability of current and future forest ecosystems. Active management for NTFPs on the other hand can potentially maintain ecosystem complexity and play an important role in restoring biodiversity and balance to damaged forests. Furthermore, extraction of a broader range of natural resources other than just timber products can lead to economic diversity and stability for rural forest communities and the state economy in general (IFCAE, 2009). Further research on the population biology, demographics, and eco-physiology of some of these non-timber forest products can provide needed data concerning the sustainability of harvest.

It is hard to state how the current level of NTFP harvesting is affecting forest ecosystems without more monitoring. Monitoring of harvested populations will also provide vital information that can direct future management decisions. Measuring harvest levels for a given NTFP can be difficult because, for the majority of products, there are no systems in place to track their removal rate. State and federal laws regulate the harvesting of some NTFP's (e.g. wild rice and ginseng), but because there is little monitoring, the result of the regulation is not know. The National Forest System is beginning to track the removal of more NTFPs and their data on princess pine is provided here. The National Forest System found that specifically for food and forage products, the number of permits increased across the country and the volume harvested grew even more (National Report, page 2-38).

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has monitored removals by tribal members on National Forest land for almost the last two decades; the best long term data available in the state (Figure 6.d). GLIFWC assists tribal governments in the protection, preservation, conservation and prudent use and management of tribal fish, wildlife, and plant resources in the Great Lakes area. They have tracked and reported on a number of plant and animal species tribal members harvest off reservation. The off reservation permits for wild plants grew from 1,491 permits in 2000 to 2,063 in the 2007. Tribes can harvest over 300 plants but track the five most collected products (conifer boughs, princess pine, ginseng, birch bark, and firewood). GLFIWC, through its Tribal Commercial Gathering Permits, can gather data on the amount of harvest in specific areas and then respond to the condition of the resource through special regulation.

6. Annual growth and removals of forest products

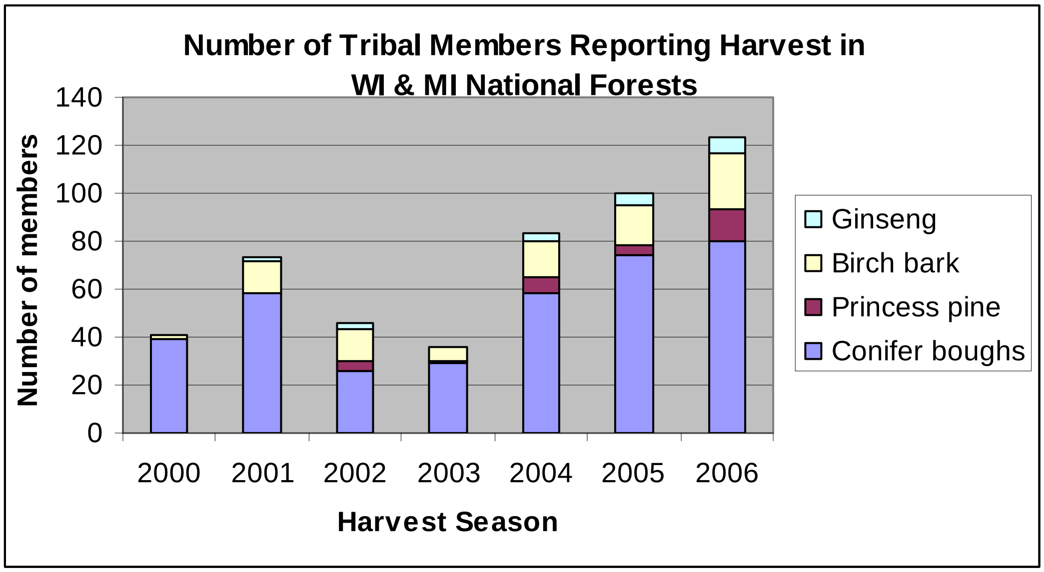

Figure 6.d: Number of tribal members reporting harvest in WI & MI national reports
Source: Danielsen, K. 2008. GLIFWC Administrative Report 08-10

Table 6.a: Amount of forest products harvested by tribal members on WI & MI National Forests

	2000	2001	2002	2003	2004	2005	2006
Conifer boughs (tons)	39	132	40	36	64	80.3	87.3
Princess pine (pounds)	0	0	265	13	263	338	463
Birch bark (trees)	2	24	145	45	148	173	287
Ginseng (pounds)	0	2	0.75	0	0.75	2.75	4

Source: Danielsen, K. 2008. GLIFWC Administrative Report 08-10

Tribal members are from the ten member tribes of the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). These include: Bad River, Lac Courte Oreilles, Lac du Flambeau, Lac Vieux Desert, Mole Lake, Red Ciff, and St. Croix. Three tribes are not located in Wisconsin, (Bay Mills, Keweenaw Bay, Mille Lacs) but are included in the data presented.

This indicator measures harvest levels of non-wood forest products where data exists, when known, describes trends in specific product removals, and discusses efforts to track removals in the future. Even with this monitoring, we still lack the ability to determine the level of harvest that could be considered sustainable. A discussion on the value of these products is in Criterion 6, Indicator 13.5.

Data for NTFPs typically exists for commercial products and those that are harvested by permit on national and state forests. Often, county and state forests issue free permits for harvesting NTFPs; because there is no charge for these, the current data collection system does not include free sales. Currently, there is no way to track harvesting of NTFP on privately owned land unless the product is sold. Christmas trees are occasionally considered NTFPs. In Wisconsin, Christmas tree farms are regulated by the Department of Trade, Consumer Protection and Agriculture. The federal economic census categorizes Christmas tree farms as crop production (US Census, 2009). The major NTFPs of commercial value in Wisconsin are maple syrup, balsam boughs, moss, princess pine, and ginseng. Culturally and ecologically important non-commercial species are mushrooms, birch bark, and berries. Figure 6.e shows the volume of three tree species that provide valuable NTFPs. The decline of paper birch and balsam fir is of concern.

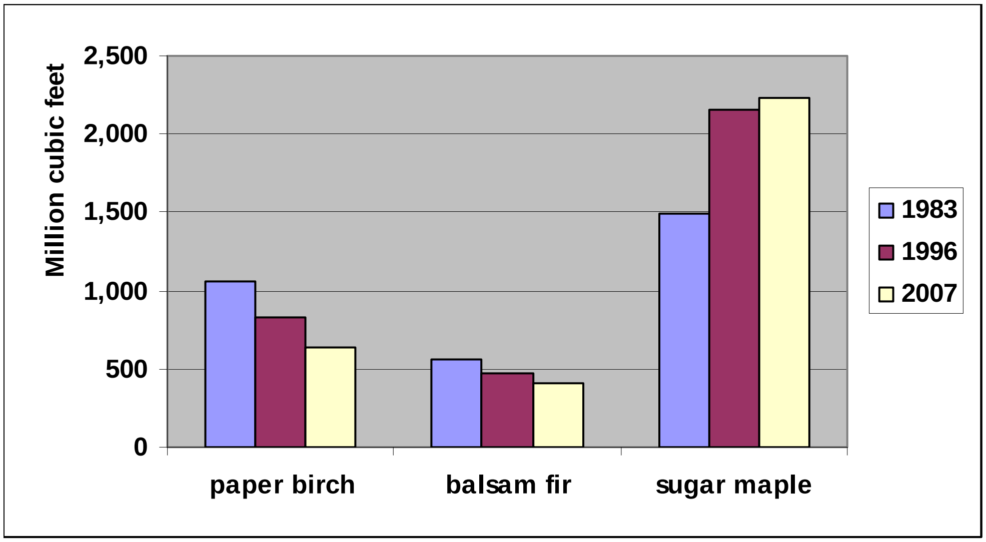

Figure 6.e: Paper birch, balsam fir, and sugar maple cubic feet 1983, 1996, 2007
Source: FIA, 2007

<u>Maple Syrup</u>
Wisconsin's maple syrup production, jumped from 75,000 gallons in 2007 to 130,000 gallons in 2008, an increase of 73% Figure 6.f). Sugar content of the sap decreased, requiring 37 gallons of sap to produce one gallon of maple syrup. In 2007 and 2008, Wisconsin was one of the top five producers of maple syrup in the nation (USDA, NASS, 2008).

<u>Boughs</u>
Balsam and pine boughs are harvested mainly for use in decorations during the winter holidays. The general public or companies can purchase a permit to harvest boughs on county, state, and national forests. On county and state forests, 50 units (a tree sheared for balsam boughs) were purchased by permit in 2007-2008 (DNR, 2009). On National Forests, boughs may be collected with a permit. In 2008, a total of 147 permits were sold for 269 tons of boughs (CNNF, 2009). To understand the magnitude of harvesting in Wisconsin without a complete dataset, it is useful to compare with Minnesota which may be similar. They estimate their bough industry at greater than $20 million per year (http://www.extension.umn.edu/specializations/environment/ntfp.html).

<u>Birch Bark</u>
There were no recorded birch bark sales on county and state lands in 2007 (DNR, 2009). FIA has begun collecting data on birch bark in several northeastern area states. The first report should be available in a few years and will provide the best data to date on the amount of birch bark harvested across the state. GLIFWC tribal members are harvesting more birch bark in the Great

Lakes region; only two trees were reported harvested in the 2000 season compared with 287 in the 2006 season.

Aspen-birch represents about 20% of all forest land in the state. Total acreage has slowly and steadily declined since the 1980’s (see Criterion 1, Indicator 2). It is uncertain whether this decline is of concern because the demand for harvesting birch bark statewide is unknown. If harvests are very small, this may not be a current issue but one to investigate further. Harvesting birch bark requires medium to large diameter trees. Even though the cover type is in decline, a greater percentage of trees have moved into the medium and large diameter size classes.

Moss

Sheet moss and sphagnum moss may be harvested by permit on county, state, and national forest. In the last decade, there have been very few harvests on state property.

Princess Pine

Sheet moss and princess pine (*Lycopodium* spp.) are gathered by Native Americans, hobbyists or to be sold commercially. From a 1995 study, approximately 170,500 pounds per year of princess pine (85.25 tons) were collected annually from just two buyers in Wisconsin and the Upper Peninsula of Michigan (Matula, 1995). Ground pines are considered to be a mid-seral species, occurring in forest stands 10 to 30 years in age and will decline in very old stands. In general, if temperatures become warmer and the forest becomes drier, these species would be expected to decrease (http://www.extension.umn.edu/specializations/environment/components/lycopodium1.html).

Princess pine is monitored on national forests. An individual is allowed to harvest up to 400 lbs. of either princess pine or sheet moss per year and a fee is charged based upon the amount they wish to collect. Starting in 2007, permit holders were given information about princess pine and sheet moss. This included a species identification guide for princess pine, harvesting guidelines, and a voluntary harvest survey to be filled out and mailed back to the Chequamegon-Nicolet National Forest (CNNF). The survey collects information on gathering locations, quantity harvested, and number of harvesting trips made. The information collected from permit holders will allow managers to better understand the pressure harvesting has upon the resource, and enable sustainable management. New requirements for gathering sheet moss and princess pine on the CNNF took effect January 1, 2008. Permittees will now be required to return monitoring forms before receiving another permit.

Table 6.b: Amount (lbs.) of special forest products permitted for harvest on the CNNF from 2004-2007

Year	Sheet Moss (lbs.)	Princess Pine (lbs.)
2004	5,500	600
2005	4,900	200
2006	6,100	400
2007	4,800	504

Source: CNNF, 2009

The number of sheet moss collection permits issued from 2004-2007 have allowed an annual average harvest of up to 5,200 lbs. of sheet moss forest wide (Table 6.b). Not all permittees were likely to maximize their harvest, so the actual harvest could be lower. With the new monitoring methods, the harvest data will be more accurate.

The number of princess pine permits issued (and the amount harvested) each year varied considerably (Table 6.b). GLIFWC member tribes' harvest greatly increased over the last several years although the total amount of all tribal members is a small proportion of what is allowed for harvest on the CNNF. The amount harvested and the locations of the harvest will continue to be monitored to determine if the forest can sustain the desire for princess pine.

Ginseng *(Panax quinquefolius)*

Ginseng is probably the best known example of a NTFP population that changed as a result of harvesting. Recognizing that commercial demands may cause over harvesting of ginseng, Wisconsin law regulates the harvest, sale, and purchase of wild ginseng in the state. In order to promote the most sustainable harvesting practices, international trade agreements permit U.S. export of wild ginseng only from those states that can annually show that harvest and export are not harming the wild ginseng resource (see s. 29.611Wisconsin Statutes and Administrative Rules and chapter 28).

Mineral Collection

The Chequamegon-Nicolet National Forest authorizes recreational mineral collecting, such as panning for gold or rock collecting, without the need for a permit. Gold panning is only allowed with the use of small hand tools (pan, small shovel, and hand pick). Occasional recreation panning for an individual or group is limited to extremely small areas of stream disturbance: A few scattered areas of less than 1 square foot and totaling less than 40 square feet within a 500 foot segment of a stream and that occur less than 5 days per year. Gold panning is not permitted in classified trout water before April 15th and after September 15th. You must also avoid disturbing fish spawning nests. The Wisconsin Department of Natural Resources has the responsibility and jurisdiction concerning water quality. Because this is not a permitted activity, the CNNF maintains no formal data regarding recreational mineral collection.

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Criterion 3: Maintenance of Forest Health and Vitality

Overview

Healthy forests are able to provide ecological, economic and social functions while maintaining biodiversity. Healthy forests can adapt to change and recover from disturbance. The frequency and intensity of these disturbances are important parameters to consider. Whether from natural or human causes, forests can change in ways that reduce or imperil benefits important to society including provision of clean water, wildlife habitat and raw material for wood products and mitigation of pollution.

Diseases and insects, climate change, air pollution, catastrophic events, invasive plants, fire, and improper care and management (for urban trees) impact forests. The forest ecosystem requires monitoring for the incidence, severity and impact of these factors. Metrics associated with the acute and chronic impact of insects, diseases, exotic plants, air pollution, climate change, and fire provide critical information needed to address forest health and sustainability issues.

Fire can be extremely dangerous or beneficial to the health of forests. Due to the major role humans' play in fire management, this criterion discusses fire suppression activities that protect the health of forests and prescribed fire activities to restore and manage forests.

Over the millennia, fire in the forested ecosystems played a major role in the spatial patterns, composition and structure of Wisconsin's forests. Since the early 1900's, however, DNR and its predecessors have taken an aggressive forest fire suppression stance to maintain forests and protect lives and property. Adding to the complexity of the picture, residential development in forested areas grew at exponential rates in recent decades. On average, 1,700 fires now burn about 6,000 acres in the state annually.

The choice to aggressively fight wildland fire has direct effects on fire dependent ecosystems. A counter-balance to the suppression of fires is prescribed burning. It is a management tool to assist in selectively bringing fire back to fire dependent ecosystems that otherwise would be difficult to sustain.

Indicators

> **7. Area of forest land affected by potentially damaging agents**
> **8. Area and percent of forest land subject to levels of specific air pollutants that may cause negative impacts on forest ecosystems**
> **9. Wildfire impacts on forest resource sustainability**

Major Conclusions[1]

1) Invasive plants and disease on rural and urban lands are a concern.

Tracking non-native and invasive plants consistently across boundaries and communicating across ownerships is a challenge.

- Exotic and invasive pests such as the emerald ash borer, hemlock woolly adelgid and beech bark disease are posing a significant threat to the health of ash, hemlock and beech and the forest ecosystems they inhabit. Combinations of invasive insects could have a potentially devastating impact, especially on northern forests and southeastern cities.
- A focused effort on management activities that reduce the forest's susceptibility to invasive pests is needed.
- Aggressive non-native plants are negatively impacting forest regeneration across the state, and potentially harmful species continue to arrive. The lack of consistency and accuracy of invasive plant data and the methods used to collect the data makes analyzing the extent and condition of invasive species difficult.
- Wisconsin's urban forests are generally healthy and vigorous, yet specific stressors could have significant impact on future urban tree mortality. Emerald ash borer poses a mortal risk to 20% of urban trees. The predominance of a limited number of other urban tree species increases the risk of susceptibility to new invasive species that have not yet arrived in Wisconsin. For example, Asian Long Horned Beetle could decimate the even higher percentage of maple trees in our urban areas.

2) The challenges presented by wildland fires are changing, and adjustments in how managers respond will be needed to continue to effectively address the threat caused by wildland fires.

- The principle causes of wildfires have changed over time. Because of technological improvements, railroads are causing fewer fires. The number one cause of wildland fires is debris burning of various kinds. A new automated burning permit system is intended to reduce the number of fires caused by debris burning.
- Due to successful wildland fire suppression and additional tree mortality from invasive pests, fuel loads are increasing risk of severe fires requiring more resources and changing tactics to suppress.
- Changing weather patterns are increasing the extremes of fire conditions and behavior. Gathering enhanced weather information would improve the capacity to forecast fire conditions and understand the extent and impact of climate change.
- Development between wildlands and urban areas, called the Wildland Urban Interface (WUI), is increasing exposure of improvements to wildland fire.

3) Fire dependent community types are seldom being renewed with prescribed fire due to cost, risk and air quality concerns.

[1] (Items in bold are conclusions drawn by reviewing statements of finding from the Assessment. The bulleted items below each conclusion are the findings).

The scarcity of fire will affect biological diversity and habitat for specific species.

- Additional research on the timing, intensity, and effectiveness of different types of controlled burn activities could help land managers use this tool more effectively.
- The DNR's goals for maintaining biological diversity, especially for native prairie, oak savanna and barrens species, will be difficult to attain without more emphasis on prescribed burning.
- Non-burning alternatives to prescribed fire such as fuel removal through biomass harvests, mechanical site preparation, improved artificial tree regeneration, and herbicide use may be necessary to improve biological diversity and achieve forest management goals in some vegetative types.

4) Long-term climate related changes in temperature and precipitation will directly and indirectly impact the health and vitality of Wisconsin's forests.

Based on observed and modeled climate change, Wisconsin will become warmer in the decades to come. Affects could be most dramatic in the northern half of the state.

- Wisconsin's forests occupy a unique position in the Great Lakes region because many of its tree species exist on the edge of their natural ranges. Transitions are likely as temperature and precipitation change. Some species could be pushed outside of their genetic limits, and others afforded a more favorable growing environment.
- Spread and persistence of invasive and exotic species are likely to increase if climate change results in additional stress on Wisconsin's native vegetation.
- Increased winter temperatures and frequencies of extreme precipitation events will likely result in additional tree stress and increases in the amount and frequency of forest disease and pest infestations in Wisconsin.
- The combination of higher temperatures and land-use changes could increase the fuel loads in Wisconsin's forest increasing the likelihood of wildfire and the need for the strategic use of prescribed fires and other fuel reduction management activities.
- Air quality restrictions related to human health concerns could increase under warmer climatic conditions and restrict the extent and timing of prescribed fire.
- Wisconsin's cities experience an urban heat island effect, and climate changes could exacerbate the problem. The urban tree canopy will be important in helping mitigate this effect.

7. Area of forest land affected by potentially damaging agents

7.1 Tree mortality

Tree mortality, although a natural part of a developing forest, can also be an indicator of an unhealthy ecosystem. Analysis of tree mortality over time is required to understand the levels of mortality that are considered within a normal range and levels that are indicative of an unhealthy forest. Monitoring tree mortality is key to understanding the impact of biotic agents.

Total tree mortality has not changed significantly since 1996 (Figure 7.a) but certain species have experienced elevated mortality (Table 7.a). For instance, paper birch, balsam fir, elm, aspen, jack pine and black spruce have experienced mortality rates far above the average for all species. The exact cause of this mortality is not clear. It is likely that many factors have influenced the health of these species including the limits of biological age, drought, insects and diseases and potentially an increase in the winter temperatures.

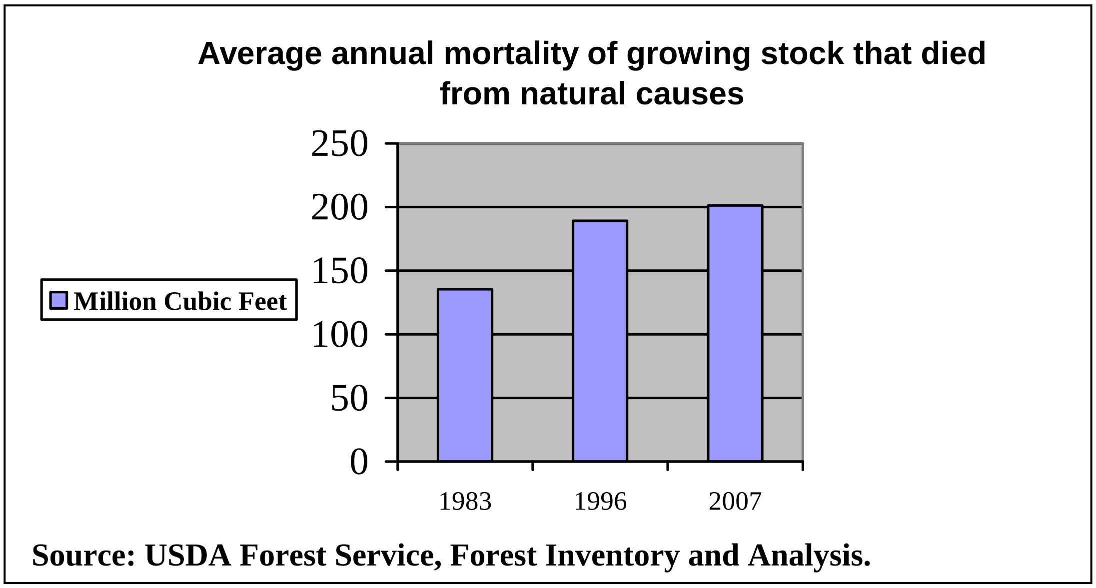

Figure 7.a: Average annual mortality of growing stock that died from natural causes in 1983, 1996, and 2007
Source: FIA, 2007

Table 7.a: Mortality, gross growth and ratio of mortality to gross growth 1996-2007

Species	Annual Mortality (million cft)	Annual Gross Growth (million cth)	Ratio of mortality to gross growth
Paper Birch	17.0	18.0	97%
Balsam Fir	19.0	26.0	75%
Elm	20.0	29.0	70%
Aspen	54.0	123.0	44%
Jack Pine	6.0	12.0	49%
Spruce	5.0	16.0	33%
Yellow Birch	2.0	6.0	34%
Red Oaks	23.0	90.0	25%
White Oaks	6.0	30.0	20%
White Pine	7.0	60.0	12%

Ash	7.0	51.0	14%
Hemlock	2.0	10.0	21%
Basswood	4.0	30.0	14%
Soft Maple	9.0	85.0	11%
Hard Maple	5.0	62.0	8%
Hickory	2.0	11.0	19%
Red Pine	2.0	70.0	3%
Total[2]	**201**	**793**	**25.4%**
Source: USDA Forest Service, Forest Inventory and Analysis			

<u>Urban forest tree mortality and health</u>
The statewide assessment of urban forest health began in 2002 with a national urban forest health monitoring program pilot carried out in partnership with the USDA Forest Service. As this was baseline data, mortality and health trends are not yet available. However, the data provides indicators of the current health of Wisconsin's urban forests.

Crown measurements evaluate the growth and vigor of the crown, as a whole, of each tree. Crown dieback is demonstrative of tree health and is defined as recent mortality of small branches and twigs in the upper and outer portion of the tree's crown. Both hardwood and conifer trees with crown dieback greater than 25 % may be in decline. Over 95% of urban trees have a dieback less than 25 % (Cumming, et al. 2007). Crown density is an estimate of the crown condition of each tree relative to its potential, by determining the percentage of light blocked by branches and foliage. Crown density reflects gaps in the crown that may have been caused by declining tree health. For hardwoods and conifers, density estimates less than 30 percent generally indicate the tree is in poor health. The majority of Wisconsin's urban trees (90%) exhibits a crown density greater than or equal to 30% (Cumming, et al. 2007).

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[2] Totals include all species. There are minor species (i.e. hickory, cottonwood) that are not included in the table.

Damage indicators of urban forest health
At least one type of damage appeared on 19 percent of all trees sampled in urban plots. Species showing the greatest amount of damage included *Fraxinus americana*, *Acer negundo*, *Populus tremuloides*, *Picea glauca*, and *Acer platanoides*.

Table 7.b: Most common types of urban damage and frequency of damage type among trees with urban damage

Urban damage type	**Frequency**
Stem decay	23%
Other human damage	11%
Butt rot	10%
Hypoxylon canker	10%
Included bark	10%
Poor pruning	10%

(Source: Cumming, et al. 2007)

Forest health monitoring damage indicators do not fully capture information about damage types and agents found in urban areas. Of all the urban trees sampled, 9 percent showed some type of urban damage. The most common urban damage encountered was stem decay (Table 7.b). Wood decay is a serious concern in urban areas, since its presence increases the potential for tree failure. The specific cause of decay or initiating factors has not been identified.

Overall the trees in Wisconsin's urban forest are healthy and vigorous. However, specific stressors could have significant future impact on urban tree health and mortality. Two are most notable: 1) emerald ash borer poses a mortal risk to 20% of urban trees and 2) the prevalence of butt and stem decay is likely to result in substantial urban tree removal because of the potential public safety impact and also tree loss due to storms.

7.2 Catastrophic events
In Wisconsin, catastrophic events affecting forests include flooding, tornadoes, or storms that produce high speed winds (>100 mph). This type of event occurs annually on a small scale, affecting localized groups of trees. Large-scale impacts (>5,000 acres of forest land affected) occur less frequently.

Impacts of flooding are variable depending on the length of time trees are subjected to saturated soil, age of tree and depth of water. Seedlings and saplings are more susceptible to flooding than older trees; conifers are more susceptible to adverse impact than hardwoods. Some species such as silver maple, green ash and willow tolerate saturated soils for several weeks without noticeable impact. Tracking flooding events has become more important in the last decade as climate change begins to influence weather events that cause damage to trees. Monitoring trends will provide information needed for forest managers to reduce the impact of flooding through species selection and management.

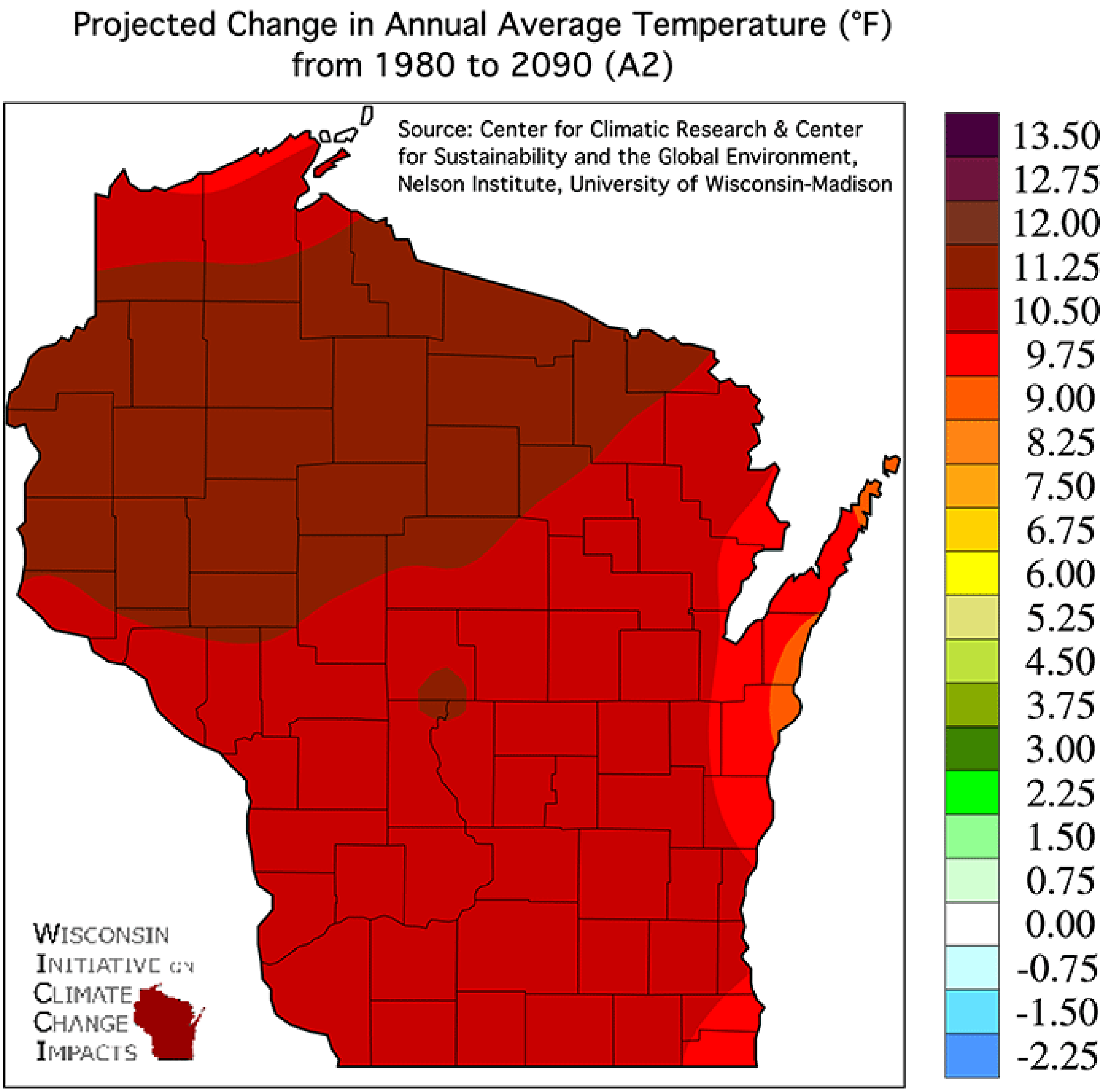
High winds cause damage to trees including uprooting and stem breakage. Forest stands that are uprooted are often very challenging to reforest given the extreme level of site disturbance.

Timber types can be dramatically changed from late to early succession. If salvage is delayed, the economic value of affected stands is decreased or lost due to timber stain and decay. Stem breakage creates large wounds (>50 square inches) that lead to stain, decay and degrade in wood quality.

Catastrophic events such as flooding and high winds are tracked through state and national databases. Data on the extent of these events and in some cases, the impact, have been collected and summarized in the annual report of the forest health protection program yet no standards have been implemented for documenting these events. Methodology for capturing the impact of catastrophic events on Wisconsin's forests in more consistent format should be developed and implemented.

7.3 Climate

Climate models endorsed by the Intergovernmental Panel on Climate Change (IPCC) show a continuing upward trend in warming. Without actions for intervention, average temperatures are projected to rise between 2 and 6 degrees Celsius by 2100 (IPCC, 4th assessment). To put this into context, a 2 degree warming is expected to have irreversible impacts on natural systems, including a 30 percent increase in plant and animal extinctions (IPCC, 4th assessment). These same models have been downscaled to the state level and produce similar results but with more variability across the state, as shown in Map 7.a.



Map 7.a: Modeled changes in annual average temperature
Source: Vimont et al, in review

It is also is important to note that these changes are already occurring over the past thirty years. Figure 7.b below shows that the frost free period in the state has been on the rise since the early 1990s. Figure 7.c shows the Palmer Drought Severity Index, which is a good indicator of drought. In the last decade, Wisconsin experienced three consecutive years of drought in central and northern areas. This is also consistent with Map 7.b

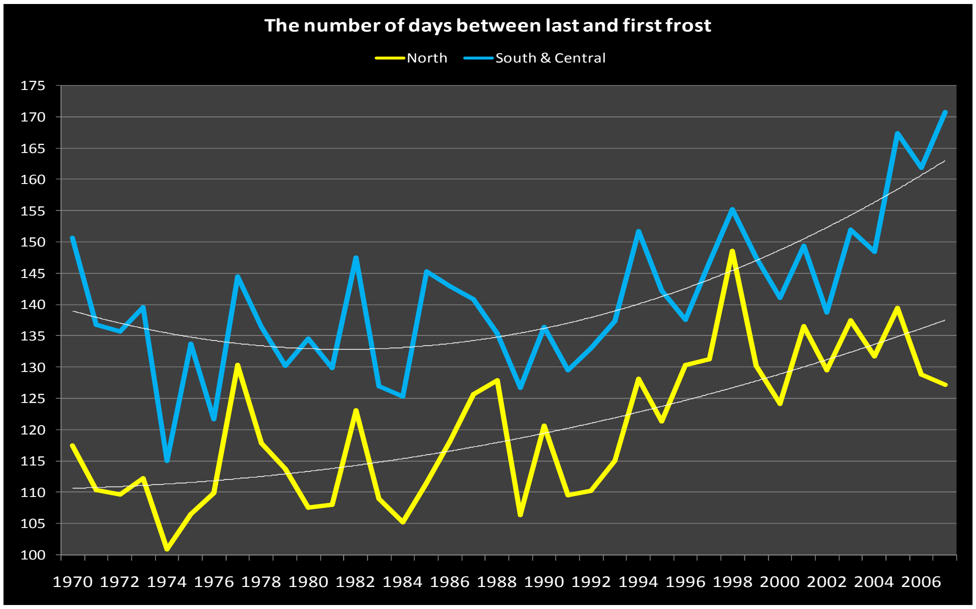


Figure 7.b: Number of days between last and first frost in northern and southern Wisconsin from 1970 to 2005
Source: Wisconsin State Climatologist

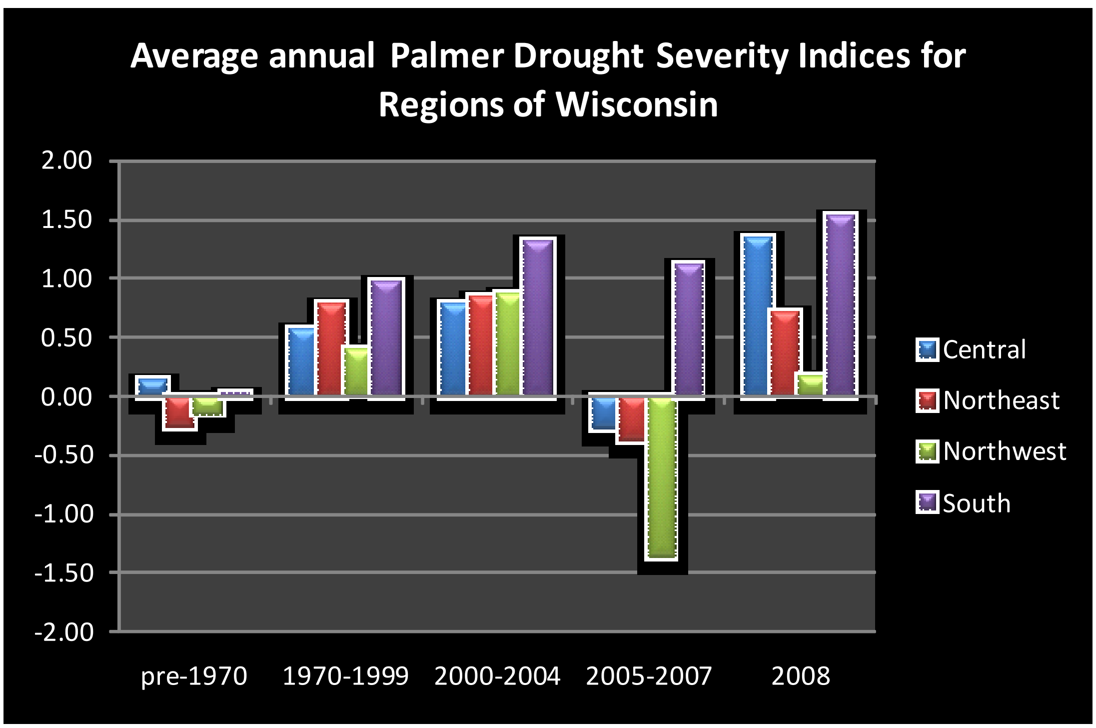
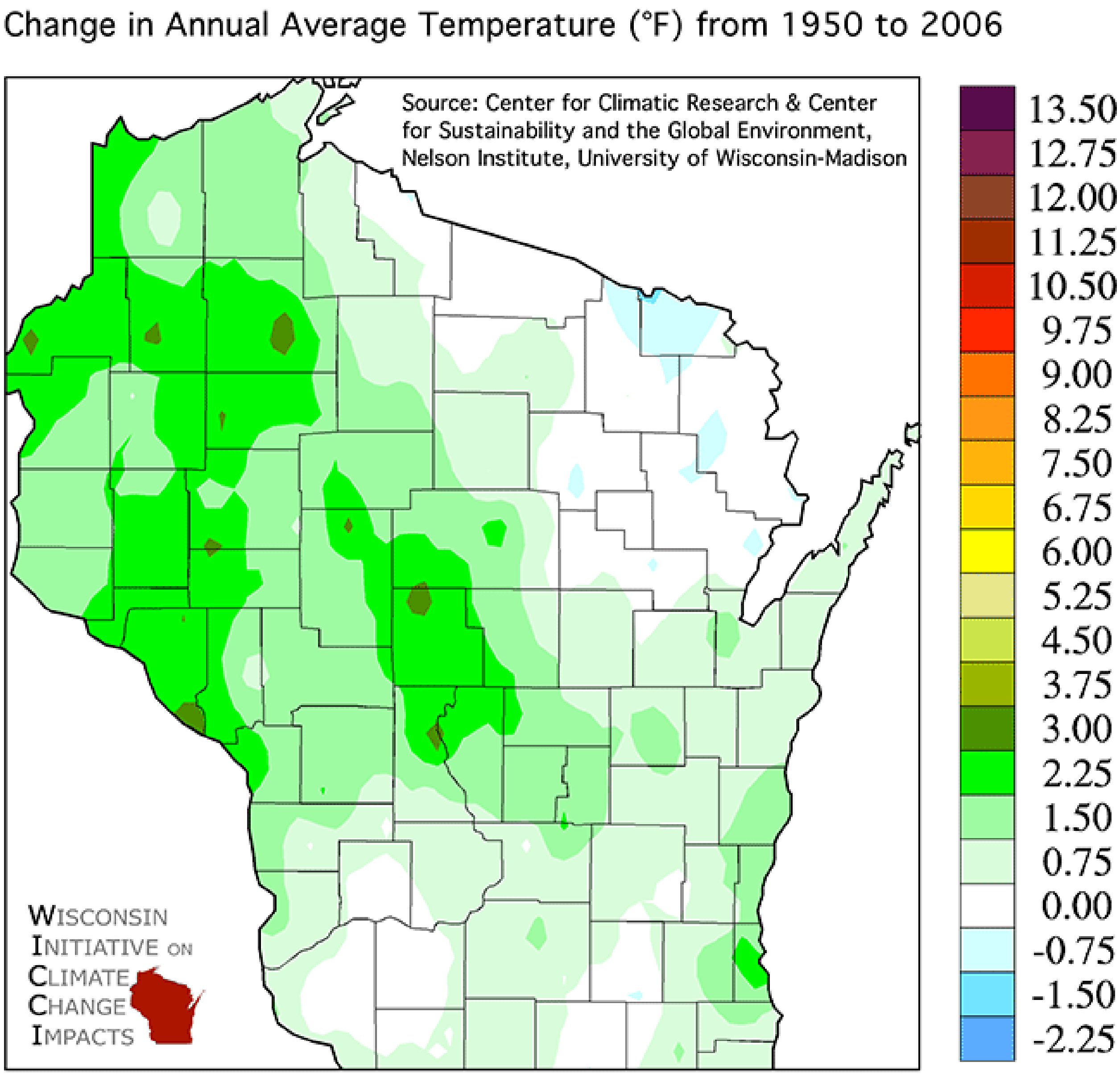


Figure 7.c: Average annual Palmer Drought Severity Indices for Regions of Wisconsin.
Source: Wisconsin State Climatologist



Map 7.b: Observed changes in annual average temperature
Source: Kucharik, in review

Based on observed and modeled climate change, forest ecosystems in the state will be subject to summer droughts, less snow cover and milder winter temperatures, and increases in extreme precipitation events (Lorenz, in review), (Kucharik, in review). These changing temperatures will push species beyond their adaptability limits, inducing heat and moisture stress. These environmental stressors will lessen population resilience to pest and disease outbreaks in northern forest types.

Forest composition in the northern half of the state could be the most affected by climate change. Wisconsin's forests occupy a unique position in the Great Lakes region as many of its tree species exist on the edge of their natural ranges. For example, red pine is at its southern limit, black walnut at its northern limit and American beech at its western limit. Range edges are likely to expand or contract as temperature and precipitation changes, and so some of these species could be pushed outside of their genetic limits and others afforded a more favorable growing environment.

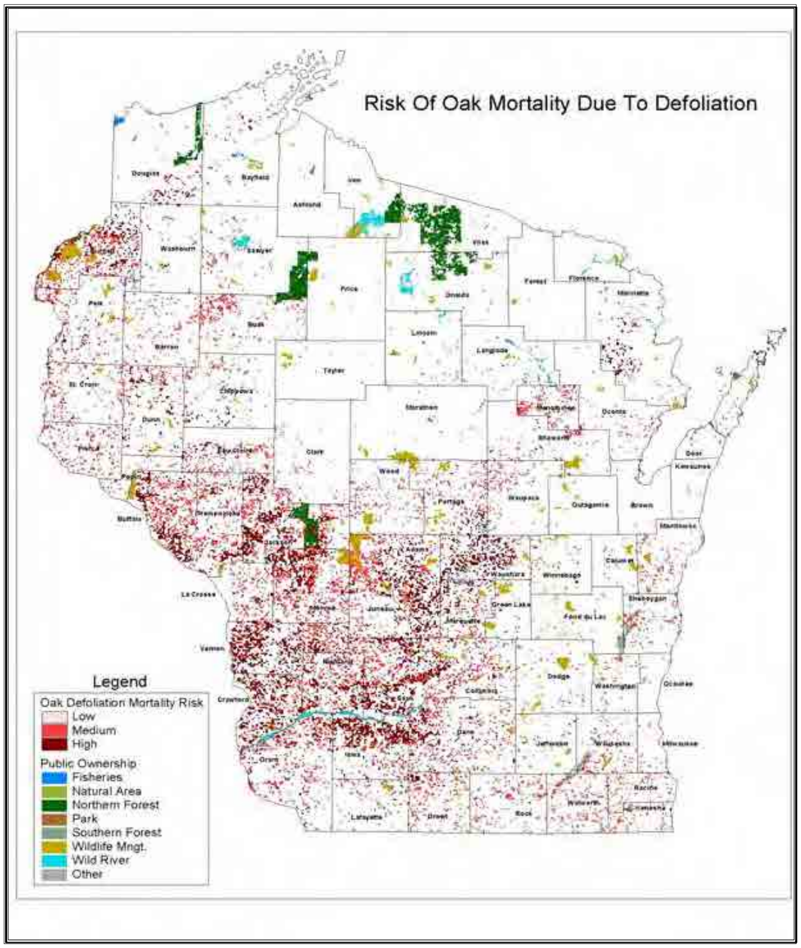
Wisconsin’s natural resources, including forests have been and will continue to be affected by a changing climate (US Climate Change Science Program, US Dept. of Commerce, NOAA 2009). Selected species including paper birch, balsam fir, elm, aspen, jack pine and black spruce have experienced mortality rates far above the average for all species due in part to insects, diseases and climate factors. The direct role of climate change on these mortality rates is not known, yet these species are considered most susceptible to climate change that includes warmer winter temperatures and drier growing seasons. Climate change scenarios from NOAA and WICCI support a continuation of decline and mortality of these species at a rate higher than the average for all tree species.

7.4 Insects and Diseases

Insects and diseases play a variety of roles in the forest ecosystem. At low levels, they kill suppressed, unhealthy trees, contributing to the natural process of forest succession and development and nutrient cycling. Natural cycles with periodic outbreaks and waves of mortality and succession do occur. Several native insects have been documented to reach outbreak levels where large numbers (>5,000) of acres are affected for several years before the insect’s population collapses. Pest cycles can increase tree mortality to a level that negatively affects forest stand stocking levels, clean water, wildlife habitat, and raw material for wood products, creating an unsustainable forest. Monitoring the incidence, severity, impact and location of forest insect and disease populations provides the information needed to focus mitigation strategies and broadens our knowledge on the influence these organisms play on forest ecosystems.

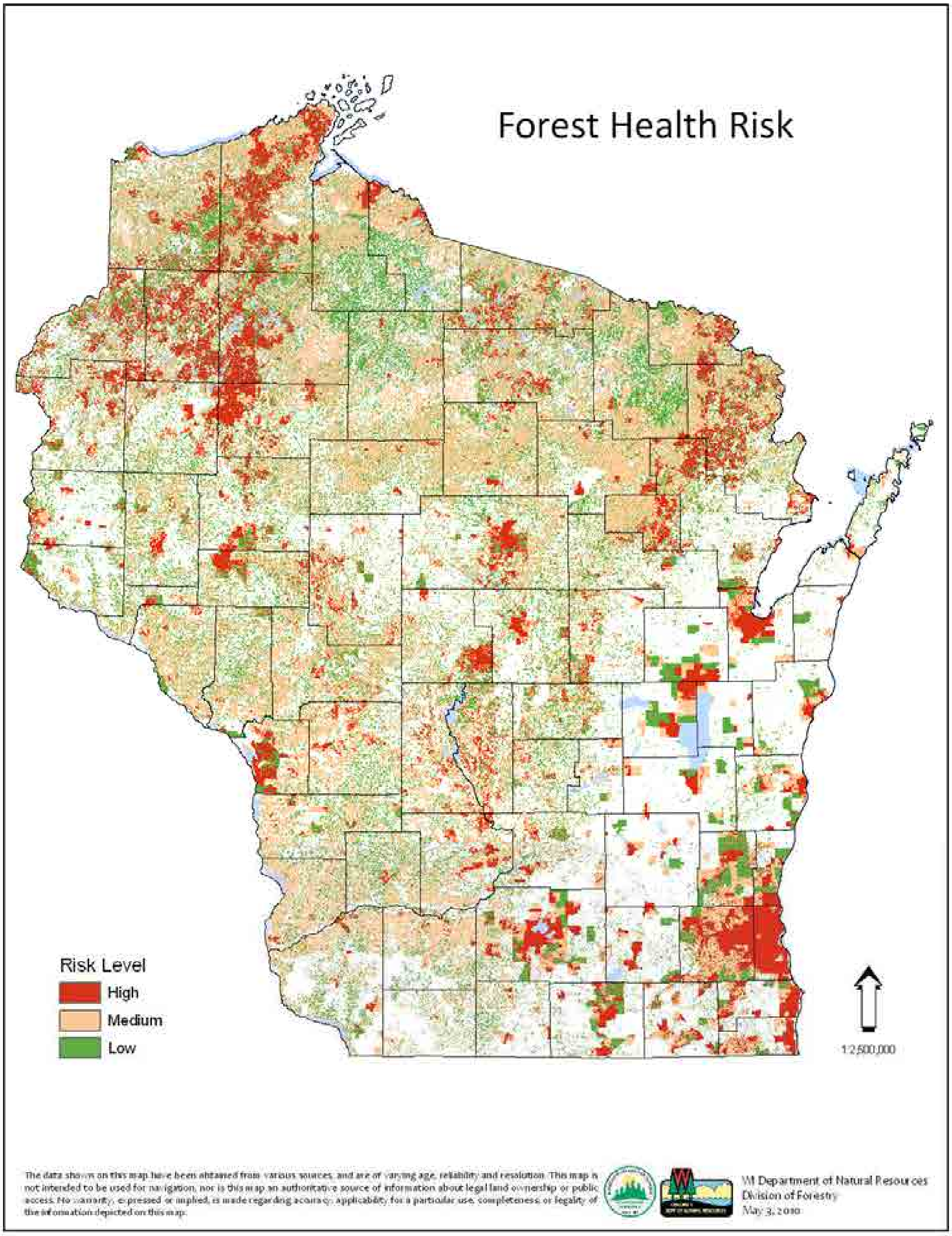
<u>Future Risk</u>

Threats from exotic insects and diseases have increased significantly since 2002. If successfully established, exotics can kill native tree species more quickly than native pests due to the lack of host resistance and biological controls. The hemlock woolly adelgid is known to be present in western Michigan; gypsy moth populations are building in central and southern Wisconsin and within the last year, the emerald ash borer and beech bark disease were found in the state. Recent detections of sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pines. The emerald ash borer has the potential to eliminate ash from the forest environment. There are limited options for reducing the impact of these exotic species yet a focused effort on management activities that reduce the forest’s susceptibility to mortality should be a top priority for Wisconsin’s land managers. Map 7.c illustrates areas of the state that are at risk for oak mortality from defoliation by the gypsy moth and other oak defoliators. Identifying areas at risk is an excellent tool for forest managers to use when prioritizing areas for mitigation. Risk assessments and maps can also provide valuable information for locating early detection surveys.



Map 7.c: Future risk of mortality to oak due to defoliation by gypsy moth and other summer defoliators
Source: DNR, 2009

Wisconsin's forests are at risk of mortality by both native and exotic insects and diseases. Map 7.d illustrates areas at various levels of risk of experiencing 25% or more tree mortality over 15 years from a combination of pests. Native forest insects and diseases contributing to risk of mortality include forest tent caterpillar, oak wilt, jack pine budworm, Diplodia shoot blight and canker, red pine pocket mortality and pine bark beetle. Exotic insects and diseases contributing to risk of mortality include gypsy moth, hemlock woolly adelgid, beech bark disease, sudden oak death and emerald ash borer.



Map 7.d: Areas at low, moderate, and high levels of risk for experiencing 25% or more tree mortality over 15 years due to native and exotic insects and diseases
Source: DNR, 2009

Diseases that kill forest trees have long played an important role in forest succession, reducing tree density in overstocked stands, creating openings in the canopy that encourage successful regeneration and providing down woody material. In some cases, trees diseases can cause such high levels of mortality that a species may be reduced to only a few individuals on a site or statewide. Butternut canker, caused by the fungus *Sirococcus clavigignenti-juglandacearum*, has infected more than 95% of Wisconsin's butternut trees, significantly limiting the presence of this species. Oak wilt, caused by the fungus *Ceratocystis fagacearum*, is widespread in southern Wisconsin where red and black oak in both rural and forest settings are at risk from infection and mortality. The ecological impact of oak wilt has not been determined but efforts are underway to assess the impact of this disease. Annosum root rot, caused by the fungus, *Heterobasidium annosum*, is a significant threat to the health of pine plantations. Both oak wilt and annosum root rot can cause high levels of mortality within a forest stand; preventative measures have been developed for both of these diseases. Implementing these measures is critical to limiting their impact. Development of policy and guidance related to management of forest diseases provides an important link between scientifically-tested management practices and implementation of those practices.

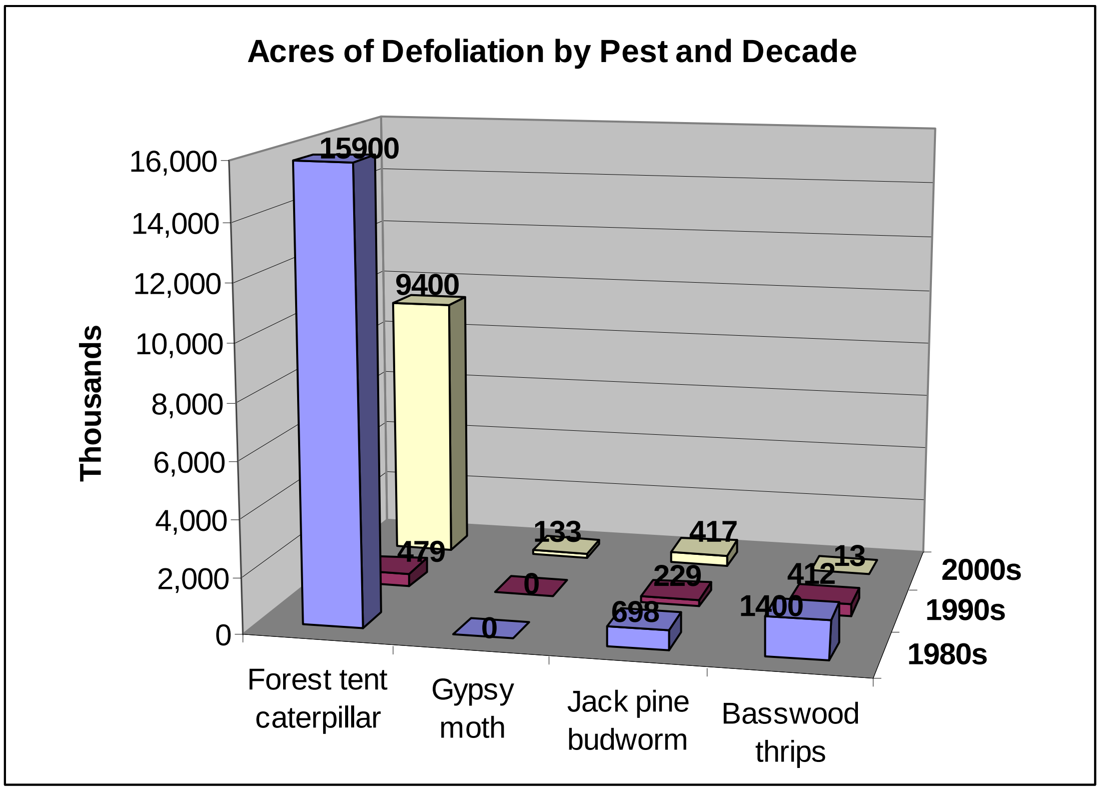
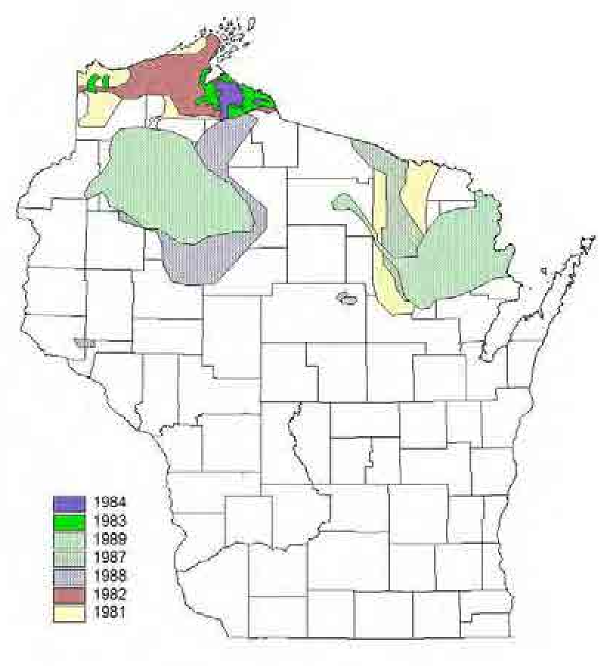
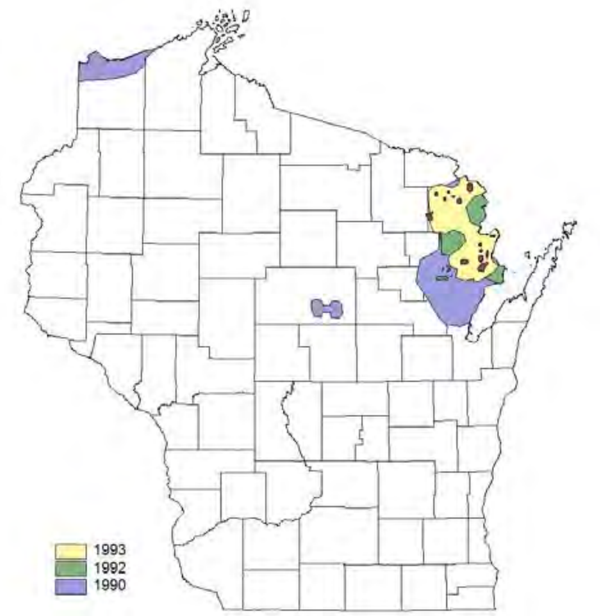


Figure 7.d: Acres of forest land defoliated by forest tent caterpillar, jack pine budworm, basswood thrips and gypsy moth by decade. (DNR, 2009)

The forest tent caterpillar, *Malacosoma disstria*, is a native insect that feeds primarily on oak and aspen in northern Wisconsin. Feeding typically occurs early enough in the summer for trees to produce a second compliment of leaves. Extensive areas of Wisconsin's forests have been defoliated by this insect, with outbreaks typically lasting 3 years. The number of years between outbreaks varies widely (Map 7.e, 7.f, and 7.g). When defoliated trees refoliate, a reduction in stored carbohydrates occurs. This stress, combined with drought, disease such as Armillaria root disease or other defoliators can lead to tree mortality. Factors contributing to the collapse of populations of the forest tent caterpillar include cool, moist weather during caterpillar development, availability of host material and parasitism by Sarcophaga aldrichi.



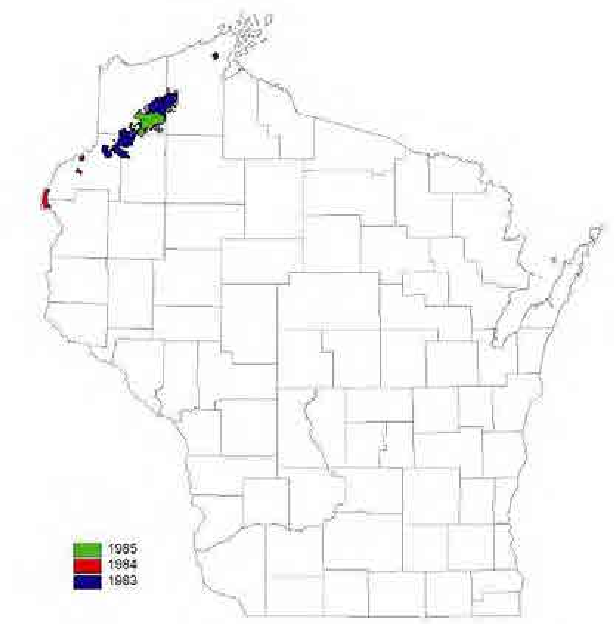
Map 7.e Area of forest land defoliated by the forest tent caterpillar in the 1980's
Source: DNR, 2009



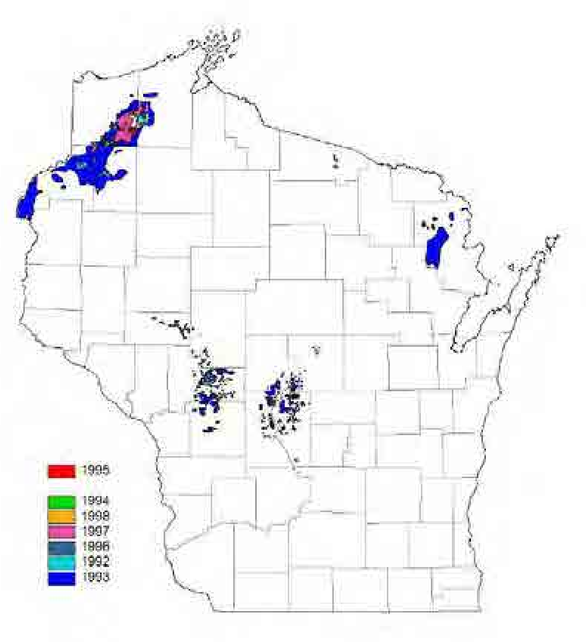
Map 7.f Area of forest land defoliated by the forest tent caterpillar in the 1990's
Source: DNR, 2009

Map 7.g Area of forest land defoliated by the forest tent caterpillar in the 2000's
Source: DNR, 2009

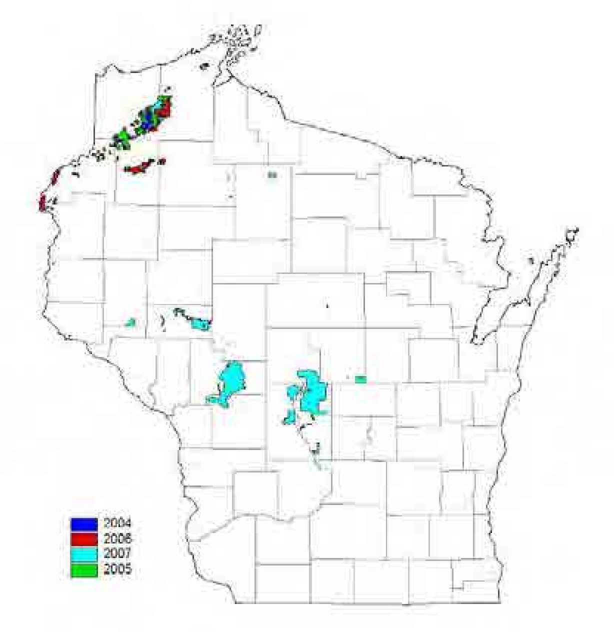
The jack pine budworm, *Choristoneura pinus*,is a native insect and is the most important defoliator of jack pine. Areas of defoliation have been documented since the mid-1950's (Map 7.f, 7.g, and 7.h). Since 1954, there have been 5 outbreaks where defoliation was extensive. Approximately half of the Northwest Sands ecological landscape and 10% of the Northeast Sand and Central Sand Plains ecological landscapes were defoliated in the 1990's. The severity of injury from budworm feeding is uneven across the landscape from year to year. Resulting tree mortality depends not only on the amount of foliage consumed but also the number of sequential years of feeding. Like the forest tent caterpillar, factors contributing to the collapse of populations of the jack pine budworm include cool, moist weather during caterpillar development, availability of host material and parasitism by several species of insects.



Map 7.h Area of forest land defoliated by the jack pine budworm during the 1980's
Source: DNR, 2009

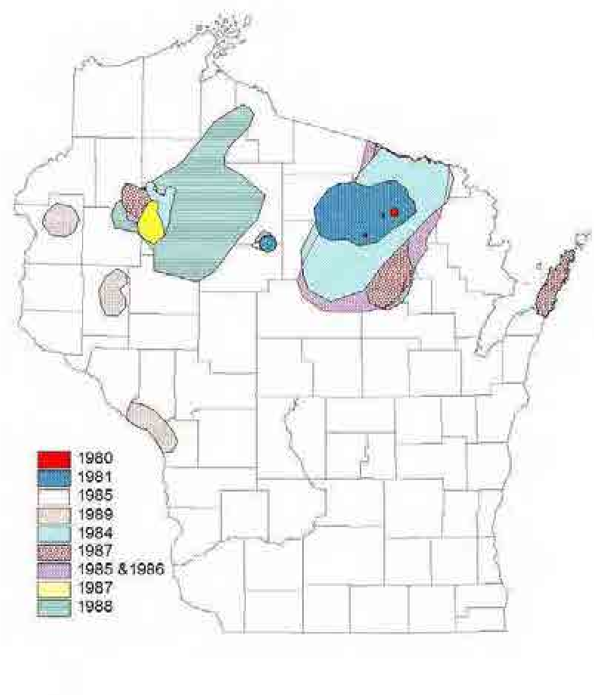


Map 7.i Area of forest land defoliated by the jack pine budworm during the 1990's
Source: DNR, 2009

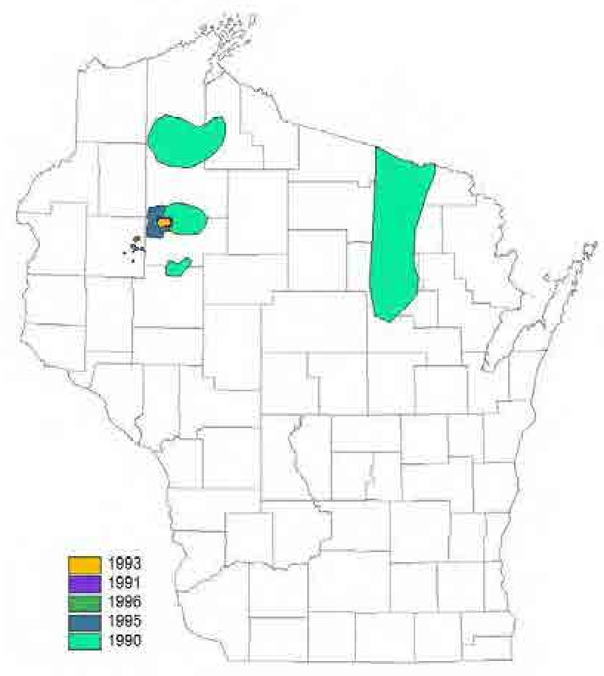


Map 7.j Area of forest land defoliated by the jack pine budworm during the 2000's
Source: DNR, 2009

The introduced basswood thrips, *Thrips calcaratus,* defoliates American basswood in early spring as the leaves are beginning to unfold from the bud. Affected trees may have leaves that are stunted and discolored. Heavy feeding in sequential years can cause a decrease in radial growth. This exotic insect is native to Europe and was first observed in Wisconsin in the late 1980’s. Information related to factors that cause a collapse in the thrips population is not known.



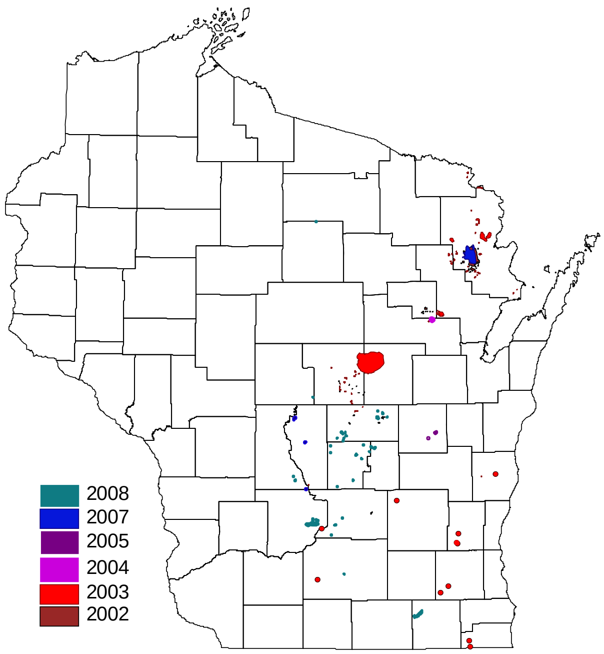
Map 7.k Area of forest land defoliated by basswood thrips during the 1980’s
Source: DNR, 2009



Map 7.l Area of forest land defoliated by basswood thrips during the 1990’s
Source: DNR, 2009

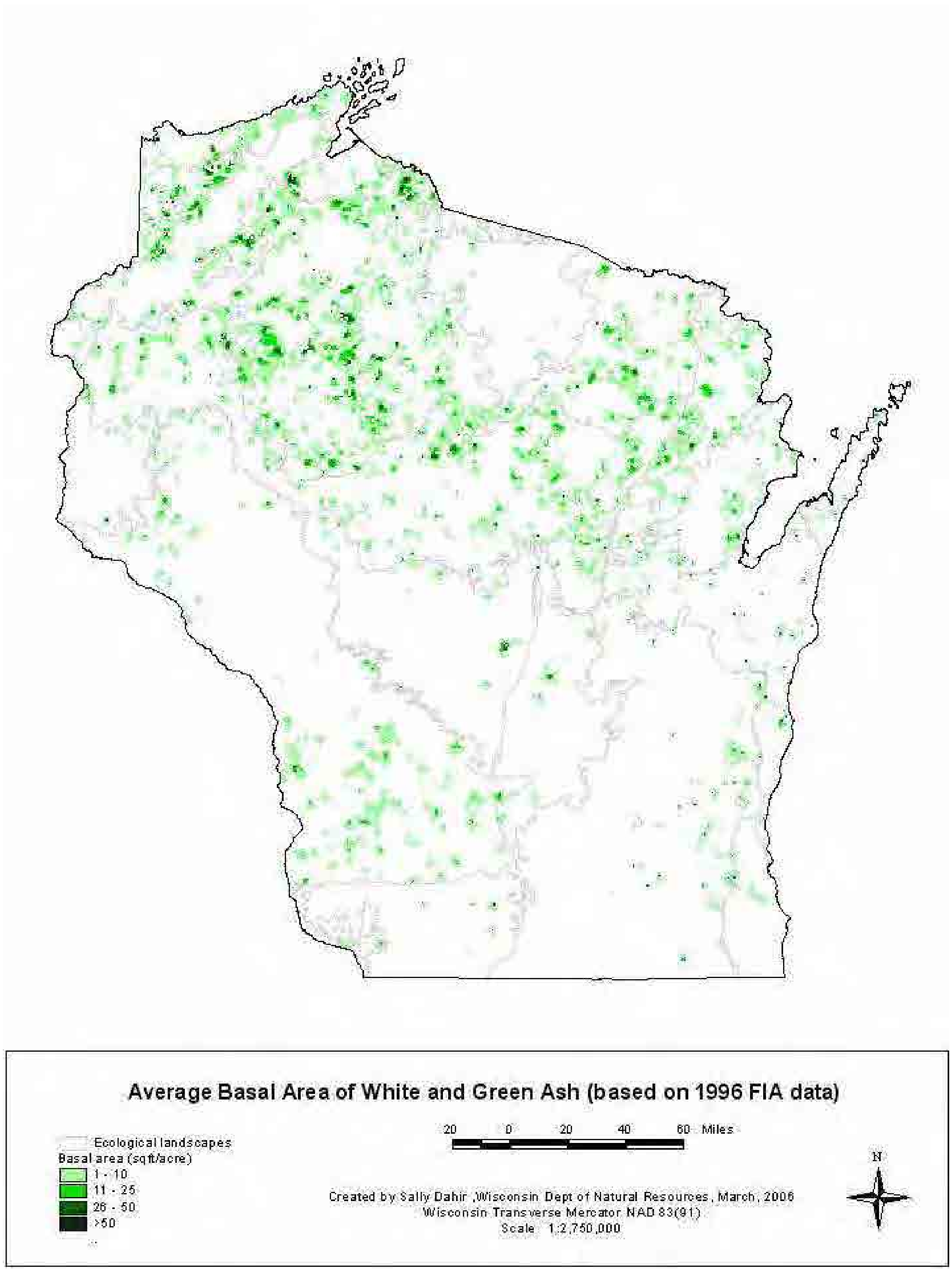
Map 7.m Area of forest land defoliated by basswood thrips during the 2000's
Source: DNR, 2009

The European gypsy moth, *Lymantria dispar*, is an exotic insect that has been known to be in Wisconsin since the 1990's and is currently spreading from east to west across the state. The gypsy moth will feed on over 200 species of trees but the most significant impact of feeding is expected to occur to all of Wisconsin's native oak species. Radial growth loss is the most common impact of feeding by the gypsy moth. Seedlings, and trees that are stressed by drought, defoliation by other insects and any other factors that induce stress, are most susceptible to incurring dieback and eventual mortality. Factors contributing to the collapse of populations of the gypsy moth include cool, moist weather during caterpillar development, availability of host material, predation and parasitism by several species of insects and infection of caterpillars by fungi.

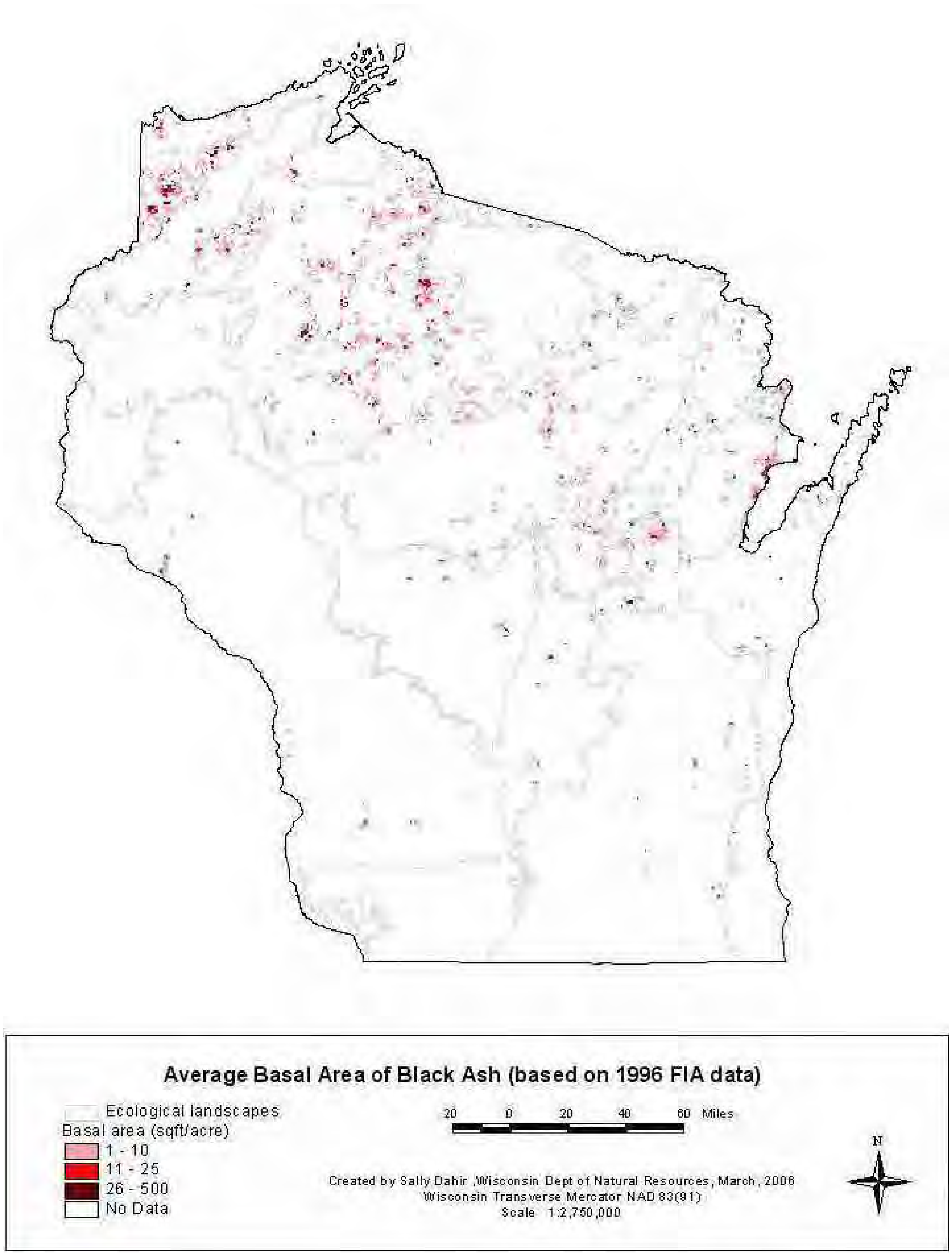


Map 7.n: Area of forest land defoliated by the gypsy moth, 2002 – 2008
Source: DNR, 2009

The emerald ash borer (EAB), *Agrilus planipennis*, is an exotic insect that was first observed in Wisconsin in 2008. EAB is native to eastern Russia, northern China, Japan, and Korea. As of August 2009, EAB was found in Vernon, Crawford, Kenosha, and Brown counties. Unfortunately, new EAB locations are continually being found. For the most up-to-date information, see Wisconsin's Emerald Ash Borer Information Source (http://www.emeraldashborer.wi.gov/). There are over 700 million ash trees (>1" in diameter) in Wisconsin's forests. Approximately 5.2 million urban trees, about 20% of all trees in Wisconsin's cities and villages, are ash. Some communities report ash components as high as 55% of all public trees. Once emerald ash borer is in an area, options for minimizing tree mortality are limited. A lack of effective early-detection tools contributes to this problem. Pursuing strategies to reduce the impact of EAB before it becomes established can help minimize the cost of removing, processing and utilizing large volumes of dead and dying ash.



Map 7.o: Average basal area of white and green ash
Source: FIA, 2006



Map 7.p: Average basal area of black ash
Source: FIA, 1996

White and green ashes are a component of several timber types including northern hardwoods, central hardwoods and bottomland hardwoods (Map 7.o). Black ash is a significant component of ash swamps in northern Wisconsin. (Map 7.p) The widespread distribution of ash in urban and rural forests will require extensive planning and funding of activities that reduce the impact of EAB through treatment with pesticides or removal and replacement of ash in urban settings or reduction in ash density in rural forests.

The density of ash in forest lands varies widely with approximately 65% of forest land with ash having <20% of the basal area as ash. Forests having >20% of the basal area as ash may be impacted to a level that sustainability is threatened without intervention with activities that encourage regeneration of non-ash species. Of particular concern are lowland, wet mesic and mesic sites where regeneration practices are not well developed and the number of tree species that grown on these sites is more limited than drier sites.

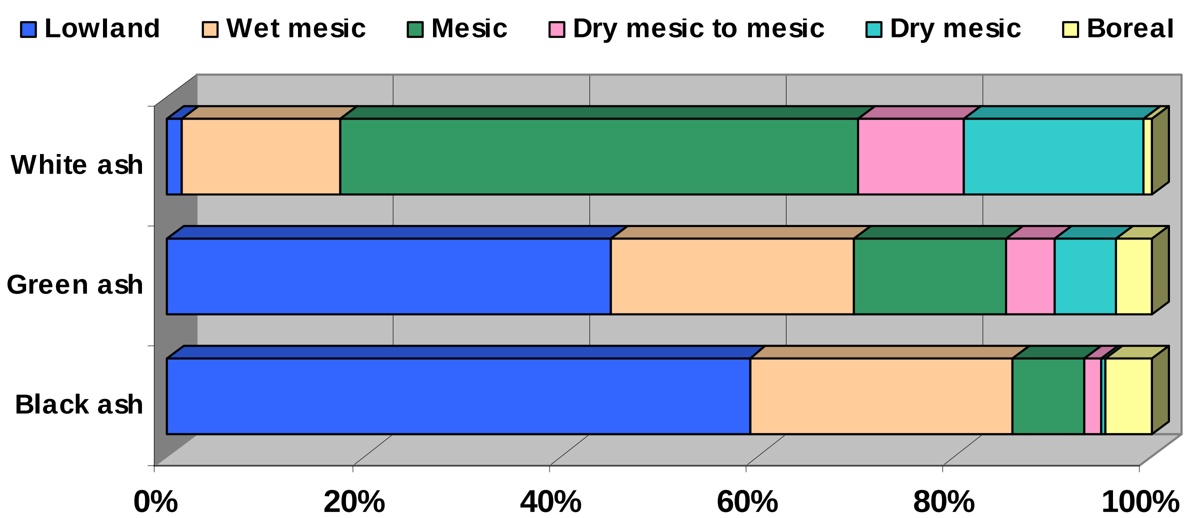


Figure 7.d: Percent of acreage by habitat type for FIA plots with a relative density of 10% or more
Source: FIA, 2007

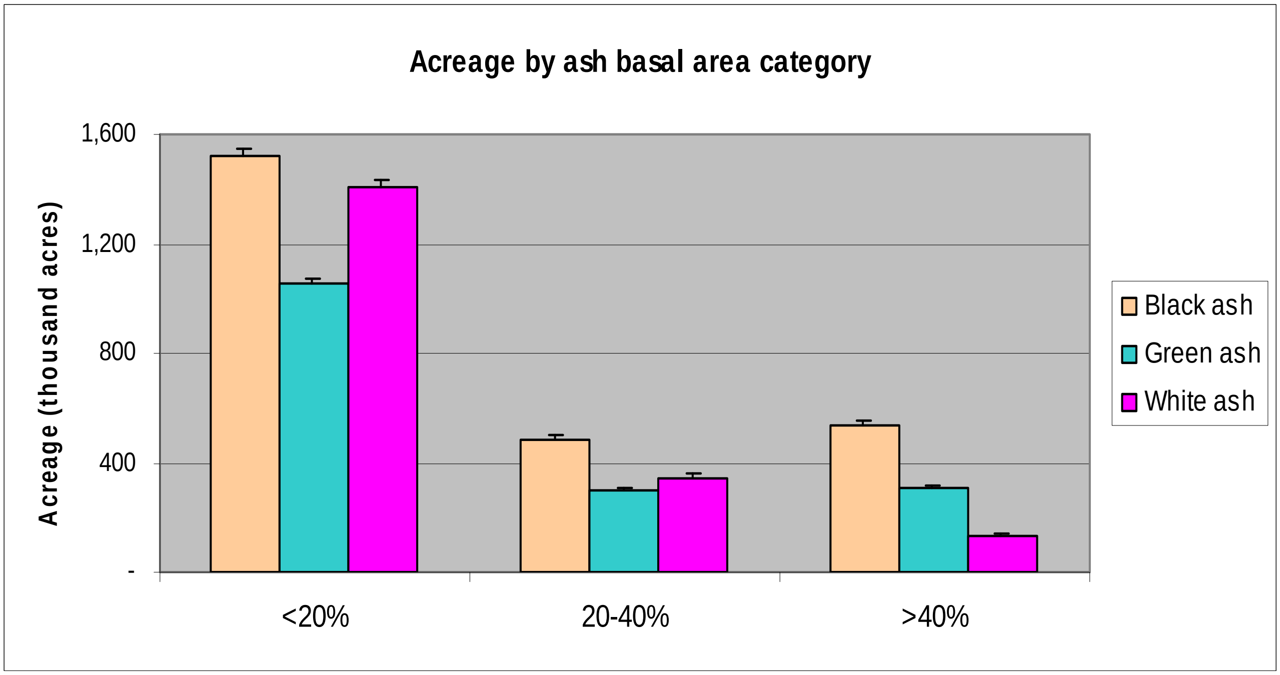


Figure 7.e: Number (in thousands) of acres of black, white and green ash by three basal area categories

Source: FIA, 2007

7.5 Invasive Plants

Invasive plants, both exotic and native, have been recognized as a threat to forest sustainability and are clearly an emerging issue in forestry. Aggressive non-native species are impacting forest regeneration in many parts of the state, and potentially harmful species continue to arrive. As the exchange of products and people continues unabated around the world, there is an increasing awareness that non-native, invasive plants are causing serious problems wherever they are found. Called by some the "least reversible" of all human impacts, exotic invasive species invasions can cause great harm to the environment, economies, human health, and aesthetics. Such invasions threaten biological diversity by producing population declines of native species, as well as altering key ecosystem processes like hydrology, nitrogen fixation, and the fire regime (White and Brittion, 1997).

Humans play a large part in accelerating the spread of invasive plants in forested communities and their detrimental effect on sustainability. Common threats and issues include the globalization of our society and increased pressure on land which causes disturbance, continual introduction of species, man caused spread, and spread by nature.

Despite a fair amount of research by scholars, land managers and other interested individuals, there is little information that quantifies the ecological and/or economic effects of these plants. In spite of this, it is useful to consider the anecdotal, qualitative, and scattered measures of quantitative information that these studies offer. Most studies attempt to illustrate how invasive plants affect forest regeneration, species richness, biodiversity, ecosystem processes, and nest predation.

The DNR, Division of Forestry underwent a study in 2005 on invasive plants in forests. The results identified several species that are of greatest impact to Wisconsin's forests. These include garlic mustard, buckthorns, Eurasian bush honeysuckles, reed canary grass, Japanese barberry, black locust, multiflora rose, dame's rocket, autumn olive, Japanese knotweed, leafy spurge, spotted knapweed, and Oriental bittersweet. Specifically, ash, beech and hemlock are at risk of experiencing a high level of mortality from exotic pests.

Invasive plant inventory data has been gathered for many years in Wisconsin and by many different sources. While this is beneficial and critical in assessing threats and trends, the data is generally not complete and is not consolidated into one location to best utilize the data.

The following inventory data is ongoing:
1- FIA has been collecting invasive woody and shrub data each year since 2000 in a complete 5 year cycle. In the future, these efforts will be expanded to include some herbaceous plant data. FIA data are available from the USFS through a web-based system. FIA data can be used to look at statewide trends; there are not enough plots in the state to draw conclusions about an area land base that is smaller than the state.

2- In 2006 and 2007, DNR, Division of Forestry conducted an assessment of invasive plants at specific locations on state-owned forests. Locations included heavily traveled and used areas such as: trail heads, trails, roads, campsites, etc. This data is available from the DNR website. Inventory will continue in varied amounts at the state-owned forests to supplement the existing data.

3- The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) have been conducting inventories and gathering data for the entire state for many years and is currently the best resource for statewide invasive plant inventory data. GLIFWC data are available from GLIFWC through a web-based system.

4- There are many other organizations and agencies involved in an attempt to collaborate and consolidate invasive plant inventory data. In particular, the National Institute of Invasive Species Science (NIISS) is taking the lead on developing a website application that will be able to link all of the other databases in Wisconsin. These include: DNR, Invasive Plants Association of Wisconsin (IPAW), UW-Herbarium, and the several Cooperative Weed Management Areas (CWMA). NIISS and the UW-Herbarium data are also available through web-based systems.

There is no consistent, common dataset to accurately assess the distribution and therefore the threat of invasive plant species. However, the NIISS application is intended to be the link between the many databases that exist. Wisconsin's Sustainabilty Framework ranked this data need as one of the critical gaps in knowledge (See Data Gaps Appendix H). The GLIFWC database is the most comprehensive database to date. The DNR, Division of Forestry is also going to be conducting inventories on a more regular basis; however, it will not be a statistically viable inventory. The purpose of these inventories is to have a place based inventory that will inform everyday activities and bolster the existing inventory.

The following figures illustrate the differences between data sets. The first example (Figure 7.f) is pulled from the UW-Herbarium website for Japanese Knotweed (*Polygonum cuspidatum)* distribution. The second and third maps are from the GLIFWC (Figure 7.g) and NIISS (Figure 7.h) website, respectively. The first and second indicates that 23 counties contain *Polygonum cuspidatum* while the third shows 33 counties. Furthermore, the DNR is in the process of writing an administrative rule to classify invasive species and during this process of gathering public input, staff gathered as much distribution data for certain species as they could in order to better classify the species. For *Polygonum cuspidatum,* survey information indicated that 44 of the 72 counties have occurrences of this species as opposed to the 23 and 33 indicated in the distribution maps above. The 2004 FIA Invasive Pilot survey did not find any plots in the ten counties that were part of the survey. Due to the lack of consistency and accuracy of the data that is available makes analyzing the extent and condition of invasive species extremely difficult and unreliable.

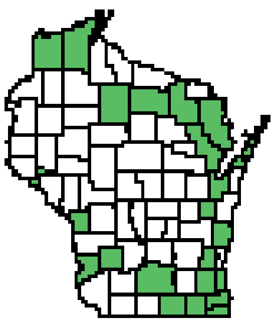


Figure 7.f: UW Herbarium website for *Polygonum cuspidatum* distribution
Source: http://wisplants.uwsp.edu/scripts/Detail.asp?spcode=POLCUS, 2007

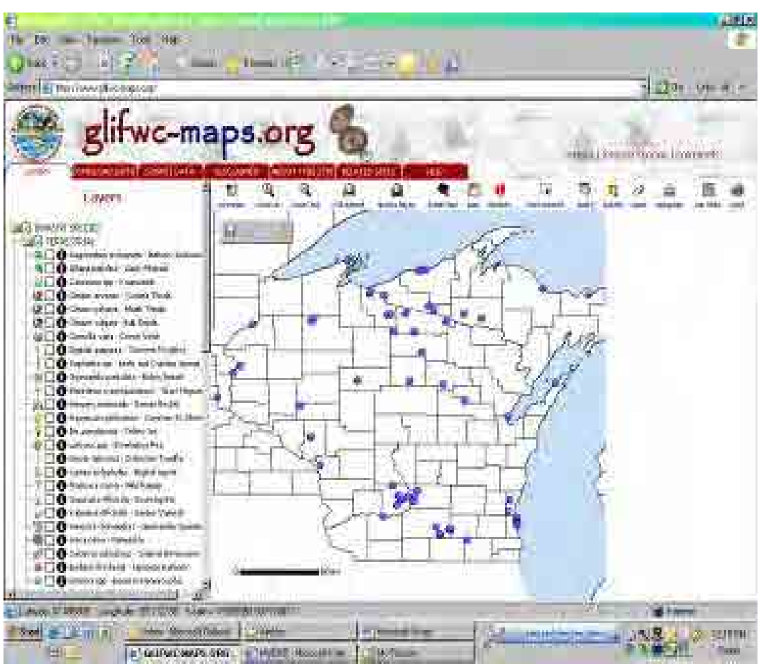


Figure 7.g GLIFWC website for *Polygonum cuspidatum* distribution
Source: http://www.glifwc.org/invasives/Fallopia_spp/id.html, 2009

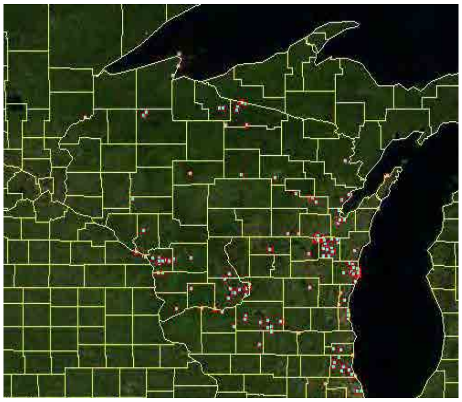


Figure 7.h: NIISS website for *Polygonum cuspidatum* distribution
Source: http://www.niiss.org/, 2010

Despite the increasing spread of invasive plants and new species entering the state, there are many opportunities to minimize their spread and introduction. One such strength is the Wisconsin Council of Forestry sponsored development of Best Management Practices for Invasive Species, focusing on four separate, but parallel tracks: Forestry, Recreation, Urban Forestry and Right-of-ways. Another growing opportunity is cooperative weed management areas (CWMA) such as the Northwoods CWMA (http://www.northwoodscwma.org/). These groups mobilize many partners to conduct work on the ground as well as educational and outreach material.

The DNR has also implemented an Early Detection Rapid Response Program to attempt to identify and control the species that are not yet in the state or are in low numbers such that control is feasible. The early detection program is becoming more established each year and along with the proposed rule, the reporting of species that are not yet here or are not yet common in the state will become more common. This will allow us to more accurately assess threats and prioritize management efforts. Another DNR initiative is an administrative rule to limit the introduction, possession, transfer and transport of invasive species.

8. Area and percent of forest land subject to levels of specific air pollutants that may cause negative impacts on forest ecosystems

8.1 Air Pollution

Air pollutants can alter physical processes such as water flow and elemental cycling, which can influence the relationship between insects, diseases, and their hosts. Forests have significant and dynamic interactions with the atmosphere. Air pollutants can reduce forest productivity and diversity, especially in sensitive species and genotypes. This section is focused on forest interactions with three categories of atmospheric compounds—greenhouse gases, criteria air pollutants, and acidic deposition—that are substantially affected by human activity. (For more information on air pollutants referenced in this section, see the list of sources listed at the end of section 8.1. This list contains both general references and specific publications used to write this report.)

The largest and most essential of these interactions is the uptake and respiration of carbon dioxide. Our forests and other ecosystems process tens of millions of tons of carbon dioxide annually. Carbon dioxide is captured during photosynthesis and most of it is returned to the atmosphere through respiration. A very small fraction (in the single digit percentiles) is captured in plant biomass and soils annually. Determining the amount of carbon stored in plants and soils can be difficult. Current estimates suggest as much as eight million tons of carbon dioxide is stored every year in our forest vegetation and soils. This capture or sequestration of carbon is, and will become even more, important as we seek to reduce Wisconsin's net greenhouse gas emissions.

The remaining greenhouse gases (including methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) have little to no direct effect on forests. However, potential changes in climate patterns caused by these gases, such as droughts, storms, and length of the growing season, could significantly affect forest communities.

Criteria pollutants and acidic deposition include ground level ozone, nitrogen and sulfur oxides, fine particulate matter, lead, and mercury. These compounds are released or formed naturally during volcanic activity, forest fires, lightning strikes, and other processes. These pollutants are typically present in the atmosphere at extremely low concentrations, but human activity has resulted in forests being exposed to elevated concentrations. Forests immediately downwind of industrial and urban sources are especially affected.

Oxygen (O_2 at 21%) and nitrogen (N_2 at 78%) are the dominant constituents of the atmosphere. Other compounds and pollutants are present in trace quantities relative to oxygen and nitrogen. Carbon dioxide (CO_2) is the most abundant of these constituents, with a current concentration of about 386 parts per million (ppm). However, CO_2 is increasing at a rate of about two ppm every year. Prior to the fossil fuel combustion and extensive land clearing of the last 200 years, CO_2 concentrations averaged around 280 ppm.

Other greenhouse gases and all of the criteria pollutants are measured in the tens to hundreds of parts per billion. These compounds are substantially affected by seasonal climatic factors as well

as industrial and agricultural activities. Exposure to criteria pollutants and acidic deposition has been slowly decreasing due to regulatory actions and technological improvements.
Criteria pollutants, and especially greenhouse gases, have been shown to influence forests communities when assessed over decades and longer time frames. Acute foliar injury symptoms related to criteria pollutant exposure (i.e., ground level ozone) have been documented in ozone sensitive species. Current ozone exposures may be having impacts on some aspects of forest productivity (e.g., growth of ozone sensitive species in the higher exposure areas along Lake Michigan). However, quantifying impacts on productivity would be difficult to measure relative to the more important effects of drought, flooding, insects, diseases, and land management practices.

Concentrations of the major greenhouse gases (carbon dioxide, methane, and nitrous dioxide) in the atmosphere have varied over the millennia, but their concentrations have increased substantially with the fossil fuel combustion associated with industrial development and the land clearing associated with population growth and economic activity.

Carbon dioxide is an essential plant nutrient, but elevated atmospheric concentrations may lead to internal imbalances in tree nutrition, affect insect-disease relationships, and influence climate patterns. Nitrogen and sulfur compounds are essential plant nutrients as well, but their emissions are a direct cause of acidic deposition. Uptake and/or deposition of excess quantities of these compounds affect forest sustainability and ecosystem processes.

In contrast, ground level ozone can have toxic effects at even low concentrations (70-90 parts per billion). This compound is the most widespread regional air pollutant in the United States. The impacts of excess ozone range from acute foliar injury to chronic loss in tree productivity, and/or genetic diversity in forests.

All of these compounds may act synergistically with unanticipated consequences on forest ecosystem health and diversity. Generally, these changes to forest systems are considered to have undesirable impacts with potentially adverse effects on the economic and ecological benefits we derive from our current forests.

Major issues associated with atmospheric interactions include the following:

1. Changes in forest communities, economic relationships, and recreational uses.
2. Changes to insect-disease relationships as well as fire and management regimes.
3. Reductions in forest productivity and diversity including changes in forest species composition, acute foliar injury, and effects on sensitive species and genotypes
4. Changes to physical processes such as water flow, elemental cycling, wildlife habitat, and associated forest values

<u>Forest indicators and trends</u>
Trees, whether in urban or rural settings, will take up or filter pollutants and greenhouse gases from the atmosphere (see Table 8.a). This improves air quality, but a range of impacts, some

anticipated and some not, may also occur. The following trends in atmospheric pollutant concentrations are anticipated over the next ten to twenty years.

Table 8.a: Annual pollution removed by Wisconsin's urban forest

Pollutant	**Amount removed by Wisconsin's urban forest (metric tons/year)**
Ozone	3,310
Particulate matter	1,750
Nitrogen dioxide	760
Sulfur dioxide	520
Carbon monoxide	63

Source: Cumming et al., 2007

Greenhouse Gases – Greenhouse gas concentrations will continue to rise unless significant regulatory and voluntary efforts are made to reduce emissions at personal, state, national, and global levels. Increasing concentrations will contribute to climate change and will impact forest health and productivity. Effects are likely to be observed statewide and may be assessed as having positive or negative impacts depending on the specific parameter being measured. For example, certain species may become more prevalent or have greater productivity, while other species are diminished. Regardless, changes in the climate and our forests will alter traditional land uses, management activities, and recreational uses.

Criteria Pollutants – Ozone concentrations in the atmosphere and nitrogen, sulfur, and mercury emissions from regulated sources are anticipated to decrease as regulations on air pollution become increasingly restrictive at state and federal levels.

Peak concentrations and seasonal ozone exposures have been declining across the state, and particularly along the Lake Michigan shore (Figure 8.c, see Newport). The amount and severity of ozone induced foliar injury on bioindicator species has also been decreasing. We anticipate foliar injury symptoms will continue to be observed on sensitive species, though the amount and severity of injury is anticipated to continue declining, particularly in southeast Wisconsin if ozone exposures continue to decline (Table 8.b). Any impacts of ground level ozone on forest productivity are also expected to decline.

Acidic Deposition – Sulfates (SO4), the most acidifying element in acidic deposition, have been declining (formerly 4-6 lbs/acre now ranging from 2-3 lbs/acre). Unlike sulfates, nitrogen deposition has essentially remained the same at 4-6 lbs/acre. Current air pollution regulations will result in continued reductions in the rate of sulfur deposition. Some decrease in nitrogen deposition is anticipated, but the change is anticipated to be relatively small.

The following images display trees with ozone induced foliar damage (Figure 8.a, 8.b). Both images were taken between 1983-2007 at peak exposure. Ozone induced foliar injury creates a distinct, sharp edged inter-vein black to dark purple discoloration on the upper surface of FIA bio-indicator plants. The injury is contained in the palisade cells and is therefore internal to the leaf and cannot be rubbed or washed off. Injury is most obvious in August.

Figure 8.a: Ash with ozone induced foliar injury.
Figure 8.b: Black cherry with ozone induced foliar injury

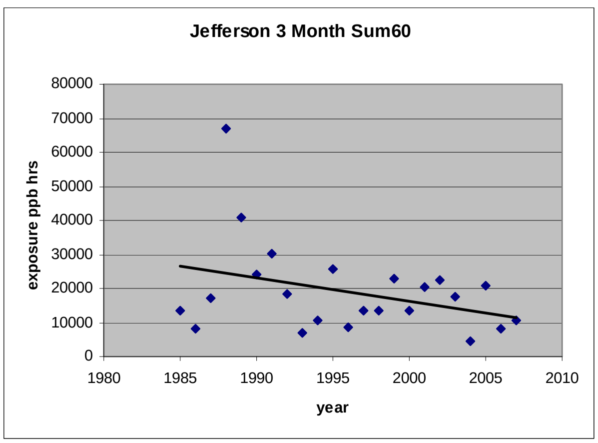
Table 8.b: FIA P3 bio-indicator trend ~2002-2007 (table showing annual trends in ozone injury)

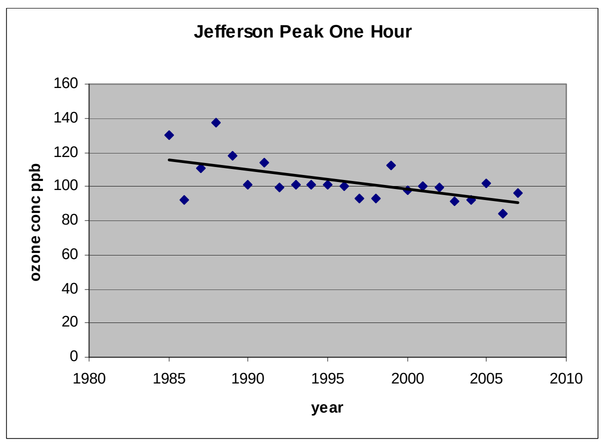
	Data	Big leaf aster	Milkweed	Dogbane	Ash (white/ green)	Black cherry	Blackberry	Grand Total	% Injured plants
2002	# Plants surveyed	349	1396	723	969	935	571	4,943	2.2
	# Plants with injury	0	53	8	12	31	3	107	
2003	# Plants surveyed	417	1455	960	974	1059	517	5,382	0.8
	# Plants with injury	4	20	7	0	14	0	45	
2004	# Plants surveyed	422	1473	953	1023	964	618	5,453	1.4
	# Plants with injury	1	31	16	1	26	0	75	
2005	# Plants surveyed	260	900	570	495	455	253	2,933	

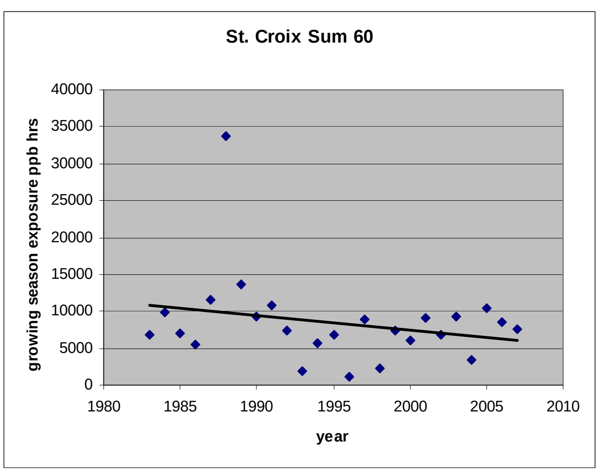
	# Plants with injury	0	17	3	1	3	0	24	0.8
2006	# Plants surveyed	207	831	573	470	473	255	2,809	1.4
	# Plants with injury	0	10	11	3	14	0	38	
2007	# Plants surveyed	220	785	523	350	412	170	2,460	0.2
	# Plants with injury	0	3	0	0	2	0	5	
Total number of plants surveyed		1,875	6,840	4,302	4,281	4,298	2,384	23,980	
Total number of plants with injury		5	134	45	17	90	3	294	
% Injured plants		0.3	2.0	1.1	0.5	2.1	0.1	1.2	

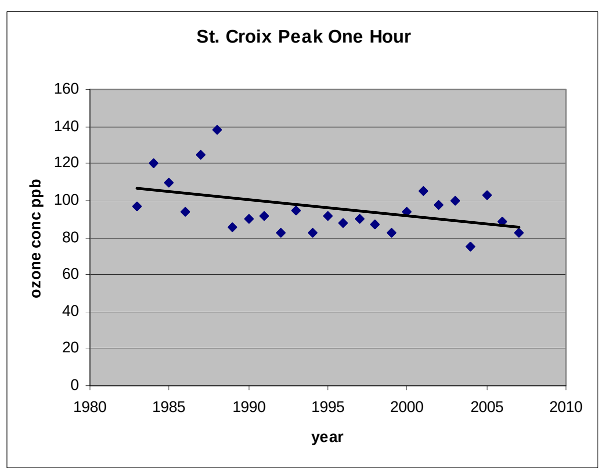
Source: FIA, 2007

DNR staff surveyed between 55 and 57 plots from 2002-2004 as part of an expanded biosite network. The network was reduced to the FIA ozone base grid in 2005 and 29 and 33 plots were surveyed in 2005-2007.









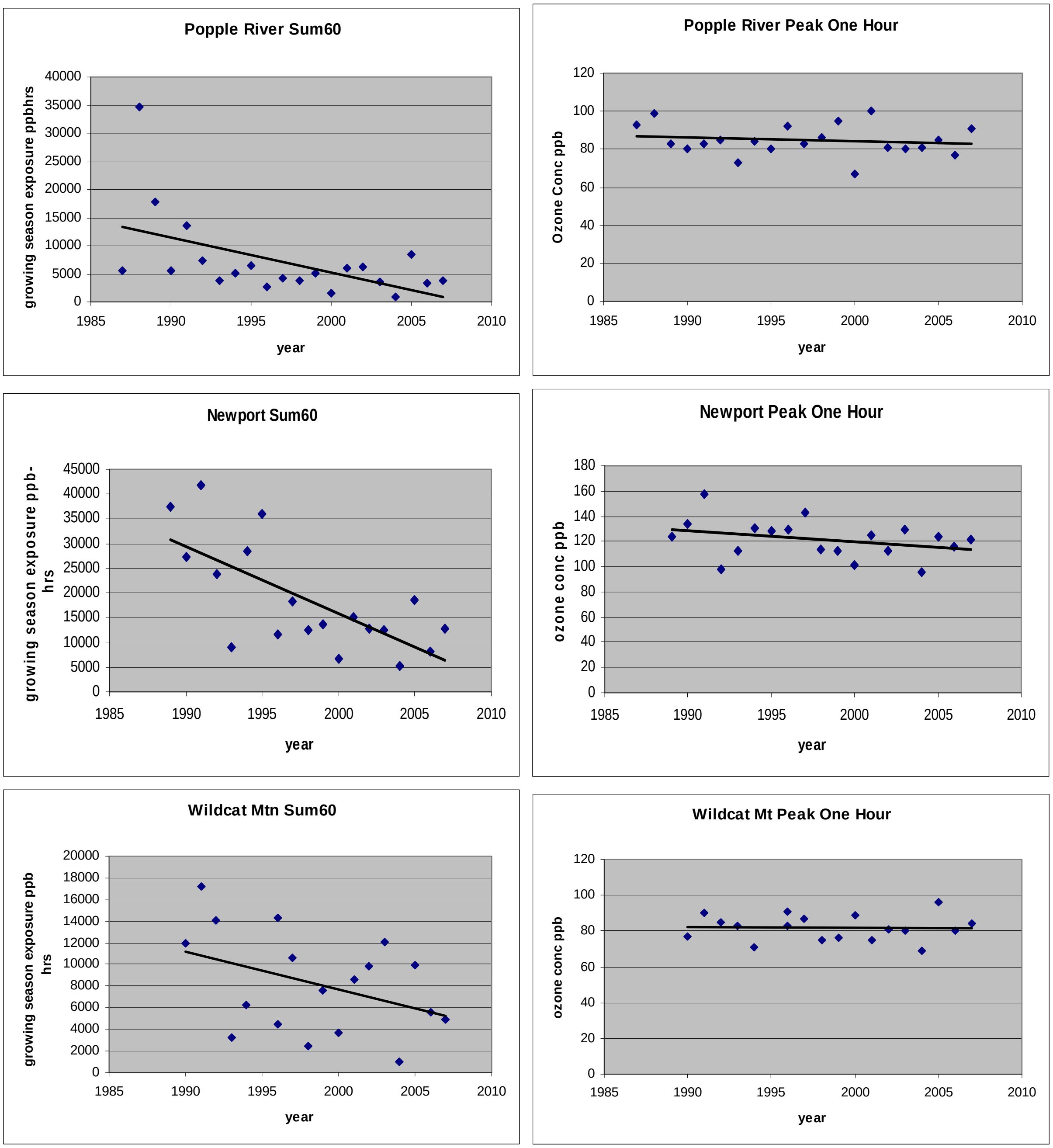


Figure 8.c: O3 trends at 5 sites in Wisconsin ~1983-2007
Summary and peak one hour seasonal exposure.
Source: WDNR, 2007

8.1 List of Sources

Descriptions of different categories of air pollutants

EPA criteria pollutants: http://www.epa.gov/air/urbanair/

EPA acid deposition: http://www.epa.gov/acidrain/

8. Area and percent of forest land subject to levels of specific air pollutants that may cause negative impacts on forest ecosystems

EPA greenhouse gases: http://www.epa.gov/climatechange/emissions/index.html

Net uptake of carbon is very low and measured in single digits.

US Climate Change Science Program: http://www.climatescience.gov/Library/sap/sap2-2/final-report/sap2-2-final-all.pdf page 23

University of California Santa Barbara: http://www.esm.ucsb.edu/academics/courses/202/Lectures/ESM202Lecture7_2008_pdf.pdf

EPA: http://www.epa.gov/sequestration/index.html

Chemical composition of the atmosphere

NASA: http://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html

Air quality trends

EPA: http://www.epa.gov/airtrends/sixpoll.html

Quantifying impacts on forest ecosystems

NPS: http://www.nature.nps.gov/air/Pubs/pdf/gpra/GPRA_AQ_ConditionsTrendReport2006.pdf

NPS: http://www.nature.nps.gov/air/AQBasics/ecologic.cfm

Sources of greenhouse gases and increase in atmosphere

EPA: http://www.epa.gov/climatechange/science/index.html

EPA: http://www.epa.gov/climatechange/science/recentac.html

Ozone effects on forests

EPA: http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=446635

Increasing rates of greenhouse gas accumulation in the atmosphere

EPA: http://www.epa.gov/climatechange/science/recentac.html

Criteria pollutant air quality trends

EPA: http://www.epa.gov/airtrends/sixpoll.html

Ozone trends and ecosystem impacts

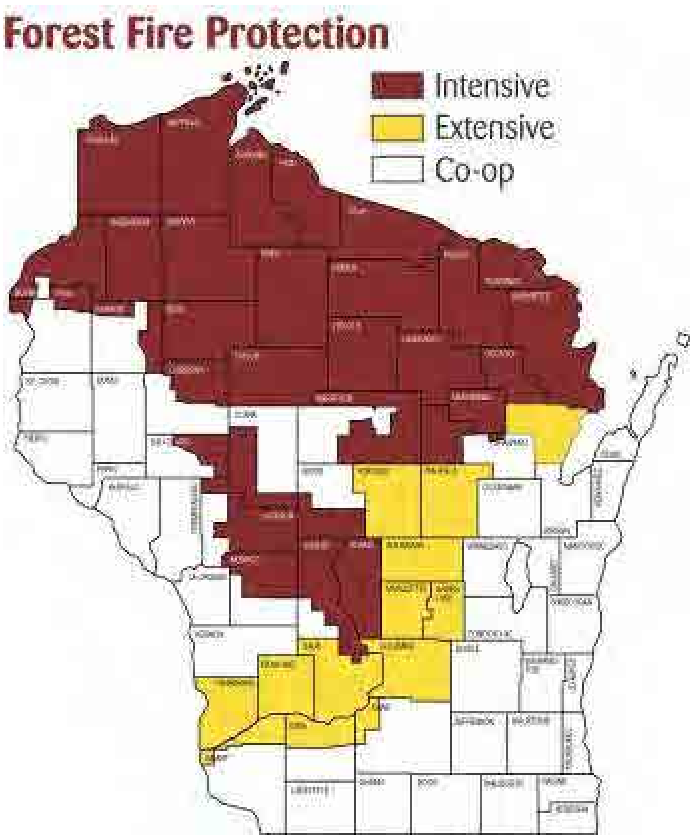
FIA: http://fia.fs.fed.us/library/fact-sheets/p3-factsheets/Ozone.pdf

USDA Forest Service: http://nrs.fs.fed.us/fia/topics/ozone/default.asp

USDA Forest Service: http://www.nrs.fs.fed.us/fia/topics/ozone/pubs/pdfs/ozone%20estimation%20document.pdf

9. Wildfire impacts on forest resource sustainability

Note on data source:
Data in the following section is limited to extensive and intensive areas of forest fire protection. The intensive level of forest fire protection covers areas with more forest cover and high hazard fuel types. DNR takes the lead with a significant commitment of fire suppression equipment and staff in intensive areas, and local fire departments assist. Fire suppression responsibilities in the extensive area are a partnership between DNR and local fire departments. In cooperative level forest fire protection areas, local fire departments take the lead and DNR assists when needed. Tracking fires on the co-operative areas is difficult due to the many units of government responding to fires. This results in a significant data gap for accurate comprehensive information on fire occurrence in the co-op area.



Map 9.a: Forest fire protection areas
Source: DNR, 2009

9.1 Number of forest fires

The number of fires varies annually depending on weather, fuel conditions and human activity. Based on a 33 year average, approximately 1,700 fires burn 6,000 acres each year. These acres are predominately forested but include other vegetation cover such as agricultural fields, shrubland, wetland, etc. About 200,000 acres cumulative burned between 1975 and 2008 in the intensive and extensive protection areas. Many more acres were threatened by small fires, but suppression activities stopped their spread. Periodic drought cycles drastically affect the number of fires and acres burned. (See indicator 7.3 for an in-depth discussion of climate.) In Figure 9.a, fires peaked in 1977, 1980, 1988, 1994 and 2004 due to droughts.

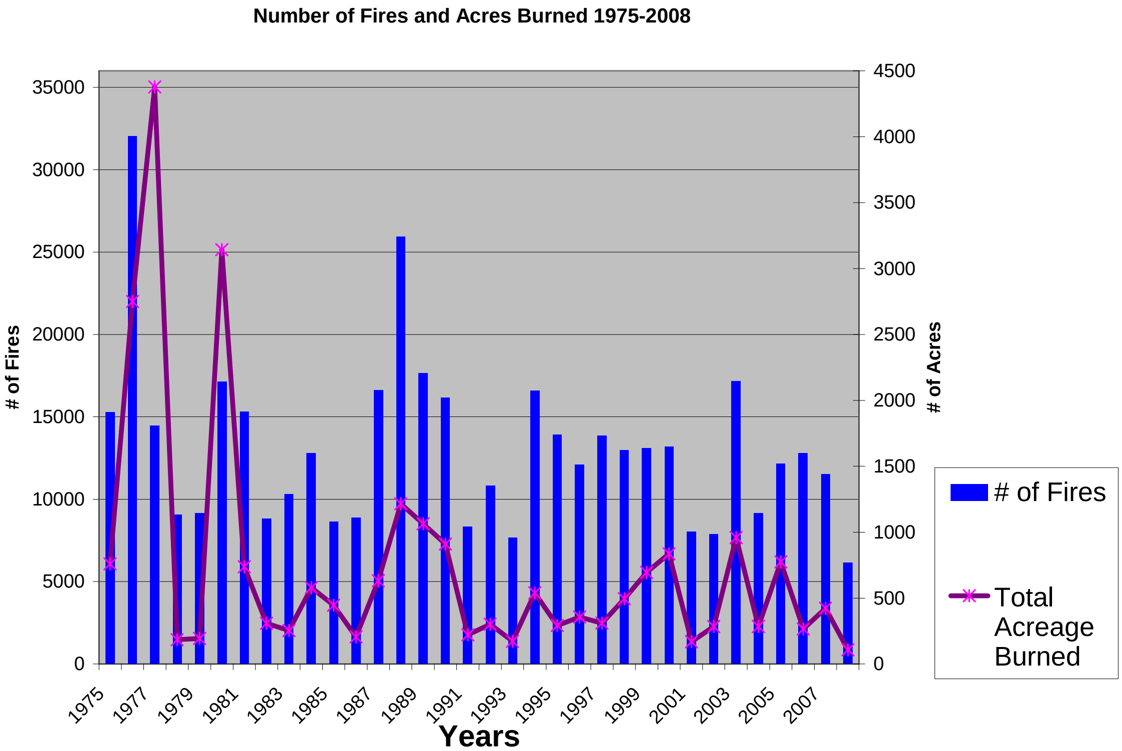


Figure 9.a: Number of fires and acres burned 1975-2008
Source: DNR, 2009

Fire suppression affects the composition, structure, and function of forests. Fire-dependent communities such as oak savannas and pine barrens are unable to maintain their open character and eventually lose the native species that are not adapted to low disturbance habitats. A disruption of the frequency of fires in our forests can result in a build up of down woody debris (fallen trees, branches, leaves, and duff). During times of drought and high fire danger, this material can result in high flame lengths, high heat output, and significant control problems. Very dense and crowded stands with older trees can also facilitate the movement of forest insects and diseases.

9.2 Forest fire influences

Fire ignition and severity are dependent on physical, meteorological and societal factors. Physical factors include fuel type, fuel class, fuel condition and arrangement. Meteorological factors include wind, relative humidity, precipitation patterns and drought. Societal factors include, housing, human attitudes and activities, income levels and government controls. These factors affect the wildland urban interface, wildfire locations, wildfire causes, and the issuance of burning permits as explained below

Landscape Factors – Wildland-Urban Interface

Initially in the 20th century, housing was concentrated mainly in urban areas. By the later part of the century, people began moving to the outer fringe of cities and suburbs. Increasingly, housing development continues to move deeper into rural areas in clustered subdivisions and scattered individual homes. This movement has created a condition called the wildland-urban interface (WUI) where people, homes, and property are intermingled with wildland vegetation. The structures can potentially become just another piece of burnable fuel in the event of a wildfire. Unfortunately, many people are moving into wildland areas do not adapt to the fire dangers that exist around them.

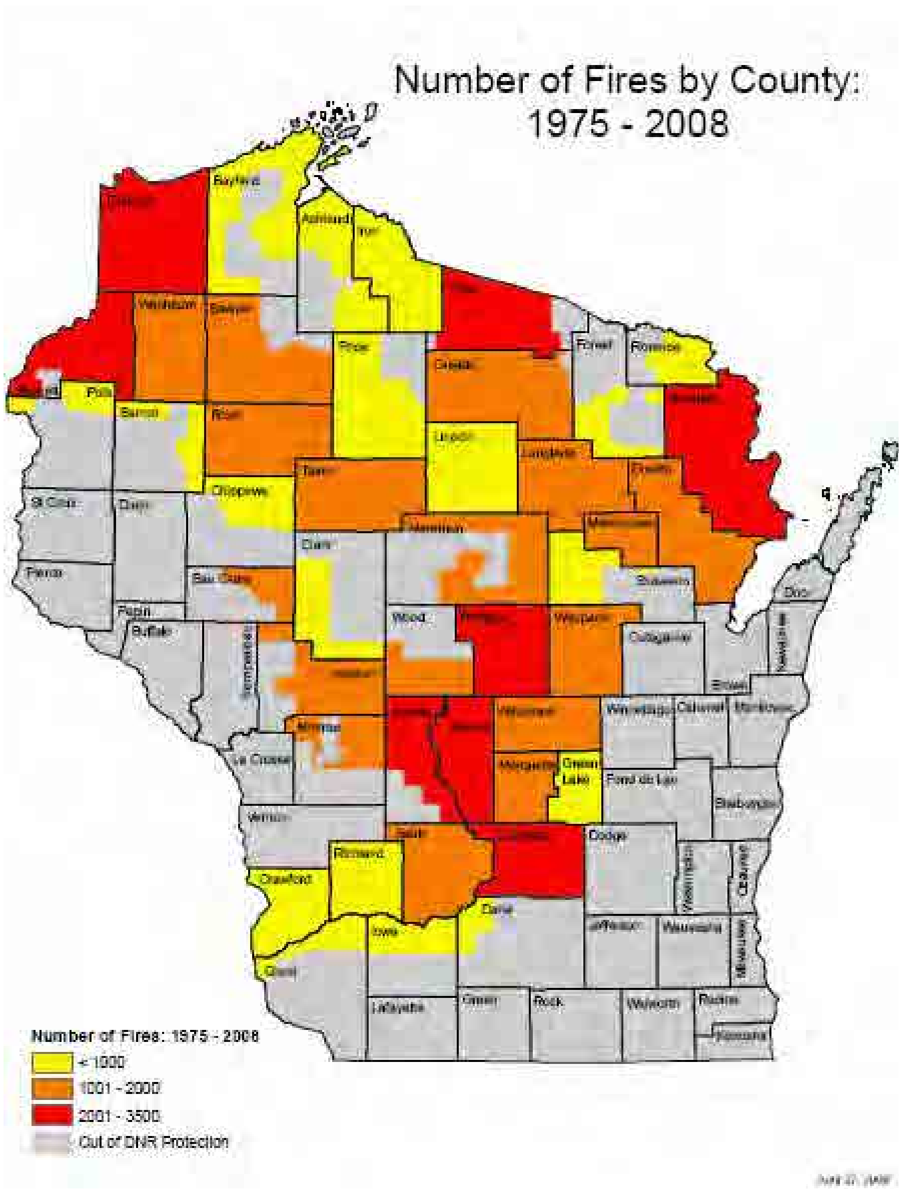
The risk of wildfire increases as more people live and recreate in forested and rural areas. In Wisconsin, people cause over 98% of all wildfires. Most of the ignitions are accidental and caused by debris burning, equipment use, improper ash disposal, and warming fires. The potential increase in frequency of wildfires increases the risk of a catastrophic wildfire.

There is great concern to fire officials when homes are built in areas of highly flammable vegetation, especially when the structures themselves are made of flammable materials. The concern increases when homes are built in remote areas or when roads and driveways are narrow or sandy, which may make it impossible for emergency vehicles to get to homes. Vegetation that is allowed to grow close to the sides of buildings is especially troublesome.

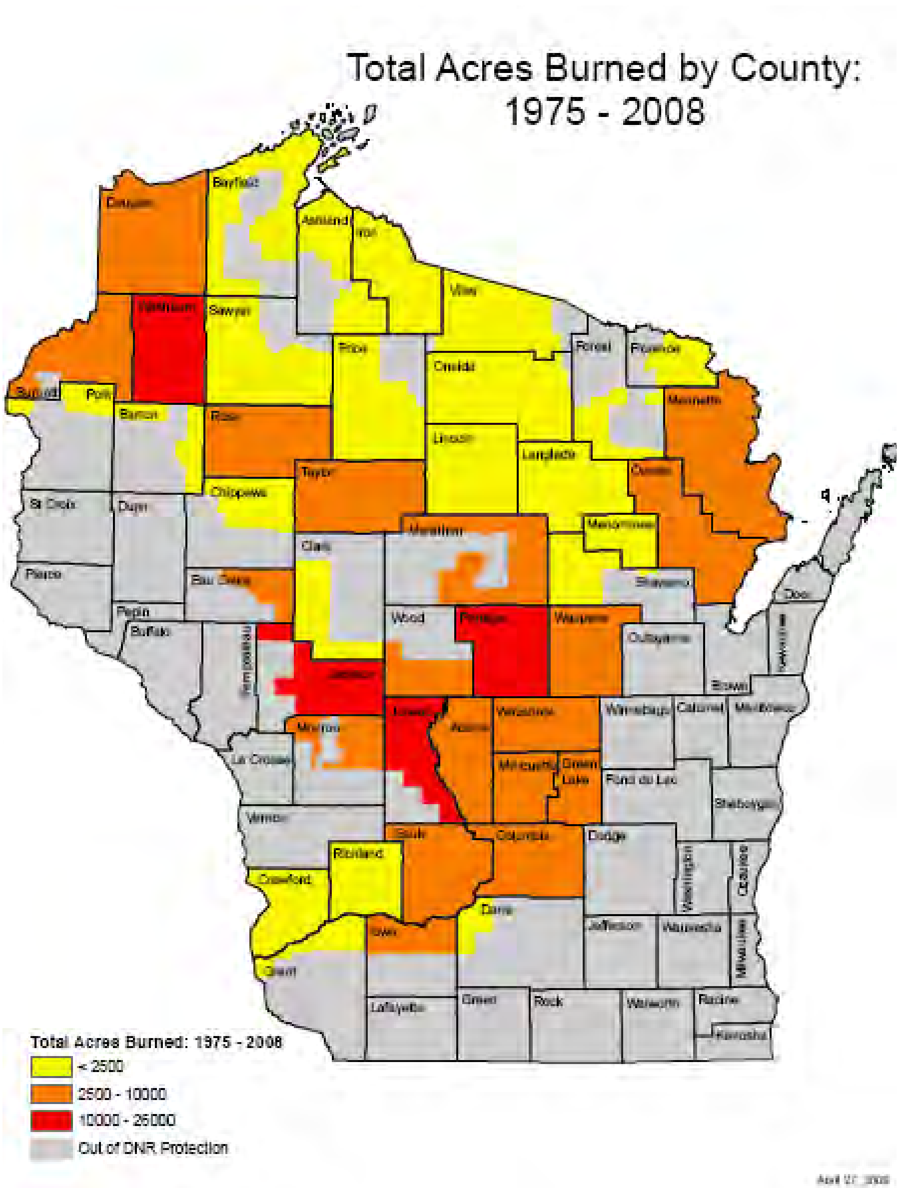
Although housing in the WUI is increasing, the number of available firefighters and equipment is not growing at the same rate. Often times, firefighters in fire-prone areas are working as volunteers and may not be fully aware of the potential problems in a community. These firefighters may be expected to evacuate communities, fight structure fires and respond to wild fires all in the same day. Such demands require a higher level of training than may be available.

<u>Fire Locations</u>

Forest fire occurrence and location are directly related to residential population and seasonal recreational activities. Forest fire causes in Wisconsin are 98% human activity related. Counties with high fire occurrence (see Map 9.b and Map 9.c) have a large residential or seasonal recreation population base. Furthermore, the relationship between human activity and fire starts also mean forest fires in Wisconsin tend to threaten structures and related property improvements. These wildland urban interface fires are complicated and challenge efforts to limit damage to forests and improvements.



Map 9.b: Number of fires by county: 1975-2008
Source: DNR, 2008



Map 9.c: Total acres burned by county 1975-2008
Source: DNR, 2008

Fire Causes 1975-2008
As noted previously, 98% of Wisconsin's fires are caused by human activity. The number one cause of forest fires in Wisconsin is debris burning, which includes the burning of household waste, brush, leaves and broadcast burning. Control of this human activity is primarily done through a burning permit system. DNR requires burning permits in intensive and extensive areas, and some municipalities in the cooperative fire protection areas also require burning permits. These burning permits regulate the type, quantity, days and time of debris burning. The number two cause of forest fires fall into the miscellaneous category, which includes fireworks, power lines and improper ash disposal. Equipment and arson are the third and fourth leading causes of wildland fires, respectively.

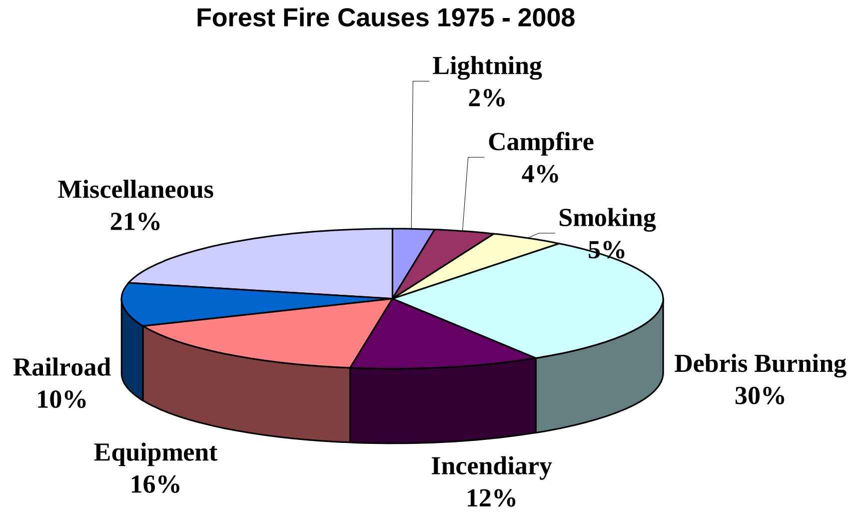


Figure 9.b: Forest fire causes 1975-2008
Source: DNR, 2009

Railroad fires decreased significantly over the last 30 years. Engineering improvements in fuels, exhaust systems, and brake technology have caused this reduction. Furthermore, technology has improved the monitoring of train and locomotive systems and has allowed malfunctions to be repaired before multiple fires are ignited.

Equipment fires jumped substantially in recent years. The increase of more mobile and available machinery in the forest has increased the occurrence of fires. Recreational use of machines, primarily ATVs, has produced fires in more remote and inaccessible areas. These fires can produce larger more damaging fires due to a delayed detection.

The trend in debris burning caused fires has remained relatively stable for the last three decades. Prevention of these fires has relied on statewide efforts to regulate burning. A burning permit system is in place across all areas where DNR has forest fire protection responsibilities. This burning permit system is enforceable through state statutory authority. Debris burning is limited to natural materials and certain times usually after 6 pm, and fires must be attended.

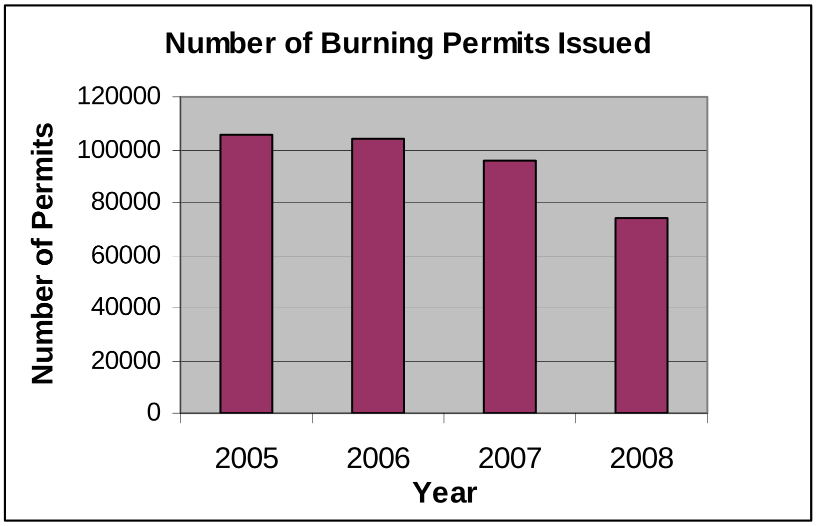


Figure 9.c: Burning permits issued 2005-2008
Source: DNR, 2009

As population increases, the expectation was that burning permits would also increase. That general trend has ended recently with the automation of the DNR burning permit system. The automated system allows the restrictions of burning activity to be controlled on a daily basis, based on weather conditions and activity. This new control is very responsive and will help manage burning activity on a day-to-day basis to decrease debris fire starts. In 2007, the burning permit system was converted to a web based and telephone call-in system. Each day, the fire danger is considered and the restrictions on burning determined. This system, based on physical and meteorological factors, allows day-to-day decision making on when burning will be allowed, tightening the control on burning activities. This control reduces fire starts and limits the corresponding damage that fires will cause. Further refinement and improvement of this burning permit system is ongoing.

9.3 National Fire Danger Rating System

The National Fire Danger Rating System (NFDRS) is a predictor of fire risk. The system uses weather factors, fuel characteristics, and many other factors. It is commonly used to inform and educate the public of the risk of fire in a particular area. The system is also used as a planning tool for fire suppression to determine staffing, resource needs and detection levels.

Figure 9.d compares the number of days, number of fires and average fire size by the 5 levels of NFDRS danger. On a Low fire danger day, a fire will occur only every third day. A fire burning on a Low fire danger day will burn, on average, 1.7 acres (larger, perhaps, because of a lack of detection activity on such days). On an Extreme fire danger day, on average, 1.5 fires can be expected to occur, with each fire burning 4.6 acres. The NFDRS system is an accurate predictor of fire activity and fire size on a day to day basis. The NFDRS system is predicated on accurate local weather data collected at automated weather stations. The DNR must continue to take advantage of technological advances in weather gathering systems to assure that our fire prediction systems are based on accurate weather data.

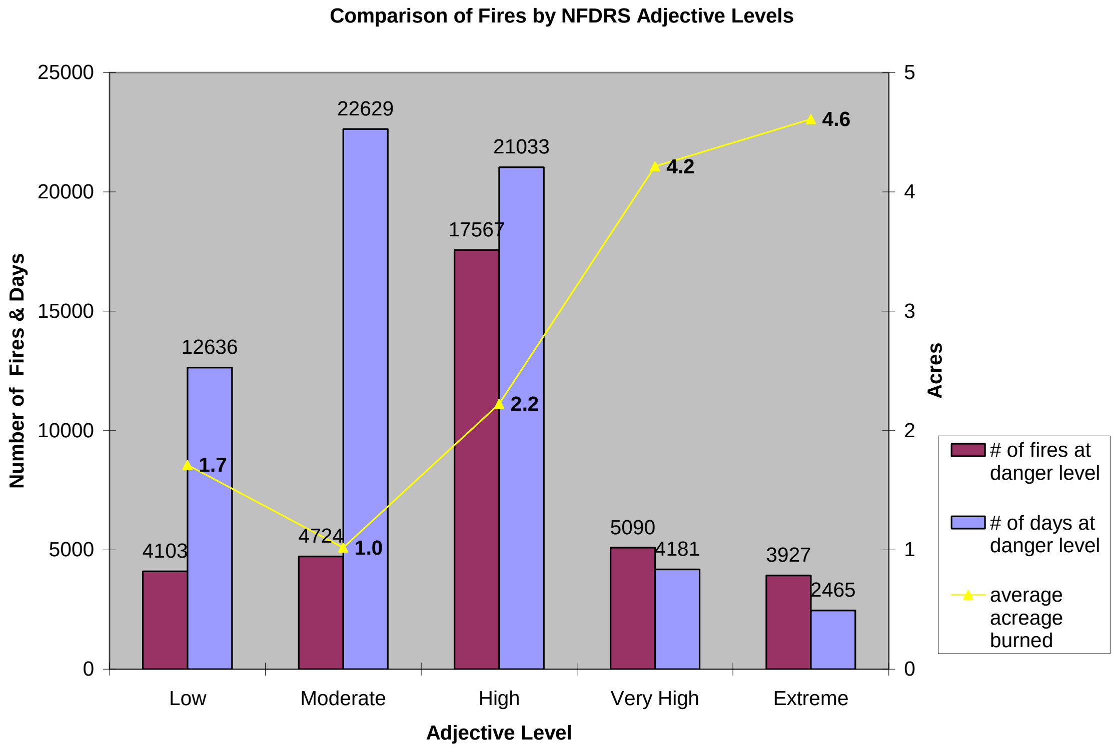


Figure 9.d: Comparison of fires by NFDRS adjective level 1975-2008
Source: DNR, 2009

9.4 Prescribed fire

Prescribed fire is the intentional application of fire to vegetation under specific environmental conditions to accomplish planned land management objectives. Many federal, state and non-government organizations promote the use of fire to efficiently achieve land management goals including: fuel reduction, site preparation, disease control, wildlife management, and biological community restoration and maintenance.

About 500 prescribed burns are conducted on over 20,000 acres per year (Figure 9.e), but the need in Wisconsin is much higher. There are, however, numerous constraints. Conducting a prescribed burning program involves the cost to equip and train experienced crews. Smoke and its impact on air quality are a major concern in many parts of the state. There is also an increasing risk of property damage if fires escape due to an abundance of improvements across the landscape.

The purpose of most prescribed fire applications in Wisconsin is to positively affect habitats. Some examples include maintaining grassland habitat for nesting waterfowl and other grassland birds; maintaining oak woodland vegetation; maintaining native prairies and savannas; rejuvenating brushy wetlands; and natural regeneration of forests, such as jack pine and oak. Other habitats have either degraded beyond maintenance and/or need full restoration. Restoration sites generally need more prescribed fire treatments than those only in need of maintenance.

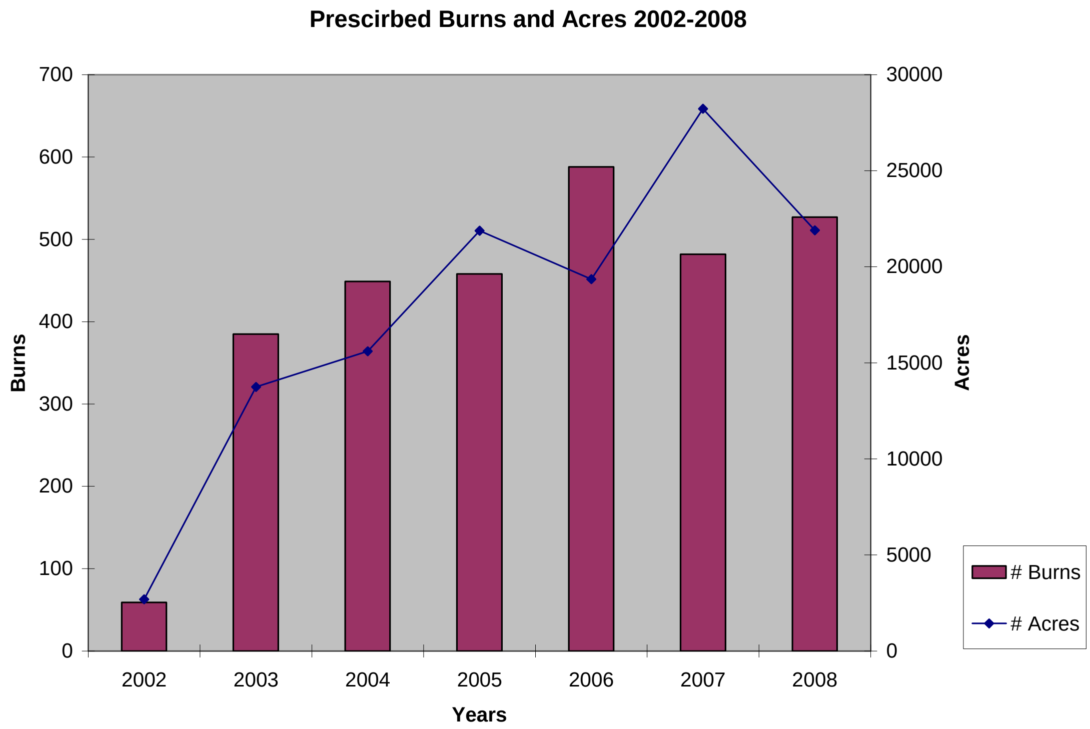


Figure 9.e: Prescribed burns and number of acres 2002-2008
Source: DNR, 2009

A major component of Wisconsin's natural heritage is fire-derived. Many ecosystems in the state developed under the regular influence of fire. Oak is of special concern. Field foresters have generally recognized the challenge of regenerating oak in oak and central hardwood stands, especially on better sites. Fire has been a powerful influence in establishing and maintaining the oak component in these types, and prescribed burning is a critical tool to address the oak regeneration issue. There are also similar issues with various pine and other timber types, where prescribed burning could play an important role in the future. Specific acreages of such types and the extent of the need for prescribed fire on an annual basis are not clear.

Prescribed fire in Wisconsin is being accomplished by a variety of agencies, companies and individuals. Land management objectives vary greatly from hazard mitigation, fuels reduction, forest regeneration, and invasives control to prairie rejuvenation. One of the identified needs to better assess the efficacy of prescribed burning would be a web-based system to assess the impact of burns. Such information is not always captured and shared to help others burn more effectively. The system would require time and funding to develop, and resources for training and maintenance.

The present statewide prescribed burn management program is insufficient for existing public lands. With additional purchase of land and cooperative grassland/savanna management by all partners, the need will continue to grow. Several issues that will need to be addressed are:

1. Resources to manage the prescribed burn needs on state lands are inadequate.

2. The DNR’s goals for maintaining biological diversity, especially for oak savanna and barrens species, will mostly likely be difficult to attain without more emphasis on prescribed burning.
3. Non-burning alternatives to prescribed fire such as fuel removal through biomass harvests, mechanical site preparation, improved artificial tree regeneration, and herbicide use may be necessary to improve biological diversity and achieve forest management goals in some vegetative types.

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Criterion Four: Conservation & Maintenance of Soil and Water Resources

Overview

Wisconsin is often noted for its productive forests and clean lakes and streams. Not surprisingly, the health of Wisconsin's forests and water resources are closely tied. This criterion assesses the sustainability of Wisconsin's forest lands as they broadly relate to soil and water resources.

Forests contribute to productive soils and clean water resources in a number of ways. Trees and shrubs provide a protective canopy over soils, intercepting and slowing rainfall. Leaves, twigs, and branches contribute organic matter that builds a protective layer over the soil, insulating it from damage. This organic material also plays an important role in ecological processes, including nutrient storage and carbon cycling.

In addition, responsibly managed forests generally have very low rates of soil erosion relative to other types of land uses. This helps to maintain soil nutrients on-site for use by trees and other vegetation. It also helps to prevent sedimentation in lakes, streams, and wetlands, ensuring clean water and protecting aquatic habitat.

Beyond environmental factors, the quality of soil and water resources also influences an ecosystem's ability to sustain forest economies and forest-dependent businesses and communities.

Criterion 4 Indicators:

10. Soil and water quality in forested areas
11. Area of forest land adjacent to surface water and forest land by watershed

Major Conclusions[1]

1) The amount of forest land in Wisconsin with some type of protection for soil and water resources is growing.

Wisconsin successfully protects water and soil resources using a voluntary program rather than regulation. This program uses best management practices (BMPs) to promote water quality in managed forest areas. The BMP program can be considered a success as studies have shown that silviculture is not a significant source of water quality impairment in Wisconsin. The continuation of the BMP program will further success.

- Over 10 million acres of Wisconsin's 16 million acres of forest land have a management focus that includes protection of soil and water resources.
- When forestry BMPs for Water Quality are correctly applied, water quality is protected over 99% of the time. When not applied, impacts to water quality are observed 66% of the time.
- Training is needed for foresters, loggers, and forest road construction contractors to improve the use of forestry BMPs for forest roads and skid trails.
- In 2006, a set of rivers, streams and lakes that appeared impaired were assessed. The primary sources of impairment were atmospheric deposition of toxics and non-point source pollution. Silviculture was not a significant source of water quality impairment.

[1] (Items in bold are conclusions drawn by reviewing statements of finding from the Assessment. The bulleted items below each conclusion are the findings).

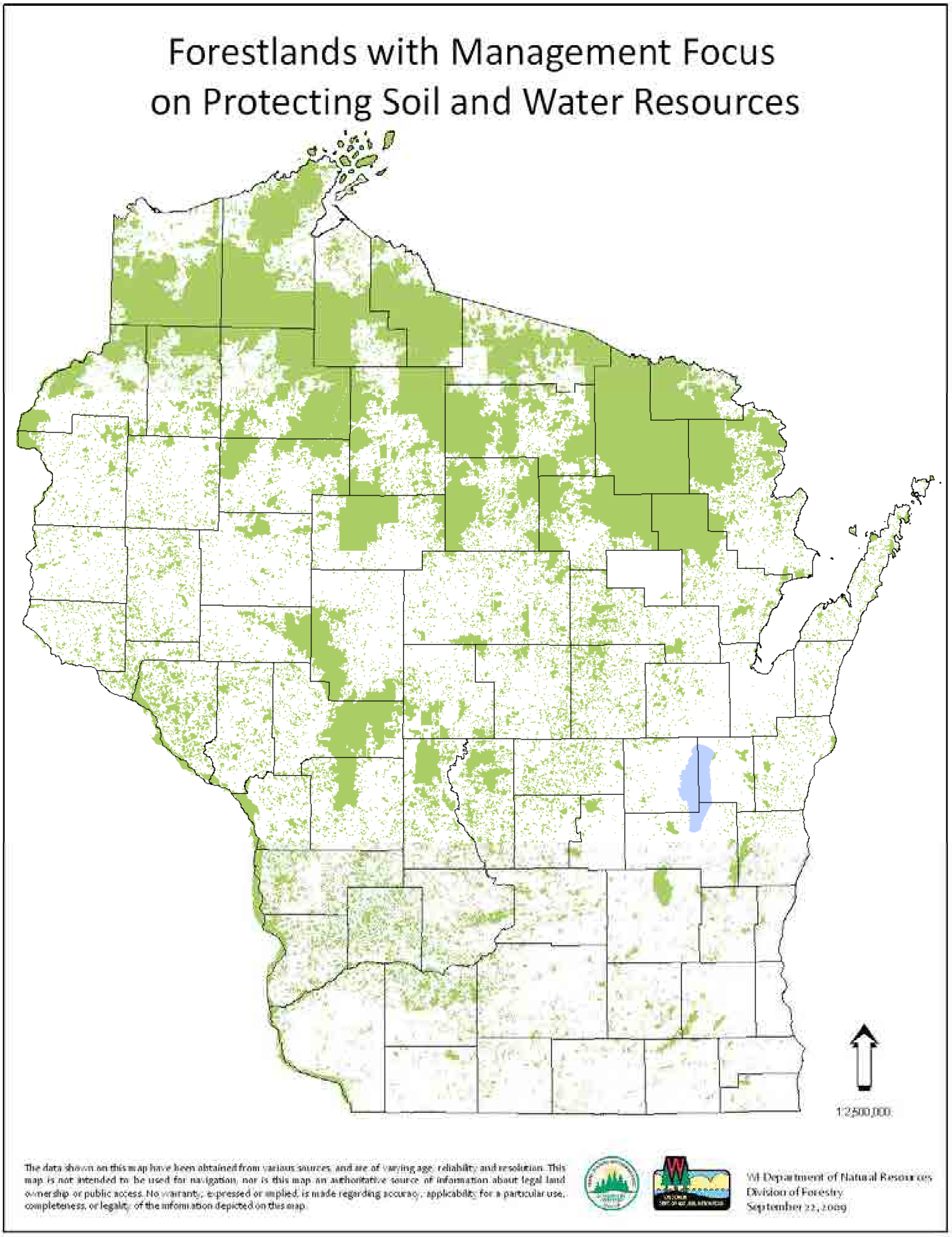
10. Soil and water quality in forested areas

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.



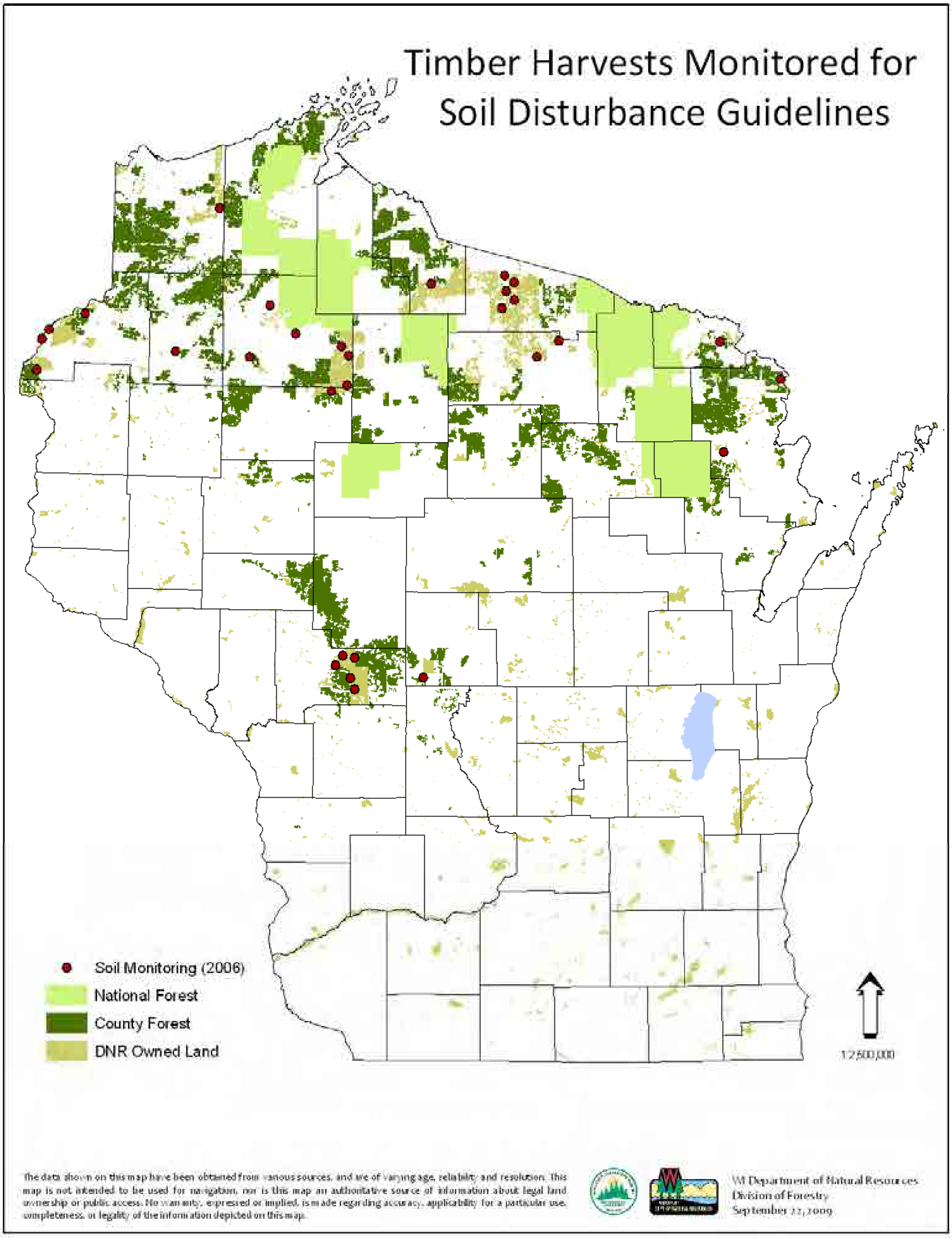
Map 10.a: Forest lands with a management focus on protecting soil and water resources
Source: DNR, 2009

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.



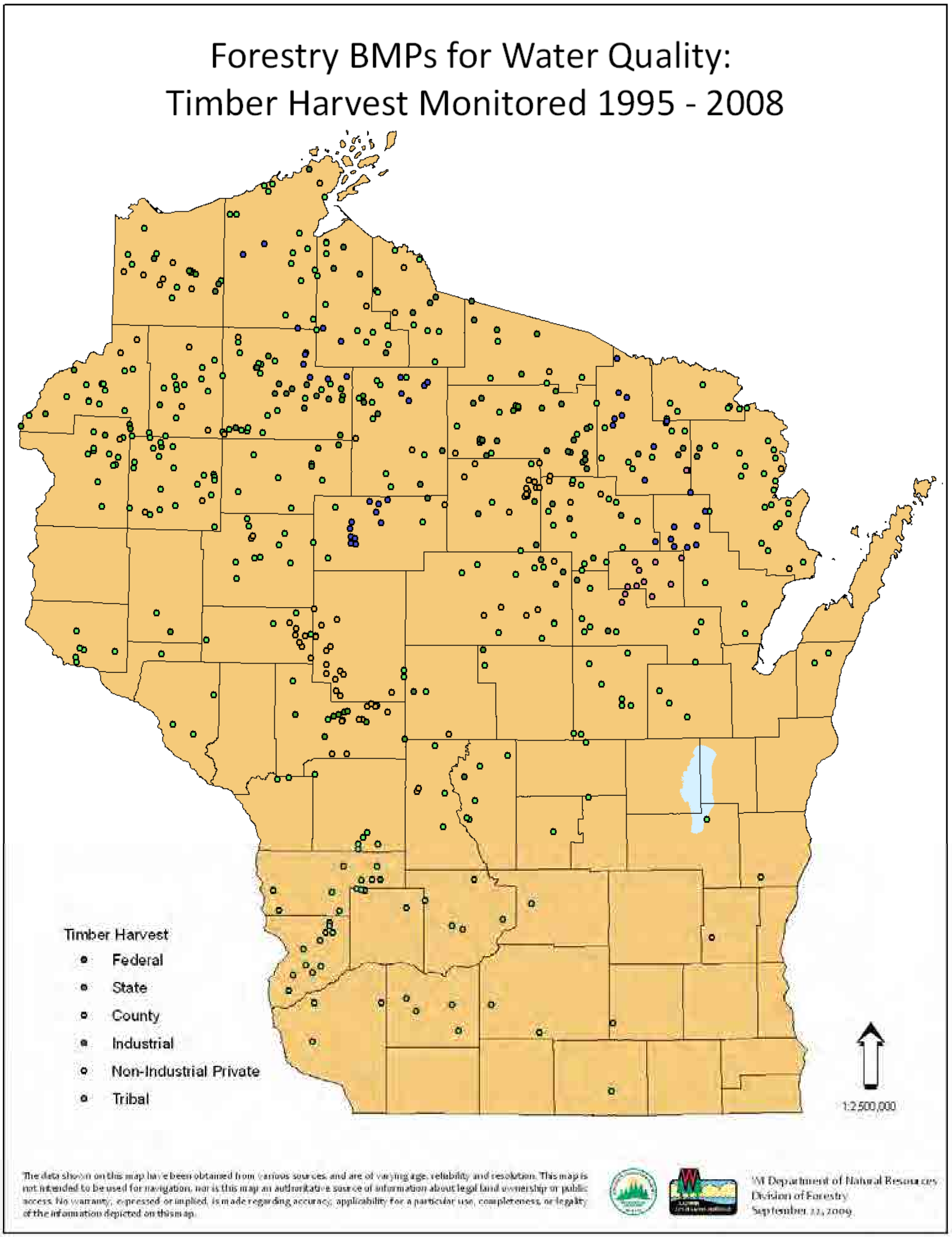
Map 10.b: Timber harvests monitored for soil disturbance guidelines
Source: DNR, 2009

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.

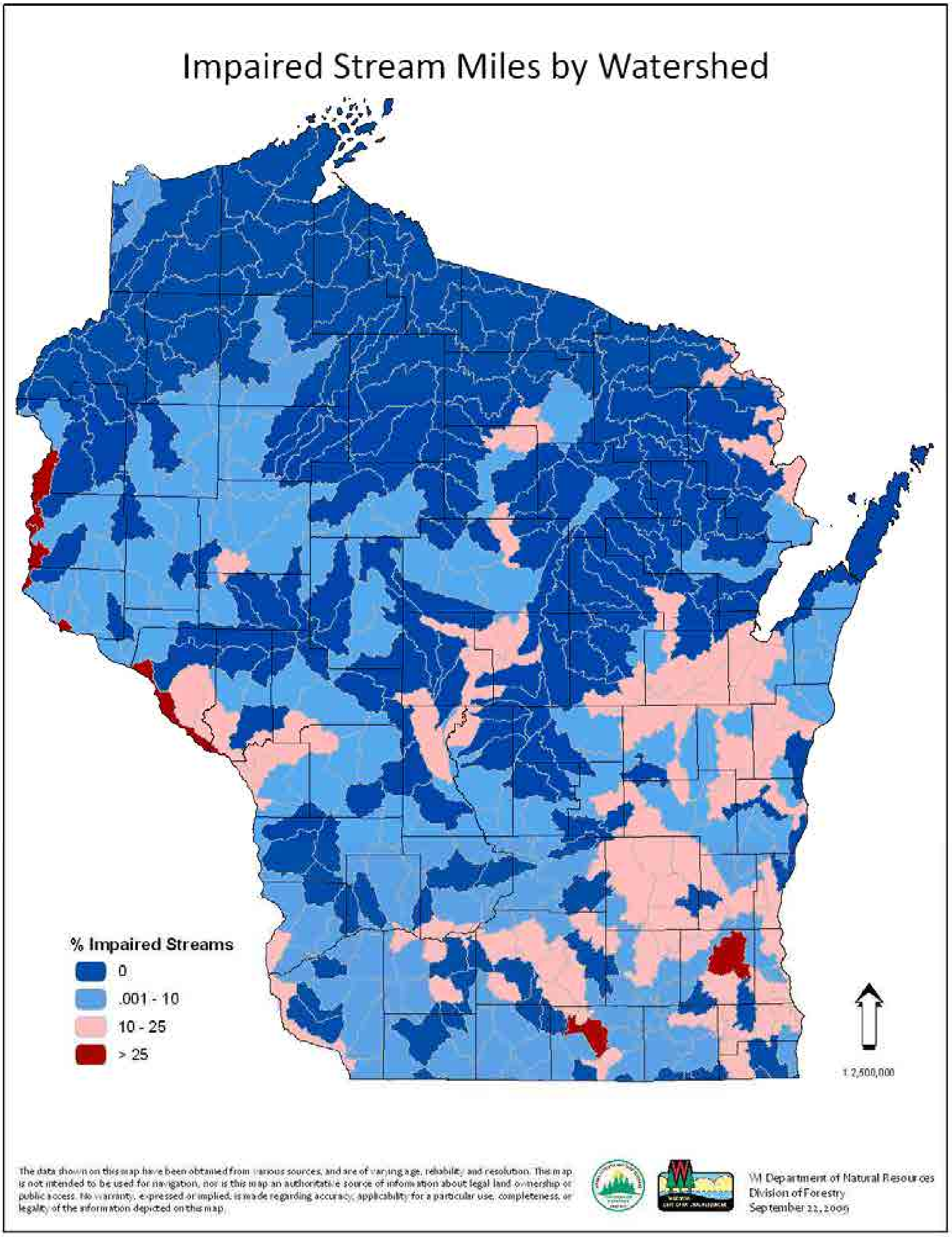
For instance, nearly 2,200 miles of rivers and streams are impaired by sediments and over 1,200 miles by phosphorus and temperature (Table 10.h). These impairments could be tied to failing septic systems or dams and their impoundments. Dams impound sediment behind them, leading to high phosphorous concentrations. 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.

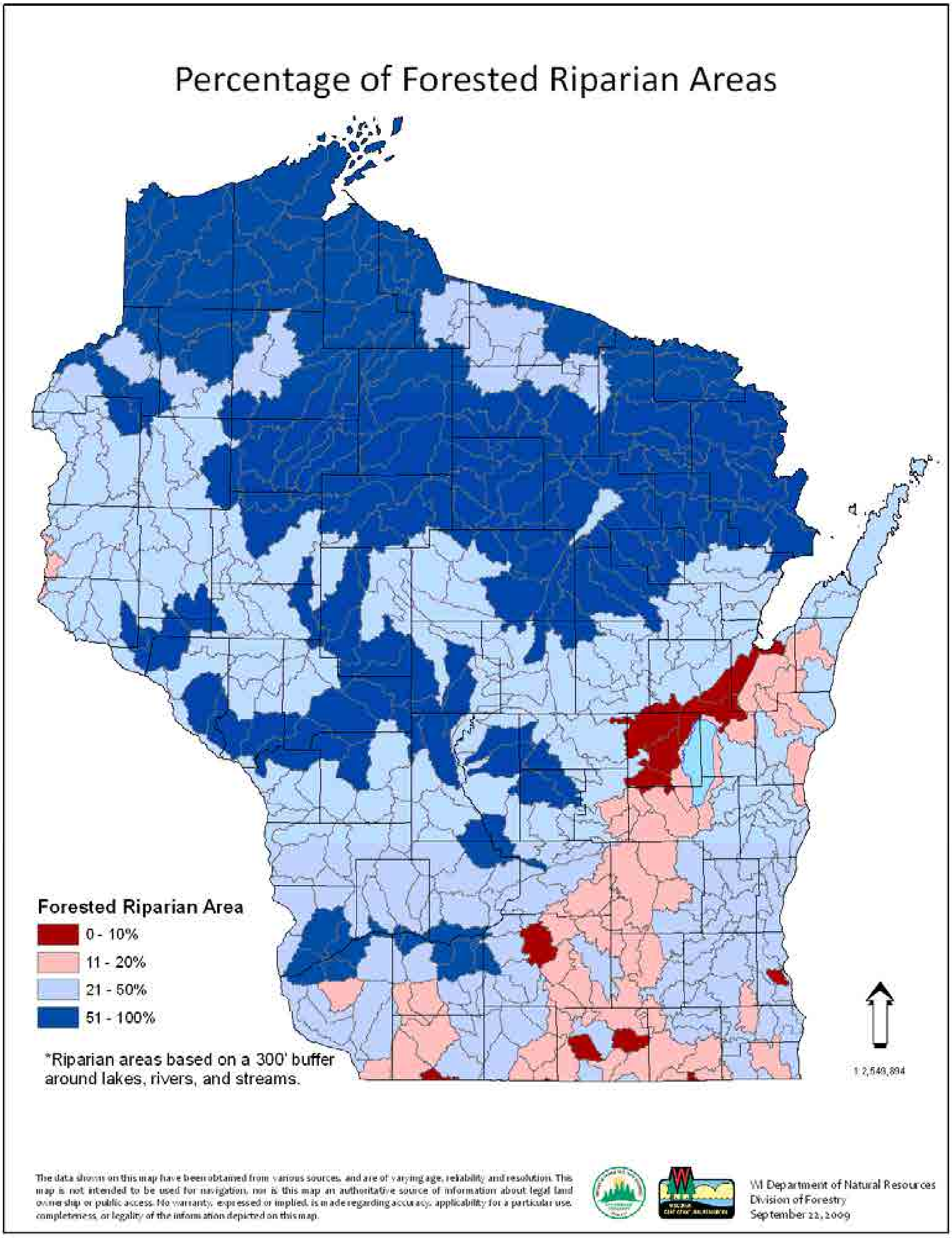
Table 11.a: Watersheds per percentage of riparian area forested

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

Source: WDNR

It is important to note that not all of Wisconsin’s watersheds were historically heavily forested. In some areas of the state, especially below the tension zone (the border of ecological sections—roughly the transition between northern and southern forests), open forest or grassland communities were common, while north of the tension zone, more heavily forested communities were dominant.

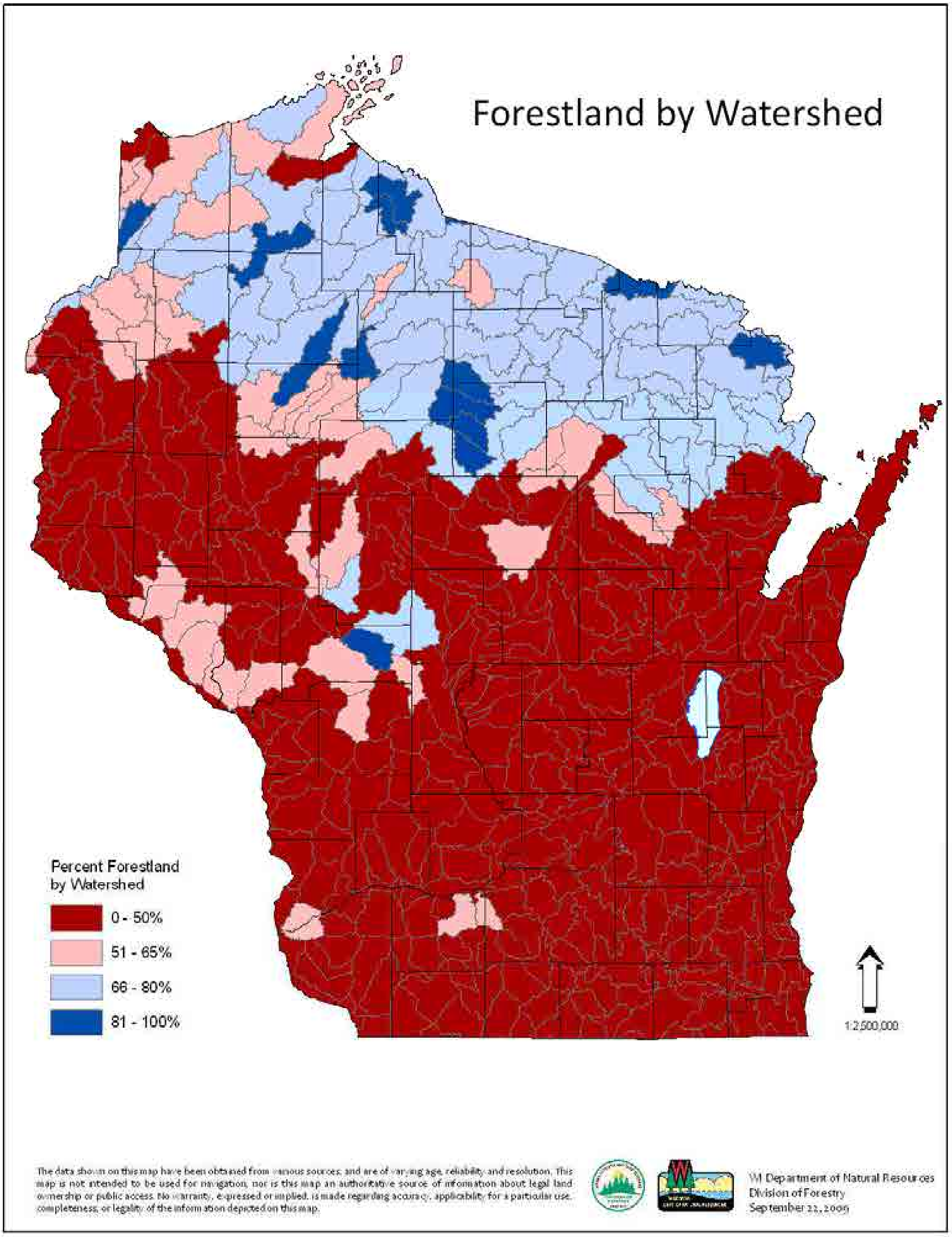
Based on a 300-foot buffer, 19 watersheds have fewer than 10% of their riparian areas forested (Table 11.a). Looking in particular at the watersheds for Bull Creek-Des Plaines River in Waukesha County and Bass Creek in Rock County, which had over 25% of their streams designated as impaired (Map 10.d), Bull Creek has less than 20% of its riparian areas forested and Bass Creek has between 21% and 50% of its riparian areas forested (Map 11.a). In watersheds with similar conditions, one goal may be to reforest riparian areas. In areas with higher percentages of riparian forests, the focus may be to maintain these forested buffers.



Map 11.a Percentage of forested riparian areas
Source: DNR, 2009

11.2 Amount of forested riparian areas

Maintaining a watershed in a forested condition can help to protect water quality and maintain aquatic habitat many species depend upon. Studies conducted in Wisconsin found that when 80% or more of a watershed is in a forested condition, streams have a high IBI (index of biological integrity) and maintain aquatic habitat features (Wang et al 1997). Other studies have found that if a watershed can be maintained at 65% forest cover and less than 10% impervious surfaces, the hydrology of that watershed is maintained, especially the stability of those streams (Booth 2000).



Map 11.b: Forest land by watershed
Source: DNR, 2009

In Wisconsin, only 15 watersheds (4% of watersheds) are more than 80% forested (Map 11.b). Maintaining forest cover will help to ensure these watersheds support healthy populations of aquatic species as well as the habitat and clean water they depend on.

There are also 251 watersheds (nearly 70%) with less than 50% of their land cover forested. Looking again at Bass Creek and the Bull Creek-Des Plaines River watersheds, both have less than 50% of their watersheds forested. The goals in these watersheds and similar watersheds may be to increase the amount of forested land cover, consistent with historic vegetation communities and wildlife habitat objectives.

11.3 Amount of impervious surfaces

Impervious surfaces, like roofs, parking lots, and roads prevent rainwater and snow melt from soaking into the ground. Water runs off of impervious surfaces and can increase the quantities of water that flows into lakes, rivers, streams, and wetlands. One result is more “flashy” streams with water levels that rise dramatically during runoff events with much lower water levels during dry periods. In watersheds with low levels of impervious surfaces, the flow pattern is typically less “flashy” because runoff can soak into the ground and be slowly released to lakes, streams, and wetlands over time, maintaining a more stable base flow.

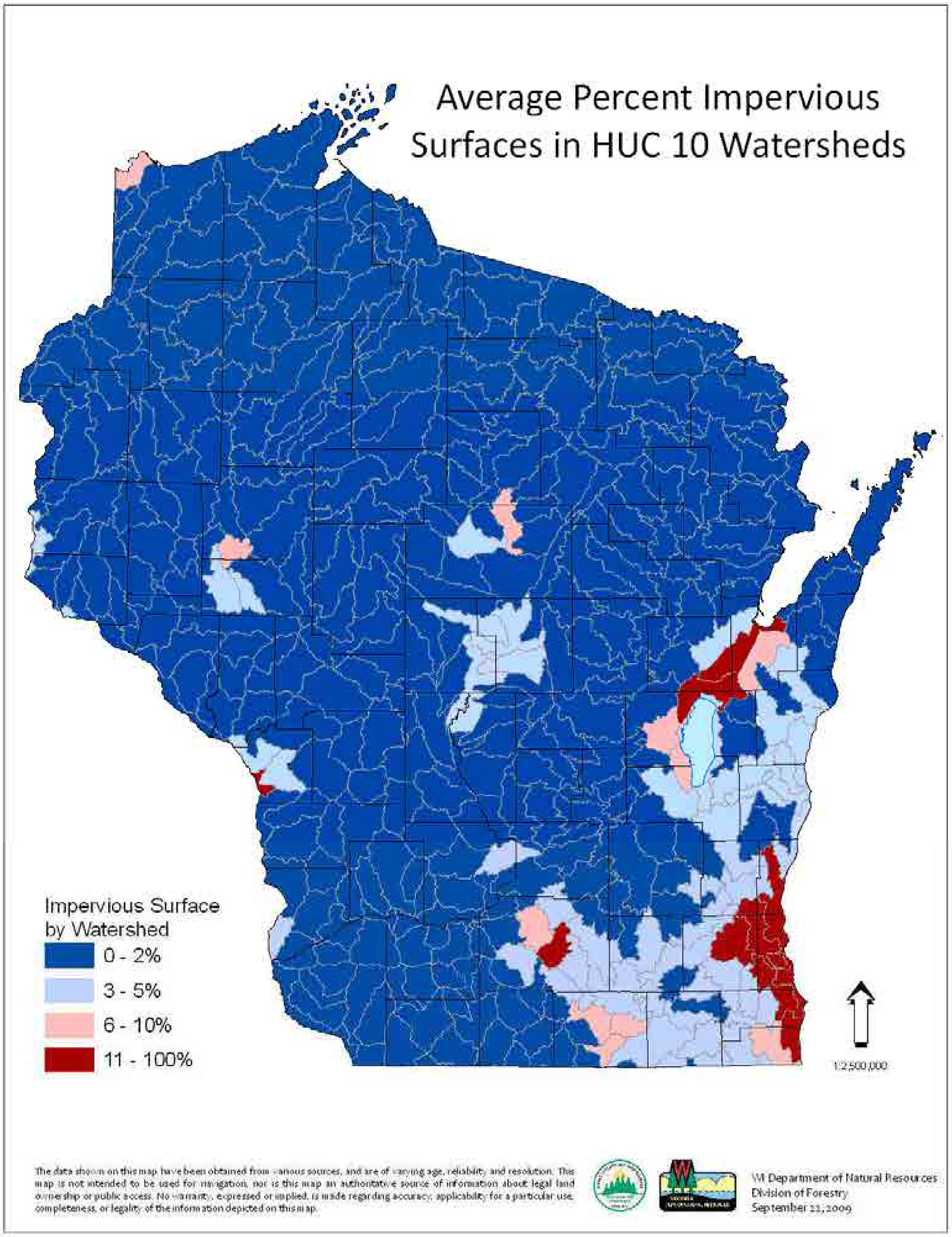
Studies in Wisconsin have found that when more than 10% of a watershed is urbanized, index of biotic integrity (IBIs) drop to poor or very poor (Wang et al 1997). A more recent study in the eastern United States has found sensitive fish species, such as darters, begin to disappear from watersheds when impervious surfaces rise to as little as 2% of a watershed (Wenger et al 2008).

Table 11.b: Watersheds per percentage of impervious surfaces

Percentage of Impervious Surfaces	Watersheds
0% - 2%	322
3% - 5%	29
6% - 10%	6
11% - 100%	11
Source: WDNR	

Based on 2001-2002 data, over 85% of Wisconsin watersheds are likely to be in very healthy condition with less than 2% of the watershed area in impervious surfaces (Table 11.b). A small number (11) of watersheds have greater than 11% of their land cover in impervious surfaces. Bass Creek has 6%-10% of its land area in impervious surfaces while Bull Creek-Des Plaines River has more than 11% of its watershed in impervious surfaces (Map 11.c).

Specifically in urban areas, it has been found that as urban areas keep growing, the amount of impervious surfaces also increases. With this growth, the urban forest coverage also increases (Table 11.c). This trend is consistent regardless of whether the urban growth is measured by a change in population density or in jurisdictional boundaries.



Map 11.c: Average percent impervious surfaces in HUC 10 watersheds
Source: DNR, 2009

Urban land area can be defined several ways. In this section, the term “urban” is defined by population density and delimited using the United States Census definitions of urbanized areas and urban clusters. A second way of measuring urban is to measure land within a city or village, as defined by jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. This is referred to as “community” in this report

Urban land area increased from 2.5% in 1990 to 3.0% in 2000. Impervious surface typically covers 24.3% of urban land statewide. Community land increased from 4.3% of Wisconsin’s land area in 1990 to 4.9% in 2000. Impervious surfaces typically cover 17.2% of community jurisdiction land. Overall impervious surfaces cover 1.5% of Wisconsin’s land area.

Based on the Wang et al study, a threshold of 10% “urban” area, or 17% to 24% “community” area, will drop IBIs to poor or very poor. Green infrastructure, such as forested buffers, can help to minimize the effects of impervious surfaces on water quality and improve IBI scores.

Table 11.c: Statewide summary of area, green space, and impervious surface land cover in urban, community, and urban or community areas

		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Land area	km^2 (2000)	140,236.7	4,197.0	6,843.7	7,849.8
	% Land area (2000)	100.0	3.0	4.9	5.6
	km^2 (1990)	140,236.7	3,565.4	6,034.8	6,878.5
	% Land area (1990)	100.0	2.5	4.3	4.9
	% Change (1990-2000)	0.0	17.7	13.4	14.1
Total green space (2000) [d]	km^2	138,140.0	3,178.8	5,666.4	6,575.3
	% Land area	98.5	75.7	82.8	83.8
Impervious surface cover (2000)	km^2	2,096.8	1,018.2	1,177.3	1,274.5
	% Land area	1.5	24.3	17.2	16.2
	Per capita (m^2/person)	390.9	277.9	310.7	n/a

a. Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters.

b. Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places.

c. Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries.

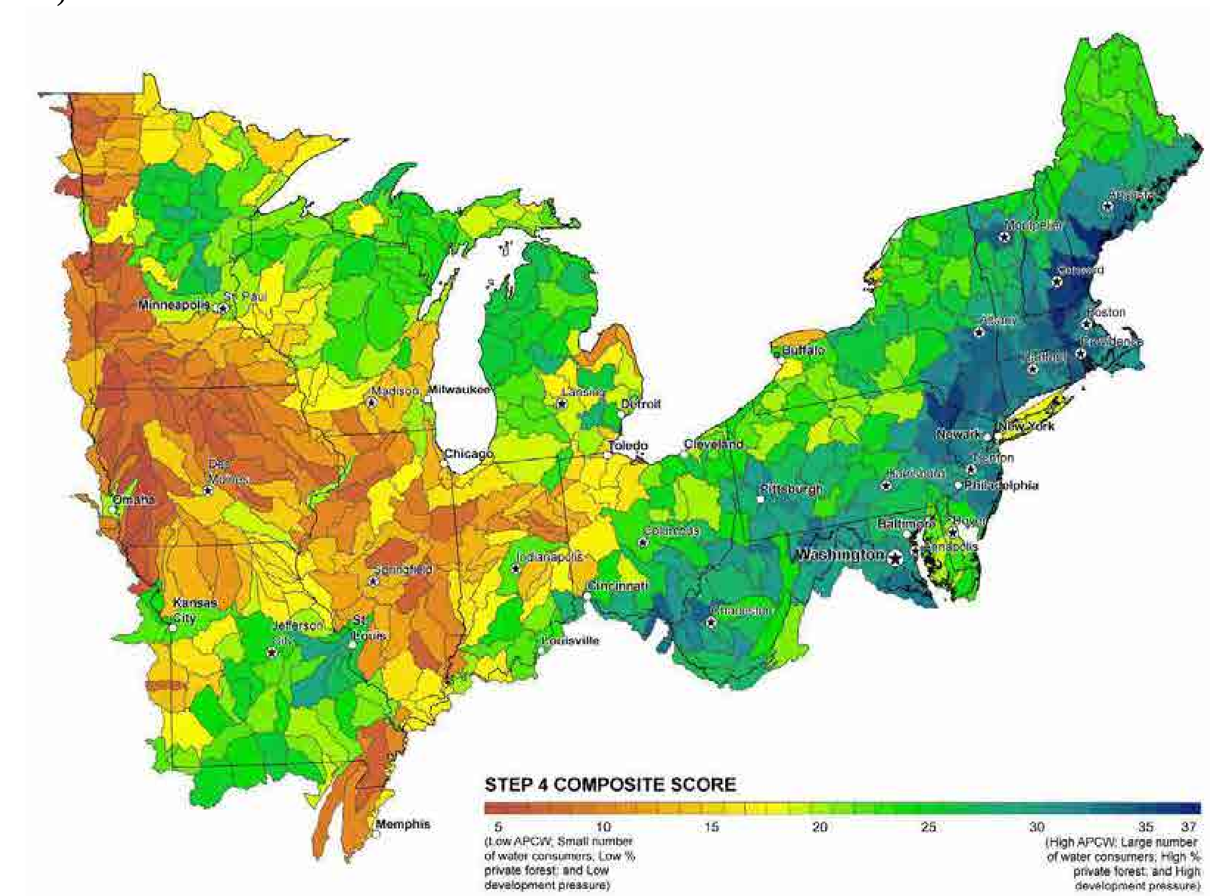
d. Total Green Space = Total Area – (Impervious Surface Area + Water Area)

Source: NLCD and US Census

Forests, water, and people analysis

Forests play a critical role in preserving clean water supplies by maintaining a protective forest floor that prevents soil erosion, and filters and infiltrates water. Protecting and responsibility managing forests should be an essential part of future strategies to ensure clean water supplies in Wisconsin.

In order to identify watersheds in the Northeastern Area that are threatened by land use change or in need of management to sustain and improve forests that protect water supplies, the US Forest Service State and Private Forestry conducted a GIS analysis that identified private forests that are most important for drinking water supply and most in need of protection from development pressure. The final report for the Northeastern Area, which documents the analysis procedure and results, can be found at http://www.na.fs.fed.us/watershed/fwp_preview.shtm. This report analyzed Wisconsin's watersheds in the context of all watersheds in the Northeastern Area (Map 11.d).

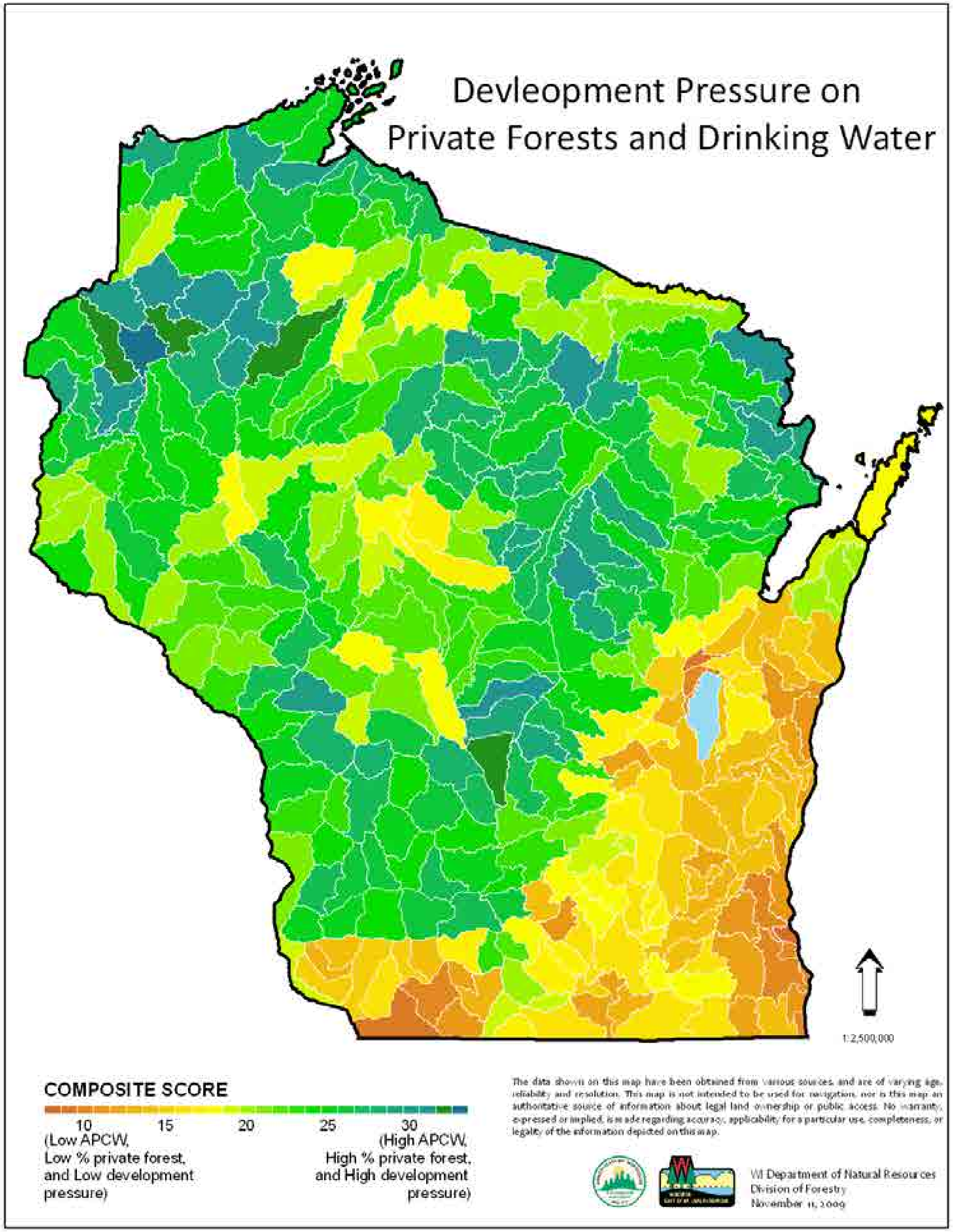


Map 11.d: Northeastern Area Development Pressure on Forests and Drinking Water Supplies

Source: Northeastern Area State & Private Forestry

In order to evaluate the importance of watersheds within Wisconsin, the DNR Division of Forestry repeated this analysis for the state with finer resolution data (Map 11.e). A slight modification was also made to the analysis because some people get their drinking from groundwater rather than surface water in Wisconsin. This resulted in the watersheds being rated the same in Step 2 of the analysis, because it was determined that, in Wisconsin, all watershed are equally important for drinking water.

The map combines data on the ability to produce clean water, surface drinking water consumers served, percent private forest land, and housing conversion pressure, to highlight important water supply protection areas that are at the highest risk for future development. The greater a watershed's development pressure, the more blue it appears on the map, and the higher its score.



Map 11.e: Development pressure on private forests and drinking water in Wisconsin
Source: DNR, 2009

The results of this analysis identified watersheds that have large areas of private forests that are important for maintaining clean water and in need of protection from development pressures. These are the high scoring watersheds in the analysis. Low scoring watersheds either have a large percentage of protected forestland or have low percentage of forestland. A low score does not mean a watershed is unimportant, rather depending on why it is ranked low, it may be an example of a successfully managed and protected forested watershed or it may be a priority for reforestation and other efforts.

The highest and lowest ranking watersheds are:

Highest Ranking Watersheds			Lowest Ranking Watersheds	
Score	Watershed		Score	Watershed
33	North Fork Clam River		8	Kinnickinnic River
32	Duck and Plainville Creeks		9	Fox River – Appleton
32	Shell Lake and Upper Yellow River		9	Galena River
32	Clam River		10	Little Lake Butte des Morts
32	Weirgor Creek and Burnett River		10	Menomonee River
31	Pemebonwon and Middle Menominee Rivers		10	Middle Pecatonica River
31	Big Roche-A-Cri Creek		10	Lake Winnebago – North and West
31	Upper Little Wolf River		10	Root River
31	Upper Apple River		10	Pike River – Kenosha
31	Pelican River		10	Oak Creek
31	Lower Namekogan River		10	Wind Point
31	Couderay River			
31	Trego Lake – Middle Namekogan River			

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Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles

Overview

The global carbon cycle is a natural process. In forests, carbon dioxide is transformed through photosynthesis into elements of plants including roots, shoots, leaves and wood. This process of converting carbon into plant material is often described as carbon sequestration. Stored carbon dioxide is released as plants respire, and as dead plants and fallen leaves break down into the soil or are burned by fire. The capture and release of carbon dioxide in forests occurs simultaneously, but when the net balance results in carbon dioxide removals from the atmosphere, forests act as a carbon "sink." Conversely, when forests give off more carbon dioxide than they capture they become a carbon "source." Whether or not a forest acts a sink or source depends on age, vigor, pest and disease influences. The capacity of forests to store carbon may become an important factor in reducing atmospheric carbon dioxide concentrations, mitigating global climate change, and reducing future reliance on carbon based fuels.

Carbon can also be stored in forest products. Long-lived products such as dimension lumber store carbon for hundreds of years and keep it from being released to the atmosphere. However, using wood for paper, or burning it for energy, can release much of the carbon in a short time frame.

Urban forests, in addition to storing carbon, can reduce carbon dioxide emissions by providing shade and reduces carbon based energy inputs needed for heating and cooling.

The selected indicators in this Criterion—forest biomass, carbon pools and change in carbon—reflect key inputs to determining a forest carbon balance. A consideration of multiple forest carbon pools takes into account the complete carbon cycle in forests, from leaf litter to dead wood and soil.

Criterion 5 Indicators:

12. Forest ecosystem biomass and forest carbon pools

Major Conclusions[1]

1) Incorporating climate science and monitoring information into landscape management activities would help adapt forests to new and changing conditions, mitigate greenhouse gas emissions responsible for climate change, and to meet changing demands for forest products and other ecosystem services.

- In general, maintaining forested lands translates directly to maintaining carbon stocks, and forest management that increases forest area or growing stock volume increases forest carbon. There may be potential conflicts, however, between carbon stock goals, traditional forest utilization and increased biomass utilization as demand for alternative energy sources grow.
- The Wisconsin Council on Forestry developed Biomass Harvest Guidelines in 2008 that include ongoing monitoring to assess the effectiveness of the retention standards. Supporting those evaluations, updating the guidelines as needed, and requiring licensees who operate bioenergy plants to follow the Biomass Harvest Guidelines would be important precautions to preserve soil carbon in forests.

2) There is considerable opportunity for storing additional carbon in Wisconsin's forests.

Silvicultural practices that increase the rate of growth, hold stands to a higher maximum tree size class, increase basal area, extend rotations, promote structural retention, increase forest area, and other techniques can store additional carbon. There are further opportunities to increase carbon storage after harvest through conversion of material to long lived wood products.

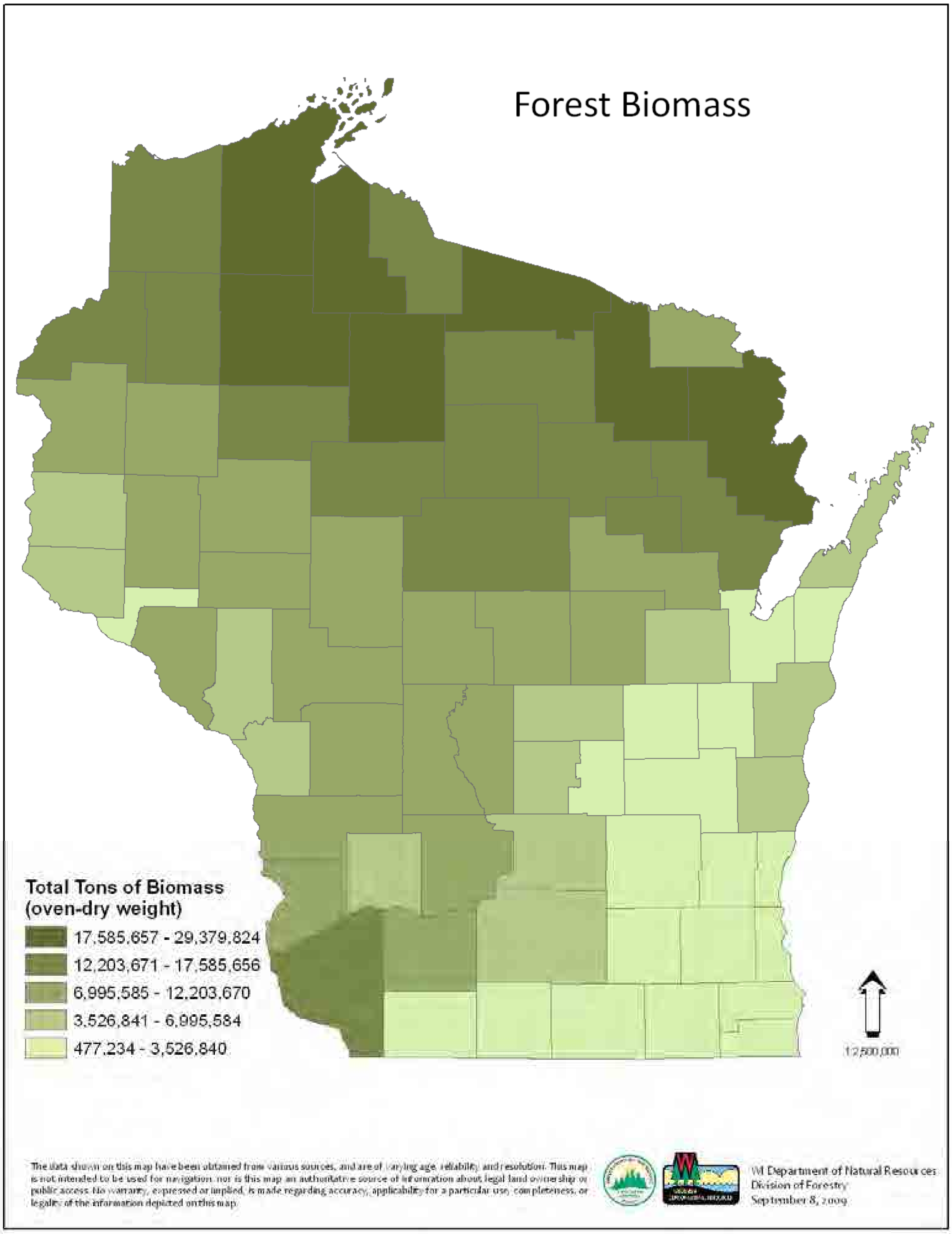
- Historically, Wisconsin held 57% more above-ground carbon in live trees than the state does today.
- Wisconsin's forests are a net carbon sink. The carbon sequestered contributes to lowering the atmospheric balance of carbon dioxide by 27.7 million tons per year, with a net balance of 8.4 million tons sequestered after emissions are included.
- Wisconsin's current 14% urban forest canopy avoids 50,000 tons of carbon emissions from fossil-fueled power plants annually, but expanding the canopy to a recommended 40% could nearly triple that reduction.
- For every ton of above ground carbon, there are approximately 1.88 tons of below ground carbon, and so a complete and healthy ecosystem stores more carbon than live trees alone. This is a critical concept that must be taken into consideration when evaluating management alternatives for impact on carbon emission or sequestration.
- At present, Wisconsin's carbon pools are concentrated in northern counties that are more densely forested. Different forest types vary in their carbon storage potential. Oak/Hickory and Maple/Beech types dominate the proportion of total carbon stored within the state, but Spruce/Fir stores the most carbon per acre.

[1] (Items in bold are conclusions drawn by reviewing statements of finding from the Assessment. The bulleted items below each conclusion are the findings).

12. Forest ecosystem biomass and forest carbon pools

12.1 Forest ecosystem biomass

In the context of this assessment, forest ecosystem biomass is the amount, in short tons, of above ground living tree material over a certain area. Woody biomass is approximately 50% carbon, so the quantification of biomass is important as an indicator of carbon stored in forests. Growing stock volumes are an indicator of biomass and carbon stocks, and may be used to assess this change in the future.



Map 12.a: Tons of forest biomass by county (oven-dry weight)
Source: FIA, 2009

Map 12.a shows that biomass stocks are concentrated in the northern counties of the state, which are more densely forested. The distribution of biomass follows forest volume distribution as the two are correlated, although biomass is also related to wood density. A county with high growing stock volumes will also generally have high biomass stocks.

Disturbances such as those experienced by Wisconsin's forests during the Cutover can result in long-term negative effects to a site's capacity to sequester and store carbon (Gough et al 2007). It is essential manage disturbance regimes and management to maintain soil and site productivity to maintain the carbon storage capacity of forests.

12.2 Forest carbon pools

Forest carbon pools represent a complete picture of the forest resource quantified along a standard unit of measure. Pools include carbon measures for below ground dead wood, down dead wood, standing dead wood, above and below ground live material, understory, and forest floor.

Table 12.a: State level forest carbon pools

Carbon Pool	Mean tons/acre	Million tons
Below Ground	66.7	500.9
Above Ground Live	19.7	147.8
Understory	3.8	28.3
Below Ground Live	3.5	26.2
Down Dead and Stumps	2.8	20.8
Above Ground Standing Dead	1.4	10.6
Forest Floor	7.7	3.3
Urban Forest (whole live tree) [a]	3.1	0.9

Source: USFS, COLE, May, 2009

a. Urban Forests of Wisconsin: Pilot Monitoring Project 2002

Table 12.a shows the estimated distribution of forest carbon pools statewide. Carbon stored below ground is the single largest carbon pool and standing dead wood is the lowest. Despite being the largest carbon pool, below ground carbon is also the most difficult to measure and research that leads to increased certainty in its measurement is ongoing.

The highlight of the forest carbon pool distribution is the relationship between above and below ground carbon. For every ton of above ground carbon, there are approximately 1.88 tons of below ground carbon. This is important in providing a reference point for the scale at which carbon is stored in Wisconsin’s forests. Soil carbon stocks are higher in clay soils than sandy soils, because clay protects organic matter from decomposition (Cowie, 2006). Furthermore, the ratio of standing live tree carbon to other carbon pools puts into context the amount of organic material contained in forests. Standing live trees (above ground live) make up a quarter of all carbon within the forest (below ground, understory, below ground live, down dead and stumps, above ground standing dead, and forest floor). This makes for a challenge in assessing the majority of forest carbon pools, as research to quantify below ground forest carbon pools and turnover rates is incomplete.

As demand for alternative energy sources grows, the demand for greater levels of biomass may change and effect soil carbon. There are concerns that soil carbon stocks could be depleted by bioenergy production because a higher proportion of the organic matter and nutrients are removed from the site compared with conventional forestry focused systems. Models described in research indicate that bioenergy production systems are likely to enhance soil carbon where they replace conventional agricultural crops. Soil carbon losses may, however, occur where soil carbon is initially high if forestry practices do not adequately protect soil productivity (Cowie, 2006). With that concern in mind, DNR through the Wisconsin Council on Forestry developed Biomass Harvest Guidelines in 2008, and the guidelines include ongoing monitoring to assess the effectiveness of the retention standards. Although current research asserts that soil carbon loss associated with bioenergy production would be negligible compared to greenhouse mitigation through avoided fossil fuel emissions, requiring licensees who operate bioenergy plants to follow the Biomass Harvest Guidelines would be an important precaution to preserve soil carbon.

12.3 Forest carbon by forest type

The variation of species composition within a forest influences the amount of forest carbon each forest type stores. Examining forest carbon by forest type can show which species distributions store the most carbon within the state.

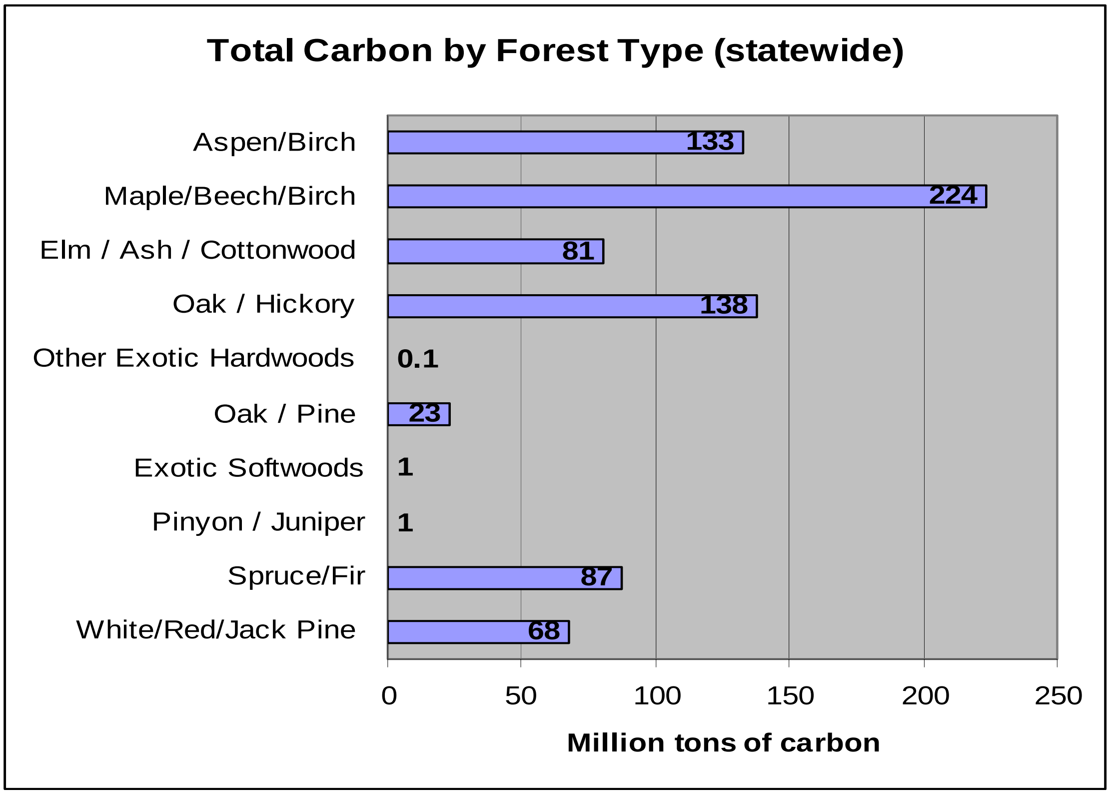


Figure 12.a: Wisconsin forest carbon pools by forest type (USFS, COLE, May, 2009)

Figure12.a shows the total amount of carbon by forest type statewide. Mean carbon per acre varies from 46 tons per hectare in Exotic Hardwoods to 122 tons per acre in Spruce/Fir.

Mean forest carbon values for Wisconsin mirror growing stock volumes with one exception. Oak/Hickory and Maple/Beech dominate the proportion of total carbon stored within the state, but Spruce/Fir stores the most carbon per acre.

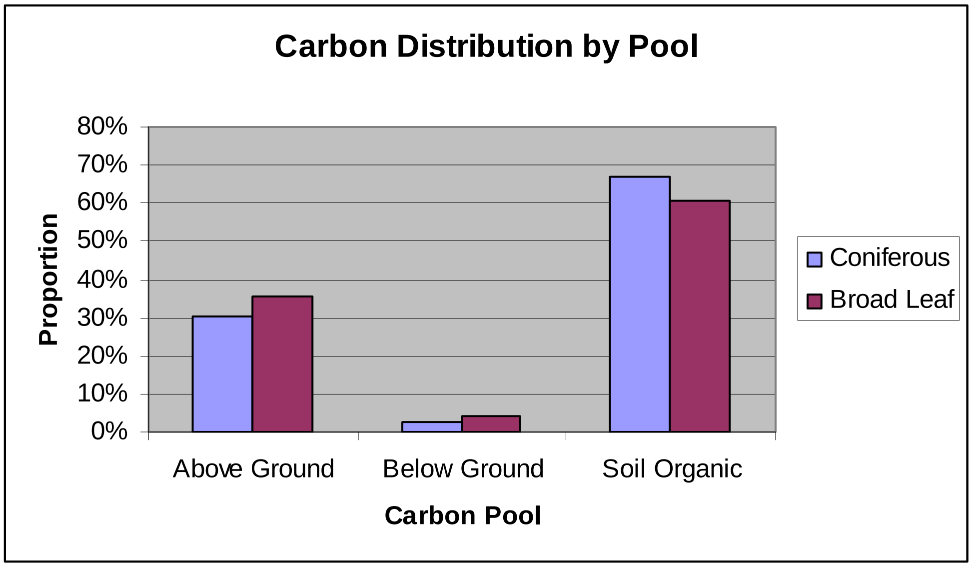


Figure 12.b: Wisconsin's forest carbon distribution by pool (USFS, COLE, May, 2009)

Figure 12.b compares above ground and below ground carbon storage for broad leaf and coniferous forest types. In both coniferous and broad leaf forest types, the largest portion of carbon storage occurs in the soil. The amount of carbon stored in forest soils points to the value of the complete forest ecosystem in carbon storage. A complete system stores more carbon than live trees alone, and should be taken into consideration when evaluating management alternatives for impact on carbon emission or sequestration.

12.4 Change in forest carbon

The data shown in this indicator represent the average annual change in forest carbon at the state level. This metric shows the role Wisconsin forests play in carbon sequestration.

Table 12.b: Wisconsin forest carbon change over time	
Year	Billions of Tons of Carbon Stored
2003	1637.8
2004	1613.3
2005	1618.9
2006	1666.7
2007	1673.3
5 year change	35.5
Source: USFS COLE, 2007	

Table 12.b shows the change in statewide forest carbon from 2003 to 2007 as derived from FIA data. Both mean forest carbon per hectare and total forest carbon increased over this time period. Total forest carbon increased by an estimated 2.1 percent over this time period.

Change in forest carbon follows closely with change in forest growing stock (see Table 2.c in Criterion 1 for change in growing stock). Efforts in forest conservation have maintained Wisconsin's large forest carbon sink, sequestering 7 million tons of carbon per year, or 27.7

million tons of carbon dioxide equivalent. Maintaining Wisconsin's urban forest canopy at its current 14% cover annually avoids 50,000 tons of carbon emissions from fossil-fueled power plants (Cumming et al, 2007). Expanding the canopy to the recommended 40% could nearly triple that reduction.

The current amount of carbon stored in Wisconsin's forests is much lower than it was historically. Recent research estimates that at the time the original Wisconsin land survey was conducted in the mid-1800's, above-ground carbon in live trees totaled 434 million metric tons. This figure fell to about 120 million metric tons after the Cutover, and has since increased to about 276 million metric tons (Rhemtulla et al., 2009). This illustrates a considerable opportunity for additional carbon storage, although reassessing overall land-use choices in balance with desired ecosystem services would be involved.

If increasing carbon storage is desired, there are forest management tools to do so. Management practices that could result in greater carbon storage in existing forests include holding stands to a higher maximum tree size class, increasing basal area, extending rotations, and promoting structural retention (such as conserving snags and down woody debris on site). Reforesting open lands that were formerly forests, and manipulating the composition of forests with stocking could also increase carbon storage. If these practices are used, it is also important to consider the impacts on the forest as a whole, and the carbon cycle changes to the ecosystem.

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Rhemtulla, M., D. Mladenoff, and M. Clayton. 2009. Historical forest baselines reveal potential for continued carbon sequestration. PNAS Early Edition 106 (15): 1-6.

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United States Carbon Cycle Science Program (http://www.carboncyclescience.gov/default.php)

Northern Institute of Applied Carbon Science: Forests Absorb Carbon Dioxide (http://nrs.fs.fed.us/niacs/forests/)

Earth Observatory: the Carbon Cycle (http://earthobservatory.nasa.gov/Features/CarbonCycle/)

King, A.W., L. Dilling, G.P. Zimmerman, D.M. Fairman, R.A. Houghton, G. Marland, A.Z. Rose, and T.J. Wilbanks (eds.) North American Carbon Budget and Implications for the Global Carbon Cycle. By the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. 2008. Online: http://www.climatescience.gov/Library/sap/sap2-2/final-report/. Chapter 1.

Criterion 6: Socioeconomic benefits of forests and their ecosystem services

Overview

Forests provide raw materials needed for manufacturing and a setting for Wisconsin's robust recreation industry. Forests also yield intrinsic values that are often taken for granted or are unknown because they are not directly traded. For example, one can look up the market value of oak timber, but not oak's monetary value as a wildlife food source. Other "behind the scenes" ecosystem services like carbon sequestration, erosion control, clean water, and heat mitigation are important, too. While not all forest benefits are quantifiable, this criterion presents available economic and social data to gauge our forest's ability to improve and sustain our quality of life.

A few of the measurable parameters this criterion tracks include the status of wood products, employment, education, funding, and recreation opportunities as well as forest ownership and land use. Knowing who owns the forests and how these lands are being used can infer benefits into the future. Many other intangible values related to people, societies, and culture may, however, be of equal or greater importance. For example, a sense of place is difficult to value, yet it can drive the real estate market or business recruitment. For indigenous peoples, the cultural components of forests (like food, medicine, and ceremonial uses) are essential to the perpetuation of a tribe's identity.

Recognizing that such elusive values exist, a new indicator was developed for the Montreal Process which addresses the importance of forests to people. It attempts to understand the "breadth and intensity of the emotions through which individuals and communities connect with trees and forests." These feelings are important motivators of human behavior and are often the reasons why individuals—alone or as members of groups—support or oppose specific forest management activities related to "sustainability". Wisconsin's data gap concerning such issues could be closed through future surveys and focus groups, but until time and funding are available for that type of social research, available data are used here as a proxy.

Criterion 6 Indicators:

13. Wood and wood products production, consumption, and trade
14. Outdoor recreational participation and facilities
15. Investments in forest health, management, research, education, and wood processing
16 Forest ownership, land use, and specially designated areas
17. Employment and wages in forest-related sectors

Major Conclusions[1]

1) The total value of all forest products harvested from Wisconsin forests slowly declined from a peak in 2000.

The 2008-2009 recession exacerbated a decline. As the economy rebounds, the industry is expected to recover, but not necessarily with the same players or mix of commercial products as before. New markets for certified wood, biomass and bio-fuels could influence growth.

- Wisconsin remains the #1 paper producer in the nation, a position it has held for over 50 years. Although the paper sector experienced mill closures as a result of global competition, it still reports $13.8 billion in shipments and 9% of Wisconsin's manufacturing value of shipments.
- Of five forest products sectors, wood furniture manufacturing suffered the most substantial (-35%) decline in shipments due to overseas competition.
- The total forest products industry payroll dropped 31.6% after adjustment for inflation since its peak in 1996. Employment dropped by about the same amount (30.51%).
- New markets are developing in biomass, bio-energy, and recycled material, presenting the paper sector with both challenges and opportunities.
- Growing demand for certified wood products from responsibly managed forests helped stabilize paper and solid wood sectors in the Great Lakes region due to a concentrated supply relative to the rest of the country, according to industry executives.
- Wisconsin harvests more of its forest growing stock per year than is consumed by its residents, providing evidence that the forest products industry as a whole is an export industry that brings in new dollars into Wisconsin's economy.

2) Forests remain highly relevant to the state's economic health and are influenced by public policy.

- Recreational use of forests is estimated to contribute approximately $5.5 billion to the Wisconsin economy through travel-related and equipment expenditures. Trends in forest-based recreation point toward an increasing economic benefit over the next decade.
- Wisconsin's forest products industries remain a vital component of the state economy, comprising 13.8% of the value added in all manufacturing sectors.
- Wisconsin's wood products sector shipped $20.5 billion of product in 2006. Of this, 67% was from the paper sector.
- Wisconsin's forests produce valuable ecological services like carbon storage and regulated water flows that may provide additional economic returns to Wisconsin landowners if related financial exchanges continue to develop.
- Wisconsin' urban forests annually provide over $64 million in environmental services including carbon sequestration, air pollution mitigation, and energy savings that could be an effective tool to help address climate change and energy independence. Recycling city trees salvaged from pest outbreaks, storms or other factors into valuable forest products may offer opportunities for additional economic benefits and help keep wood out of landfills.

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[1] (Items in bold are conclusions drawn by reviewing statements of finding from the Assessment. The bulleted items below each conclusion are the findings).

- Wisconsin forests provide native tribes with non-timber forest products to make their life-way and places to practice relevant cultural activities.

3) The statewide forest management system will need to make changes in order to operate effectively with reduced funding and smaller workforce.

Two major components of the forest management infrastructure are 1) stable funding that supports governmental forestry operations and grants for private forestry initiatives and 2) a well-educated workforce. Traditional government funding sources have dropped and the forestry workforce is decreasing.

- Two major state forestry account policy changes—the first reduction in the mil tax rate since 1937 and utilization of a greater share of the account for purposes other than DNR forestry operations—may reflect a shift in public values relative to forestry and other economic concerns. This change could signal a reduction in rural and urban forestry programs that rely on public funding and a need for more private initiatives.
- Federal forestry funding also fell or is more difficult to acquire. For example, states must compete for 15% of S&PF funding that was previously appropriated. 2008 federal fire grant funding was 50% of the total from five years previous.
- Forest management positions will see over 50% of the workforce turn over in the next decade due to the baby boomer generation entering retirement and at a time when the number of forestry graduates in the Lake States is declining. The shortage could result in prolonged vacancies, increased labor costs, or acceptance of less qualified replacements.
- The forest products industry employs over 68,000 people, but the number of jobs and the payroll in the wood products industry have fallen 30% since 1996. While new forest-based industries may emerge, it is not clear if they will employ as many people as in the past.
- One of the weakest links in the responsible forestry chain is the status of the logging sector. The average logging firm has been in business for over 20 years and the average firm owner is 47 years old. There are relatively few new firms entering the sector. Among firms with employees, over 85% reported difficulty finding skilled and reliable workers.
- DNR has met the target number of positions trained to lower level positions in fire readiness operations and command. A training gap analysis shows significant shortages in higher level command, operations, planning and logistics positions.
- Forestry research programs are not integrated across agencies, but due to limited resources, partnerships for research and coordination of efforts are all the more crucial. Private research done by forest industry also declined sharply after large industrial owners began monetizing their land base through sell-off to other ownership structures, shifting more research responsibility to other partners.

4) Private land ownership patterns are changing and forest land values are increasing, which makes it difficult to keep forests as forests.

Industrial land holders selling large forest blocks off in small parcels are one of the largest factors influencing this change.

- Statewide, average forest land values increased from $311 per acre to $2,438 in the last seventeen years, an annualized increase of 12.87% compared to a 2.76% annualized inflation rate over the same period.

- Total non-industrial private forest acreage rose 14.23% and forest industry ownership fell 51.50% during the 38 year span (1968-2006) as land was transferred to other ownership categories.
- The average non-industrial private forest parcel shrank from 37 acres in 1997 to 28 acres in 2006. The number of small parcels less than 50 acres grew – parcels in the smallest 1-9 acre category nearly doubled – and area in ownership categories over 100 acres dropped.
- The portion of land owned by forest products companies fell from 62% in 2002 to 24% in 2008 after transfer primarily to Real Estate Investment Trusts.

5) Changing land ownership patterns and forest land values affect the ability of landowners and resource agencies to effectively and efficiently address management on the ground.

Small non-industrial private forest parcels are challenged to maximize their economic returns due to operational inefficiencies. Landscape scale management becomes more complicated as the parcel size decreases. The overall number of MFL parcels is increasing the demand for plans and stressing the supply of service providers.

- The number and acreage of MFL entry orders more than doubled in ten years. The increase was not uniformly distributed but rather focused in some areas of the state, locally intensifying assistance shortages.
- The State Legislature revised the Managed Forest Law requiring landowners to pay for land management planning services from private foresters rather than receive free planning assistance from DNR. About 20 full-time equivalent forester positions within DNR were shifted from private forestry to public land management duties.
- The number of cooperating forester firms grew from 73 in 1999 to 127 in 2009, about a 74% increase. The number of foresters available in those firms rose about 83.5% over the same ten-year period.

6) As budgets are tightened, some public land management has been deferred.

- As captured in forest certification reports, the state is struggling to complete property management master plans, collect biotic data, maintain roads and infrastructure, control invasive species and address other critical public land management duties.
- Implementing Act 166 (legislation mandating timber management and harvesting on state properties) is a challenge for many small state properties that do not have master plans addressing timber management.
- While 457,962 acres of public land were purchased with Knowles-Nelson Stewardship Program funds since 1990, an often overlooked corollary is that per acre budgets for land management have shrunk. In the DNR Division of Land, overall funding per acre dropped almost 50% between 1990 and 2007 and was further reduced during the 2008-2009 recession.
- As DNR resources fall, decisions are being made to limit operations such as service center operations, facility maintenance, recreation opportunities and education programs.
- The reductions for the DNR Urban Forestry program decrease the amount and type of aid available for communities all across Wisconsin in their efforts to sustainably manage their urban forests. This affects 80% of Wisconsin's population right where they live.

7) People are changing behavior based on their environmental beliefs, which are being reflected in state programs and policies.

- There is an increasing trend of buying more certified products. 76% of consumers expect to spend the same or more on green products this year.
- In 2004, Wisconsin Governor Jim Doyle issued an Executive Order directing the Department of Administration to establish state building standards based on green building design specifications that include use of certified wood. Construction analysts forecast overall green building markets for both non-residential and residential construction will more than double between 2009 and 2013.
- Knowles-Nelson Stewardship Program was reauthorized as part of the 2007-2009 State Budget for a ten-year period. The annual bonding authority was increased from $60 million to $86 million for this additional 10-year period.
- Wisconsin has established over 600 State Natural Areas, perhaps the most successful program of state reserves in the country.
- Between 2004 and 2009, Wisconsin achieved third-party forest certification on over 7 million acres, 44% of the state's forest resources. DNR led the effort through bipartisan support in the State Legislature to fund certification audit costs and program improvements.
- Private land trusts and conservation organizations like Gathering Waters Conservancy and The Nature Conservancy that have protected over 300,000 acres in Wisconsin illustrate how public-private partnerships are essential to achieve land conservation goals.
- The prospect of reduced property taxes compels many people to enter into conservation easements with land trusts, but in practice there has been wide variation in how easements are considered by assessors across the state, thereby reducing the effectiveness of easements as a conservation tool.
- The federal Forest Legacy Program is effective at leveraging other funds for conservation easements. For example, five properties totaling 52,377 acres were protected with conservation easements valued at $25,751,000 using $11,400,000 in Forest Legacy funds.
- Many communities from all across Wisconsin utilize some type of memorial tree program to aid their tree planting efforts. These donations provide valuable funding for new trees.
- Public demand for recycled products helped to drive a change in paper production. Based on 2003 figures, about 41% of Wisconsin paper and paperboard products were recycled materials, and that will likely increase. In 2009 a record-high 63.4% of the paper used in the U.S. was recovered for recycling.

8) Managing the supply for forest based recreation opportunities is difficult to plan for due to shifting demand.

Technological trends and landownership changes evolve quickly and are hard to keep pace with. It is difficult to measure the ecological, economic and social effects of various types of recreation. Without an evaluation and monitoring system, making decisions regarding recreation is challenging.

- Continued growth in ATV and related motorized recreation is expected as technology improves, generating demands for more trails and increased maintenance costs for existing trails on both public and private land.

- Primitive or tent-camping on state-owned land is extremely popular but the supply of desirable campgrounds is not meeting the need.
- In our health-conscious society where more people are engaging in outdoor recreation, trail shortages (especially for hiking, bicycling and equestrian use) were identified across the state.
- Based on experience with MFL and changes in state trespass laws, private landowners are allowing less public access to their property. A statute change in 2007 that prohibits leasing of closed MFL land is also restricting the supply of private land available for hunting leases.
- Although the state enacted an Outdoor Activities Grant Program in 2007 intended to purchase easements and land for outdoor recreation, the program remains unfunded in the 2009-11 biennium due to the economic recession.
- Friends groups help public land managers by addressing some of the deferred management such as facility development, invasive species control, and naturalist programming.

9) Certification of forest lands continues to be an opportunity for landowners and industry.

- About a third of U.S. certified land and 53% of FSC-US certified land are located in Minnesota, Wisconsin and Michigan.
- Certification of such a large amount of Wisconsin's forests enhanced the state's ability to market forest products and likely helped reduce the economic impacts to the state's forest products industry from the current global recession, based on testimony of state forest products company executives.
- If certification of Wisconsin forest land is to continue to grow, the greatest opportunities reside in National Forests and small family forest owners who do not have MFL plans. Some industrial MFL owners with about 765,000 acres who were excluded from the original MFL Group program may now be interested in joining a DNR-sponsored certification program.

13. Wood and wood products production, consumption, and trade

13.1 Value of wood-related products

The value of wood-related products and shipments indicates the relative importance of Wisconsin forests as a source of raw material for a wide variety of uses. Tracking the values of goods and services through the production process, from the forest to the end of secondary processing, explains a key dimension of the economic contribution that forests make to local, state and national economies. Several related measures can be used to analyze the relative value of products by industry. They are: total value of shipments, cost of materials, and value added. (Detailed definitions are located in the Glossary.) These measures appear in the subsequent graphs in terms of both current dollars and dollars adjusted for inflation according to 2007 constant dollars.

Total value of wood related products can be assessed through the total value of shipments (analogous to sales) in the forest product industry. Total value of shipments for the forest products industry has declined since reaching a height of $26.8 billion in 1995 (in constant 2007 dollars), dropping to $20.5 billion by 2006 (Figure 13.a).

Value added is considered to be a valuable measure for comparing the relative economic importance of manufacturing among industries and geographic areas. While total value of shipments dropped in terms of constant 2007 dollars from 1995, value added by wood products increased around 2002, when cost of materials fell at a faster rate relative to total value of shipments (Figure 13.a).

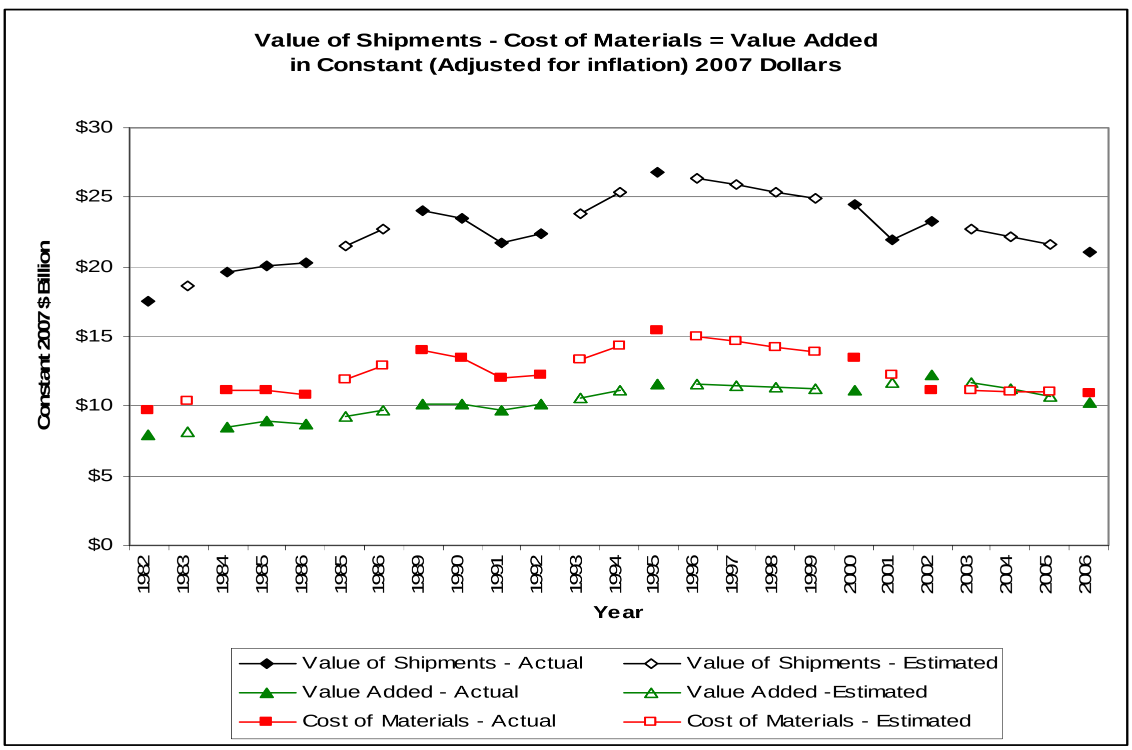


Figure 13.a: Forest industry value added (constant 2007 dollars) (US Economic Census, 2007)

Among wood product industry subsectors, the paper manufacturing subsector contributes the majority of the value of shipments ($13.8 billion), or 9% of the value of shipments for all manufacturing in Wisconsin in 2006. According to the Wisconsin Paper Council, the state continues its rank as the top U.S. paper producer, a position it has held for over 50 years. Only the wood furniture subsector experienced a recent decrease in total value of shipments, dropping from $2.3 billion in 2002 to $1.5 billion in 2006. In terms of share of all manufacturing's value of shipments, none of the five forest products industry subsectors have had gains from 2002 to 2006. Growth in forest products manufacturing has not kept pace with other manufacturing in Wisconsin, and when adjusting for inflation, a gradual reduction in value added is apparent over the last 5 years (Figure 13.a).

The obvious decline in total value of shipments in the forest products industry, combined with a decline in value added through those shipments indicates an industry in transition. Cost of materials has not fallen at the same pace as value of shipments, cutting into the overall value added to the economy by the industry. The changes within the paper manufacturing and processing industry and the wood furniture subsector are especially important. Large paper mills have closed, while wood furniture manufacturing had the greatest percentage decline, due to stiff overseas competition which benefits from cheaper labor, readily available wood fiber, and low transportation costs. In 2006, Wisconsin's exports of furniture and fixtures (NAICS 337), was 10% of the U.S. GDP in furniture and fixtures. This is above the average of 7.5% for the eastern hardwood region but still is low potentially due to the difficulty in transporting products to ports (Bowe et al 2008). Again, compared to the eastern region, Wisconsin ranked below the median for exports of primary wood products. However, Wisconsin's forest products industries remain a vital component of the state economy, comprising 13.8% of the value added in all manufacturing sectors.

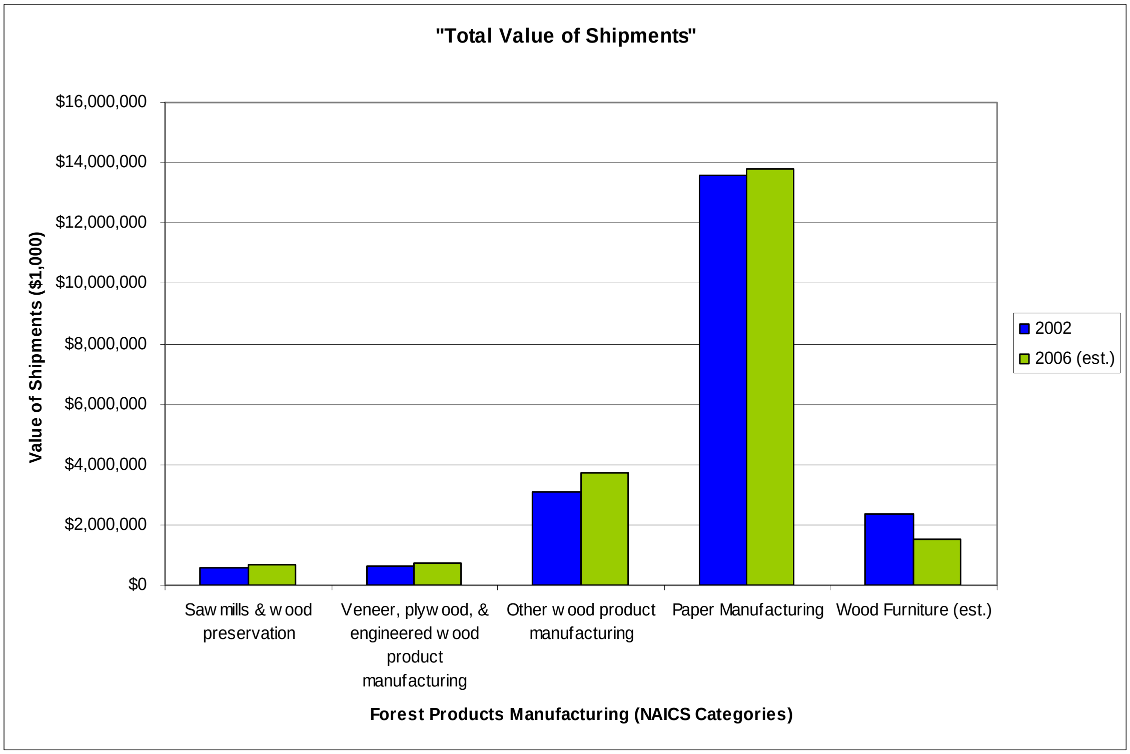


Figure 13.b: Total value of shipments (US Economic Census, 2007)

13.2 Production of roundwood

An important indicator of a sustainable forest is the level of actual timber harvested. This information is an important measure of whether or not the current timber cutting levels can be sustained. (See also Indicator 6: metric 6.1 - Net growth and removals.) Production levels are also a good indication of the health of the forest products industry.

Roundwood is the unit of measure for products and refers to the volume being harvested for industrial and nonindustrial products such as the following:

Softwoods include all softwood species.

Hardwoods include all hardwood species.

Sawlogs includes roundwood logs and bolts processed at sawmills into a variety of sawn products (lumber, cants, squares, blanks, etc.). Principal sawlog species are oaks, maples, aspen, and red pine.

Veneer logs includes roundwood logs and bolts processed at veneer mills into a variety of peeled, sliced, stamped, or cut products (sheathing, panels, plywood, containers, sticks, etc.). In the East, this product code may include logs exported for processing. Principal veneer species are maple, aspen, birch, oaks, and black walnut.

Pulpwood/fiber byproducts include roundwood logs, bolts, and chips used in the manufacture of wood pulp for making paper and paperboard products. Fiber byproducts identify mill residues as being used in the manufacture of wood pulp or composite products (particle board, chip board, flake board, engineered lumber products, etc.). Principal pulpwood species are aspen, maples, jack pine, red pine, birch, and fir.

Composite products include roundwood logs, bolts, and chips used in the manufacture of reconstituted wood products (chip board, flake board, oriented strand board, engineered lumber, etc.). Principal species used in composite products include aspen, jack pine, and birch.

Fuelwood/fuel byproducts include roundwood logs, bolts, and chips used as fuel in industrial, residential, and institutional situations. Fuel byproducts identify mill residues as being used for industrial, residential, and institutional fuel. Principal fuelwood species are oaks, elm, maples, and aspen.

Post, poles, and pilings includes roundwood logs milled (cut, peeled, etc.) into standard sizes (lengths and circumferences) to be put in the ground to provide vertical and lateral support in buildings, foundations, utility lines, and fences. Post, Poles, and Pilings may include nonindustrial (unmilled) roundwood that has been cut directly into posts for domestic and local uses. Principal species for posts, poles and pilings include cedar, pines, oaks, and aspen.

Miscellaneous products/Miscellaneous byproducts include roundwood logs, bolts, and chips processed into a variety of products not previously listed (charcoal, cooperage, excelsior, etc.). In Wisconsin, a large proportion of this category is the 60 log cabin manufacturers. Miscellaneous byproducts identifies mill residues as being used for a variety of products not previously listed (mulch, bedding, charcoal, small dimension lumber, etc.).

Wisconsin forests yielded a total of 414.2 million cubic feet of roundwood in 2007, up from 408.6 million cubic feet in 2002, but considerably less than 1997 total production of 435.2 million cubic feet. Hardwood species comprise the vast majority (79.2%) of total roundwood production in Wisconsin, a proportion that has been stable over the last decade (Figure 13.c).

Over half (52.8%) of all roundwood produced in Wisconsin (for both hardwood and softwood species) in 2007 is pulpwood destined for paper and paperboard production. For all species in 2007, sawlogs were second-most prevalent (24.1% of all roundwood), followed in descending order of production by composite products, fuelwood, miscellaneous products, and post, poles, & pilings (Figure 13.c).

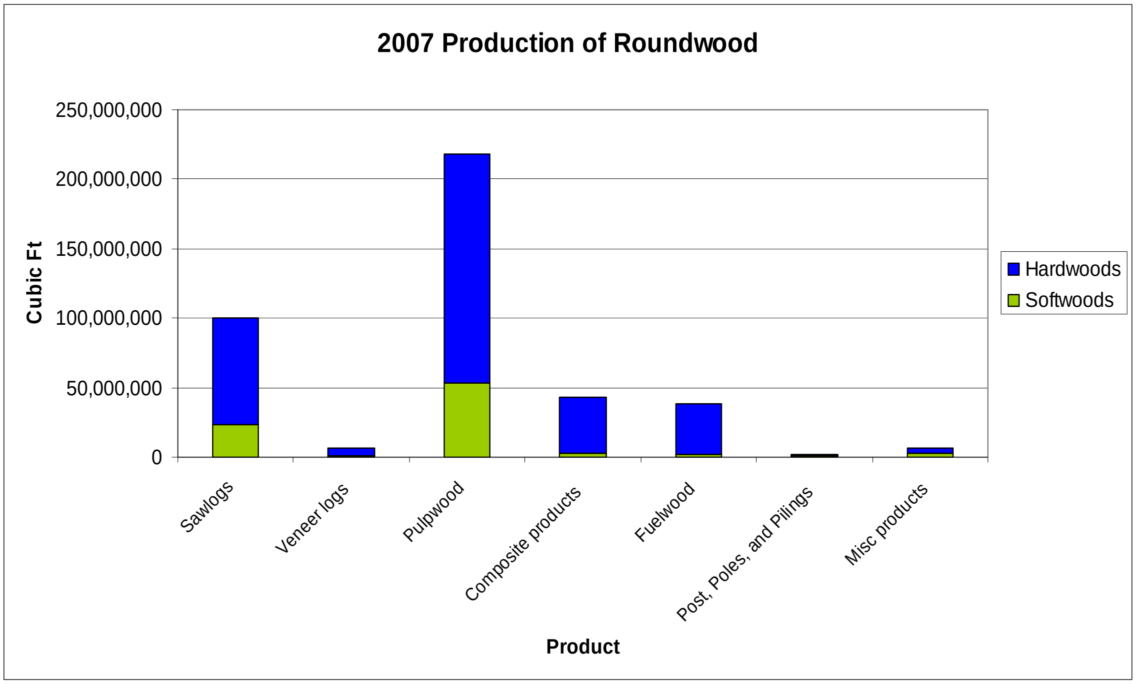


Figure 13.c: 2007 Production of roundwood (US Economic Census, 2007)

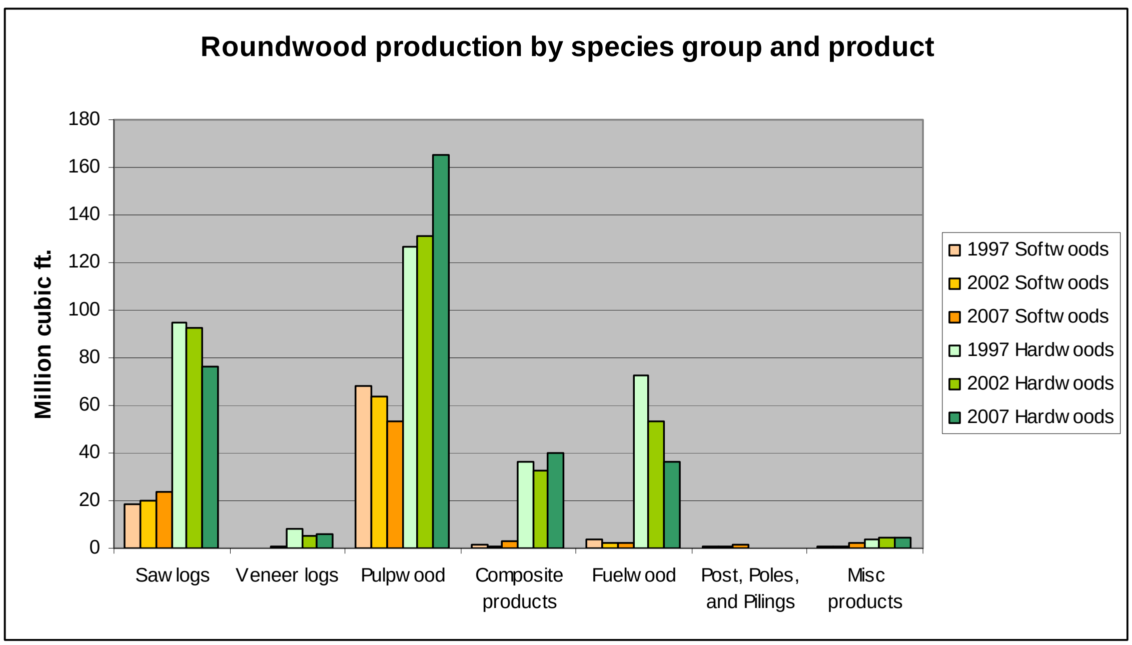


Figure 13.d: Roundwood production by species group and product (US Economic Census, 2007)

Softwood production is decreasing slightly over time from 1997 (92.6 million cubic feet) to 2007[2] (86.3 million cubic feet). More softwood is being used as sawlogs in 2007 (23.7 million cubic feet) than in 1997 (18.2 million cubic feet), and to a lesser degree more softwood is being

[2] 2007 data is based on models for the Forest Service RPA.

used in composite products and miscellaneous products over the same time period. Conversely, production of softwood pulpwood declined from 68 million cubic feet in 1997 to only 52.3 million cubic feet in 2007. This trend among softwood toward larger diameter sawlogs may reflect the maturation of softwood stands, especially among red pine plantations throughout the state (Figure 13.e).

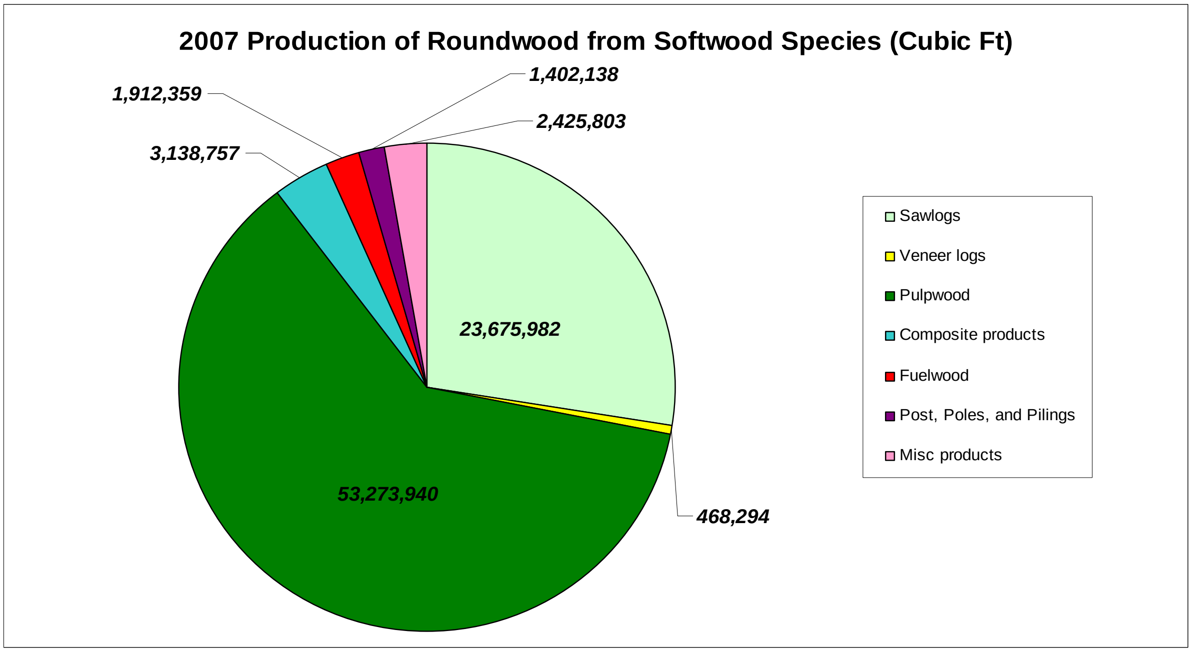


Figure 13.e: 2007 Production of roundwood from softwood species (cubic ft.) (US Economic Census 2007)

Hardwood production is changing differently from softwood, as the resource base of large diameter valuable hardwoods dwindles and forest regeneration undergoes changes resulting from past management that may have harvested larger trees. Meanwhile, the wood products industry changed capacity and function of its facilities to better utilize the available merchantable timber. Total hardwood roundwood production declined from 1997 (342.7 million cubic feet) to 2002 (319.6 million cubic feet), but rebounded somewhat by 2007 (328 million cubic feet). Hardwood pulpwood production continues to increase, growing from 127 million cubic feet in 1997 to 165.3 cubic feet in 2007. Strikingly, 2007 was the first data year in which pulpwood comprised greater than half (50.4%) of all hardwood production, up sharply from only 37.1% in 1997. Conversely, hardwood sawlogs production decreased nearly 20% in just ten years, dropping from 94.5 million cubic feet in 1997 to only 76.3 million cubic feet in 2007. Hardwood roundwood comprises well over 90% of total production in both fuelwood and in composite products, but while fuelwood production steadily declined over the past decade, composite products now constitute a larger proportion of all roundwood production. Whereas in 1997 hardwood composite products comprised only half of hardwood fuelwood production, by 2007 there was more hardwood going into composite products (39.9 million cubic feet) than hardwood in fuelwood (36.4 million cubic feet); a marked shift in hardwood production (Figure 13.f).

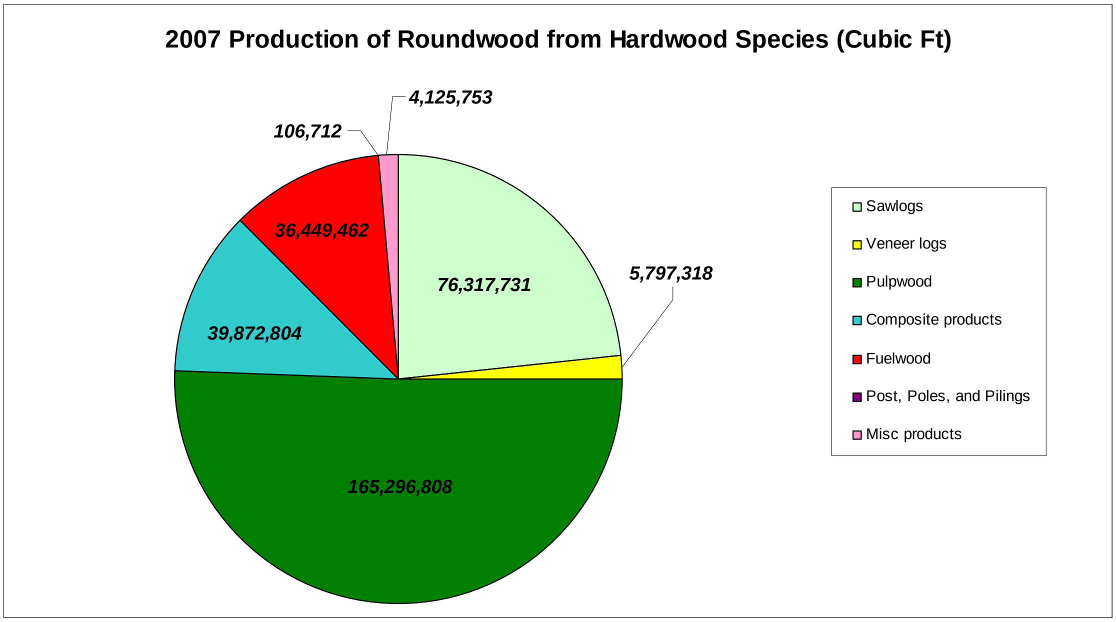


Figure 13.f: 2007 Production of roundwood from hardwood species (cubic ft.) (US Economic Census, 2007)

Wisconsin's roundwood production is changing in response to both shifting market forces and a changing resource base in the forest. China, for instance, ranks the United States as the top source for their hardwood lumber but the United States must compete heavily for this market with countries such as Russia and Brazil (Bowe et al. 2008). Hardwood production continues to represent the dominant portion of roundwood processed in the state. Due largely to trends in hardwood species, Wisconsin is processing less sawlogs and more pulpwood in 2007 than it did in 1997. Fuelwood production is in steady decline, replaced in part by an increase in composite products and miscellaneous products.

There are several new industries interested in wood products. New pellet plants, bio refineries, power generation, and University campuses could raise the biomass consumption in Wisconsin by 1.5 million dry tons if all the proposed plants were built. Expanding interest in the use of wood biomass is coming from many directions. Proposed new plants will likely create significant new demand (i.e. 1,000,000 to 1,500,000 dry tons per year) for wood fiber in the next one to four years. This would be the equivalent of adding a large kraft pulp mill to the state. New plants being proposed are of significant size related to wood demand. While some of the proposals will not be viable, undoubtedly some of the proposed plants will occur. Even if only one or two of them successfully come on-line, the timber demand in the market will increase significantly creating price pressure on existing supply.

Assuming 320,000 dry tons (640,000 cords) per year of new demand divided by the public lands average harvest of 8 dry tons (16 cords per acre[3]) equals 40,000 acres of new sales required per year to meet this new demand. The wildcard is how much forest biomass will be collected from existing and new sales. The logging residue on timber sales in Wisconsin, of which little is used,

[3] Barkley, Jeff, personal communication, May 2008.

is estimated for 2007 to be approximately 2.2 million dry tons. Wisconsin is currently harvesting 60% of its net annual growth annually.

Currently there is 369,000 dry tons of wood pellet capacity in the state. Much of this capacity is not operating due to lack of economically available feedstock. There are four more plants that have applied for permits or are in the planning process that would need an additional 370,000 dry tons of material. Not all of these plants will be built. The bulk of the future supply for the new pellet plants will be coming from the forests because the supply of mill residues is already under contract to existing plants. If all of the plants were running at capacity and the proposed plants built, the total demand would be 739,000 dry tons. A significant portion of this demand will be met by mill residues and the rest coming from forest biomass.

Bio-refining and ethanol production is the next area that will significantly alter demand. Two pulp mills are working on bio-refining projects to produce ethanol, diesel, jet fuel, etc. Each of these projects would be looking for an addition 250,000 dry tons of wood to feed the plants.

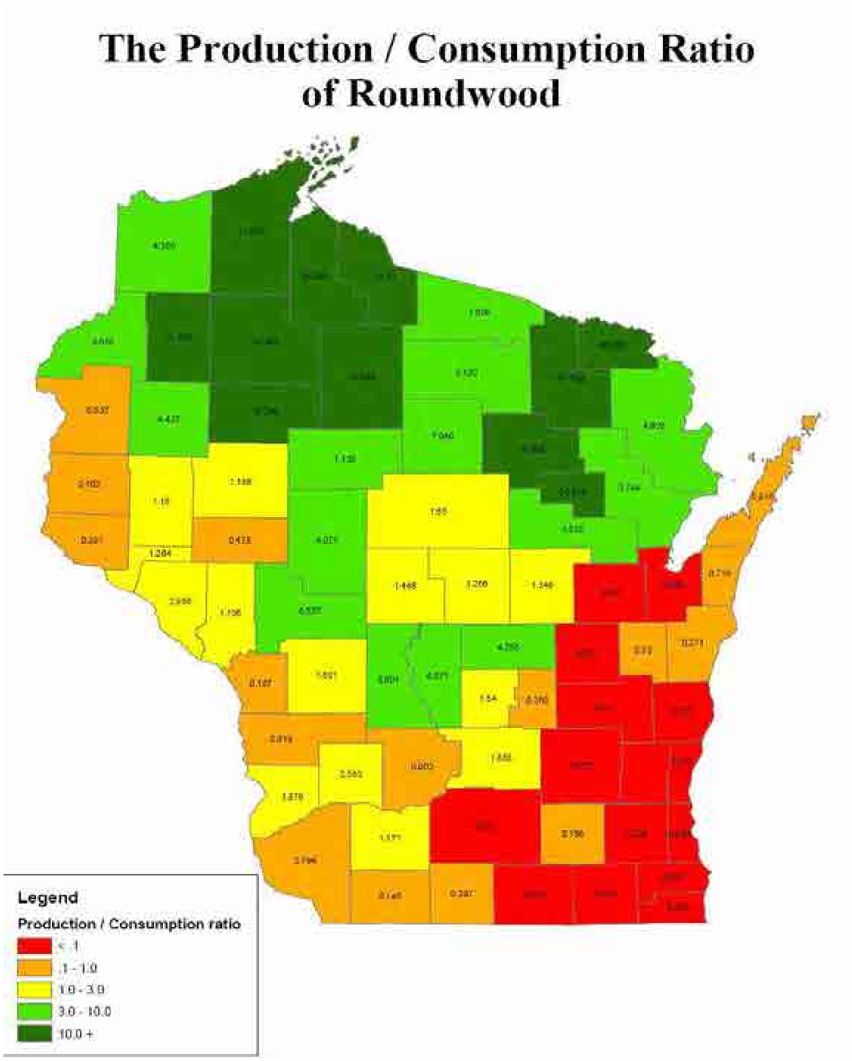
Utility renewable energy production is another new area of potential wood demand. Five different utilities, three in Wisconsin and two out-of-state, are looking for biomass for electricity generation. Their interest is from 50,000 dry tons to 250,000 dry tons each per year. Excel has applied to the Public Service Commission to convert their Ashland plant to all wood increasing demand by about 125,000 dry tons at that location. Excel has also announced that they will increase their biomass consumption by 14,000 dry tons at their French Island plant near La Crosse. DTE Energy Service is in the process of purchasing a coal boiler in Cassville Wisconsin and converting it to biomass with the electricity to be sold to Dairy Land Power. They will be looking for about 340,000 dry tons of biomass. If all of these occur, the demand for biomass by the utilities will increase by 479,000 dry tons on top of that is 144,000 tons dry tons they are currently using.

The Governor has directed UW-Oshkosh, UW-Stevens Point, and UW-Superior to explore ways to become energy independent. Each of these schools is looking at biomass as part of their energy mix. UW Oshkosh and UW Stevens Point have both developed plans for providing some of the energy needs from biomass and would use about 10,000 dry tons of biomass each. UW Madison is proceeding with work to convert their Charter Street boiler to biomass which would use approximately 200,000 dry tons of biomass a year.

13.3: Production and consumption of roundwood equivalent

Roundwood equivalents of harvest are defined as an estimate of the solid volume (i.e., total wood content) of a processed log in cubic units derived by multiplying the final products by a product recovery factor. The procedure for estimating roundwood equivalent of products provides a simple technique for estimating the major portion of timber harvest levels. This technique is less expensive than conducting surveys and can be done on an annual basis, which provides a benchmark that can be used in conjunction with the FIA survey approach, helping to ensure the accuracy of both methods.

By measuring per capita consumption of roundwood, comparisons can be made with other regions and states regarding their consumption. Usage trends also become more noticeable, as the relationship between production and consumption of roundwood shifts over time. This relationship can be easily described through the production/consumption Ratio (P/C ratio) of roundwood. The P/C ratio divides total annual production in a locality by total annual consumption in the locality. As such, a P/C ratio of greater than 1 indicates a region which produces more roundwood than is consumed locally, while a P/C ratio of less than one indicates a region consuming more roundwood than it currently produces.



Map 13.a: 2005 Production/consumption ratio of roundwood
(Source: USFS Timber Product Output, 2005)

Generally it can be said that southern Wisconsin counties tend to have very low P/C ratios, while northern Wisconsin counties have P/C ratios well above 1. Logically, sparsely populated northern counties with high percentages of productive forest land have much higher P/C ratios than do southeastern counties with the opposite conditions. Florence County has the highest P/C ratio (50.3) in Wisconsin, while ten other remote northern counties also each produce greater than 10 times as much roundwood as they consume. Conversely, those counties with the lowest P/C ratios, which produce virtually no roundwood in relation to their consumption, all contain or border the Milwaukee, Madison, Green Bay, or Chicago, Illinois metropolitan areas. Even St. Croix, Pierce and Polk Counties in the northwest, bordering the Twin Cities, Minnesota metro area, have lower P/C ratios than their Wisconsin neighbors. The degree of urban influence in a county appears to be correlated with its P/C ratio (Map 13.a).

Wisconsin as a whole produced 414.3 million cubic feet of roundwood in 2007, while consuming 284.3 million cubic feet, yielding a statewide P/C ratio of 1.46. Wisconsin harvests more of its forest growing stock per year than is consumed by its residents, evidence that the forest products industry as a whole is an export industry which brings in new dollars to Wisconsin's economy.

13.4 Recovered paper

Recovered paper consumed by paper and paperboard mills in Wisconsin can reduce waste in landfills and increase process efficiency. An estimate of the amount of recovered paper is available through the Wisconsin Paper Council, which annually surveys the mills belonging to its member companies.

Recovered paper includes various grades of paper that have been recycled by the consumer or recovered by paper and paperboard mills. Total recovered paper includes the following:

- Mixed paper: a mixture of various qualities of paper not limited by type of packing or fiber content
- Newspaper: baled newspaper containing less than five percent of other papers.
- Corrugated cardboard: baled corrugated containers having liners of test liner, jute, or kraft.
- Pulp substitutes
- High-grade de-inking: baled, sorted, fresh dry newspapers, not sunburned, free from magazines, white blank, pressroom over issues, and paper other than new, containing not more than the normal percentage of rotogravure and colored sections.

In 2003, the forest products industry reported 2.5 million tons (or about 41%) of the estimated 6.2 million tons of paper and paperboard produced were recycled products. According to the American Forest and Paper Association, in 2009 a record-high 63.4% of the paper used in the U.S. was recovered for recycling.. Nationwide, percent recovery rates of paper have steadily grown since the early 1990's, but Wisconsin's reported paper recovery rate in 2003 lags behind the national rate of 50.3% (http://www.afandpa.org/). This figure may be due in part to the fact that Wisconsin produces such a large volume of paper itself, skewing its recovery rate when compared to the rest of the nation. Compared to its geographic neighbors Iowa and Minnesota, Wisconsin municipal landfills have the lowest ratio of generated paper waste per capita for all five major paper categories of paper products. (WI DNR, 2003, Status of Recycling Report)

13.5 Value of non-timber forest products

Non-timber forest products (NTFP) are items harvested or gathered from forests that are not traditional wood products. Non-timber forest products are important components of the economic value of forests and their collection and processing makes an important contribution to economic activity. Many of these products also are important to indigenous people and others for their contribution to cultural values and subsistence activities (National Report, 2010). As stated in Criterion 2, indicator 6, the various types, uses, and growing locations of these products make tracking the amount of removal challenging. Due to the fact that there is not a long term database with information on the removals of NFTP, there is also no specific database for the value of those products. Typically, if a NTFP is sold, the value of that commodity can be tracked.

As ecosystem services begin to be monetarily valued, we may see NTFP develop greater monetary value. If the monetary values of NTFP are tracked, trends can signal a concern with the level of harvesting; ginseng is a good example. In 1999 the local price for wild-crafted North American ginseng approached $500 a pound (although average export prices are considerably lower, as noted below). Soaring prices are not only a result of higher demand, but of dwindling supplies (Sather, 2002). Since then, Wisconsin has instituted strict regulations and permitting of ginseng harvests.

Wisconsin’s urban forests annually provide over $64 million in environmental services including carbon sequestration, air pollution mitigation, and energy savings. These could be an effective tool to help address climate change and energy independence. (WI DNR, 2007 Urban Forestry Annual Report)

Significant volumes of wood salvaged from city trees hit by pest outbreaks, storm damage, construction activity and other factors are also recycled into both traditional wood products and non-timber products like garden mulch. Unfortunately, over half of urban wood currently ends up in landfills. In the United States over 200 million cubic yards of urban tree and landscape residue are generated every year. Of that, 15 percent is classified as “unchipped logs” equivalent to about 3.8 billion board feet of lumber, or nearly 30 percent of the hardwood lumber produced annually in the United States (Bratkovich, 2001). Wood waste represents an estimated 15.7% of the Wisconsin Municipal Solid Waste stream. Wood waste contributes approximately 747,000 tons of waste to Wisconsin landfills on an annual basis, and depositing wood waste in landfills costs over $18 million in Wisconsin and almost $7 million/year in Southeast Wisconsin. This does not include collection costs (Diggelmen, 2004). Better utilization of urban wood waste could produce additional income opportunities.

There is limited data available on the value of maple syrup, permits collected for balsam boughs on public land, and ginseng. Data for other products, specifically for Wisconsin, is not available.

Maple syrup – Maple syrup producers reported receiving $35.70 per gallon for their 2007 production and $31.20 for 2006. The average of the top ten producing states was $33.20 in 2007 (USDA, NASS).

Balsam boughs - On National Forests, balsam boughs may be collected with a permit. National Forest Service Handbook direction is to value special forest products at 10% of the value they can be sold for by the permittee. As a result, permits are currently a minimum $80 for 2 tons, and an additional $40 for each extra ton. Conditions apply. In 2008 on the Chequamegon Nicolet National Forest, a total of 147 permits were sold for 269 tons of boughs, totaling $10,767.

On county and state forests in 2007, $2035 was collected for balsam bough collection. (DNR, 2009)

A 2002 Wisconsin green industry study found the Christmas tree and wreath producer's total yearly receipts for 2002 was $50,000,000.

Ginseng - Since 1990, the price per pound of wild ginseng exports nationwide was two to ten times higher than cultivated ginseng. From 1997 to 2007, the average export price of wild ginseng was $84.50/lb (Cheng and Mitchell, 2009). Wild Wisconsin ginseng is still available on the market, although it has been defined internationally as an endangered species due to over harvesting since the mid1970s.

The data presented here should be viewed as a baseline. There is a great need for better tracking of NTFP. Currently, it is not possible to evaluate the health of the NTFP industry, and therefore, difficult to determine the monetary effect these products have for local and state economies.

The FS attempted to value NTFP nationally based on several assumptions (e.g. what the FS receives for a product is 10% of it's value per unit). They state their estimates are rough and can vary greatly when a region is the primary producer. The National Report explains the difficulty in collecting this data and evaluating it:

> "Prominent data gaps include personal use of NTFPs, and production and value from private lands. Determination of first point of sales value is problematic. There is no single source of data for NTFPs, nor is it expected that there ever will be. It is unclear how consistent or comparable data sources are in terms of value and scale. Personal use values for NTFPs have not been estimated." (page 2-73)

Wisconsin is highly dependent on the FS's monitoring systems in order to evaluate, even minimally, the monetary value of NTFP in the state.

Perhaps more significant than monetary value, NTFPs possess cultural and spiritual values that are also difficult to measure. For many Native American tribes, NTFPs are integral to their cultural traditions. There is no monetary value that could be placed on their use. Surveys show that private landowners highly value the NTFP on their land. An estimated 28,000 family forest owners (roughly 8%) stated that cultivating and collecting NTFP is a very important reason they own the land (Butler, 2008). Hunting and fishing as the primary reason for owning forest land adds another 143,000 family forest owners. Private landowners can sell NTFPs to supplement or supplant timber cutting from forest ecosystems; an alternative source of income for some woodland owners.

13.6 Chain-of-custody certified forest products businesses

Chain-of-Custody (COC) is a process used by businesses to verify that wood and their manufactured goods originates from well-managed forests. COC builds trust with customers. Being identified with illegal logging, destruction of old growth forests or use of child labor among other bad practices can be disastrous for marketing. Companies that want to project an image of environmental, social or economic responsibility engage independent COC auditors to affirm where their wood comes from.

The most frequently used COC standards by Wisconsin manufacturers are the Forest Stewardship Council (FSC) and Sustainable Forest Initiative (SFI). Those are tied to forest land management certification covered in Section 16.7.

COC businesses may include FSC or SFI forest certification trademarks on their products. Since SFI and American Tree Farm System certification programs are covered by the European Program for the Endorsement of Forest Certification (PEFC) – and since Tree Farm does not have an on-product trademark – the PEFC trademark might alternately be used for those brands. COC trademarks can denote 100% certified origin or mixed-product and percentage-based content. SFI also has a “fiber sourcing” label under which procurement audits (rather than COC tracking systems tied to third-party certified forest management operations) are used to claim that wood is sourced from lands meeting basic forest management standards.

COC certification is still in its infancy, with 7% of Wisconsin forest products manufacturers involved (97 out of 1,356 establishments). As shown in Table 13.a, the number of COC companies in Wisconsin and neighboring Lakes States Michigan and Minnesota was also relatively small in 2009. A few Lake States COC paper companies, however, represent a large share of the global trade in certified goods. In business to business transactions, the demand for certified products is especially high in the paper and printing sector. Rising interest in green building, which gives credit for use of building materials from certified forests, is also driving more COC certifications. In 2004, Wisconsin Governor Jim Doyle issued an Executive Order directing the Department of Administration to establish state building standards based on the Leadership in Energy and Environmental Design (LEED) certification. The overall green building market for both non-residential and residential construction is forecast to more than double from $36-49 billion in 2009 to $96-140 billion by 2013. (Source: McGraw Hill Construction, 2009) Consumer demand for certified goods is also expected to increase with greater public awareness of climate change and other environmental issues.

Table 13.a: Forest certification - chain of custody certificates in 2009

	Certification Standard	
State	**FSC**	**SFI / PEFC**
Michigan	54	23
Minnesota	99	40
Wisconsin	79	35
Total	232	98

Source: metafore

Table 13.b takes a closer look at 2009 COC certificate business types in Wisconsin. FSC holds the lead in the number and variety of manufacturers. SFI COC holders are notably concentrated in paper and printing. The numbers do not, however, tell the whole story since FSC’s COC program has been in place for at least fifteen years compared to only three years (since 2006) for SFI. To now, FSC’s marketing strategy was focused on building COC participants with comparatively less emphasis on developing supply from certified land management operations. SFI initially focused on building a certified forest base and only recently began serious promotion of the SFI COC trademark program. FSC’s strength in solid wood COC is likely due to exclusive US Green Building Council recognition of FSC in the past, but SFI may be added. Continued market competition between FSC and SFI should help boost public awareness of certified responsible forestry.

Table 13.b: Forest certification – 2009 Wisconsin chain of custody certificates

	Certification Standard	
Primary Business Type	**FSC**	**SFI**
Converted Paper Products	7	3
Forest Owner Manager/Logs	1	2
Lumber/Home Center/Building Supply Dealer	4	
Packaging Paper and Board		3
Paper Wholesaler/Distributor	2	5
Printer	31	17
Pulp and Paper Manufacturer	7	4
Sawmill/Wood Processor	11	1
Secondary Manufacturer - Architectural Woodwork/Millwork	2	
Secondary Manufacturer - Cabinets/Casework/Fixtures	2	
Secondary Manufacturer - Doors	4	
Secondary Manufacturer - Lumber	4	
Secondary Manufacturer - Wood Flooring	3	
Secondary Manufacturer - Windows	1	
Total Wisconsin Chain of Custody Manufacturers	79	35

Source: metafore (Note: 17 companies in the metafore database show dual FSC/SFI COC certifications.)

14. Outdoor recreational participation and facilities

Forest-based recreation plays an important role in people's lives. Many family traditions depend on forest based opportunities like hunting. Wisconsin's growing human population will potentially increase demand for additional recreation lands and facilities. Tourism and forest management are mainstays to local economies. On an annual basis, forest-based recreationists spent approximately $2.5 billion within Wisconsin communities (Marcouiller and Mace, 1999). This spending stimulates the economy further and it is estimated that forest-based recreation is a $5.5 billion industry (WEDI, 2004).

Wisconsin's Statewide Comprehensive Outdoor Recreation Plan (SCORP) is the most extensive, long-term data available to assess statewide recreation demand and supply. SCORP is conducted every five years, and the 2005-2010 SCORP provides the majority of data presented here. It measures all types of outdoor recreation activities in all settings (rural and urban) and habitats, not only forests. This section focuses on activities and facilities that typically occur in forest settings but it is not possible to specifically sort data just by land cover. SCORP divides the state into eight regions of roughly the same geographic size that represents different demographic trends, tourism influences, and environment types. For more detailed discussions on recreation trends and analysis, please see the full SCORP report.

14.1 Participation in Outdoor Recreation

Wisconsin's Statewide Comprehensive Outdoor Recreation Plan data provides days of participant activity for 95 outdoor recreation activities. Increases or decreases in these measures indicate a change in capacity (facilities or access to lands) and public demand. Participation rates indicate the size of the market for activities and demand for related services, facilities, equipment, and land. Societal welfare and the health of the economy are linked to satisfying the demands for outdoor activities. Later in this section, the supply side of recreational facilities (infrastructure, trails, campgrounds, land) are discussed and compared to the amount of participation.

Sports and activities evolve; for example, ten years ago very few people had ever heard of geocaching. The 2005 - 2010 SCORP refined broad categories to capture such transformations. Because data collection methods were changed, comparing participation rates within the same year is slightly more accurate than across years.

Table 14.a includes a sample of the 95 total recreation activities that SCORP tracks. These activities represent the type of recreation that is generally available on public and private forest land. The percent of people who participated in each activity from the 1999 and 2005-2010 SCORP reports are shown. The 2005-2010 SCORP report projected recreation trends in 2010 compared to 2005, presented in the right column.

Table 14.a: Wisconsin Resident Past, Present and Future Participation Trends

Activity	1999 SCORP* Percent of Participation	2005-2010 SCORP** Percent of Participation	2010 SCORP Future Participation Trends
Birdwatching	46.4	40.9	Increasing Demand
Camping – Developed or RV Camping	12.9	32.3	Increasing Demand
Camping – Primitive or Tent Camping	25.1	16.0	Stable
Day Hike	41.4	35.0	Stable
Fishing:	47.6	NA	Stable
Freshwater	NA	40.7	NA
Warmwater	NA	37.0	NA
Coldwater	NA	13.9	NA
Ice	NA	11.4	NA
Great Lakes	NA	11.0	NA
Hunting:	23.7	NA	Decreasing Demand
			NA
Migratory Birds	NA	5.0	NA
Upland Birds	NA	10.5	NA
Small Game	NA	14.5	NA
Big Game	NA	19.2	
Mountain Biking	21.0	NA	Decreasing Demand
			NA
Off-road	NA	20.4	NA
Single Track	NA	18.0	
Off-road Driving with ATV	12.3	23.4	Increasing Demand
Skiing – Cross Country	14.5	11.4	Stable
Snowmobiling	14.6	18.3	Decreasing Demand
Swimming – Lakes & Streams	61.0	45.8	Stable
Visit Nature Centers	NA	65.3	Stable
Wildlife Viewing	59.5	57.0	Increasing Demand
*SCORP, 1999 Table 8, **SCORP,2006, Table2-1			

Source: SCORP 2006

Wisconsin's population grew 4.72% from 2000 to 2008 and outdoor recreation participation is expected to follow suit. The baby boom population is reaching retirement age and will increase demand for appropriate outdoor recreation facilities for the growing aged population. In addition, recreation participation tends to cycle through peaks and valleys which will account for upward or downward demands for a particular activity (SCORP, 2006).

Urban forests and green spaces are of critical importance to the majority of Wisconsin’s population that lives in cities. The benefits of outdoor recreation opportunities close to home for young and old in our health-conscious society are highlighted in many research papers. For the mobility impaired or those without transportation to rural forests, urban forests and other urban green spaces might be the only option for outdoor recreation. The most popular activities in urban forests include trail-based activities such as walking and bicycling, picnicking, family gatherings, and visiting nature centers (National Report, 2010).

SCORP reported that developed or RV camping experienced a three fold increase in demand between 1999 and 2005. This is contrasted by a fairly significant decrease in primitive or tent camping. In the past, the private sector in Wisconsin has been more involved in accommodating RV camping than state forests that offer more primitive camping. Although public forests have been adjusting by installing electrical hook-ups and other facilities to support developed camping, stakeholders may demand more. Due to changing RV markets, however, land managers may need additional research before making major infrastructure changes to support additional RV camping.

The full outlook is clouded, however, by the impact of rising fuel costs and changing spending patterns from a slowing economy. Recent economic reports indicate a collapse in RV sales with many RV manufacturers going out of business. RV manufacturers expect to ship just 14,100 units in 2009, the lowest in 38 years of data collection. RV production is down 50 percent from 28,300 shipped in 2008 and down 80 percent from 71,800 vehicles it shipped in 2004 (Rueters 2009).

Off-road driving with an ATV showed an upward trend since the 1999 SCORP and it is expected to keep increasing through 2010. A third of residents in six out of the eight SCORP regions operate ATVs. Only the most urban Lower Lake Michigan Coastal and Southern Gateways regions with the least amount of undeveloped land and trails have lower participation rates around 15%. Initially, it was thought that participation would level off as it did with snowmobiling. One argument for continued increase is that ATVs can be used year-round while snowmobiles are limited to only a few months out of the year. The recent introduction of off-road side-by-side vehicles (rugged and versatile, golf-cart-like vehicles) may require future changes in mechinized-use trails if they become popular.

14.2 Lands Open to Public Recreation

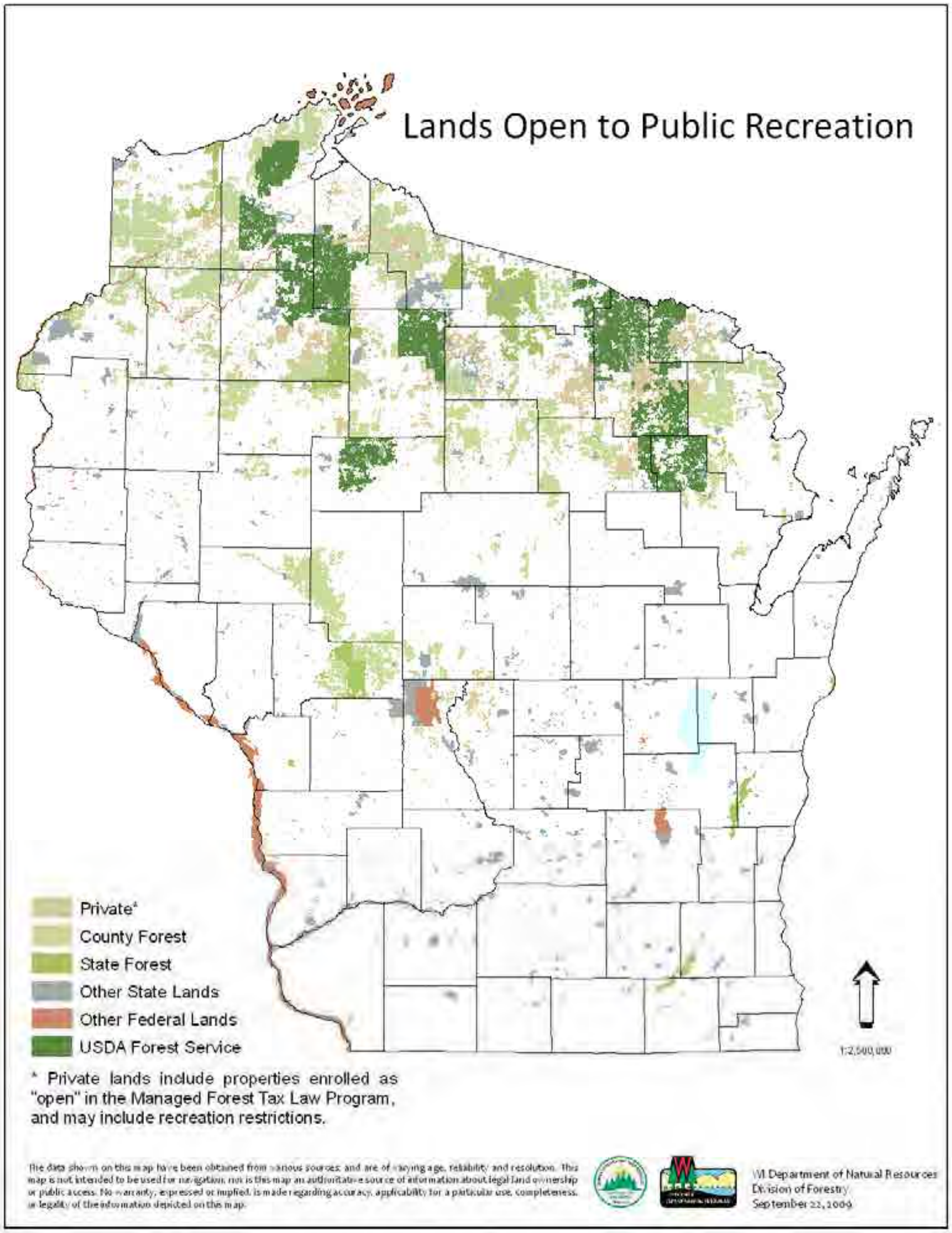
An adequate supply of public and private land and the facilities or infrastructure (e.g. boat landings, snowmobile rental businesses) to support growing recreational demand is important. Trails and campgrounds will be discussed in more detail as they support a variety of outdoor activities and have direct bearing on local economies.

Table 14b: Public recreational lands

Ownership	**Acres**	**Percent**
Municipal parks	62,004	1%
County lands	2,594,625	45%
State lands	1,366,692	23%
Federal lands	1,795,030	31%
Total	**5,782,353**	

Source: SCORP, 2006, Table D-1

As the population grows and communities expand, land is an important resource to provide recreation opportunities. Significant sectors of the state economy are dependent on growing recreation markets, and readily available lands are essential for that growth. Of the 5,782,353 total acres of public lands available for recreation, 45% of it is owned by counties, 31% by the federal government, and 24% by the state. City, town, and village parks account for 1%.



Map 14.a: Lands open to public recreation (Source: DNR, 2009)

Some private forest lands are open to public recreation. Property that is enrolled in Wisconsin's forest tax laws, the Managed Forest Law (MFL) and the Forest Crop Law (FCL) may be open to some public recreation if the landowner designates it. (See Criterion 7, Indicator 19 for a discussion of these programs). If the landowner chooses to allow public access to their forest for recreation uses, the tax incentive is greater than if they close the property to access. MFL properties allow hunting, fishing, sight-seeing, and cross-country skiing. FCL land is open for hunting and fishing only. Most industrial forest land in Wisconsin is enrolled in these programs and provides access, although most likely with restrictions.

Less private land is open to public hunting as more private landowners elect to close their land in response to use conflicts. Since a statute change in 1997, it is also no longer necessary to post "No Trespassing" signs unless a private tract is surrounded by or borders public land like a national forest, state wildlife management area, or county park (Wisconsin State Statute 943.13 1997). Using the Managed Forest Law program as a measure of changing tolerance toward public access, overall closed acreage increased from 39% to 62% of MFL land between 1999 and 2009. The change was less dramatic (from 70% to 82%) for small private MFL landowners in the same time period (see Criterion 6, Indicator 16.6).

These shifts could result in more use pressure on public lands. Use conflicts that grow out of a shortage of available hunting lands could be further exacerbated by a 2007 statute change prohibiting hunting leases on closed MFL land. Manipulation of a loophole in MFL regulations by a few large landowners who close thousands of acres to public access drew the ire of the State Legislature. Since the large landowners were closing public access in part to sell hunting leases, the Legislature added a provision to the 2007 State Budget Bill to prohibit leasing MFL land. That caught many small landowners with outstanding hunting leases by surprise. Controversies over MFL public access and leasing issues were still unresolved in 2009.

To counter the trend to close more MFL land to public access, the state enacted 2007 Act 20 to provide $1,000,000 annually for an Outdoor Activities Grant Program. The funding originates from a closed-area fee paid by MFL participants and was intended for acquiring easements or purchasing land for approved outdoor recreational activities. A severe $6.6 billion budget shortfall, however, caused the state to delete funding for the Outdoor Activities Grant Program in the 2009-11 biennial budget. While the budget eliminates funding in the 2009-11 biennium, statutory authority for the program remains (Wisconsin Legislative Fiscal Bureau 2009).

14.3 Recreational facilities on public lands

This metric shows the degree to which forest recreation capacity is meeting the needs of the population. Having forest land open for outdoor recreation is important, and it is essential that facilities are provided for a wide range of activities and physical abilities for young and old alike.

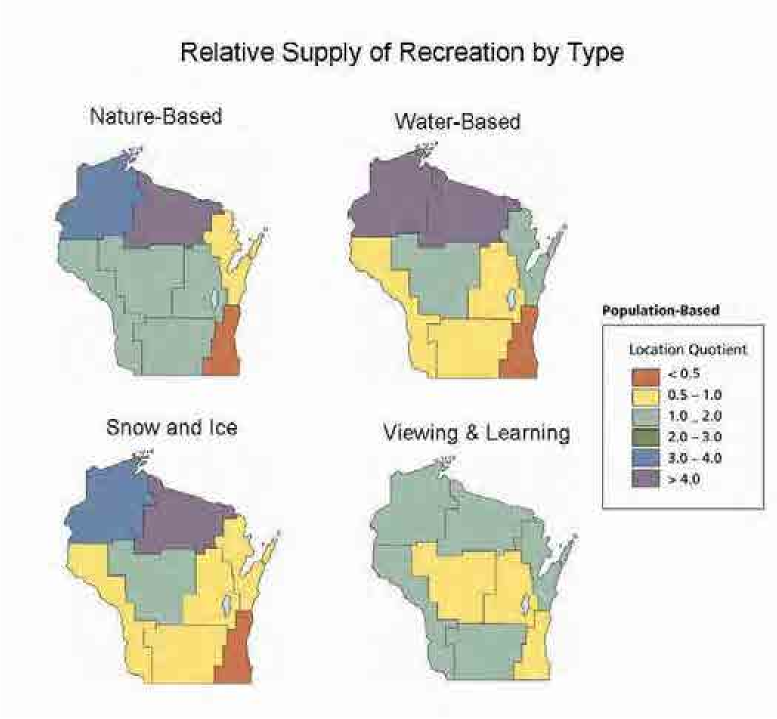
Recreation demand and recreation supply are unique elements built on different units of measures. Where recreation demand is largely based on existing and potential visitor numbers, recreation supply represents physical resources. Unfortunately, there is no data source that tracks the number or type of facilities on public land.

SCORP developed a descriptive typology to assess the relative abundance and scarcity of recreational resources in a given location. Regional forest based recreation evaluated here includes Nature-Based, Water-Based, Snow and Ice, Viewing & Learning categories. (SCORP describes six more types.) Table 14.c lists examples of facilities or activities within each typology. Urban forests are included in this supply analysis.

Table 14.c: Recreation supply typologies	
Nature-Based	State Parks, forested lands, wildlife areas
Water-Based	beaches, boat launches, fishing piers
Viewing and Learning	nature centers, Rustic Roads, historic places
Snow and Ice	ski, snowmobile and winter trails
Source: SCORP, 2006, Table 5-4	

Map 14.b presents the relative supply of recreation by type for each of Wisconsin's eight SCORP regions based on population. (For the relative supply based on area, see 2005-2010 SCORP Figure 5-3.) Regions with a low location quotient do not supply a sufficient amount for their population relative to the rest of the state.

Results from the 2005-2010 SCORP suggest that in general, highly populated regions have high demand for outdoor recreation but do not provide opportunities in proportion to their population. Northern regions have comparatively abundant opportunities relative to their low populations.



Map 14.b: Relative supply of recreation by type
Source: Adapted SCORP, 2006, figure 5-2

Table 14.d: Regional Recreation Supply Shortages	
Great Northwest	campgrounds, parks, trails – ATV, cross-country ski, dogsled, hiking, horseback riding, off-road truck and motorcycle, snowmobile, water, snowshoe & road biking
Northwoods	electrical campsites, parks, trails – inline skating
Upper Lake Michigan Coastal	non-electrical campsites, parks, trails – cross-country ski, hiking, horseback riding, & mountain biking
Lower Lake Michigan Coastal	campgrounds, parks, wildlife areas, trails – ATV, mountain biking, off-road motorcycle, off-road truck, water
Southern Gateways	backcountry camping, carry-in boat launches, natural areas, parks, public water access, trails – hiking, horseback riding, road biking
Mississippi River Corridor	carry-in boat launches, parks, ATV parks, electrical campgrounds, trails – cross-country ski, horseback riding, water, ATV
Western Sands	parks, nature centers, fishing piers
Lake Winnebago Waters	carry-in boat launches, campgrounds, trails – cross-country ski, mountain biking, snowmobile, road biking
Source: SCORP, 2006, table 5-7	

The Lower Lake Michigan Coastal region has the lowest supply of all types of nature-based recreation. These shortages include boat launches, campgrounds, and parks. There are a variety of trail shortages in this region including ATV and other motorized vehicle trails and water trails (see Table 14.d).

The southwestern part of the state, which is generally made up of the Mississippi River Corridor and Southern Gateways, is another area with limited recreation supply for the level of population (see Table 14.d). Both regions have a lack of parks, natural areas, carry-in boat launches and horseback riding opportunities. More camping opportunities have been identified as a need from the public and both felt the increase in competition for natural resources and public lands were major issues (SCORP, 2006 table-3).

14.4 Recreational trails

Many of the major recreation activities on forests require the use of trails: hiking, biking, skiing, horseback riding and often hunting. Table 14.e shows that, by far, snowmobile trials are in greatest supply across the state at 18,201 miles. This is roughly ten times more miles compared to each of the other types of trails. Even though this number is great, there are still two regions identified with snowmobile trail shortages for their level of population; the Great Northwest and Lake Winnebago Waters (SCORP, 2006, table 5-7).

Table 14.e: Statewide recreation trails	
Trail	**Miles**
Off-road truck use	63
Off-road motorcycle use	78
Water use	109
Dogsled use	159
Snowshoe use	550
Mountain biking use	1,016
Single or multipurpose	1,220
Hiking use	1,507
Horseback riding use	1,535
Bicycle use	2,596
ATV (winter) use	3,850
ATV (summer) use	1,177
Cross-country ski use	3,882
Snowmobile use	18,201
Source: SCORP, 2006, Appendix	

SCORP asked the public what their greatest recreational needs were. Table 14.f lists trail types the public thought were needed in their region. Seven out of eight regions have shortages for at least one or more trail types (SCORP table 5-7). The public feels there is a need across the whole state for more hiking trails. There is also a great need from five out of eight regions for more biking and horse trails.

At times, the public identified a need that SCORP did not find was a supply shortage. Table 14.4b identifies the need for hiking trails across all regions, but in the supply shortage analysis, only three regions lacked hiking trails. This may reflect the lack of knowledge on where to find hiking trails and so the public perceives a supply shortage or the public desires a greater amount than exists in their region.

Table 14.f: Public perspectives on top trail needs

	Great Northwest	Northwoods	Upper Lake Michigan Coastal	Lower Lake Michigan Coastal	Southern Gateway	Miss. River Corridor	Western Sands	Lake Winnebago Waters
More ATV usage opportunities					X			
More Biking Trails		X	X	X	X		X	
More Hiking Trails	X	X	X	X	X	X	X	X
More Horse Trails				X	X	X	X	X
More Mountain Biking Trails				X				X
More Trails (all types)							X	
Source: SCORP, 2006 table 5-3								

Another difference between the public's perspective and the SCORP supply shortage analysis regards ATV trails. Only the Southern Gateway region felt there needed to be more ATV usage opportunities in their region, yet SCORP found four regions with a shortage of ATV opportunities compared to other areas of the state. This may mean that the public feels the amount of opportunities in their area is sufficient, even though it may be less than other areas.

ATV trails and access routes play an important roll in the popularity of this sport. Many regional trail networks require an agreement between both public and private land owners. As of 2007, there are nearly 2,000 miles of public summer ATV trails and over 4,000 miles of public winter ATV trails. These milage totals are not the actual miles of trail available, but miles open by seasonal use. There are some trails that over-lap in seasonal use. Additionally, these numbers change annually and are nearly impossible to track because many towns frequently change their local ordinances allowing ATV use. (excerpted from: All Terrain Vehicles in Wisconsin: Summary of ATV Use, Opportunities, Funding and Recent Actions and Response to Natural Resource Board Questions. September, 2007)

14.g: ATV trail miles by ownership type	
Land Ownership	**Miles**
State Trails	318
State Properties with Trails	143
Local, County and Federal	Over 1,500
Private Land	Aproximatly 700 acres
Source: All Terrain Vehicles in Wisconsin: Summary of ATV Use, Opportunities, Funding and Recent Actions and Response to Natural Resource Board Questions. September, 2007	

Funding for trails and user conflicts are two of the greatest issues affecting the sustainability of recreation trails. Trail development, maintenance, and management is expensive and time consuming for governments. Due to the current status of both state and federal budgets, the building, repairing, and up-keep of trails are of great concern. Dedicated funding sources and active user groups have shown to support the stability and growth of snowmobile and ATV trails.

Trail use conflict occurs when the goal of one recreation participant interferes with the goals of another recreational participant at the same location or because of differences in social values. This conflict is often asymmetrical, meaning that one user group is generally more impacted by the conflict than the other. Asymmetrical conflict is most likely to occur between motorized and non-motorized recreation activities than between either two motorized or two non-motorized activities (SCORP, 2006). Resolving user conflict regarding where activities are allowed can be a contentious and lengthy resolution process. Not only do local users care about issues like this, so do citizens from around the state that visit these forests.

14.5 Number of campgrounds

Camping is one of the top twenty recreation activities Wisconsinites enjoy. 32.3% of the state campers use developed campsites and 16% use primitive camping spots. Camping supply, including all types of camping, was identified as a shortage in seven out of the eight SCORP regions (SCORP table 5-7). Statewide, there are more electric campsites (13,428) than non-electric (9,248) The Northwoods and the Mississippi River Corridor specifically identified a shortage of electrical sites and only the Upper Lake Michigan Coastal identified a shortage in non-electrical sites. The other regions only identified the need for campgrounds in general and did not specify electric vs. non-electric.

Unless fuel prices and economic changes continue to transform the market, demand for RV camping is expected to increase due to the aging baby boom population. Tent camping, which generally refers to non-electric campsites is expected to remain stable but may loose ground with the growing RV trend. (SCORP tables 5-3 & 6-3). Across most of the state, the public feels more camping opportunities are needed (SCORP table 5-3). The demand for specifically electric sites is needed in the Upper and Lower Lake Michigan Coastal regions (Figure 14.c).

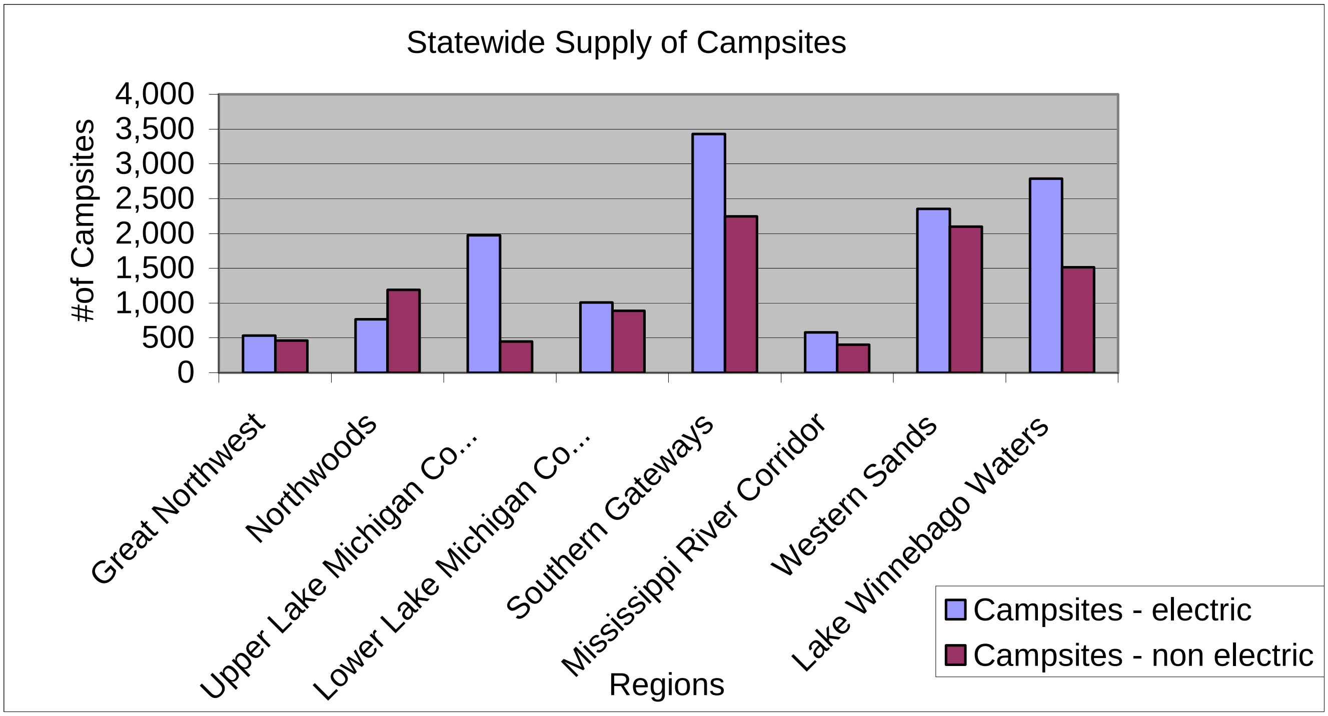


Figure 14.c: Statewide supply of campsites (SCORP, 2006)

Table 14.h: Public perspectives on top recreation needs		
	More Camping Opportunities	More Electric Campsites
Great Northwest		
Northwoods		
Upper Lake Michigan Coastal		X
Lower Lake Michigan Coastal	X	X
Southern Gateway	X	
Miss. River Corridor		
	X	
Western Sands	X	
Lake Winnebago Waters	X	
Source: SCORP, 2006, Table 5-3		

Both public and private enterprises provide camping opportunities, each with their own niche. Public land is the major provider for a rustic camping experience and trends show that campers are moving away from rustic towards more developed campgrounds. This is adding pressure for public forests to provide more of this type of experience.

Campgrounds on state-owned land are extremely popular and the supply of desirable campgrounds is not meeting the need. State forests, along with state parks have campgrounds listed on a national reservation system website that allows people to make reservations up to 11 months in advance. Some of the more popular campgrounds sites are often booked within a few weeks of them becoming available.

Camping supply issues on state forests are addressed during each property's master planning process. State Parks released their 2008 strategic plan in which they identify one of their goals as, "Expand the quality & quantity of sustainable, nature-based outdoor recreation opportunities and facilities available to Wisconsin State Park visitors." To accomplish this they list as one of their action strategies to identify existing and future camping needs and opportunities such as camper cabins, Adirondack shelters, backpack campsites, walk-in campsites, tent and group sites as well as RV campsites.

Conclusion
As individuals and families engage in outdoor recreation, they tend to support protecting and managing forests for multiple purposes including a wide range of recreation types (National Report on Sustainable Forests, 2010). Outdoor recreation is generally increasing across the country, but the increase is much greater for certain types of recreation. A few types of recreation are actually decreasing in use and demand. Across the nation, the number of recreation days in forest settings increased by 25% between 2000 and 2007 but the number and capacity of recreation sites and capacities have remained constant or increased slightly (National Report on Sustainable Forests, 2010).

The recreational issues and trends of most concern are:
Trails -
Walking for pleasure is the most popular activity in the state. It is not surprising the public feels there is a need across the whole state for more hiking trails.

Camping –
Across most of the state, the public feels more developed camping opportunities are needed, but collapsing RV sales prompt cautious analysis. Primitive or tent-camping was predicted to remain fairly stable through 2010. Campgrounds on state-owned land are extremely popular and the supply of desirable campgrounds is not meeting the need. This will have a direct effect for camping offered on state forests as the majority of campgrounds fall into the primitive camping category

User conflict –
Resolving user conflict regarding where activities are allowed can be a contentious and lengthy resolution process

Open land –

Based on experience with MFL and changes in state trespass laws, private landowners are allowing less public access to their property. A statute change in 2007 that prohibits leasing of closed MFL land is also restricting the supply of private land available for hunting leases.

New demographics –
The baby boom population is reaching retirement age and will increase demand for a number of more passive recreational activities.

15. Investments in forest health, management, research, education, and wood processing

15.1 Northeastern Area State and Private Forestry (NA S&PF) funding

The metric presents the amount of USDA Forest Service - Northeastern Area State and Private Forestry (NA S&PF) funding to partners in Wisconsin. This type of funding is a direct measure of federal investment in Wisconsin forests and the forest products industry. The mission of the NA S&PF program is to provide technical and financial assistance to private landowners, state agencies, tribes, and community resource managers to help sustain the nation's urban and rural forests and to protect communities and the environment from fires, insects, disease, and invasive plants (USDA Forest Service, 2007). NA S&PF funding is roughly 5% of the Division of Forestry's total budget.

In 2008, the U.S. Forest Service began implementing a "Redesigned" S&PF program. The S&PF Redesign assumes that our collective efforts will be most effective if available resources are focused on issues and landscapes of national importance and prioritized, using state and regional assessments, on activities that promise meaningful outcomes on the ground. The Redesign Board of Directors identified "competitive resource allocation" as an effective means of ensuring that federal S&PF dollars are invested in the most important activities.

Beginning in federal fiscal year 2008, 15% of the S&PF allocation to states was invested in projects selected through a competitive process. This competitive process is administered through a joint effort between the state forestry agencies and USFS leadership. The DNR Forestry Division manages the development and submission of proposals in Wisconsin, screening competitive proposals that typically exceed available allotments by a very wide margin.

Figures 15.a and 15.b show the level of grants in 2005 through 2008 and the dollar amounts awarded in the six tracking categories in 2008. An average of $5,261,707 was received in grants annually over the four-year period. The amount of funding awarded to each category has been relatively consistent with the exception of the Forest Legacy program, used to purchase forest land or conservation easements. Funding for Legacy acquisitions is the most sensitive as projects compete nationally for limited funds.

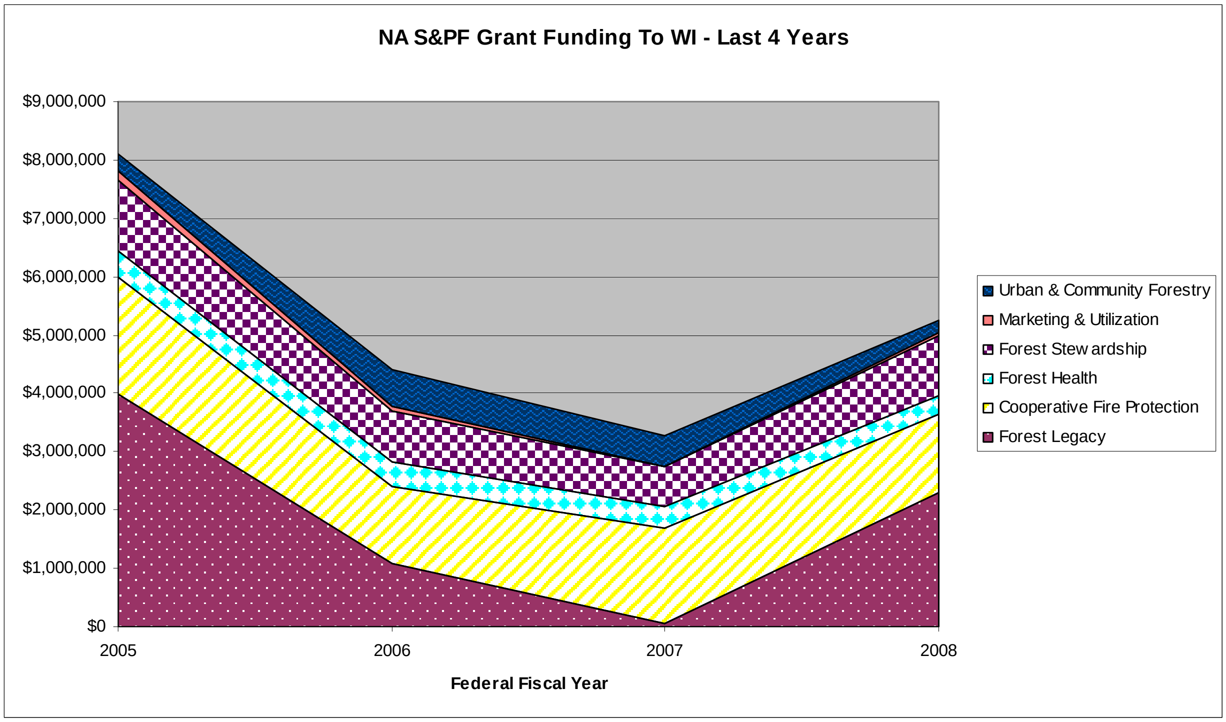


Figure 15.a: NA S&PF grant funding to Wisconsin
(Source: DNR, Division of Forestry, 2008)

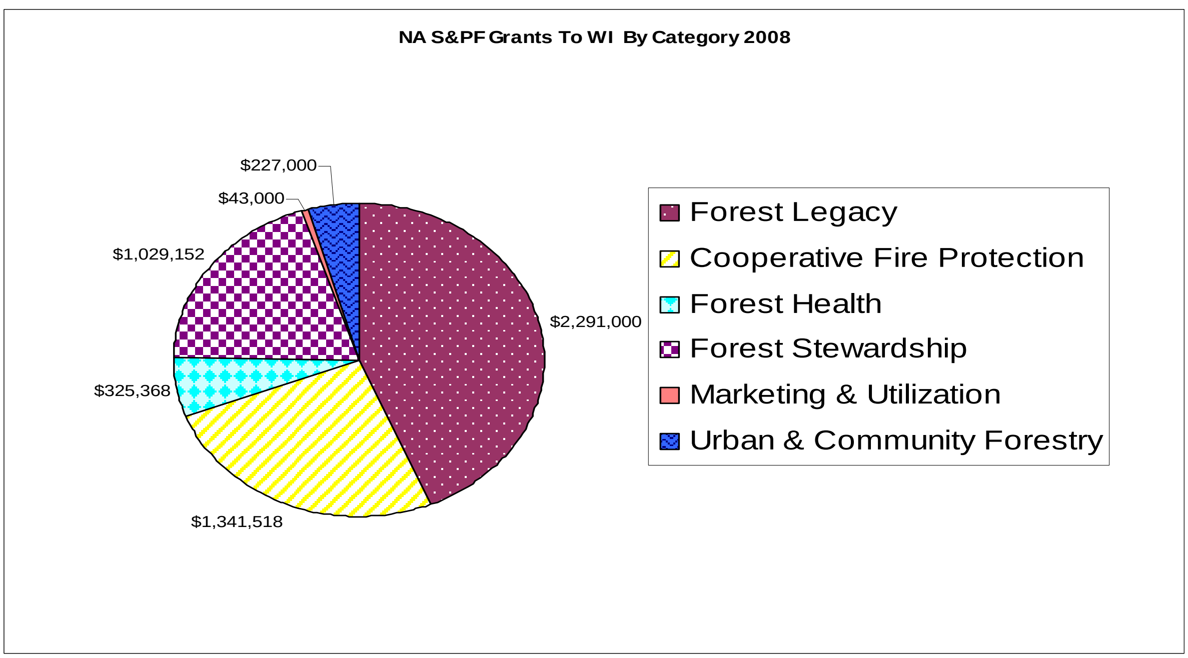


Figure 15.b: NA S&PF grants to Wisconsin 2008
(Source: DNR, Division of Forestry, 2008)

Funding for NA S&PF grants is tied directly to the Federal budget process. Depending on national issues, funding for S&PF can fluctuate greatly. To assure continued support for this important work, stakeholders have found it essential to engage the political process. The

Division of Forestry through the National Association of State Foresters, the Governor, conservation organizations, and the public through their representatives in Congress actively continue requesting Federal resources for forestry stewardship.

15.2 State forestry agency funding

State funding for the Wisconsin DNR Forestry Program is a direct measure of state investment in Wisconsin forests and the forest products industry. Wisconsin is fortunate to have a stable source of segregated forestry account funding that is able to support a relatively robust program.

Article VIII, Section 10, of the Wisconsin Constitution allows the state to appropriate moneys for the purpose of acquiring, preserving and developing the forests of the state through a tax on property not to exceed 0.2 mils (20¢ per $1,000 of property value). This tax is frequently referred to as the "forestry mil tax" and is the only property tax levied by the state. The rate of the mil tax, which is established in statute, was set at 0.2 mils in 1937 and did not change until 2005.

Revenue to the forestry account of the conservation fund from the mil tax increased an average 7.4% per year from 1970-71 to 2004-05. 2005 Act 25 limited the forestry mil tax levy to an annual increase of no more than 2.6% for the next three years. The act also specifies that the mil rate determined by the Department of Revenue for the property tax assessment as of January 1, 2007 (mil tax revenue received in the forestry account in 2007-08), would be the rate of the tax imposed for all subsequent years. The rate is now 0.1697 (16.97¢ per $1,000 of property value or about $28.65 on a home valued at a 2007 state median value of $168,800).

For 2007-08, the tax generated $84.5 million, which is 81% of the total revenue that was credited to the forestry account in that fiscal year. Statutorily, at least 12% of the revenue generated by the tax must be used to acquire and develop forests within a sixteen-county region southeast of a line running generally from Rock to Outagamie to Manitowoc Counties.

Other sources of revenue to the forestry account include: (a) revenues from the sale of timber on state forest lands; (b) revenues from the sale of growing stock from the state's tree nurseries; (c) camping and entrance fees at state forests; (d) severance and withdrawal payments from timber harvests on cooperatively-managed county forests and on privately-owned land entered under the forest crop law and managed forest law programs; (e) closed acre fees under the managed forest law program; and (f) a portion of the revenue from the sale of the conservation patron licenses, to reflect the fact that license holders are granted admission to state forests at no additional charge as part of the license. Figure 15.c shows changes in total forestry account revenue since 1999.

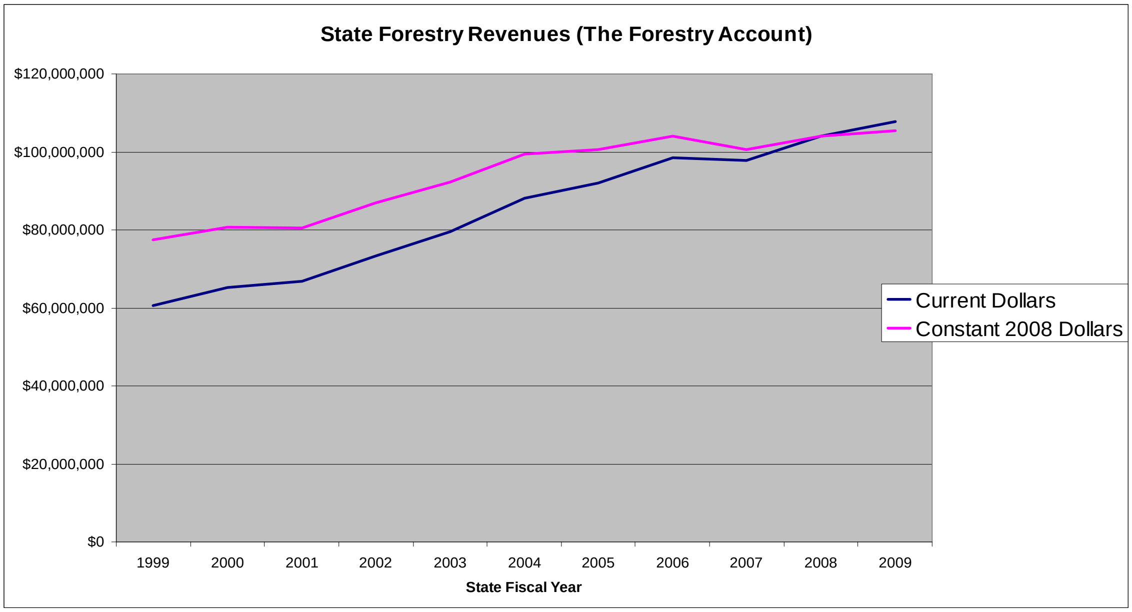


Figure 15.c: State forestry revenues 1999-2009
Source: DNR, Division of Forestry, 2009

In addition to Division of Forestry services to manage and protect public and private forest land (about half of the expenditures from the fund), the State Legislature appropriates money from the forestry account for other "forestry related" activities, the definition of which is at the Legislature's discretion. Figure 15.d shows expenditures by general categories. Table 15.a details forestry account expenditures in fiscal years 2008 and 2009. See Wisconsin Legislative Fiscal Bureau, Informational Paper 59 – Conservation Fund for a detailed description of forestry account uses.

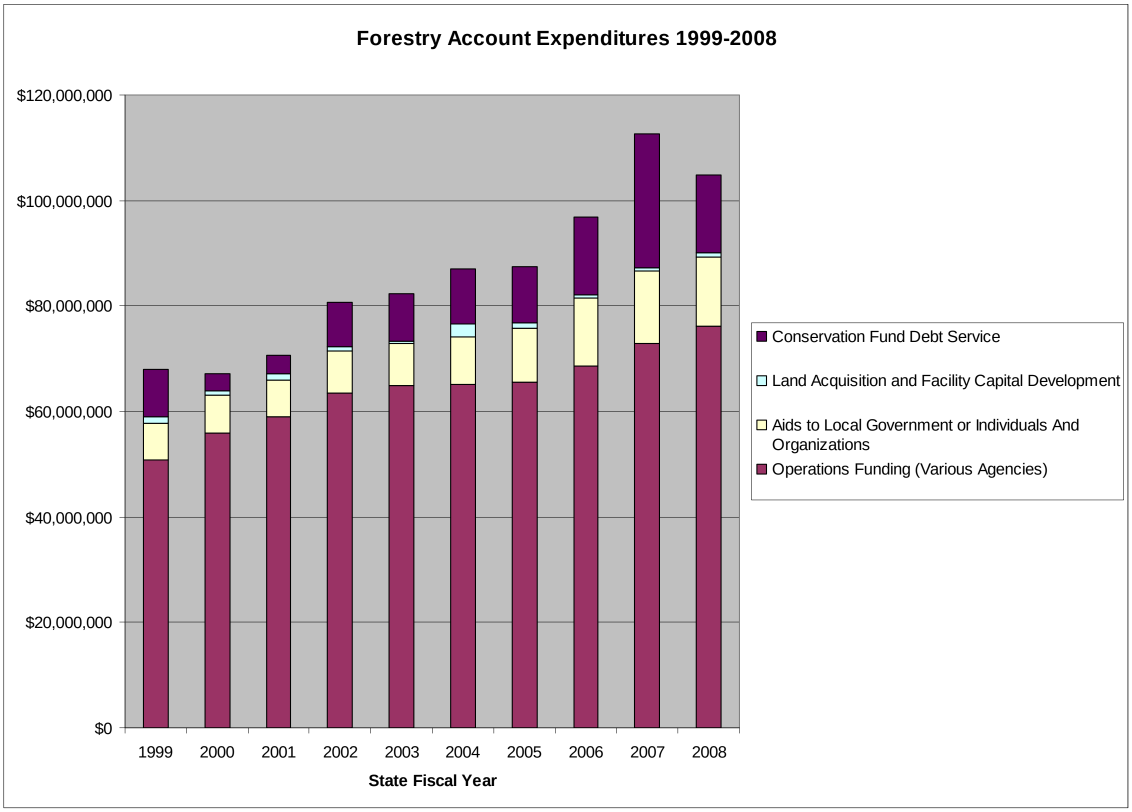


Figure 15.d: Forestry account expenditures
Source: DNR, Division of Forestry, 2008

Table 15.a: Forestry account expenditures fiscal years 2008 and 2009

	2007-08 Actual	2008-09 Appropriated	2007-08 % of Total	2008-09 Staff
Forestry Program Appropriations				
State Forestry Operations	$47,379,500	$50,780,500	47.40%	463.44
Southern Forest Operations	5,147,600	5,384,400	5.15	45.75
Stewardship Debt Service	13,500,000	13,500,000	13.51	0
FCL and MFL Aids	1,250,000	1,250,000	1.25	0
County Forest, FCL and MFL Aids	1,352,700	1,416,400	1.35	0
Outdoor Recreation Land Acquisition Grants	0	1,000,000	0	0
County Forest Loans	557,000	622,400	0.56	0
County Forest Project Loans	413,600	400,000	0.41	0
County Forest Loan Severance Payments	87,000	0	0.09	0
County Forest Project Loan Severance Payments	347,700	0	0.35	0
Urban Forestry, County Forest Grants, and County Forest Administrator Grants	1,934,600	2,128,100	1.94	0
Forestry Management Plan Contracts	0	320,000	0	0
Fish, Wildlife and Forestry Recreation Aids	235,900	234,500	0.24	0
Recording Fees	50,800	90,000	0.05	0
Fire Emergency Other States	74,800	0	0.07	0
Reforestation	122,500	101,500	0.12	0
Wisconsin Private Forest Landowner Grants	888,700	1,710,000	0.89	0

Table 15.a: Forestry account expenditures fiscal years 2008 and 2009

	2007-08 Actual	2008-09 Appropriated	2007-08 % of Total	2008-09 Staff
Fire Suppression Grants	443,400	448,000	0.44	0
Assistance for NCOs and Private Conservation	228,400	230,000	0.23	0
Forestry Public Education	175,500	200,000	0.18	0
Forestry Education Curriculum	200,000	200,000	0.2	0
Campground Reservations	288,500	0	0.29	0
Forestry Education and Professional Development	5,600	150,000	0.01	0
Karner Blue Butterfly Habitat	9,700	10,000	0.01	0
Cooperating Foresters	3,900	0	0	0
Split-Funded Appropriations				
Administration and Technology Services	$7,658,600	$8,030,900	7.66%	70.96
Customer Assistance and Licensing	4,013,600	3,276,500	4.02	34.19
Land Program Management	126,800	120,300	0.13	1.02
Bureau of Facilities and Lands	3,193,300	3,380,900	3.19	32.35
Bureau of Science Services	609,900	820,800	0.61	6.63
Bureau of Endangered Resources	236,100	255,500	0.24	2.63
Administrative Facility Repair and Debt Service	1,263,800	1,547,500	1.26	0
Aids in Lieu of Taxes	4,452,100	4,454,000	4.45	0
Resource Acquisition and Development	736,800	770,800	0.74	0
Rent and Property Maintenance	220,700	2,600	0.22	0
Taxes and Assessments	18,400	29,900	0.02	0
Miscellaneous	12,800	0	0.01	0
Other Agency Appropriations				
Agriculture, Trade and Consumer Protection	$1,452,400	$1,560,400	1.45%	9.75
University of Wisconsin System	441,300	531,100	0.44	1
State Historical Society	52,800	49,000	0.05	1
Kickapoo Reserve Management Board	718,300	744,900	0.72	3
Wisconsin Conservation Corps	800	0	0	0
Lower Wisconsin State Riverway Board	44,400	46,700	0.04	0.25
Total	$99,950,300	$105,797,600	100.00%	671.97

Source: DNR, Division of Forestry, 2009

Use of forestry account revenue is a contentious issue, diversions of the funds being a subject of intense debate. For example, the forestry account was first tapped for $1 million for aid in lieu of property tax payments (for conservation land purchased by DNR) in fiscal year 2003-2004. That has since grown to $4.45 million a year, most of which is likely to continue as a permanent draw on the account. Recurrent state budget shortages, including a $6.6 billion shortfall projected by mid-2011, have forced the State Legislature to use every available dollar in the forestry account. The effective reserve in the account is nearly zero, and the inflexibility of some charges like aid in lieu of tax payments means that core forest management functions risk substantive future reductions if revenue sources decline or fail to keep up with inflation.

15.3 Funding for forestry research

Forestry research by academic institutions and government agencies is primarily dependent on public funding. Research is typically a multi-year endeavor with some studies requiring inputs and yielding findings over decades. One measure of research support and investment is the willingness of the public and others to make such multi-year commitments.

Research funding (i.e., grants, agreements, projects) included in these data is a blend of competitive grants, federal formula funds, and funds conveyed through cooperative agreements. It is a coarse look at funds by state, federal, and industry sources. The primary organizations responsible for forestry-related research in the state are the UW-Madison, UW-Stevens Point, USDA Forest Service Northern Research Station, USDA Forest Service Forest Products Laboratory, and the DNR-Bureau of Science Services. These organizations receive the vast majority of research funding. In the case of UW-Madison and Stevens Point, portions of research funding also support activities of the UWEX Cooperative Extension Service.

Many types of research in various disciplines benefits forest management. For the following data, forestry research includes the knowledge areas of: management and sustainability of forest resources, management and control of forest and range fire, urban forestry, and outdoor recreation. The sources of the funds come from a variety of federal agencies, state government, and industry grants and agreements. This data is compiled by the USDA National Institute of Food and Agriculture (previously known as the Cooperative State Research Education and Extension Service (CSREES)) Data are available through their Current Research Information System website (http://cris.nifa.usda.gov/Welcome.html).

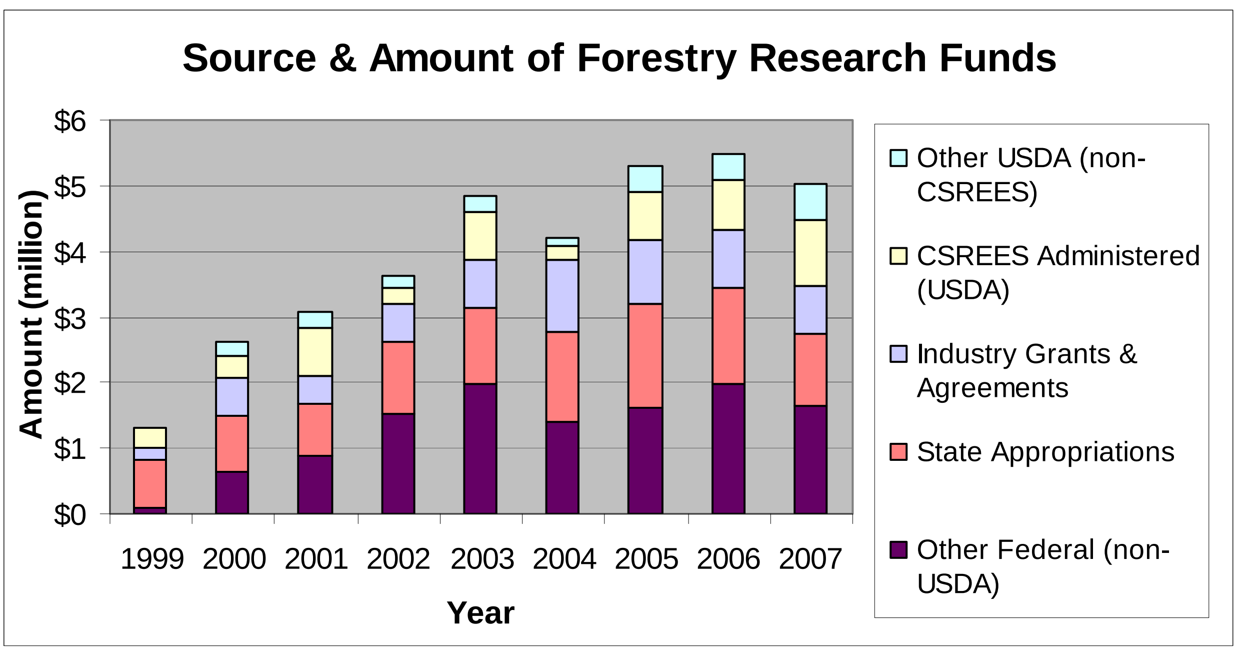


Figure 15.e: Source and amount of forestry research funds
(USDA, CREES, 2009)

Table 15.b: USDA Forest Service Research Funds (All Knowledge Areas)	
2003	$18,795,190
2004	$19,278,065
2005	$17,144,743
2006	$23,295,494
2007	$20,738,950
(USDA, REEIS, 2009)	

Figure 15.a does not include funds from the Forest Service, which maintains a significant presence in Wisconsin through the Forest Products Laboratory and research stations in Rhinelander and elsewhere. The Forest Service share (Table 15.b) includes all expenditures (i.e., salaries, benefits, facilities, supplies, etc) and extends to all knowledge areas as opposed to just those listed in Fig 15.e.

Both the UW-Madison and Stevens Point campuses of the UW-System receive formula fund from the USDA NIFA through the McIntire-Stennis Act. These funds provide for state-focused forestry research. Under the federal formula, Wisconsin received $576,607 in 2008 and $641,156 in 2009. The majority of this support is directed to the UW-Madison (the College of Agricultural and Life Sciences specifically), which has an explicit focus on research. The McIntire-Stennis Act support represents the largest share of the CSREES administered share in Fig 15.e.

The sources that make up the vast majority of the remaining federal support (i.e., non NIFA and FS) include Department of Defense, Department of Energy, National Aeronautic and Space Administration (NASA), National Science Foundation (NSF), and US AID (Agency for International Development).. An important caveat for all funding identified is that the research may or may not be Wisconsin or even regionally focused.

Over the last three years, the amount of research funding remained fairly stable across the state. There are some changes within funding sources. Industry grants and agreements hit a high in 2004 ($1,082,000) and declined since. The amount of CSREES grants steadily increased over the last four years.

In terms of research impact, there are few specific measures. The DNR, Bureau of Science Services compiled a list of over 100 forestry research activities that are occurring or recently completed as of 2008 (Martin and Pollentier, 2008). In a 2006, Journal of Forestry article, the UW-Madison Department of (then) Forest Ecology and Management ranked in the top 10 of all North American forestry programs in the nation on several measures of research publication outputs between 1997 and 2001 (Laband & Zhang 2006).

In 2006, the Wisconsin Council on Forestry recognized the need to prioritize various initiatives started by the Council, the Governor's Conference on Forestry, and Governor Doyle's Conserve Wisconsin program. They developed the "Wisconsin Research Agenda" (WI Council on Forestry, 2006). Their top research priorities are grouped by the following eight areas of emphasis:

1) Sustainable Management Certification for Wisconsin's State, County, and Private Forests
2) Conserving Wisconsin's Biological Diversity
3) Enhancing Wisconsin's Urban Forests
4) Managing the Impacts of Changes in Wisconsin's Land Use and Forest Ownership
5) Enhancing Assistance to Wisconsin Private Forest Landowners
6) Minimizing the Threat of Invasive Exotic Species to Wisconsin's Forests
7) Maintaining Wisconsin's Forest-Based Economy
8) Minimizing Recreational Use Conflicts in Wisconsin Forests

The Council recommended that the Division of Forestry develop an initiative for $200,000 per year of base funding for the 2007-2009 biennium to support forestry research that addresses needs identified in the Wisconsin Forestry Research Agenda. As well, they recommended the Division of Forestry work with the UW-System to develop a cooperative grant program for forestry research supported with WI-DNR funds. A final recommendation was for the Division of Forestry to formulate a process for assessing and prioritizing forestry research needs when developing future statewide forest plans, and develop biennial updates and revisions of the research agenda.

Despite some degree of research coordination among agencies and especially individuals, harmonization could be improved. Efforts are underway among research institutions to build closer relationships. Future assessment might consider the extent to which coordination is occurring through metrics such as co-authored publications co-principal investigator status on proposals that span different research institutions, and greater organizational ties through formal agreements and joint events.

15.4 Capital expenditures by manufacturers of wood-related products
Total capital expenditures include new and previously owned expenditures for: (1) permanent additions and major alterations to manufacturing establishments, and (2) machinery and equipment used for replacement and additions to plant capacity, if they were of the type for which depreciation accounts are ordinarily maintained. Capital expenditures by wood-related product manufacturers in Wisconsin are a direct measure of private industry investment in Wisconsin forest products industry.

Data for this metric is readily available from U.S. Department of Commerce, Census Bureau and Economic Census. The Economic Census is conducted by the U.S. Department of Commerce, Bureau of the Census every five years, in years ending in "2" and "7" (such as 1997, 2002, 2007). There is some time lag in the ability to analyze this data. As required by Federal law governing census reports, no data are published that would disclose information regarding an individual establishment or company. This provision results in some missing data in states or industries for which there are a smaller number of establishments.

For purposes of analysis, forest product manufacturers can be separated into five distinct sectors: (1) sawmills and wood preservation, (2) veneer, plywood, and engineered wood product manufacturing, (3) other wood product manufacturing, (4) paper manufacturing, (5) wood furniture and related product manufacturing. These subsectors are described below.

Sawmills and wood preservation - This industry group comprises establishments whose primary production process begins with logs or bolts that are transformed into boards, dimension lumber, beams, timbers, poles, ties, shingles, shakes, siding, and wood chips. Establishments that cut and treat round wood and/or treat wood products made in other establishments to prevent rotting by impregnation with creosote or other chemical compounds are also included in this industry group

Veneer, plywood, and engineered wood product manufacturing – This industry comprises establishments primarily engaged in one or more of the following manufacturing activities:

1. veneer and/or plywood;
2. engineered wood members; and
3. reconstituted wood products (e.g. hardboard, particleboard, insulation board, medium density fiberboard, waferboard, and oriented strandboard).

This industry includes manufacturing plywood from veneer made in the same establishment or from veneer made in other establishments, and manufacturing plywood faced with non-wood materials, such as plastics or metal.

Other wood product manufacturing – All other miscellaneous wood product manufacturing

Paper manufacturing - Industries in the paper manufacturing subsector make pulp, paper, or converted paper products. The manufacturing of these products is grouped together because they constitute a series of vertically connected processes. The paper manufacturing subsector is subdivided into two industry groups, the first for the manufacturing of pulp and paper and the second for the manufacturing of converted paper products. Pulp mills, paper mills and paperboard mills comprise the first industry group. Establishments that make products from purchased paper and other materials make up the second industry group, converted paper product manufacturing.

Wood furniture and related product manufacturing – includes the manufacturing of various products such as wood kitchen cabinets, furniture, custom architectural woodwork and millwork, shelving, and shade manufacturing.

Wisconsin’s forest products industries are significant contributors to the economy, with total capital expenditures of $711.2 million, comprising over 17% of capital expenditures in the manufacturing sector as a whole (see Figure 15.f). Three-quarters of private investment in forest products manufacturing occurs in the paper manufacturing subsector (see Figure 15.g), which in 2006 had over $533.8 million in estimated total capital expenditures, representing 13% of total capital expenditures in all manufacturing sectors. Other wood product manufacturing ranks second among forest products subsectors, with $84.3 million in total capital expenditures. Total capital expenditures in the wood furniture subsector have dropped sharply from 2002 ($70.1 million) to 2006 ($39.5 million). The sawmill and wood preservation subsector has relatively minor total capital expenditures ($30.4 million in 2006), but that number has nearly tripled since

2002. Capital expenditures in the veneer, pulpwood, and engineered wood product manufacturing subsector are relatively low and constant.

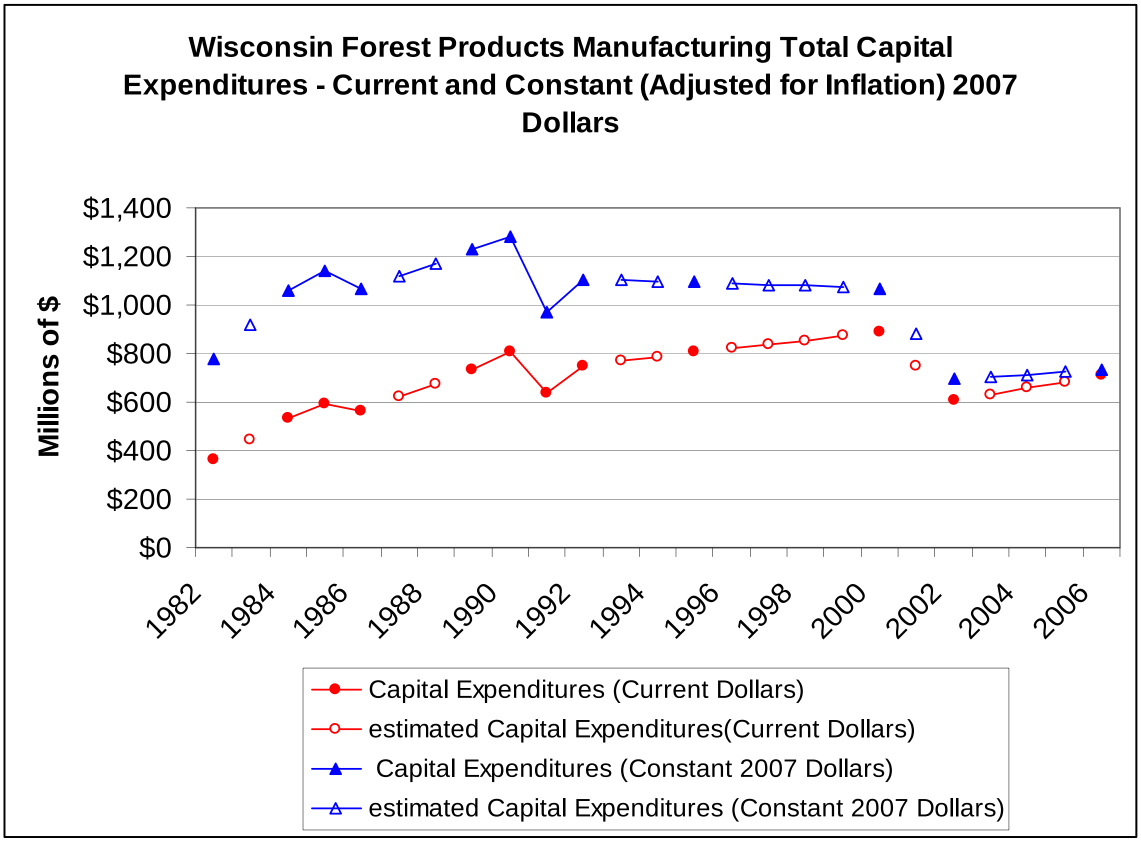


Figure 15.f: Wisconsin forest products manufacturing total capital expenditures
(Source: Wisconsin Economic Development Institute, Inc., Madison, WI)

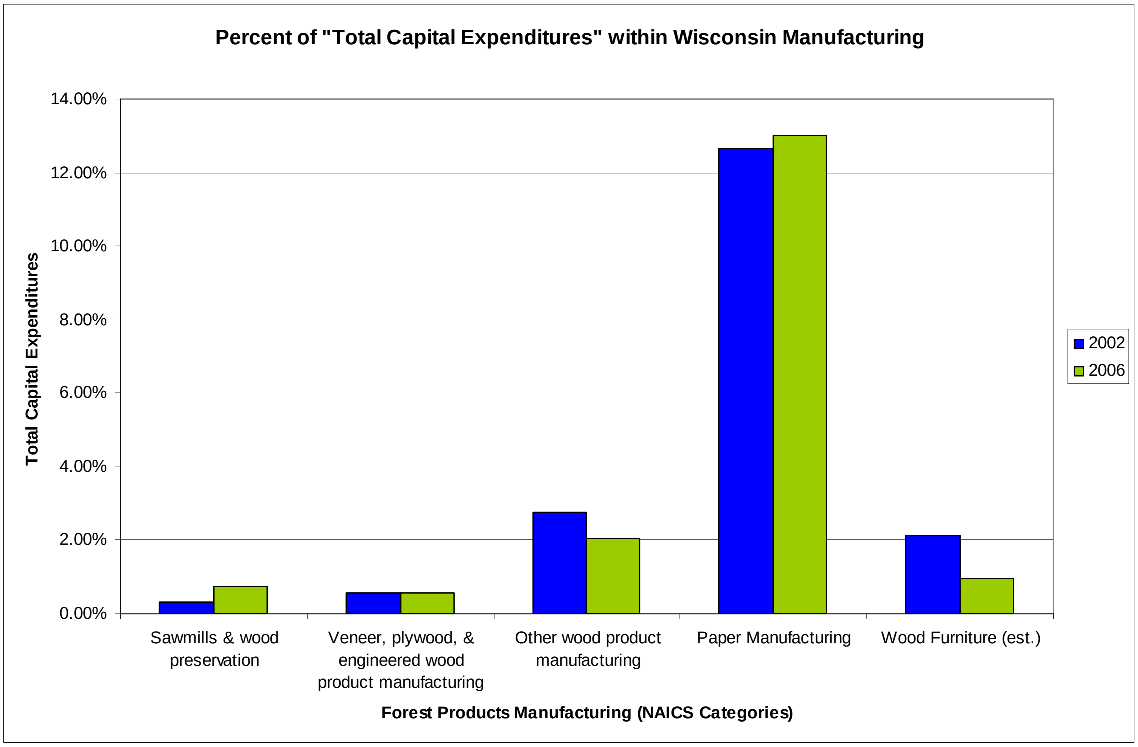


Figure 15.g: Percent of total capital expenditures within Wisconsin manufacturing
(Source: Wisconsin Economic Development Institute, Inc., Madison, WI)

In terms of constant 2007 dollars, total capital investment in Wisconsin's forest products manufacturing has been below 1982 levels since 2002. When accounting for inflation, capital expenditures peaked in 1990 ($1.3 billion in constant 2007 dollars), then leveled off until 2000, when capital expenditures plummeted as wood products manufacturers divested in timberland and closed down mills. From 2002 to 2006, capital expenditures in wood products manufacturing as a whole have rebounded somewhat, especially in the paper manufacturing subsector and the sawmill and wood preservation subsector. However, given competition with global markets, it is unlikely that wood products manufacturing will return to a point where it comprises nearly a third of all capital expenditures in manufacturing, as was the case in 1990 (31.3%).

Since 1990, the wood products manufacturing sector has seen its share of capital investment steadily decline as firms take advantage of relatively low labor and transportation costs in other locales. However, the paper manufacturing subsector remains a strong draw for capital expenditure, ranking second among 65 manufacturing subsectors.

15.5 Funding for Forestry Education (K-12)

People's views of forests are complicated and debates over their management are often in the public spotlight. As the population became more urbanized, values shifted. In some cases, knowledge about the many products that our forests provide on a daily basis has been incompletely understood, resulting in polarized debate.

Kindergarten through twelfth grade (K-12) educational programming introduces young citizens to the dynamic nature of forests and forest management and informs learners about forests both as complex ecosystems and as economic resources. K-12 programming about our forest resources envisions inspired and informed citizens that are actively engaged in sustaining healthy forests and communities. Advancing excellence in K-12 forestry education through partnerships that develop, disseminate, implement and evaluate relevant resources and services makes both good ecological and economic sense and will ultimately sustain the forest resource through informed dialogue, science based knowledge and critical thinking.

There are many institutions that focus on forestry education. For this assessment, seven were chosen to highlight (see Table 15.c). They were selected because of their statewide extent and exemplified a variety of missions. The intent of reporting the level of funding for each organization is to assess whether there is continued support for these groups by those that fund them (i.e. government, grant programs, donations). Some of these groups are young and only have a few years of data. Others were also able to report how many students their programs educated. Overall, programs that are funded through the state or federal sources have shown the most stability.

Table 15.c: K-12 forestry organizations level of funding and people served

Organization	Funding (1990's)	Funding (2008)	# of people served (1990's)	# of people served (2008)	Explanatory Notes
WEEB	$200,000 (1998)	$400,000	N/A	>20,000 (2007)	Funding shown is specifically for the forestry program, not the total WEEB budget. # of people reached with 2007 grants is a total of only 33 of 69 projects reporting.
Trees for Tomorrow	$691,080 (1998)	$930,000	18,713 (1998	14,000 (2007)	No funding comes from state or federal sources.
LEAF	$250,000 (2002)	$379,500	N/A	293,101	LEAF was founded in 2002. # of people served in 2008 includes >200,000 visits to LEAF website.
PLT	$45,000 (1998)	$85,933	803 (1998)	7,509	Some state funding.
DNR Fire	N/A	$25,000	36,865 (2005)	32,356	No data from 1990's but most likely $25,000.
Woodlinks	$30,000 (1997)	$46,000	60	700	In 1997, the program started with 3 schools (20 students/school); now 35 schools in 2008.
WFREA	N/A	$75,000	N/A	1,576	WFREA began in 1998.
(Source: Each organization provided data, 2009)					

Wisconsin Education & Environmental Board (WEEB)
The Wisconsin Environmental Education Board (WEEB**)** was established by 1989 Wisconsin Act 299, becoming law in 1990. Since the program's inception in 2005, the Board has invested over $230,000 to assist 48 school districts with their efforts to create a school forest education plan. The WEEB has a strong and active board made up of several members of the Legislature. The forestry portion of their budget doubled over the last ten years.

Trees for Tomorrow
Since this is a self-supporting property-based environmental education facility, the rising costs of building maintenance, utilities, vehicles, postage and general house-keeping may become burdensome in the near future. A slight decline in the overall number of people served over the years underscores the continued need for marketing and fund raising. To best benefit forestry education, current trends indicate that an increased focus on adult off-site programming is a possible growth area. Increased educational programming targeting older audiences with greater disposable incomes, coupled with focused marketing may sustain this facility and increase fundraising and donations. Future growth in traditional outreach to elementary, middle and high school students reflects school populations and thus maybe limited.

LEAF
Trends for this program indicate that it is a sound investment for sustained growth in forestry education. Annual increases in the number of people served coupled with up to date electronic services, targeted marketing, and access to university expertise and grant writing expertise; position this program for growth. Any decline in the principle source of funding, a surcharge on the sale of DNR nursery program tree seedlings, will impact this program's base funding and impact its ability to deliver forestry education. The LEAF budget annually leverages over $150,000 in in-kind matching contributions from partners. Best areas for growth are in professional development for educators, increased electronic outreach to audiences and updated revisions to lesson guides. Forestry education focused on school-ground tree planting and family home site tree planting could slow revenue decline.

Project Learning Tree (PLT)
PLT funding and number of people served increased over the last decade. More than half of the budget is funded by the DNR. This program has strong ties to the national PLT. There is a grant program called "GreenWorks!" that is the service-learning, community action program of PLT that partners PLT educators, students, and communities in environmental neighborhood improvement projects.

Wisconsin DNR, Fire Prevention Education
The DNR, Division of Forestry provides K-12 education through school programs, Boy/Girl Scout programs, the Juvenile Fire Setter program, and miscellaneous outdoor programs. DNR Fire Rangers communicate the Smokey the Bear message in their local schools. The state is dependent on federal funds to continue these types of programs. Historically, this has been $25,000/year. There is no state-based funding.

WoodLINKS Wisconsin

WoodLINKS Wisconsin provides educational tools and resources to teach manufacturing processes and technologies that are used in the forestry/wood products industry. This is a unique topic that is not specifically addressed by other education groups. As the forestry/wood employment sector ages, a new cohort of trained woods workers is needed. Unfortunately, the program is dependent on a variety of short term grants. A foundation was established to support this program but due to the recession this has not done well. Glacierland RC&D applied for grants to support WoodLINKS in Wisconsin but was not successful. Even with financial instability, the program has grown from 3 schools to 35. Wisconsin has the most schools in the nation in the WoodLINKS program.

Wisconsin Forest Research and Education Association (WFREA)
WFREA began in 1998 as a nonprofit organization dedicated to promoting education about sustainable forestry to Wisconsin residents and resource users. They worked in partnership with many of the other organizations such as the UW-Extension and Dovetail Partners, Inc. The association operated on grant funds; a challenge in this economy. In 2009, the association decided to end the program.

15.6 Number of university and technical college forestry graduates
Forestry will see a large percentage of the workforce turnover in the next decade due to the baby boomer generation entering retirement. Within the DNR, over 50% of forestry professionals will likely retire. It is important to understand the graduation trends of foresters and technicians so forestry employers better prepare for the challenges of the shrinking candidate pool. With the loss of trained forestry professionals and fewer forestry graduates entering the workforce, there will be a dramatic increase in the competition to recruit and retain qualified forestry professionals. This competition forces the Division of Forestry, one of the largest employers in this field, to analyze and evaluate its position on salary, benefits, and other factors important to attracting top candidates. The DNR is required to hire foresters who have a degree in forestry from a Society of American Foresters (SAF) accredited school.

Data was collected from the Wisconsin, Minnesota, and Michigan SAF accredited forestry schools. For employers in the Great Lakes region, these schools provide the majority of qualified candidates (see Table 15.d). Data was also collected from regional natural resources technician programs, which provide forestry technician candidates as well as feeding the regional SAF degree programs (see Table 15.e). Six-year totals for baccalaureate degrees spike in 2004 but then drop. Just as the regional Midwest programs are supplying fewer candidates, this trend is evident nationwide and across all the natural resource fields.

Table 15.d: Number of forestry graduates in the Great Lakes Region

Baccalaureate Degrees Awarded in Forestry						
	2002	2003	2004	2005	2006	2007
Michigan State University	n/a	n/a	27	5	n/a	7
Michigan Technological University	n/a	20	13	18	12	10
University of Minnesota - St. Paul	n/a	n/a	28	31	14	18

University of Wisconsin - Madison	12	17	10	11	11	11
University of Wisconsin - Stevens Point	90	101	105	68	89	63
Total (for available data)	102+	138+	183	133	126+	109
Source: FAEIS - Food and Agriculture Education Information Systems						

Table 15.e: Number of forestry graduates in the Great Lakes Region

Degrees Awarded from Regional Technical Colleges						
	2002	2003	2004	2005	2006	2007
Fox Valley Technical College - Natural Res. Tech	31	n/a	n/a	n/a	n/a	20
Mid State Technical College - Urban Forestry Tech	n/a	14	14	27	17	17
Vermillion Community College - Natural Res. Tech	15	26	17	18	19	n/a
Total (for available data)	46+	40+	31+	45+	36+	37
Source: School website and/or Instructor contact						

National level data from the U.S. Department of Education also shows a decline in forestry related degrees over the last decade (Figure 15.g). The number of overall forestry degrees fell about 24% between 2002 through 2008. These include a compilation of the degrees granted in the following fields of study at postsecondary institutions: general forestry, forest sciences and biology, forest management/forest resources management, urban forestry, wood science and wood products/pulp and paper technology, forest resources production and management, forest technology/technician, and other forestry. (U.S. Department of Education – Institute of Educational Sciences, 2002-2008)

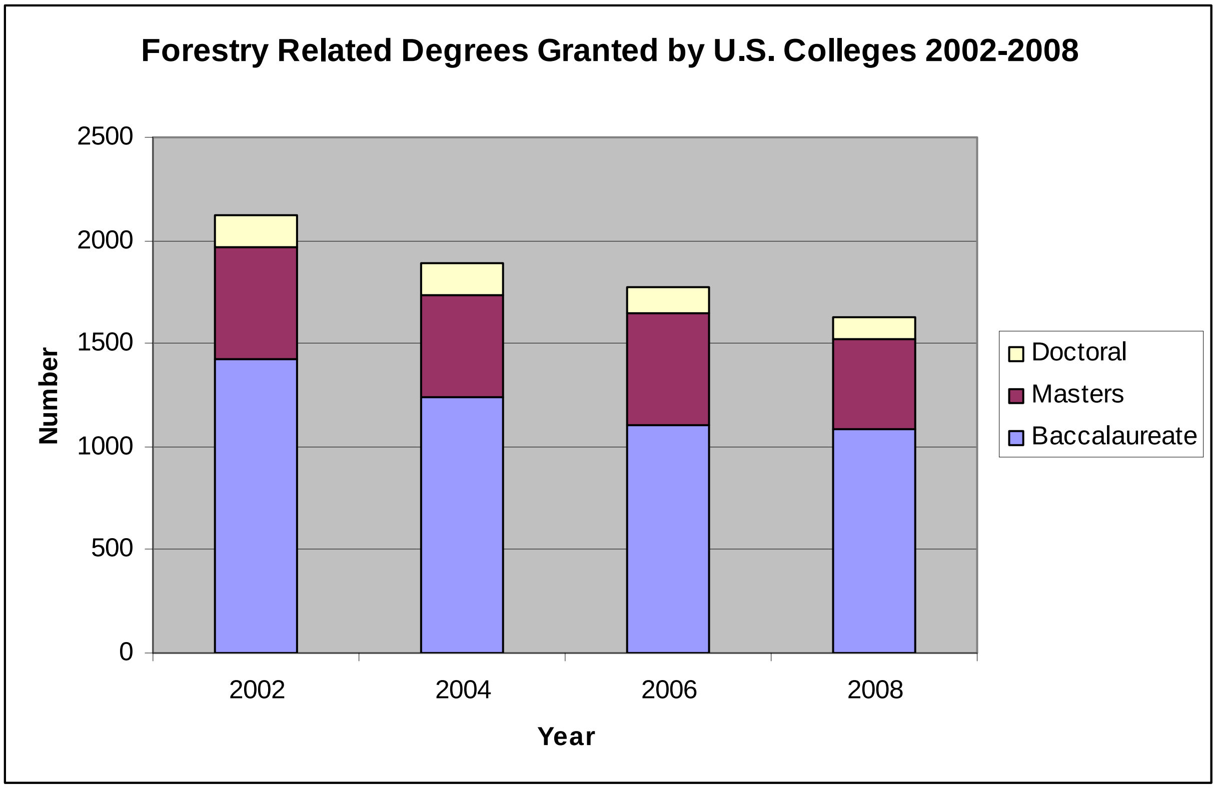


Figure 15.g: Forestry Related Degrees Granted by U.S. Postsecondary Institutions 2002-2008
Source: U.S. Department of Education – Institute of Educational Sciences, 2002-2008

The future of sustainable forest management relies upon the quality of the workforce. A shortage of forestry graduates could result in prolonged vacancies, increased labor costs, or acceptance of less qualified replacements. It is critical to adapt recruiting strategies, and potentially rebrand forestry programs as a 'green' career, in order to meet employment needs in this critical job market.

15.7 Funding for continuing forestry education for foresters and loggers and number of participants

The discipline of forestry and logging is continually changing due to new technology and research improving ecological and silvicultural practices. Foresters and loggers must keep abreast of these developments in order to best manage forests and stay current in professional societies and certifications. As well, additional education and certification such as Master Logger or SFI certification may improve a foresters or logger's competitive advantage in the market.

In order to understand whether there are opportunities for forestry professionals and loggers to obtain continuing education and whether it is supported or not, data was sought from major organizations that require or provide education. SAF, the largest professional foresters association in the nation, in 2008 offered over 200 continuing forestry education credits in Wisconsin. Of approximately 470 Wisconsin SAF members in 2009, 55 had chosen to be a "SAF Certified Forester", which requires 60 hours of continuing education every two years. Forest Industry Safety and Training Alliance (FISTA) is the largest provider of logger training and education and maintains a database of trained loggers and foresters for the Sustainable Forestry

Initiative® (SFI®). More detailed summary data were available from the DNR and the Wisconsin Arborist Association.

Continuing education for urban foresters

Urban foresters receive continuing education from a variety of sources—workshops, conferences, university and technical college classes, certificate programs, etc. The two main sources of statewide continuing education are the Wisconsin DNR urban forestry program and the Wisconsin Arborist Association, the industry's professional association. The DNR provides a variety of information sources from print and electronic newsletters, reference publications, an extensive web site, direct technical consultation and two annual opportunities for formal continuing education—a one-day urban forestry workshop series and a three-day annual conference held jointly with the Wisconsin Arborist Association. The Wisconsin Arborist Association holds two additional continuing education events annually – a summer workshop and a fall seminar.

The International Society of Arboriculture Arborist Certification requires testing to initially receive various levels of certification and then requires annual continuing education credits to maintain the certifications. Table 15.f shows the development of certified arborists in Wisconsin. These metrics can be used both as indicators of statewide capacity of trained professionals as well as indicators of ongoing annual training.

Table 15.f: Certified arborists in Wisconsin

Year	Certified Arborist	Utility Specialist	Municipal Specialist	Tree Worker	Board Certified Master Arborist
2001	187	2	0	0	0
2002	211	3	0	0	0
2003	252	5	0	0	0
2004	291	5	0	0	0
2005	318	5	0	0	0
2006	353	7	2	2	6
2007	390	9	2	3	6
2008	433	11	4	3	9
2009	485	13	5	3	10
(Source: International Soc. of Arboriculture, 2009)					

The number of certified arborists in Wisconsin has increased 160% since 2001 and there has been a steady increase in certified arborists with additional specializations. This currently represents a minimum of 5291 hours of continuing education required annually for these professionals.

Continuing education for DNR employees

The DNR provides on average 600 class hours of training a year (see Table 15.g). Training is provided in both forest management and fire. See Figure 15.h for Division of Forestry expenditures on forest management and fire training in 2008. (Specific DNR fire training classes are described below in metric 15.8)

Table 15.g: Division of Forestry Training Program number of courses, hours, and average tuition

Division of Forestry Training Statistics FY01-FY08				
Fiscal Year	Forest Management Courses	Fire Management Courses	Total Students Attending**	Course Hours
FY01	11	29	817	not available
FY02	17	27	746	not available
FY03	26	35	1554	895
FY04	9	21	826	543
FY05	13	27	1055	658
FY06	12	8	564	318
FY07	24	24	751	697
FY08	19	21	626	595

**Total student numbers include DNR and partners.
Source: DNR, Division of Forestry, 2008

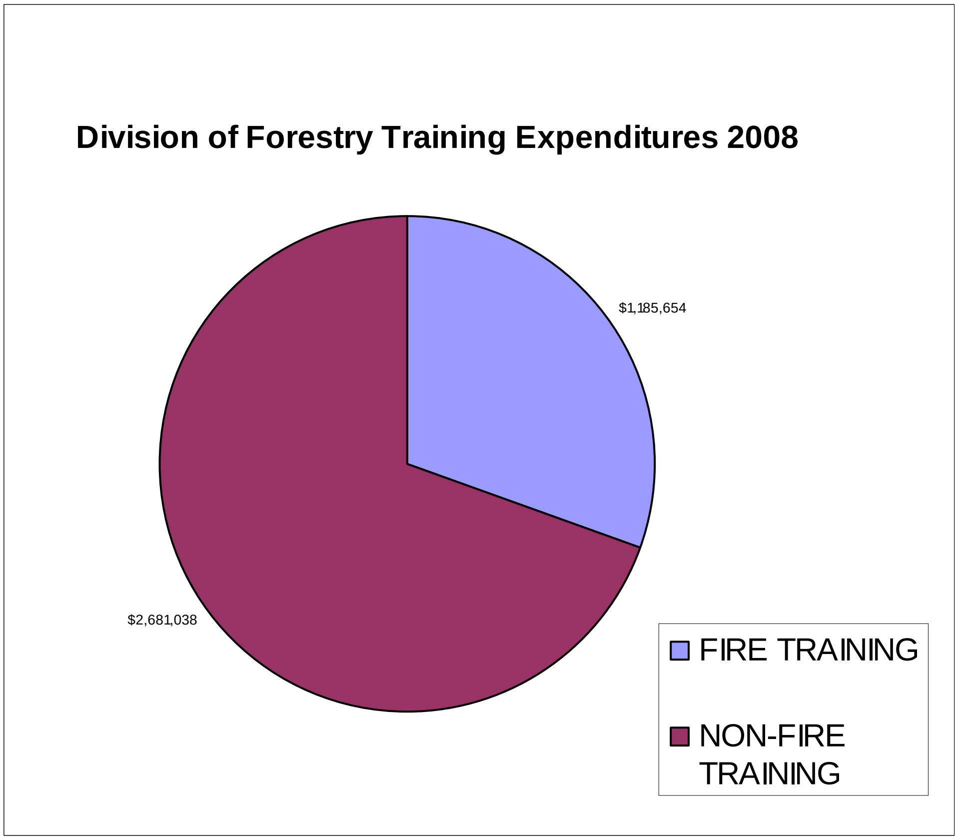


Figure 15.h: Division of Forestry fire and non-fire training expenditures 2008
(Includes all training provided to Division of Forestry staff by the Division of Forestry Training Program, DNR, and external/partner training opportunities)
Source: DNR, Division of Forestry, 2008

15.8 Fire protection investment

The investments in time and money for forest fire protection in Wisconsin are significant. Investments are made at many levels, locally through fire departments, statewide through DNR, and federally through grants to all levels. The DNR fire management program plays a key role in the sustainable management of forest resources, through limiting the damage fire causes and performs a vital service to protect public health and safety. Data on wildland fire investments is available through the DNR and Forest Service.

The following data describes the federal and state funding for the DNR's fire management program. The Forest Fire Protection (FFP) Grant program was created twelve years ago to expand the capabilities of local fire departments to respond to forest fires. DNR adopted National Wildfire Coordinating Group (NWCG) training standards and qualification system to assist federal partners on the wildland fire issues across the country. Those standards require investments of time and effort by state fire staff. One of the largest capital investments occur in fire suppression equipment. The DNR maintains a facility to design, build and evaluate a wide variety of specialized forest fire vehicles and equipment.

Federal fire grant funding continues to be a vital part of the overall funding of the fire management program in Wisconsin. The general grant funding trend has been downward. Current federal grant funding is 50% of the total from five years ago. Without these funds, the DNR fire management program must reduce the amount of grants it distributes. See Figure 15.i

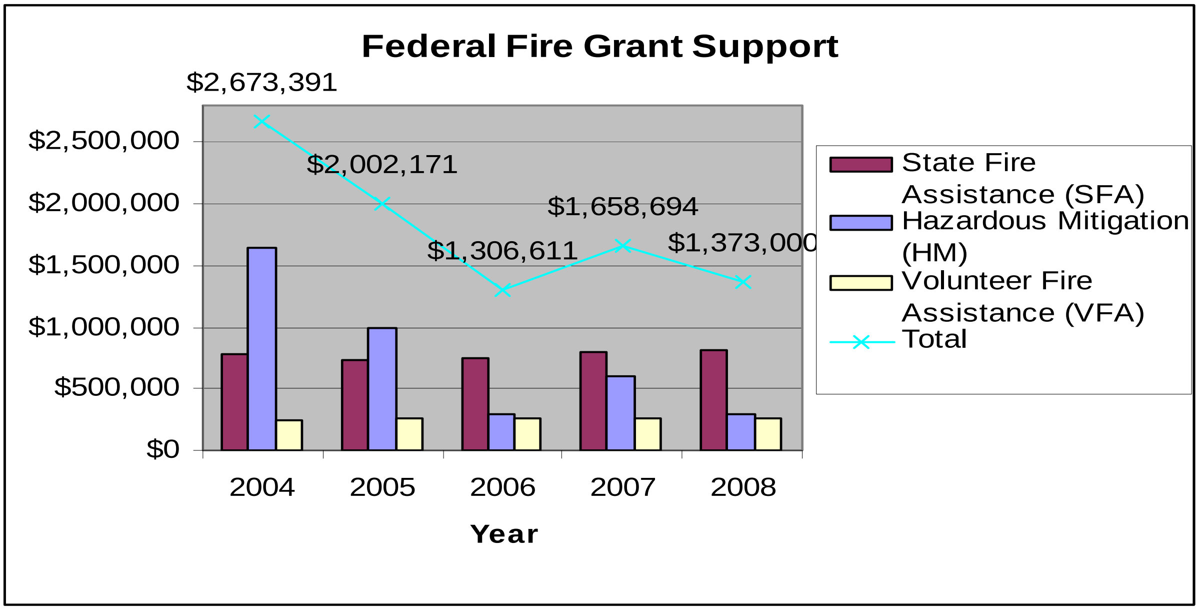


Figure 15.i: Federal fire grant support 2004-2008
(Source: DNR, 2009)

Wisconsin receives several federal fire grants and they are used for a variety of essential programs.

- The State Fire Assistance (SFA) grant monies, (dispersed to states under the National Fire Plan), support several programs. Some funding supplements Wisconsin's Forest Fire Protection (FFP) grant program. The balance of the SFA grant monies are used to support DNR fire management positions, equipment for DNR fire suppression, and safety equipment.
- SFA Hazardous Mitigation (HM) grant dollars are utilized to reduce the risk of catastrophic wildfire impacting communities. The program focuses on hazardous fuels reduction, prevention/education, and community planning in the wildland-urban interface. The program promoted Firewise practices, resulted in the creation of numerous Community Wildfire Protection Plans, and reduced flammable wildland fuels, especially in the vicinity of structural improvements. Viable projects located in a Community at Risk are prioritized for funding. This funding component dropped the most over the recent five year period.
- Volunteer Fire Assistance (VFA) grant monies, (dispersed to states under the National Fire Plan), are used to fund the DNR Forest Fire Protection (FFP) grant program which is a 50/50 cost share grant program for fire departments to purchase equipment and supplies to improve their capabilities and safety on wildland fires.

The state funds more than 75% of the DNR fire management program. State fire costs have increased in recent years. Suppression costs have varied depending on the severity and number of fires. Pre-suppression costs have continued to increase due to rising costs of vehicles, vehicle operations, personnel and equipment (see Figure 15.j). State fire program costs have fluctuated from $3.6 million (2004) to $5.6 million (2007). Fire suppression responsibilities may need to be reconsidered in light of the 2008 economic situation. Other states have required citizens to take more responsibility for protecting their assets if located in extreme fire hazard areas. State and federal budget reductions stemming from a recession in 2008-2009 have created uncertainty about future fire management funding, but Wisconsin has a history of support for this critical mission.

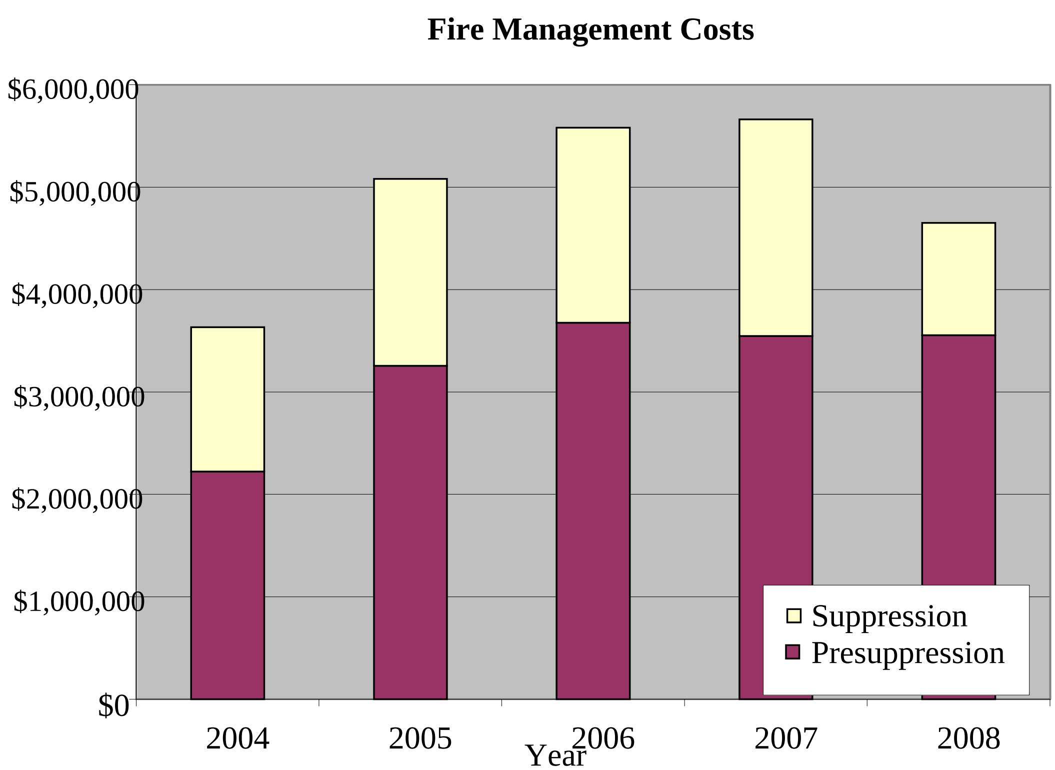


Figure 15.j: Fire management costs
(Source: DNR, 2009)

The DNR Forest Fire Protection (FFP) Grant provides cost share grants to fire departments. Federal funds provide significant support to the DNR FFP grant program. State funding of this program declined and the federal funds offset these losses. Due to the current economic downturn, further cuts in state funding to the DNR FFP grant program have taken place. The federal share of the FFP grant funding grew from 47% in 2003 to 58% in 2008. See Figure 15.k.

Local fire department grant applications average $2.4 million a year. Of those requests, an average of $800,000 is funded. This represents an unfunded need from fire departments of $400,000 every year. A recent survey of local fire departments showed that 94% have improved the safety and efficiency of their forest fire suppression efforts as a result of this grant program.

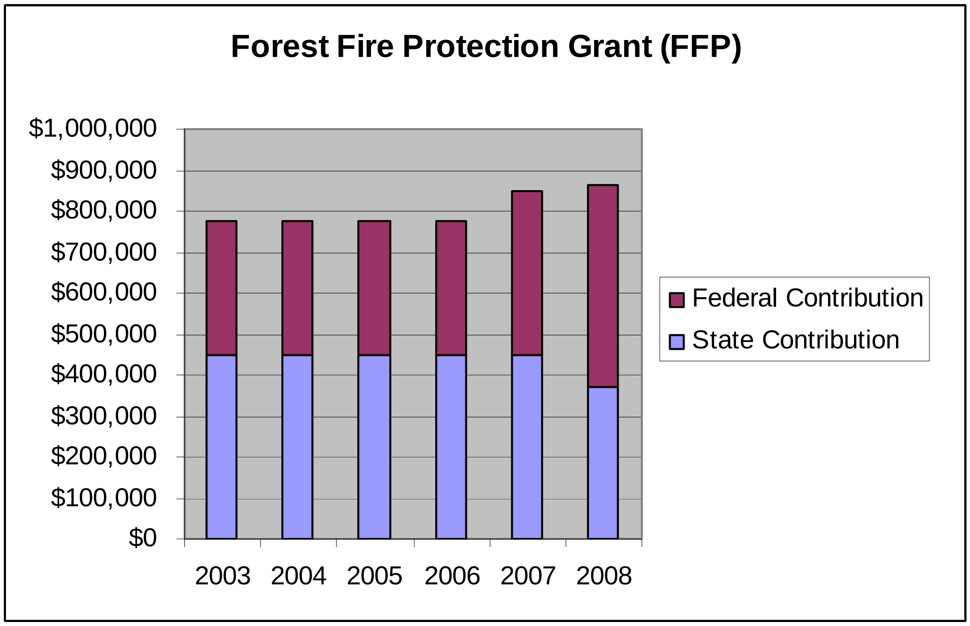


Figure 15.k: Forest fire protection grant (FFP)
(Source: WDNR, 2009)

DNR must make a substantial investment of time and dollars to train personnel to meet National Wildfire Coordinating Group position qualifications. DNR met target position quantities at the ICT4, ENGB and TRPB levels (see Figure 15.l). All of these are lower level positions in operations and command. The training gap analysis shows significant shortages in higher level command, operations, planning and logistics positions. As the DNR workforce ages and retires, critical shortages of qualified wildfire personnel will develop.

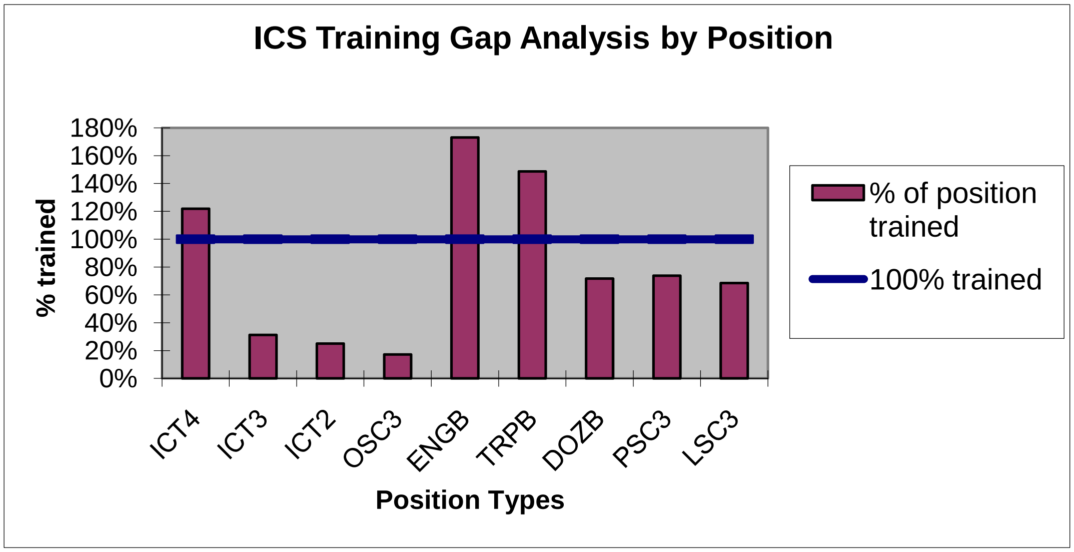


Figure 15.l: Incident command system (ICS) training gaps by position:
(Source: WDNR, 2009)

ICT4 – Incident Commander Type 4
ICT3 – Incident Commander Type 3
ICT2 – Incident Commander Type 2
OSC3 – Operations Section Chief Type 3
ENGB – Engine Boss
TRPB – Tractor Plow Boss
DOZB – Dozer Boss
PSC3 – Planning Section Chief Type 3
LSC3 – Logistics Section Chief Type 3

The DNR maintains 55 ranger stations to house fire management personnel and equipment. The DNR has a fleet of 11 type 6 engines, 47 type 7 engines, 20 type 8 engines, 83 type 4 engines, 4 marsh rigs and 79 type 5 tractor plows. This fleet of wildfire suppression equipment was assembled at a cost of over $12.7 million, and provides protection to more than 35 million acres of Wisconsin lands.

The use of fire towers and detection aircraft have been key components of the forest fire detection system for decades, identifying a significant percentage of Wisconsin's forest fires. Because of deteriorating infrastructure, and the prohibitively high cost of broad scale replacement, towers will be a part of the future detection system to a decreasing extent. Detection aircraft do not provide the comprehensive detection platform that towers do, and are increasing in their cost. Alternative and cost effective means of efficiently locating fires in their earliest stages, whether through technological development or through some sort of enhanced effort by partners, needs to be identified and developed in the next 10+ years.

16. Forest ownership, land use, and specially designated areas

16.1 Forest land and population

Human population growth is generally regarded as the greatest threat to the world's environment. Combined with increases in income and wealth, population growth leads to development pressure on forest lands (Alig, 2004). More people living in forests can mean less land for growing and harvesting trees, more need for fire planning in the wildland-urban interface, loss of open hunting grounds, spread of invasive species and the displacement of interior forest wildlife with edge dwellers, among other issues.

Wisconsin's estimated population of 5,627,967 in 2008 is 253,834 (4.72%) higher than in 2000 and 725,702 (14.8%) higher than 1990. This extends a long-running population increase trend (Figure 16.a). Neighboring states have experienced similar growth in the number of people, many of whom are attracted to recreational opportunities in Wisconsin and are in the market to own woodland.

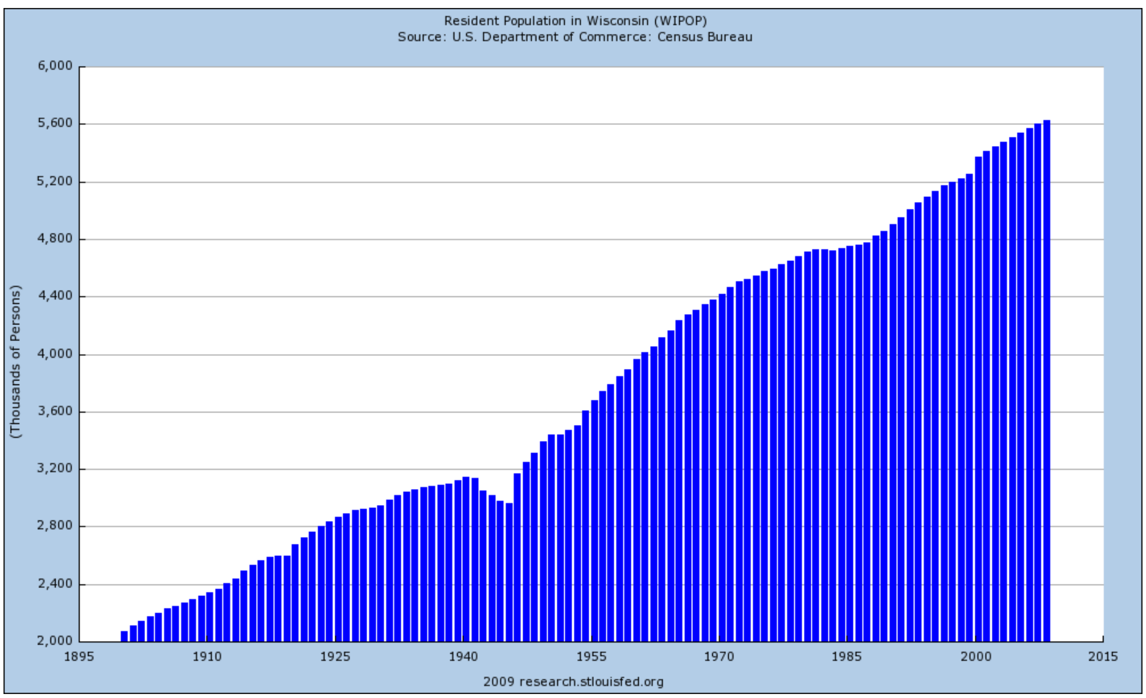
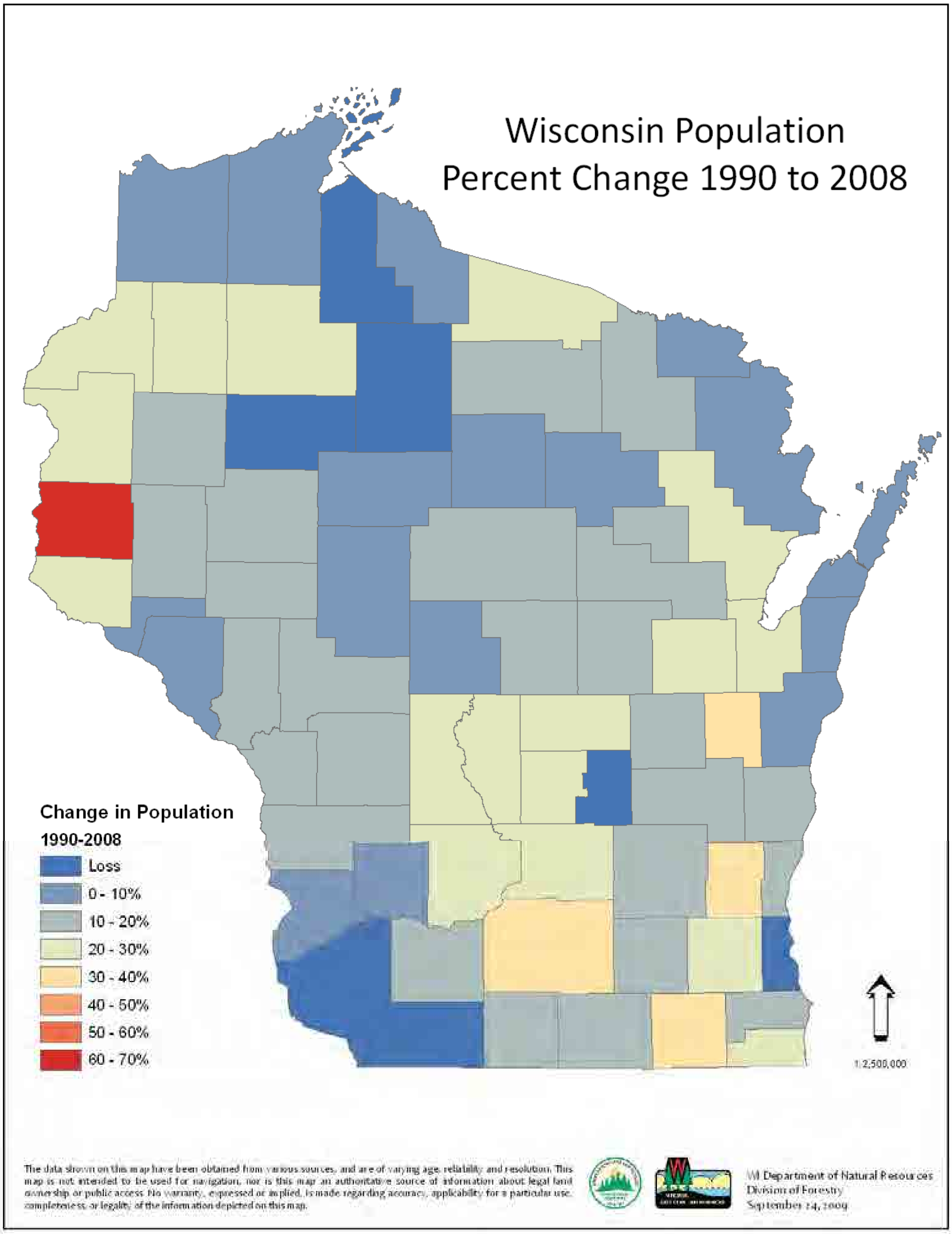


Figure 16.a: FRED®: [Resident population in Wisconsin 1900 to 2008]

Growth in resident population is unevenly distributed across the state. Map 16.a shows the areas of the state with the highest percentage increase in population from 1990 to 2008. As might be expected, the population near urban centers and along primary transportation corridors grew the fastest on a percentage basis. Proximity to the Twin Cities had significant impact on St. Croix County, for example, which experienced the largest population rise in the state with a 64% increase. Recreation destinations such as Washburn, Sawyer and Vilas Counties in the Northwoods also saw large relative increases in resident populations.



Map 16.a: Percentage change in Wisconsin population grid 1990 to 2008
(Source: U.S. Census). See data for each county in Table F.1 in Appendix F.

In addition to having more people, Wisconsin's population enjoyed sustained growth in per capita personal income (Figure 16.b). Although per capita income gains were only slightly greater than inflation during the last couple decades, Wisconsin household income (ranked 21st in the United States) increased substantially because of the growth of dual-income families (U.S. Census, 2008).

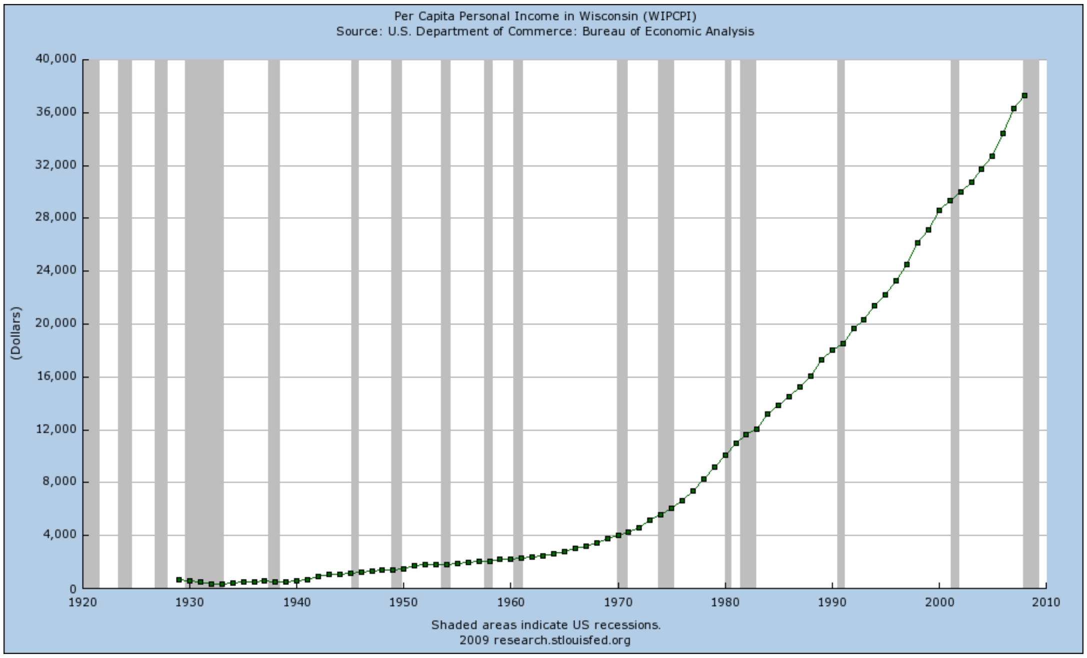
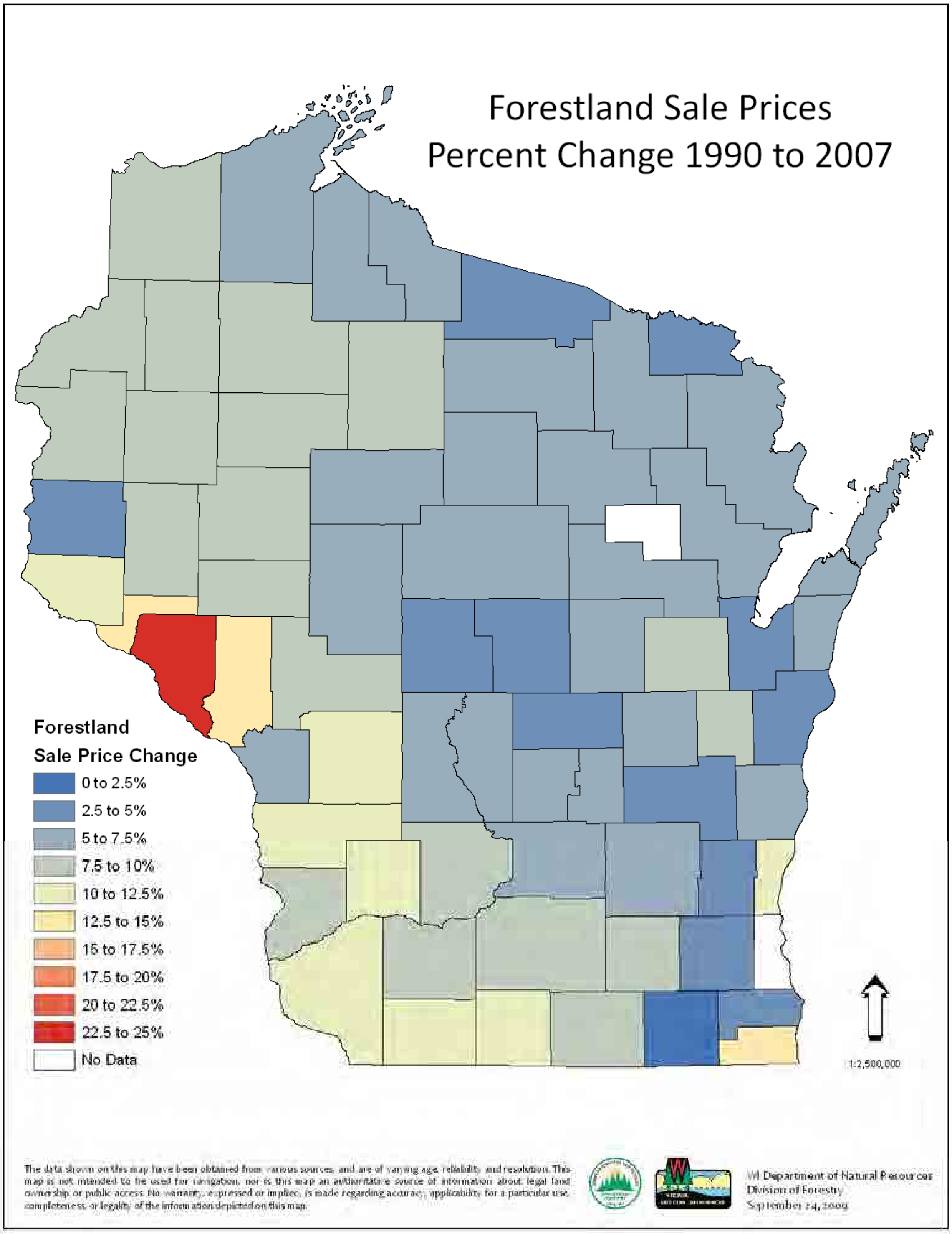


Figure 16.b: FRED® - Per capita personal income in Wisconsin 1930 to 2008

Since World War II, inflation-adjusted disposable income, consumption and wealth have roughly tripled on a per capita basis in the United States (Kennickell, 2008). For residents and non-residents alike, that translated into more interest in owning forest land and the ability to purchase it. Fueled by growing population and higher economic well-being, the demand for forest land caused sale prices to jump in the last couple decades (Map 16.b).



Map 16.b: Percentage change in Wisconsin forest land sale prices 1990 to 2007
(Source: USDA National Agricultural Statistics Service). See data for each county in Table F.2 in Appendix F.

The change in forest land values in the seventeen years spanning 1990 to 2007 is especially dramatic in western and southwestern parts of Wisconsin where smaller parcels of woodland are mixed with farms. Sale activity data complements U.S. Forest Service research that found farmers have been divesting their holdings. For example, in 1956, farmers owned 6.4 million acres of forest land in Wisconsin. By 1997, farmer-owned forest land had declined to 1.5 million acres (Leatherberry, 2001).

In La Crosse County, woodland selling for an average price of $609 per acre in 1990 sold for an average of $4,153 per acre in 2007, nearly a seven fold increase. Table F.2 in Appendix F details additional county-level price changes. Statewide, average forest land values increased from $311 per acre to $2,438, a 683% increase in seventeen years. In the eight years from 1999 to 2007, the statewide average forest land sale price went from $1,068 to $2,438, a smaller 128.28% simple increase. These figures are based on DNR analysis of USDA National Agricultural Statistics Service data on forestland sales.

The annualized compound rate of statewide forest land price increases over 1990-2007 was 12.87%. That compares to an annualized compound rate of inflation during the same period of only 2.76%. The pace of forest land price increases slowed later in the period, with a 10.87% compound annual rate of change between 1999 and 2007. This compares to a U.S. inflation rate of 2.78% over the period of 1999 to 2007, demonstrating that forest land values continued to rise relatively faster than other costs.

Changes in forest land sale prices are an indicator for other transforming values. While separating woodlands from working farms, other land splits and rural development may help more people satisfy their notion of “the good life”, high forest land values create barriers to entrepreneurial land management activities such as agriculture and timber production (Alig, 2004). Negative effects on recreation opportunities, forest health, local communities, and ecological vigor can also be anticipated from parcelization and fragmentation. Solutions will require a combination of strategies involving regulation, taxes, incentives, acquisition or easements, education and ethics. (Rickenbach and Saunders, 2009)

Policy changes and the economy greatly influence where forest land property values will head next. They were carried to their current position by the “Boomer” generation and their parents. Land use planners and managers will need to continue monitoring such trends.

16.2 Forest land ownership

Forest ownership is tracked by Forest Inventory Analysis (FIA) and the National Woodland Owner Survey (NWOS). According to the most recent comprehensive report of 2006 data, Wisconsin has 16 million rural forested acres (47% of the total land area). Of the forest land, 61.88% is held by non-industrial private forest land (NIPF) owners. The rest is owned by local government (primarily County Forests), 15.4%; federal government, 9.68%; state government, 6.61%; forest industry, 4.17%; and Native American Tribes, 2.26% (Butler, 2008).

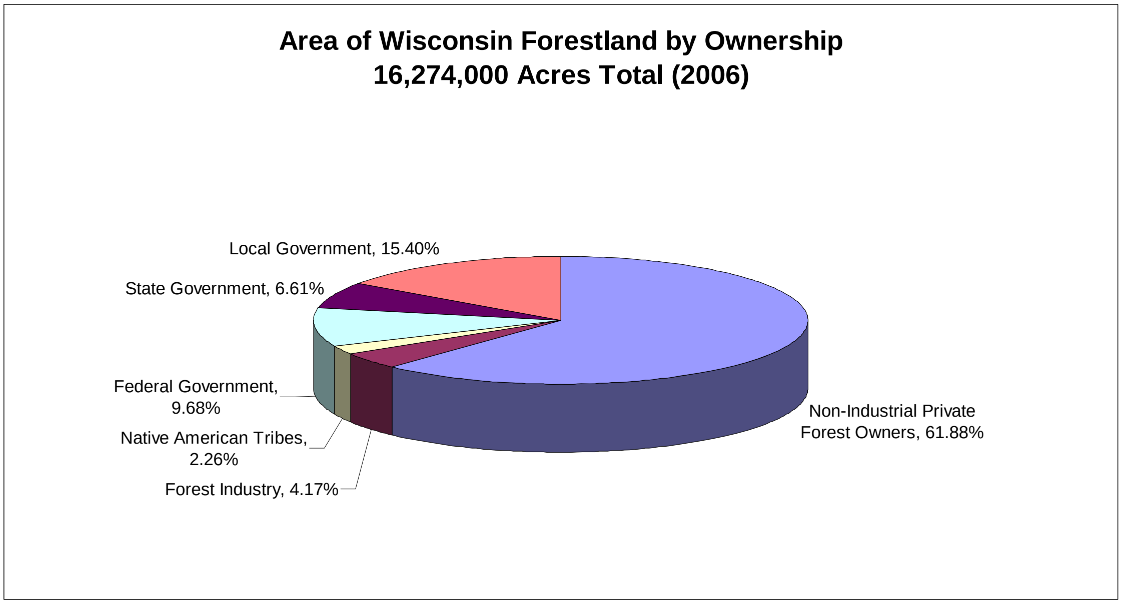


Figure 16.c: 2006 Area of Wisconsin forest land by ownership (Butler, 2008)

As described in section 16.1, more people are engaging in woodland ownership. Total NIPF acreage rose 14.23% and forest industry ownership fell 51.50% during the 38 year span shown in Figure 16.d.

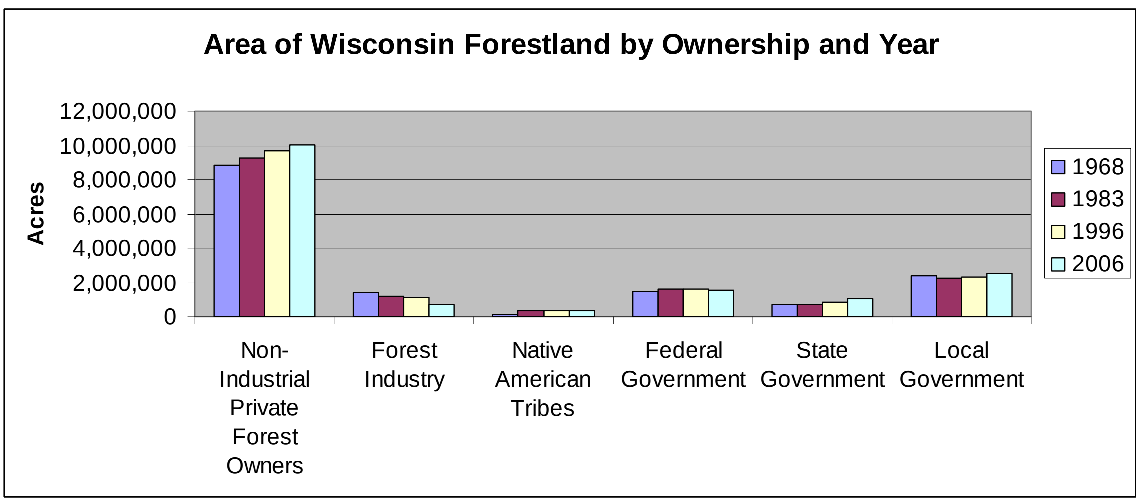
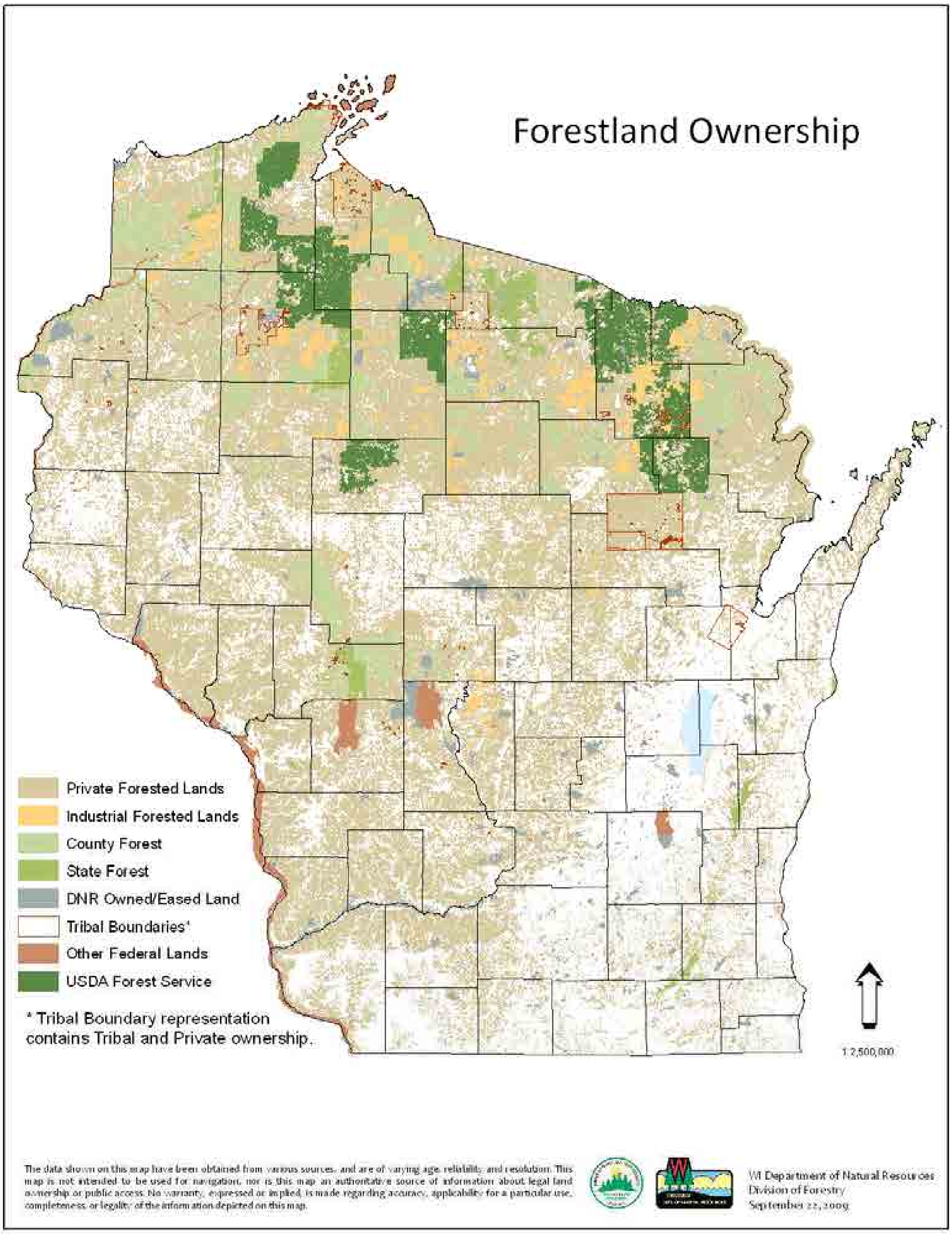


Figure 16.d: Area of Wisconsin forest land by ownership by year (Butler, 2008) (Schmidt, 1996) (Spencer 1983) (Spencer 1972) – Sampling error may account for minor variation.

The continuing evolution of private forest holdings is revealed in 1997-2006 figures. The number of private landowners jumped from an estimated 263,000 in 1997 to 362,000 in 2006, a 37.64% increase. The average NIPF parcel shrank from 37 acres in 1997 to 28 acres in 2006. The number of small parcels less than 50 acres grew – parcels in the smallest 1-9 acre category nearly doubled – and area in ownership categories over 100 acres dropped.

Table 16.a: Area of private forest land in Wisconsin by ownership size 1997-2006 (FIA, NWOS, 2007)

Size Class of Owners	**Owners *(thousands)***				**Acres *(thousands)***		
	1997	**2006**	**% Change**		**1997**	**2006**	**% Change**
1-9	92	176	91.30%		339	529	56.05%
10-19	40	46	15.00%		518	575	11.00%
20-49	69	77	11.59%		2,157	2,204	2.18%
50-99	37	36	-2.70%		2,290	2,411	5.28%
100-199	17	19	11.76%		2,111	1,996	-5.45%
200-499	7	7	0.00%		1,569	1,496	-4.65%
500-999	1	1	0.00%		435	423	-2.76%
1,000-4,999	<1	<1	0.00%		316	304	-3.80%
5,000+	<1	<1	0.00%		1,077	810	-24.79%
Total	263	362	37.64%		10,812	10,749	-0.59%



Map 16.c: Forest land ownership
(Source: WDNR, Division of Forestry, 2009)

The status of Wisconsin large-owner industrial forest land has been turbulent. Vertically-integrated forest products companies have been divesting their timberland assets throughout the U.S. Companies actions have been prompted by a perception that industrial forest holdings are undervalued and by paper and other forest products manufacturing restructuring due to global competition. Their theory was that they could take undervalued land, convert it to cash, and continue to produce paper and other products through long-term wood supply contracts with the new land owners (Hagan, 2005). That the wood supply chain will hold up over time may be a tenuous assumption as more of the land is spun off by investors to small—often recreational or residential—ownerships.

In Wisconsin, about one million acres of industrial forest blocks changed ownership not just once but multiple times in the last decade. Nearly all industrial forest land is enrolled in the state forest tax law programs, facilitating tracking ownership changes as shown in Figure 16.h. The portion of land owned by forest products companies fell from 62% in 2002 to 24% in 2008 after transfer primarily to Real Estate Investment Trusts. An additional 210,084 acres of industrial forest land were sold to a host of small ownerships and public agencies between 1999 and 2008.

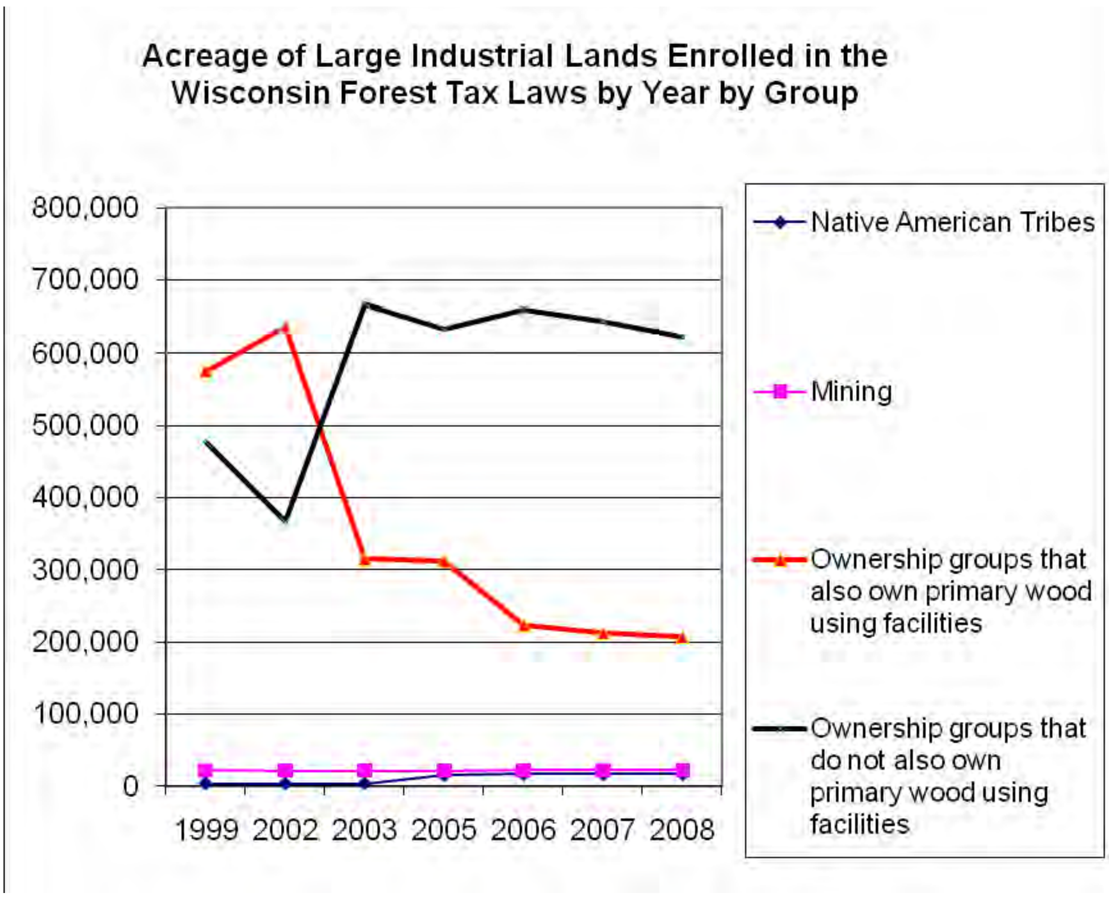


Figure 16.e: Large industrial forest ownerships by category, 1999-2007
(Source: WDNR, Division of Forestry, 2009)

In addition to negative impacts from parcelization noted elsewhere in this assessment, Hagan (2005) observes the following issues that have been experienced in Wisconsin:

- The development pressure in shoreland areas along lakes and streams grew dramatically and appears to be facilitated by landowner type change.
- Many of the new owner types (e.g., financial investors, timber brokers, individuals or families) do not participate in social discourse on sustainable forestry, such as forest certification.
- When timberland changes ownership, new owners may incur a debt burden from the land purchase that can lead to aggressive timber harvesting.
- Investment in silviculture and biodiversity research has been declining since many of the new landowners do not view research as a social responsibility associated with owning timberland, or they simply cannot afford to contribute to research.

Another implication of the growing number of NIPF owners is the need for technical forestry assistance, landowner education, and incentive programs to encourage new landowners to engage in responsible forestry. The DNR conducted private forestry assistance program reviews in 1999 and 2004 that resulted in constructive initiatives. Considering the ongoing change in land ownership and the emergence of new issues, an updated private forestry assistance review and a high-level Legislative Council study on the Managed Forest Law were recommended by the Council on Forestry in February 2010.

16.3 All public lands

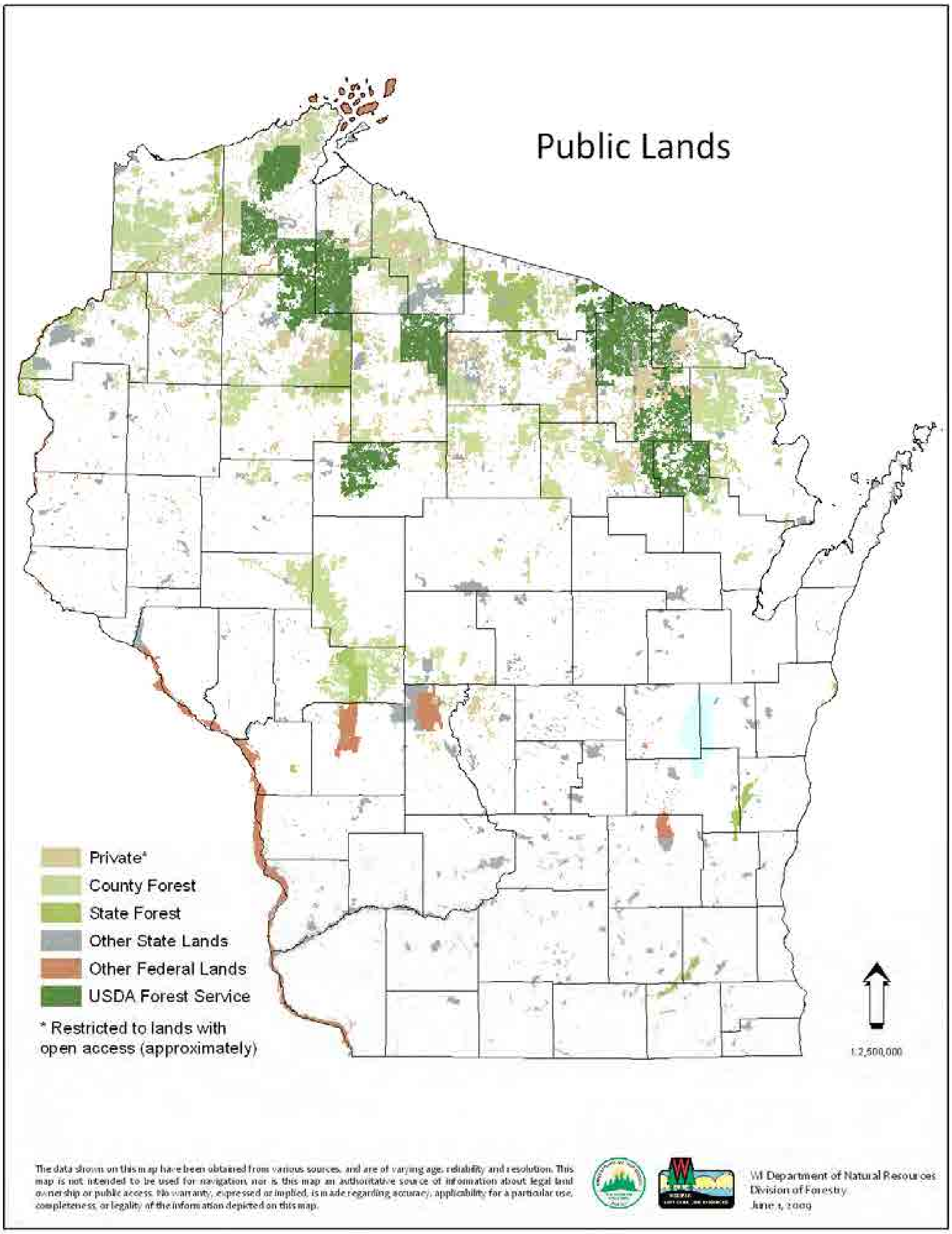
Public forest lands are generally undeveloped, and uses in Wisconsin are mostly limited to activities such as outdoor recreation, watershed protection, growing renewable forest crops, habitat management. Public lands also play a critical role in preserving biodiversity, cultural history and other non-commercial values.

Estimates from the 2006 National Woodland Owner Survey presented in section 16.2 show approximately 5,157,000 acres of public forest land, 32% of the state’s total forest area (Butler, 2008). Data based on DNR land records and other sources in Table 16.b list 6,627,415 acres of all public land in 2009. The DNR data includes grasslands, wetlands, crop fields and other property in addition to forests. Of the local government land in the table, 2,361,944 acres are located in 29 County Forests. The federal land includes 1,529,204 acres in the Chequamegon-Nicolet National Forest. Other federal land in Wisconsin is owned by the Department of Defense, the U.S. Fish and Wildlife Service, Army Corps of Engineers and the U.S. Park Service. DNR land is detailed by management program in Appendix F, Table F.3. The Board of Commissioners of Public Lands (BCPL) holdings are mainly scattered across Oneida, Forest, Price, Vilas, Iron, Lincoln, Langlade, Florence and Marinette counties. All public land is mapped by ownership in Map 16.d.

Table 16.b: Public land ownership in Wisconsin (See detail in the Appendix at end of this document)

Landowner	Acres	Percent of Land Area
Local Govt.	2,594,625	7.46%
Federal	2,335,000	6.72%
DNR	1,622,390	4.67%
BCPL	75,400	0.22%
Total	6,627,415	19.07%
State Land Area	34,758,500	

(Source: DNR, 2009)



Map 16.d: All Wisconsin public land
Source: DNR, Division of Forestry, 2009

The most important source of funding for new public land and conservation easement purchases in Wisconsin is the Warren Knowles – Gaylord Nelson Stewardship Program. The Stewardship Program was first authorized in 1989. Under the program, DNR acquires land and provides grants to local units of government and non-profit organizations for land acquisition and property development activities. The program was most recently reauthorized as part of the 2007-2009 State Budget for a ten-year period beginning with fiscal year 2010-11 and ending fiscal year 2019-20. The annual bonding authority was increased from $60 million to $86 million for this additional 10-year period (Rushmer, 2009).

As shown in Table 16.c, DNR purchased almost a half million acres of conservation land since the Stewardship Program started in fiscal year 1990. Continuing the Stewardship Program for an additional ten years provides for great stability in land protection by the DNR, local governments, land trusts, and many conservation partners. Knowing the program will continue to 2020 allows for long-range planning and patient negotiations with landowners to be successful. It will also allow the DNR and its partners to be ready and capable of taking advantage of matching federal funding sources as they become available in future years.

Table 16.c: Knowles-Nelson Stewardship Program Purchases 1990-2008

DNR Program	**Cumulative Total Acres Since 1990**
Fisheries	39,508.84
Northern Forests	128,966.67
Parks	30,412.53
Natural Area	56,076.31
Southern Forests	5,564.97
Wildlife	92,148.53
Wild Rivers	99,965.28
Other	5,319.73
Total Acres	457,962.86

Source: DNR, 2009

While the number of acres of public land has grown, an often overlooked corollary is that budgets for land management have shrunk. Figure 16.f shows the cumulative acreage purchased under the Stewardship program between fiscal years 1990 and 2007. It also shows how the fiscal resources (wages for Limited Term Employees and operations funds) available within the DNR Land Division for property management changed during that time, on a per-acre basis. Division of Land funding dropped from about $60 per acre to just over $30 per acre in that time period. The chart does not reflect mandatory state budget reductions that were made in 2008 and 2009 in response to the economic recession, and so DNR resources to manage land continue to fall. As captured in forest certification reports, the state is struggling to complete property management master plans, collect biotic data, maintain roads and infrastructure, control invasive species and address other critical public land management duties.

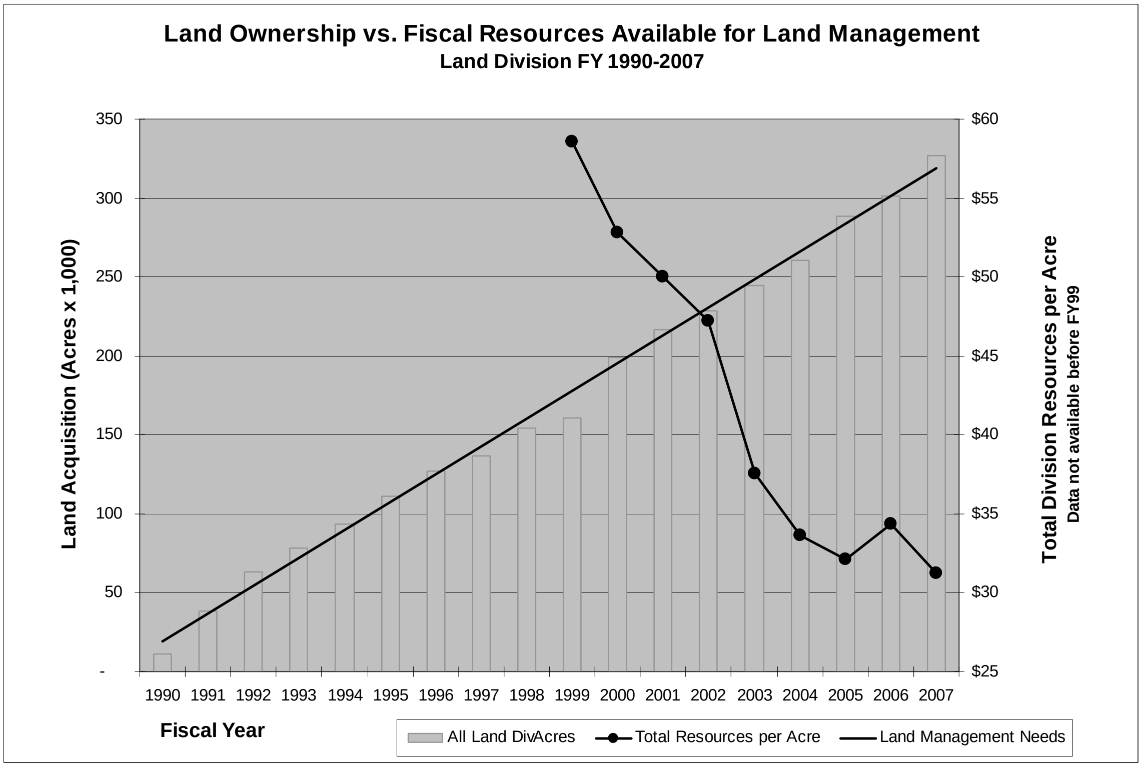


Figure 16.f: DNR land acquisition and resources available
(Source: DNR Division of Land Budget Proposal - 2009-11 Biennium, June 6, 2008)

16.4 Protected lands

The definition of "protected" forest land is subject to debate. One generally accepted approach was initially developed by the USGS Wisconsin GAP Analysis Program and currently administered by the PADUS Project is the Protected Areas Database. The database was developed as a geographic information system (GIS) dataset that represents protected areas in the coterminous United States, Alaska, and Canada, and their associated protection levels presented as Gap Analysis Program (GAP) codes. It includes land holdings that have a protection level of GAP 1, 2, 3 or 4 (see definitions below).

Gap 1. An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference, or are mimicked through management. Examples: National Parks, State Natural Areas, National Forest areas withdrawn from timber production, Wild Rivers, Nature Conservancy owned lands, National Wildlife Refuges away from the Mississippi River.

Gap 2. An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance. Examples: State Parks, State Trails, National Wildlife Refuges and associated easements along the Mississippi River, National Park Service Scenic Easements, US Army Corps of Engineers Wildlife

Management Areas, State-managed Fisheries Areas, State-managed Wildlife Management Areas, and Nature Conservancy conservation easements,

Gap 3. An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging) or localized, intense type (e.g., mining). It also confers protection to federally listed endangered and threatened species throughout the area. Examples: National Forests, State Forests, County Forests, military reservations, state and federal right-of-way and scenic easements, US Army Corps of Engineers recreation areas, National Wildlife Refuge recreation areas, DNR tree nurseries, state and federal fish hatcheries,

Gap 4. There are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout. Examples: Native American Lands, state-owned tower sites, ranger stations, right-of-way easements on private property, US Army Corps of Engineers easements, National Wildlife Refuge operations areas, DNR headquarters, statewide non-point easement program lands, and state-owned gift lands.

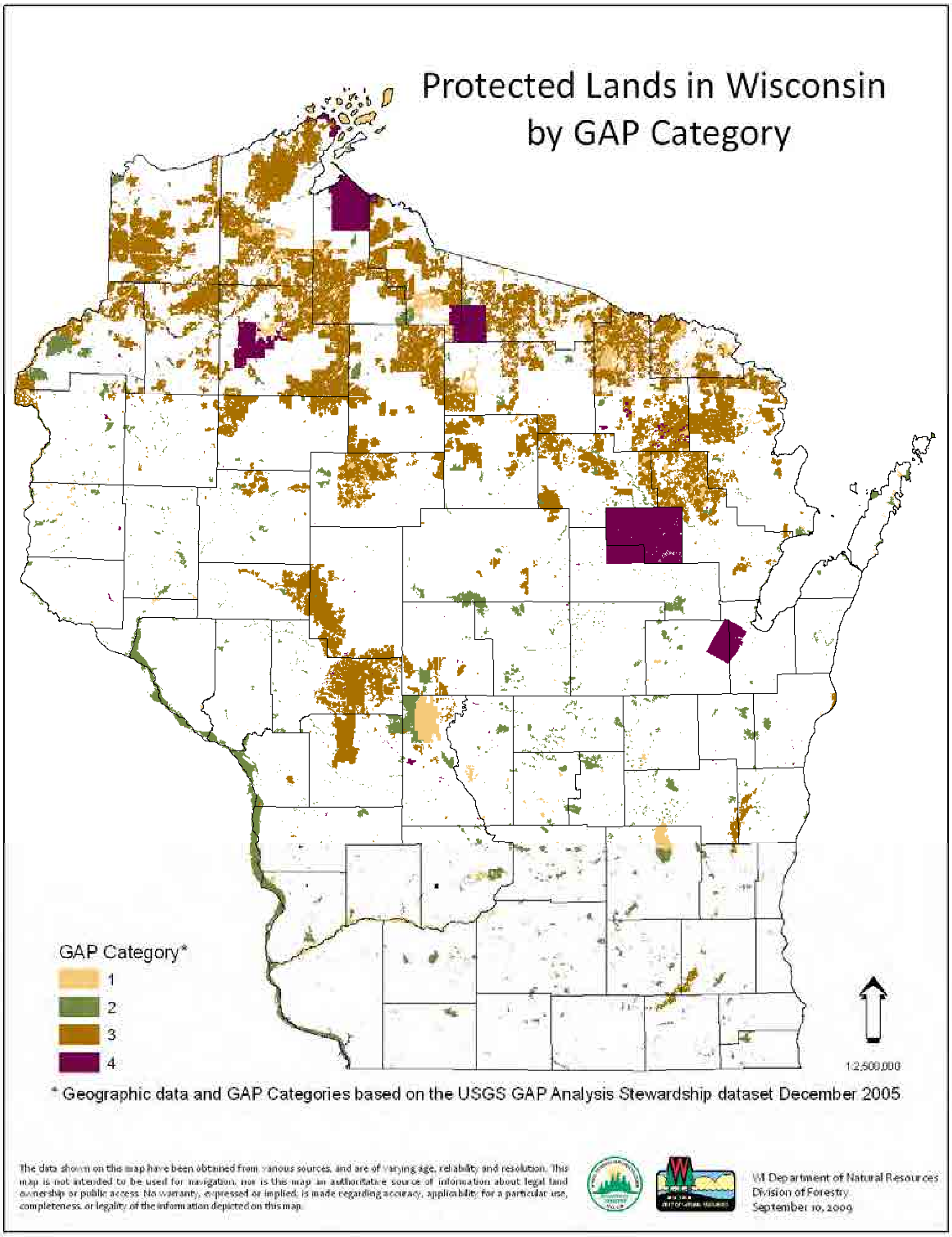
Unfortunately, the most current Protected Areas Database, PADUS version 1 created in 2009, and its predecessor, Protected Areas Database version 4, are relatively poor representations of protected lands in Wisconsin, so the USGS Wisconsin Stewardship GAP Dataset (2005) is typically used. This dataset, created in 2005, identifies a GAP code for each polygon in the dataset. Geographic data depicting protected areas is useful in helping natural resource managers assess which habitat types, species, etc. are adequately protected in existing reserve networks, and in identifying where gaps in protection exist. The USGS Wisconsin Stewardship GAP Dataset emphasizes federal and state owned areas and includes county, city, and private reserves when data are available. Some protected lands in Wisconsin such as Forest Legacy Easement lands, the Kickapoo Valley Reserve, some State Natural Areas, lands of the Board of Commissioners of Public Lands, county parks, city natural areas, and any lands protected after December 2005 are missing from this dataset. A map showing USGS Wisconsin Stewardship GAP lands is presented in Map 16.e.

Table 16.d: Wisconsin Protected Lands - GAP Area

GAP Category	Acres
GAP 1	649,196
GAP 2	981,001
GAP 3	4,148,706
GAP 4	680,899

(USGS, 2005)

GIS data for protected lands in Wisconsin is incomplete and requires regular updates as new lands are acquired. The USGS Wisconsin Stewardship GAP dataset, pictured below, which was last updated in December, 2005, records 7,459,802 protected acres that are categorized as shown in table 16.d. Many of the individual datasets used to create the GAP composite data layer have been updated, but the composite GAP layer with categories have not been updated.



Map 16.e: Lands identified in the Wisconsin Stewardship GAP Dataset
Source: USGS, 2005

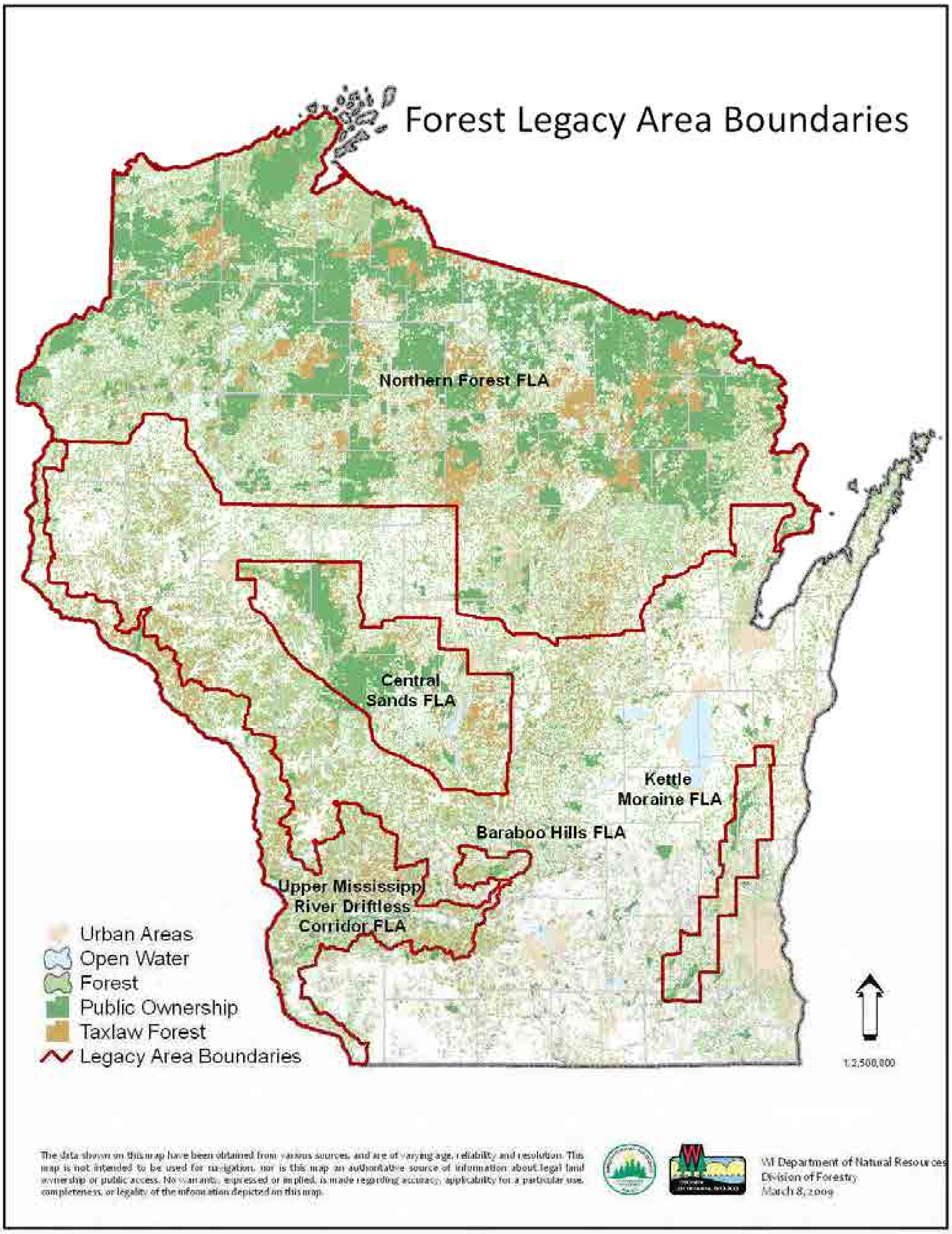
16.5 Private land with public and private conservation easements

A conservation easement is a voluntary legal agreement between a landowner and a government agency, a non-profit conservation organization or a land trust that permanently limits specified current and future uses. Such an easement could, for example, prevent livestock grazing in a stream corridor or building construction in woodland. The purpose is to help protect water quality, wildlife habitat and other natural resources. As with other easements, landowners still retain ownership and many uses of their property such as agriculture, hunting and fishing.

Conservation easements specify geographical boundaries of the agreement, and the legal document is recorded at the Register of Deeds Office. Easement rights "run with the land" which means the holder of an easement retains the easement rights even if the landowner sells the property. Any new landowner must abide by the easement.

There are a number of conservation easement programs administered by governmental agencies in Wisconsin. The DNR purchases conservation easements or provides grants to local governments for easements through four programs defined in Section 700.40 of the Wisconsin Statutes. They are targeted primarily at farming-related water quality concerns but may involve forest lands. The U.S. Department of Agriculture purchases easements under the Conservation Reserve Enhancement Program. The federal Natural Resources Conservation Service administers the Wetland Reserve Program, which includes options for permanent and 30-year easements to improve and protect private wetlands.

As part of the 1990 Farm Bill, Congress created the Forest Legacy Program (FLP) to identify and protect environmentally important private forest lands threatened with conversion to non-forest uses such as subdivision for residential or commercial development. To help maintain the integrity and traditional uses of private forest-lands, the Forest Legacy Program promotes the use of conservation easements.



Map 16.f: Wisconsin Forest Legacy Areas
Source: WDNR, 2010

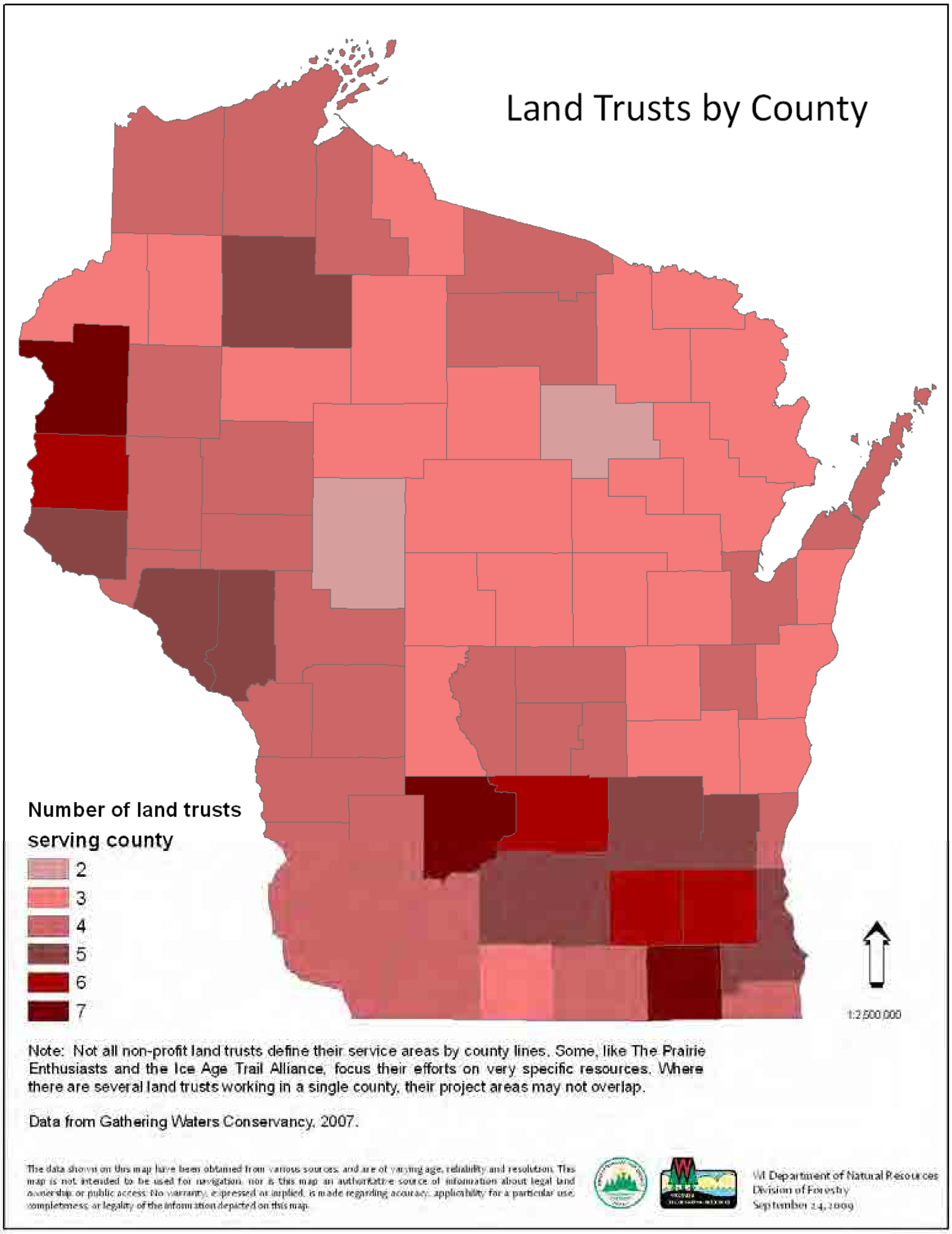
The Wisconsin FLP program is administered by the DNR Division of Forestry. For a complete description of the program and how it is administered, please see the Statewide Forest Strategy. 75% of funding for easements comes through federal grants, and the Wisconsin Knowles-Nelson Stewardship Program generally fulfills the 25% state cost-sharing requirement. With minor exceptions, state FLP properties allow public access. FLP also requires annual DNR monitoring to assure that landowners abide by the terms of the easements. As of 2009, five FLP projects identified in Table 16.e have been funded. Two properties totaling 35,377 acres were protected with conservation easements valued at $13,251,000 using $5,000,000 in Forest Legacy funds. $6.4 million in Forest Legacy Funding for three additional projects totaling over 17,000 acres had a cost share component of over $12.5 million in State, local, and donated funds. (USDA Forest Service, 2004, A Forest Legacy Success Story)

Table 16.e: Wisconsin Forest Legacy Program Easements - 2009

Project	**Acres**
Baraboo Hills	924.65
Holy Hill (Kettle Moraine FLA)	198.64
Tomahawk Timberlands (Northern Forest FLA)	36,883.30
Wolf River (Northern Forest FLA)	18,511.00
Wild Rivers (Northern Forest FLA)	7,260.00
TOTAL FLP ACRES	**56,517.59**

Source: WDNR, 2009

Governmental agencies like the DNR would lose many purchase and easement opportunities without private non-profit conservation organizations to help. Gathering Waters Conservancy is a service center for more than 50 active land trusts that collectively protect and manage an estimated 200,000 acres with significant ecological, scenic, recreational, agricultural, and historic value. The Nature Conservancy was instrumental in protecting more than 141,600 acres in Wisconsin. Considering that such private efforts can dwarf governmental conservation easement programs, continued efforts to build such public-private partnerships are essential to achieve land conservation goals. Not all non-profit land trusts define their service area by county lines. Some, like The Prairie Enthusiasts and the Ice Age Trail Alliance, focus their efforts on very specific resources. Where there are several land trusts working in a single county, their project areas may not overlap.

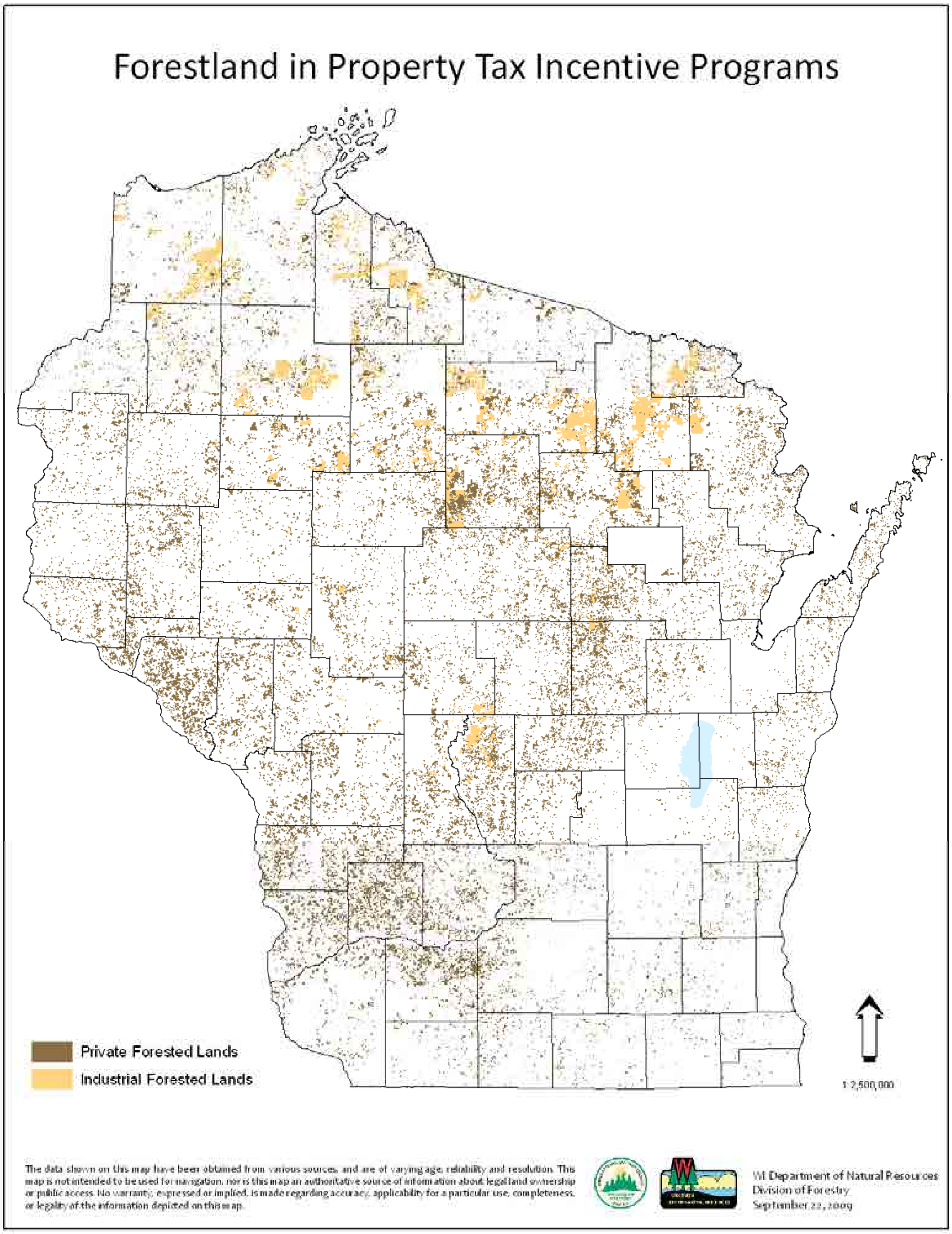


Map 16.g: Land trusts by county
Source: Gathering Waters Conservancy, 2007

Surveys conducted by Gathering Waters indicate that property tax policy changes might be needed for conservation easements to be more effective. Current Wisconsin real-estate assessment rules for tax assessors only require that they “consider” the presence of conservation easements when they establish a parcel’s assessed value. Since most assessors do not know how to interpret the impact of an easement on the residual land value, conservation easements have been little help in lowering taxes. Other states have developed clearer assessment rules with formulas based on proximity to urban areas and other factors in an effort to encourage use of conservation easements to promote related public benefits.

16.6 Forest land in property tax incentive programs

Rising forest land values, discussed in section 16.1, have an impact on all forest owners whether or not they have recently bought or sold land. The effects of higher values are experienced through property tax changes. For good or bad, property taxes have a profound influence on land management decisions people make, e.g. whether to plan for future generations or exploit timber for a quick return; whether to keep forest land as a family legacy or sell all or part of it.



Map 16.h: Forest land in property tax incentive programs
Source: DNR, 2009

Table 16.f shows Wisconsin forest land property taxes since 1965, the annualized compound rate of tax change for five-year or one-year intervals, and the U.S. annualized inflation rate during the same period. For example, average forest land property taxes between 1995 and 2000 increased at a 10.70% annual compound rate, while inflation was only 2.47% annually. When forest land property taxes increase at a significantly faster rate than inflation, landowners tend to look for relief.

Table 16.f: Average Property Tax on Wisconsin Forest land, 1970 - 2007

Year	Average Property Tax per Acre of Taxable Forest Land	Forest land Property Tax Annualized Compound Rate of Change for Interval	U.S. Inflation Rate for Interval
1965	$0.56		
1970	$0.87	9.21%	6.82%
1975	$1.42	10.29%	8.85%
1980	$3.31	18.44%	8.87%
1985	$5.90	12.25%	5.51%
1990	$6.87	3.09%	3.94%
1995	$7.76	2.47%	3.13%
2000	$12.90	10.70%	2.47%
2001	$15.73	21.94%	2.83%
2002	$17.96	14.18%	1.59%
2003	$20.65	14.98%	2.27%
2004	$23.26	12.64%	2.68%
2005	$23.53	1.16%	3.39%
2006	$24.82	5.48%	3.24%
2007	$27.33	10.11%	2.85%

(Source: WI DOR calculated tax rates.) This table reflects reductions associated with Wisconsin forest tax law incentives and, since 2005, Agricultural Forests classification.

Many landowners reacted to the differential between forest land tax changes relative to other costs over the last ten years. Some who owned woodland in conjunction with farms sought to take advantage of newly implemented Agricultural Use Value Assessment rules through conversion of woodland to pasture or cropland, by letting livestock graze woods or by clearing trees. Taking such action, though destructive to forests, could reduce a farm woodlot's taxes by an average 84% compared to non-agricultural classed land (Boldt, 2002).

Concern about the unintended consequences of forest land conversion on farms led to the enactment of Agricultural Forest classification in 2004. It provides tax relief to landowners of woodlands adjacent to agricultural lands. For lands in Agricultural Forest, property taxes are reduced to 50% of their value compared to forest land under general assessment. An estimated 1.4 million acres of woodland associated with farms in Wisconsin receive this benefit without any additional requirement to follow a forest management plan. The Department of Revenue estimates that farmers own about another 700,000 acres of woodland that is enrolled in the Managed Forest Law (MFL) program, which does mandate planning (Pingrey, 2005).

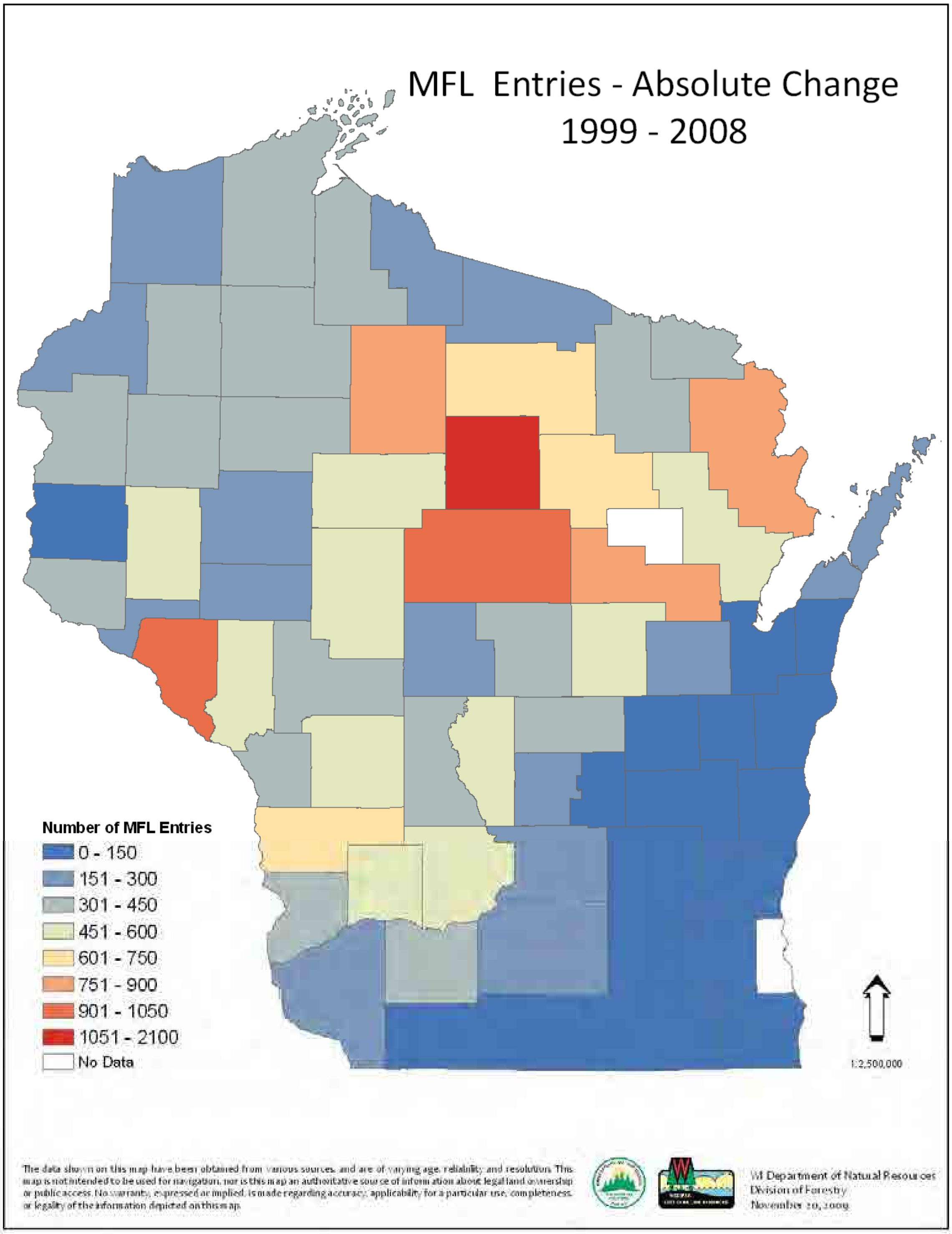
The impact of general property taxes on forests may actually be greater than that shown in Table 16.f. The average taxes for forest lands in the table include property enrolled in forest tax law programs and, since 2004, Agricultural Forest classification. Department of Revenue figures for 2007, for example, show an average forest tax of $27.33 per acre including forest tax law lands and Agricultural Forests. The average rate for forest land under general taxes, however, was $32.00 per acre. That higher value is calculated as the statewide average equalized value per assessed acre of taxable forest land multiplied by the net statewide tax rate for 2007. Further, the apparent slowing of tax increases in 2005 with a small 1.16% increase is due to the introduction of Agricultural Forests, but those benefits were not enjoyed by owners of non-farm forest land. The Agricultural Forest effect begins to fade soon after 2005 as farmers' assessments are adjusted and the new provision is maxed out.

Other landowners with rising property taxes turned to the Managed Forest Law. MFL participation provides up to a 95% reduction in property taxes. Table 16.g shows that MFL acreage for all landowner categories rose 58.94% between 1999 and 2009. The number of MFL entry orders jumped 109.31% – more than doubling in ten years. For non-industrial private forest land (NIPF) owners, both the number of participants and the acreage enrolled more than doubled (112.98% and 115.78%, respectively), with a significantly higher relative amount going into the program as closed to public access. The increase in MFL enrollments was not, however, uniform across the state. Some areas experienced two to three times the average increase in new MFL properties as shown in Map 16.i.

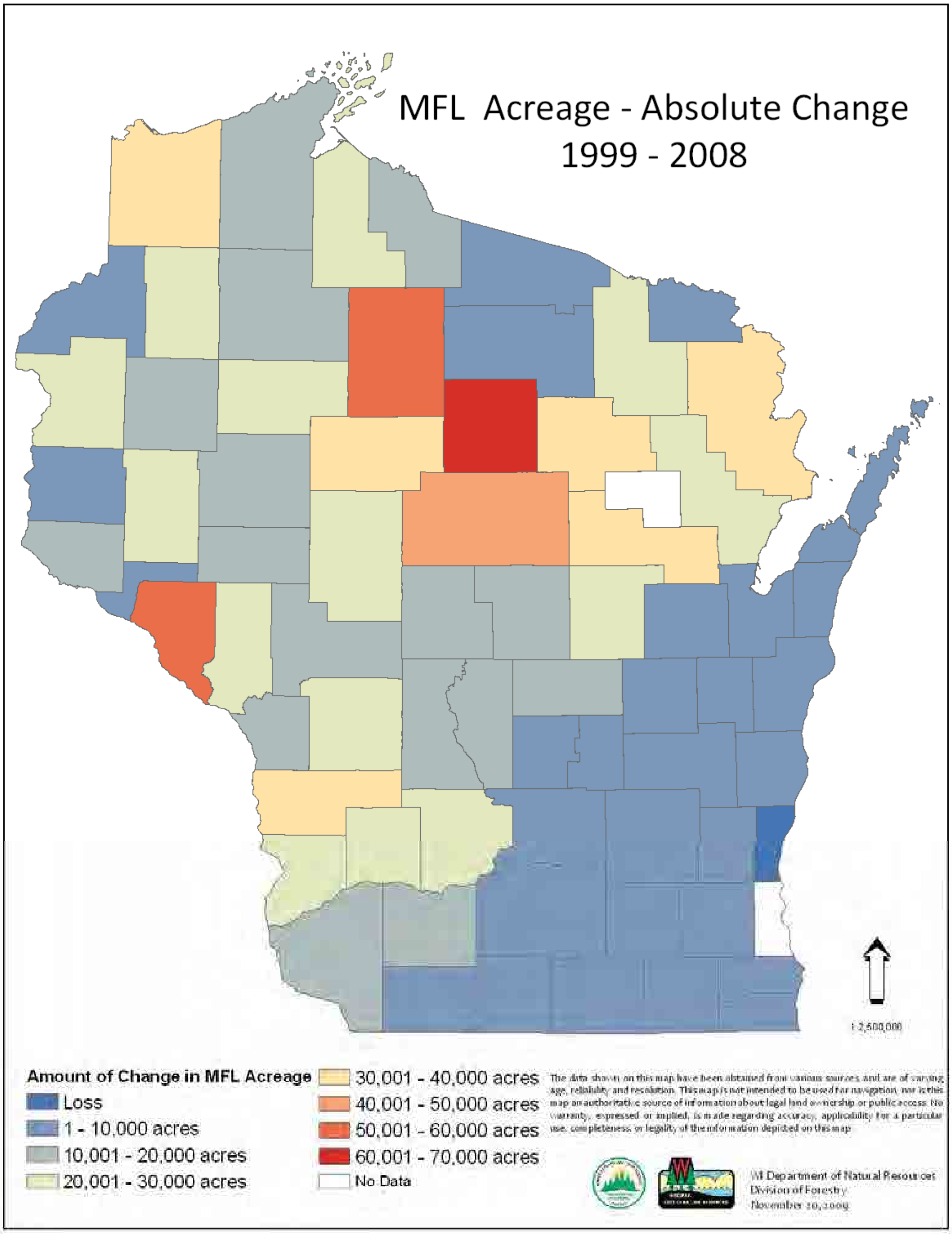
Table 16.g: Managed Forest Law Participation Changes 1999-2009

		1999	2009	Change 1999-2009	% Change 1999-2009
Non-Industrial Private Forest (NIPF) Owners	**Number of Orders**	20,002.00	42,601.00	22,599.00	112.98%
	Open Acres	316,714.65	417,700.11	100,985.46	31.89%
	Closed Acres	737,424.41	1,856,937.40	1,119,512.99	151.81%
	Total Acres	1,054,139.06	2,274,637.51	1,220,498.45	115.78%
Industrial Landowners	**Number of Orders**	1,044.00	1,451.00	407.00	38.98%
	Open Acres	853,784.33	738,263.84	-115,520.49	-13.53%
	Closed Acres	4,439.43	26,572.42	22,132.99	498.55%
	Total Acres	858,223.76	764,836.26	-93,387.50	-10.88%
All Landowners	**Number of Orders**	21,046.00	44,052.00	23,006.00	109.31%
	Open Acres	1,170,498.98	1,155,963.95	-14,535.03	-1.24%
	Closed Acres	741,863.84	1,883,509.83	1,141,645.99	153.89%
	Total Acres	1,912,362.82	3,039,473.77	1,127,110.95	58.94%

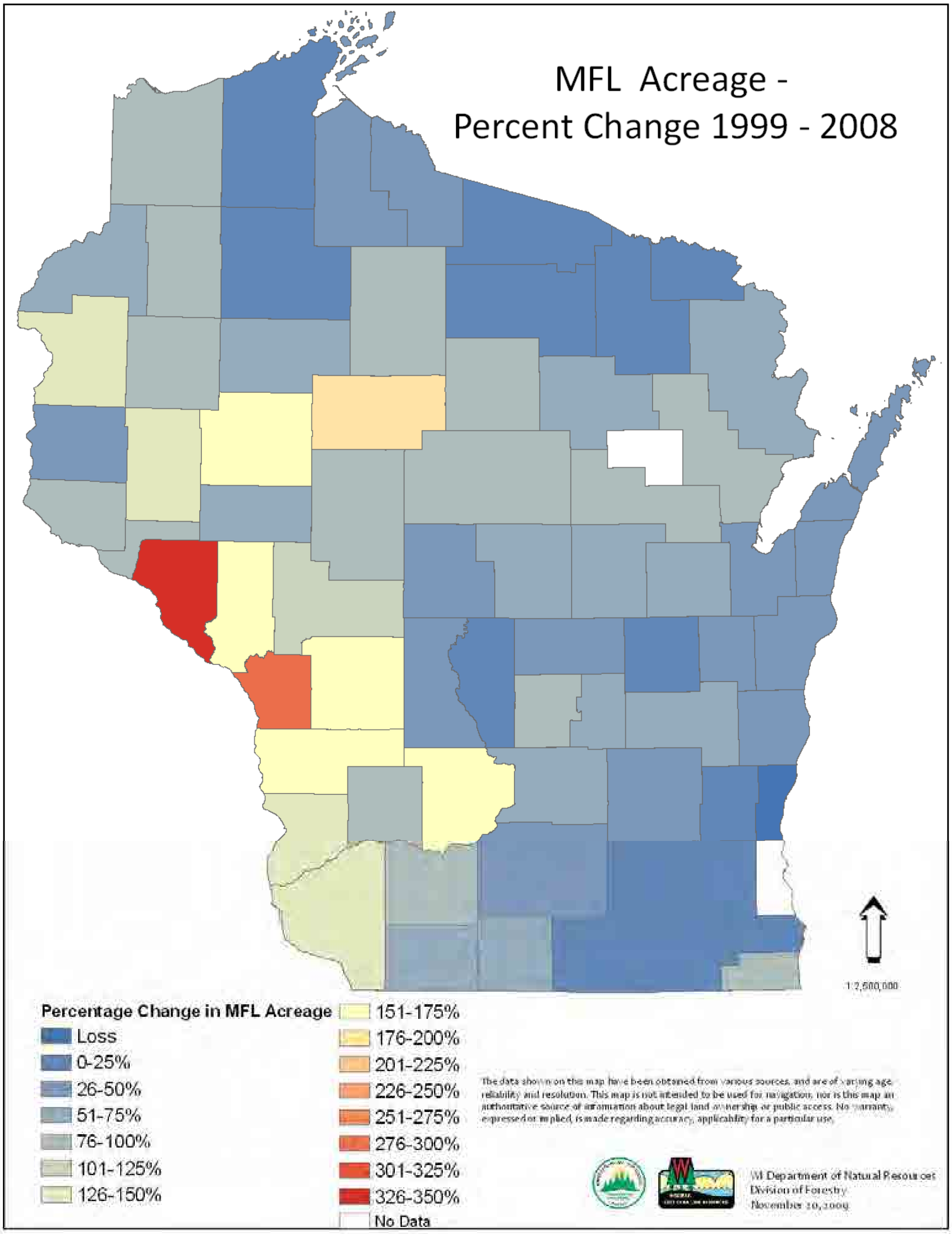
Source: WDNR, 2009



Map 16.i: MFL entries - absolute change, 1999-2008
(Source: DNR, 2009. Map based on single data points centered in each county.)



Map 16.j: MFL acreage - absolute change, 1999-2008
(Source: DNR, 2009. Map based on single data points centered in each county.)



Map 16.k: MFL acreage - percentage change, 1999-2008
(Source: DNR, 2009. Map based on single data points centered in each county.)

Land enrolled in the Forest Crop Law (FCL) program continues to decline as older contracts expire. FCL signups ended in 1986, but the last of the FCL orders will be active until 2035. In 1999, there were 520,000 acres in FCL. By 2009 the area had dropped to 229,184 acres with about 1,800 entry orders split 55% NIPF and 45% industrial ownership. All FCL land is open to public access.

One of the primary concerns for townships and counties is how the number of forest tax entries affect property taxes others must pay. Prior to 2004, new MFL enrollments had small effect on most other property tax payers because the state shared revenue formula generally compensated local governments for any loss in tax revenue. State revenue sharing for each county and municipalities was frozen at its respective 2003 level, for 2004 and beyond. Shared revenues have been replaced by county and municipal aids. For most tax districts the impact of MFL land is still relatively low. Research indicates that a 20% increase in MFL enrollment would raise taxes, on average about $1.90 on other property assessed at $100,000. Some townships with a large amount of land in the Agricultural Forest category and a lower per-capita tax base might, however, be especially vulnerable to greater impacts. (Rickenbach and Saunders, 2009)

The rapidly rising popularity of MFL since 1999 worried state legislators. They saw DNR struggling with the workload associated with the steep increase in applications. Towns perceived looming tax impacts (real or not) on other taxpayers. Some legislators were also upset with apparent manipulation of MFL provisions by a few landowners to close land to public access so they could lease it to private hunting clubs. The result of these and other concerns led to numerous MFL statute changes between the years 2000-2008. Additional details about Wisconsin's forest tax law programs, recent revisions and repercussions of policy changes are presented in section 19.2 of the Assessment.

16.7 Forest acres certified

Forest certification is a market-based mechanism giving assurance that forest products originate from responsibly-managed woodlands. Independent auditors review forest management programs to verify conformance to the chosen standards. The standard-setting bodies are themselves separate from land management operations and the audit process. The standards that are applied most often in Wisconsin include Forest Stewardship Council (FSC), Sustainable Forest Initiative (SFI) and American Tree Farm System (ATFS) forest certification.

Forest certification is important in enhancing Wisconsin's ability to market forest products, but it also promotes sustainability in a broader sense, not merely the ability of land to produce timber. Certification does not mandate timber cutting, but rather responsible management for any identified environmental, social or economic objective. About 44% of Wisconsin's forest is certified. Table 16.h shows the distribution of certified land among various standards in Wisconsin. Of the certified land, 55.70% is public land and 44.30% is private ownership.

Table 16.h: Wisconsin Forest Certified Acres

	Certification Standard				
	FSC Only	**Dual FSC/SFI**	**SFI Only**	**Dual ATFS/FSC**	**ATFS Only**
Wisconsin State Forests (DNR)		517,734			
DNR Lands (Parks, Wildlife Areas, Natural Areas, etc.)		1,023,453	57,225		
Wisconsin County Forests (DNR)	165,958	1,464,167	723,772		
Wisconsin Managed Forest Law Group (DNR)				2,239,205	
Forest Industry and Other Landowners	361,635	5,411	342,096		
Traditional (Non-MFL Group) Tree Farms					194,427
Total by Standard	**527,594**	**3,010,765**	**1,123,093**	**2,239,205**	**194,427**

Table 16.h.2: Total Wisconsin Forest Certified Acres

Total WI Certified Acres (All Standards - no double counting)	**7,095,083**
Percent of WI Forest land Certified (All Standards)	**43.60%**
FSC Certified Acres	**5,777,563**
SFI Certified Acres	**4,133,858**
ATFS Certified Acres	**2,433,632**

Source: DNR, January, 2009

The Lakes States are a "forest certification hub" relative to the rest of the nation (Fernholz, 2008). As shown in Table 16.i, about a third of U.S. certified land and 53% of FSC-US certified land are located in Minnesota, Wisconsin and Michigan. Assuming no overlap from land certified under more than one standard, 16.22% of U.S. forest land was certified in 2009. Considering dual certifications, the actual is likely closer to 12% of U.S. forests certified. (In Wisconsin, about 70% of the certified land is either dual FSC/SFI or FSC/Tree Farm certified.) Over 20 million acres have been certified in the three Lakes States in five years from 2004-2009. The percentage of each state's forest land certified as of June 2009: Minnesota 50%; Wisconsin 44%; Michigan 26%.

Table 16.i: U.S. and Lakes States Land Management Forest Certification

FSC [1]	**Acres**	**Certificates**
United States (June 2, 2009)	30,861,619	115
Minnesota	6,096,827	9
Michigan	4,570,027	3
Wisconsin	5,777,563	7
Lakes States	16,444,417	19
Percent of FSC Acreage in 3 Lakes States	53.28%	16.52%

SFI [2]	**Acres**	**Certificates**
United States (June 3, 2009)	61,921,042	181

Minnesota	6,960,652	9
Michigan	4,991,965	3
Wisconsin	4,133,858	5
Lakes States	16,086,475	17
Percent of SFI Acreage in 3 Lakes States	25.98%	9.39%

American Tree Farm System [3]	Acres	Parcels
United States (Approximate 7/16/2008)	29,000,000	73,000
Wisconsin (June 3, 2009)	2,433,632	41,865
Percent of U.S. Tree Farm Acreage in WI	8.39%	57.35%

United States – Percent Certified

US Forests - Acres	751,000,000
FSC Certified	4.11%
SFI Certified	8.25%
Tree Farm Certified	3.86%
Total (if no overlap from dual certifications)	16.22%

Sources: [1]FSC-US, [2]Metafore, [3]AFF

Interest in certification was initially spurred by demand from large paper companies seeking to remain competitive in global markets. The paper and printing sector has since been joined by a growing number of solid wood manufacturers that have established chain-of-custody certificates in order to market certified product lines (see Indicator 13.6). Many manufactures claim the most significant area of growth they have experienced is in the demand for certified forest products. Although no figures are available for the direct economic impact of the Lakes States' certification efforts, anecdotal evidence from manufacturers indicates that certification helped minimize the impacts of the global economic recession in 2009.

Public agencies involved in certification report other benefits. It improves program consistency, promotes public awareness and involvement, and corroborates the need for additional resources to manage land. Public agencies embrace certification as a voluntary tool to achieve statutory purposes.

If certification of Wisconsin forest land is to continue to grow, the greatest opportunities reside in National Forests (about 2.3 million acres) and the balance of small family forest owners who do not have MFL plans (about 6 million acres). Approximately 575,000 acres that are owned by 9,100 small landowners who have Forest Stewardship Plans but are not in the MFL program, may have potential for certification. At least some of the larger industrial owners with 764,836 acres who have not pursued certification on their own and who are not now included in the MFL Certified Group (which is restricted to "family forest" owners with less than 2,470 acres) may now have interest in joining a DNR-sponsored certified group.

17. Employment and wages in forest-related sectors

17.1 Wood-related products and manufacturing employees, payroll, and wages

Measuring the employment of wood products manufacturers is important in tracking the industry's socioeconomic benefit to state and local communities. Based on 2007 data, the forest products industry contributes about $3.1 billion per year in wages to the Wisconsin economy – about 13% of all manufacturing wages in the state. The forest products sector employed 68,846 people in 2007, and their average personal income was $44,438. That is 22.5% higher than the Wisconsin average per capita personal income of $36,272 in 2007. (Bureau of Labor Statistics & Census Bureau, 2009) (FRED®, 2009)

Forest products related employment adds significantly to Wisconsin's economic and social well-being, a fact state policy makers recognize and attempt to address. Unfortunately, market factors outside their control are at play. While the most recent data demonstrates the sector still holds a prominent position, it is in decline as indicated in Figure 17.a. The total forest products industry payroll has dropped 31.6% after adjustment for inflation since its peak in 1996. Figure 17.b shows that employment dropped by about the same amount (30.51%).

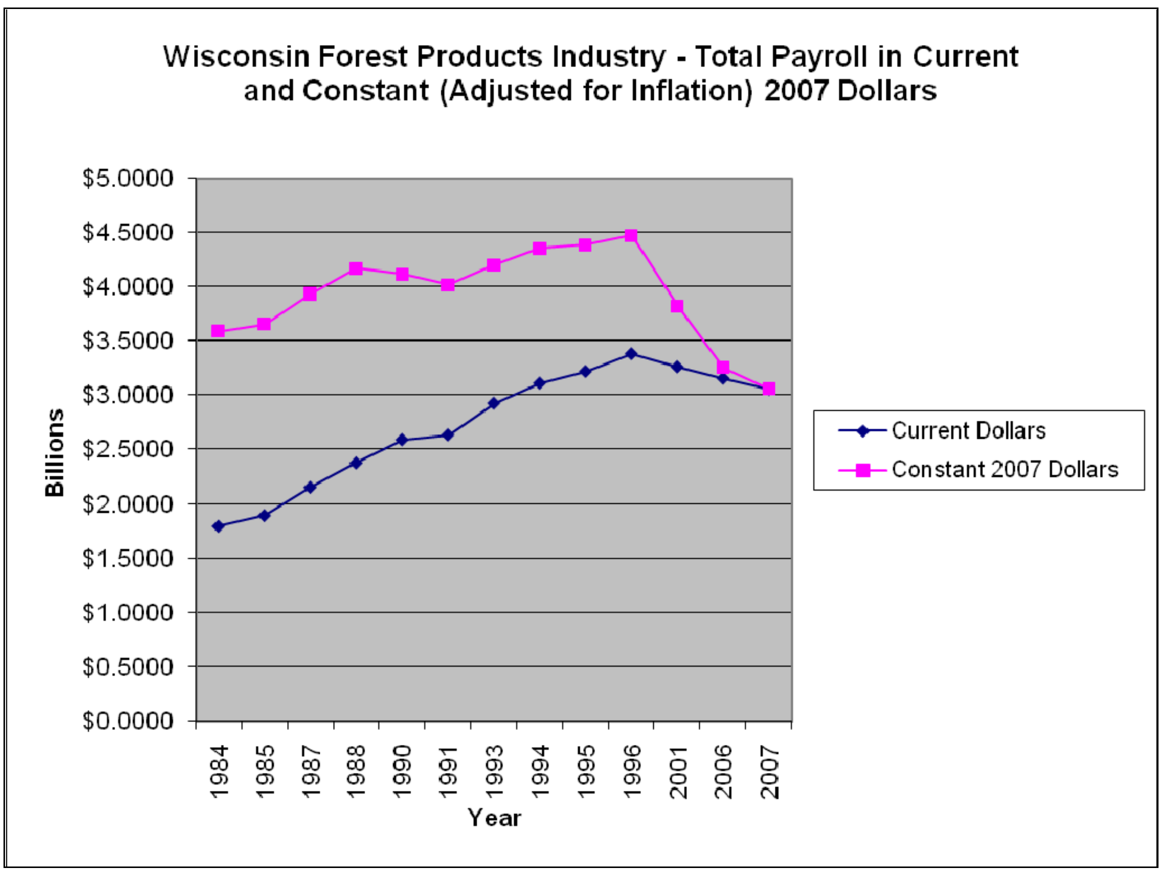


Figure 17.a: Wisconsin forest products industry – total payroll in current and constant (adjusted for inflation) 2007 dollars

Source: Wisconsin Occupational Employment Statistics (OES) Survey, 2009

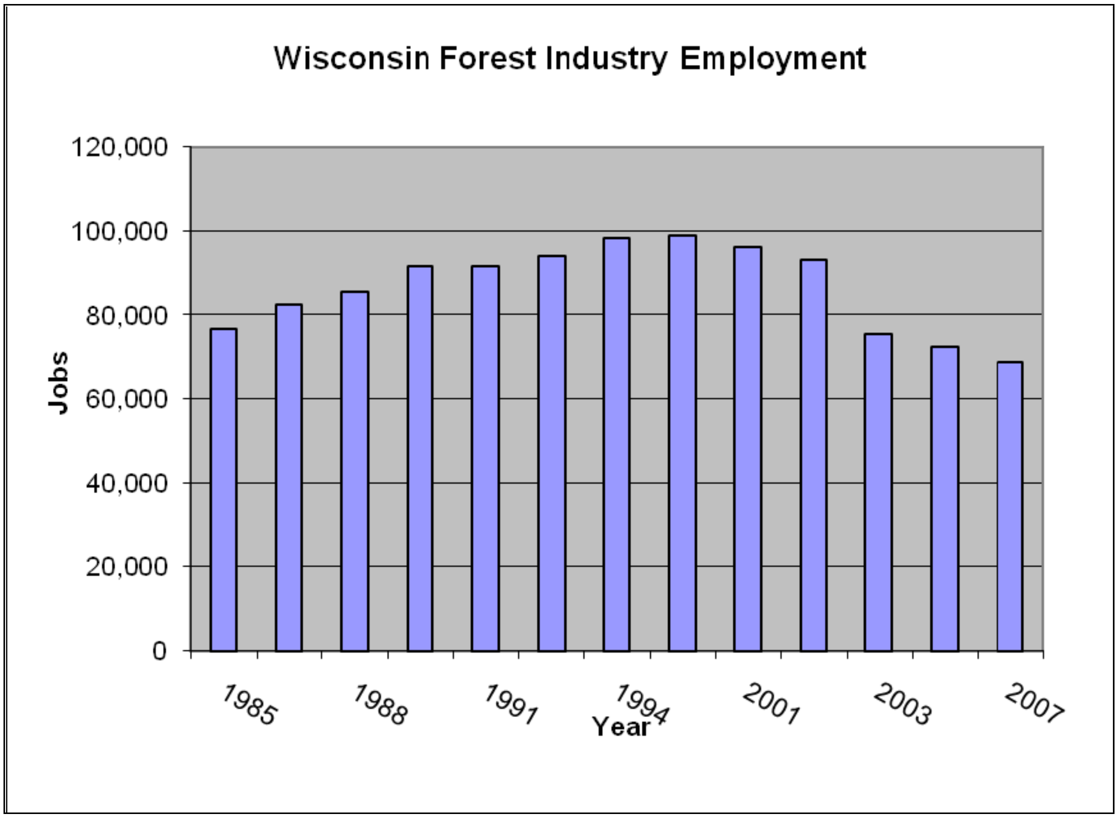


Figure 17.b: Wisconsin forest industry employment
Source: Wisconsin Occupational Employment Statistics (OES) Survey, 2009

The decline in Wisconsin manufacturing employment is not restricted, however, to the forest products sector. Data in Figure 17.c indicates that the wood product and paper industries are following a trend line similar to manufacturing in general. In 2003, the Wisconsin Paper Council observed the following factors driving changes in paper industry, but most also apply to other forest products manufacturers:

- The U.S. and global economies have been experiencing a slowdown that started in 2000.
- There has been a global supply-demand imbalance for paper since the mid-1990s. A shift to electronic media was a significant cause, and many local and regional newspapers have gone out of business.
- Foreign competition and outsourcing production to other countries is growing.
- U.S. manufacturers have been forced into consolidations (mergers and acquisitions), closure of less efficient mills and the implementation of new technology in an effort to trim costs, resulting in the loss of jobs.
- Market adjustments have restricted investment in new forest products manufacturing capacity.

The data presented in the preceding figures do not reflect additional cutbacks that occurred during the 2008-2009 recession. For example, paper manufacturers NewPage, Domtar and Wausau Papers announced mill closures in Kimberly, Wisconsin Rapids, Port Edwards and Appleton that will result in the loss of about 1,400 jobs in 2008-2009. Combined with the impact of a depressed housing market, many others in the forest products industry are affected as well.

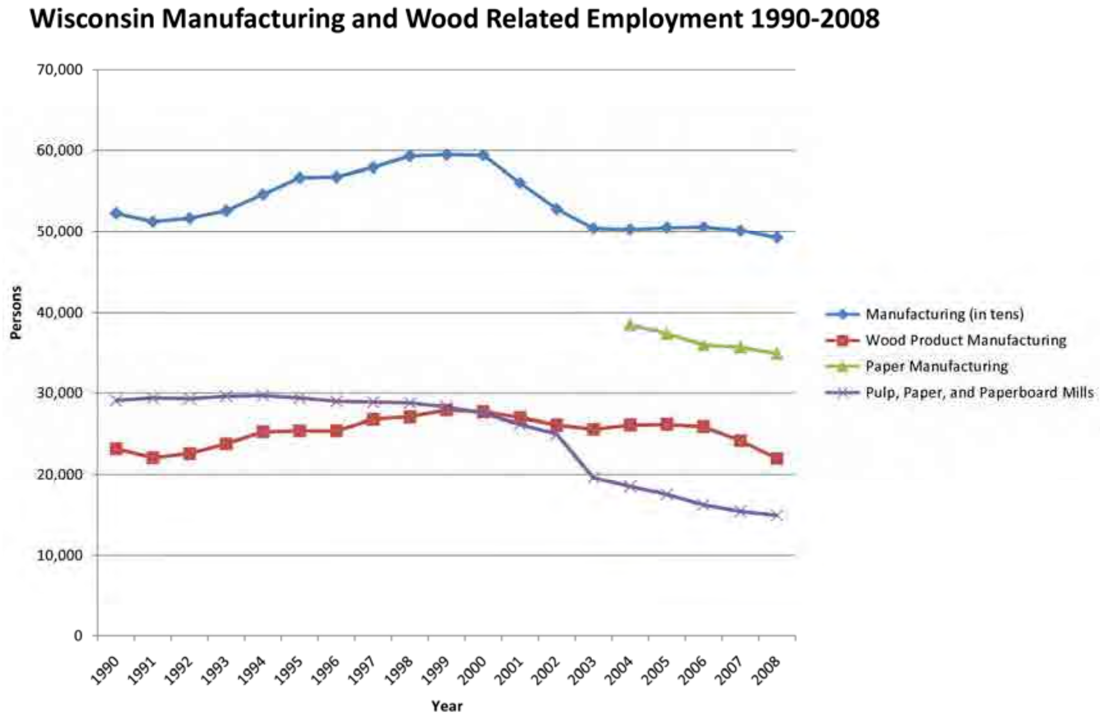


Figure 17.c: Wisconsin manufacturing and wood related employment 1990-2008
(Source: WORKnet – Wisconsin Dept. of Workforce Development, 2009)

Most financial analysts expect the economy to rebound by mid-2010. That will help some sectors of the forest products industry. Other long-term dynamics such as globalization and a transition to digital media, however, will continue to influence change. Several variables that could influence future trends are: regulatory issues, incentives to manufacturing, development of new forest products, and competition from emerging bio-fuels markets and other ideas to assure a healthy forest industry that provides good jobs and a place to sell timber from well-managed forests.

17.2 Forestry employment and salaries
Loggers, foresters, forestry instructors, researchers and other land management specialists perform essential functions to plan, implement and evaluate responsible forestry. Data for public employers measures government's commitment to public land management, forest health, forest protection and private forestry assistance management. Private sector forester and logging employment are related to Wisconsin's ability to supply commercial raw materials and to protect and improve resources for non-commodity values. A look at academic positions helps measure our ability to train land managers, conduct research and to educate landowners.

Public Employment (National, State, County)
The DNR is the largest public agency providing services for management of the state's forest lands. In 1999, the agency employed 2,910 full-time employees, increasing to 2,975 in 2003.

Specialists from across DNR give guidance pertinent to the management of forests, but the Division of Forestry has the most direct role. Unlike the rest of the agency, the number of budgeted full-time permanent positions within the Division of Forestry has been steadier with a loss of six in 2007 and then a slight rebound shown in Figure 17.d. There will be an additional two position reductions in the Division of Forestry for the 2009-2011 biennium. Of the 467 authorized permanent Forestry positions available in 2008-2009, about 20% were devoted to fire protection services and 80% to forest management. The authorized Full Time Equivalent (FTE) labor expense for the Division of Forestry was $23,104,141 annually in 2008 and 2009. The adjusted average annual salary was $48,115 at $23.13 per hour.

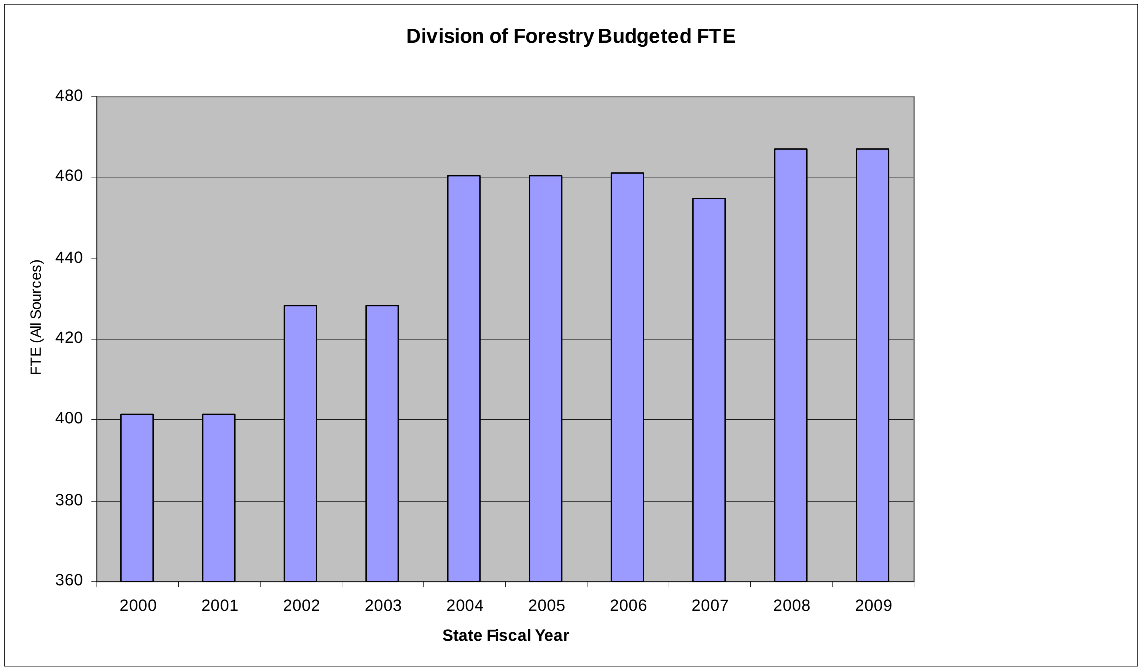


Figure 17.d: Division of Forestry budgeted FTE
Source: Wisconsin DNR Division of Forestry

<u>Private Employment</u>
Cooperating Foresters complement forest management guidance provided by DNR. Cooperators include private consulting foresters and industrial foresters who sign an annual agreement with the state. The agreement establishes silvicultural standards, continuing education requirements and reporting policies. In return, DNR refers private landowners to Cooperators for assistance.

The number of Cooperating Forester firms grew from 73 in 1999 to 127 in 2009, about a 74% increase. The number of foresters available in those firms rose about 83.5% over the same ten-year period. The increases reflect the impact of DNR policy decisions. Following the 1999 DNR Private Forestry Study, the Division of Forestry concluded that DNR staff should step away from setting up timber harvests on private land and encourage landowners to hire Cooperators. Landowners are able to pay Cooperating Foresters from timber sale proceeds. In 2005 the State Legislature changed the Managed Forest Law (MFL), ending free management plan writing services by DNR foresters in lieu of landowners hiring Cooperators for that work. About 20 full-time equivalent forester positions within DNR were shifted from private forestry to public land management duties. Although the decline in free management planning assistance was a difficult adjustment for some private landowners, the Legislature reasoned that landowners would be able to pay Cooperating Foresters from property tax savings afforded by MFL. The changes freed up time for DNR foresters to attend the needs of new forest land owners not in MFL, better administer MFL and to focus more time on public land management activities. The net result has been more private and public land management accomplished.

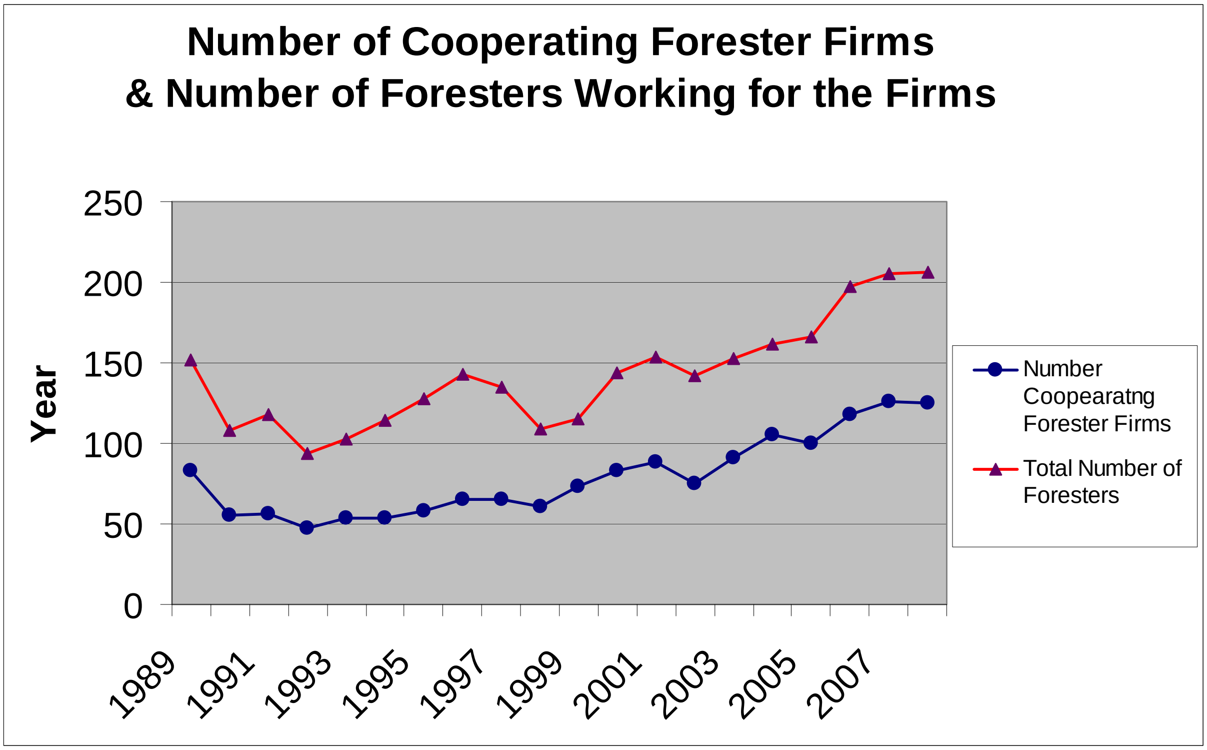


Figure 17.e: Number of cooperating forester firms and number of foresters working for those firms
Source: Wisconsin DNR Division of Forestry, 2009

Statewide forester employment and salary data from the Wisconsin Department of Workforce Development is presented in Figure 17.f. It combines public and private employment (WORKnet, 2009). Between 2000-2007, the number of foresters increased 71.43% and their wages rose an estimated 5.64% after adjustment for inflation. In 2007, the statewide average wage for Wisconsin foresters was $50,380 a year at $24.22 an hour.

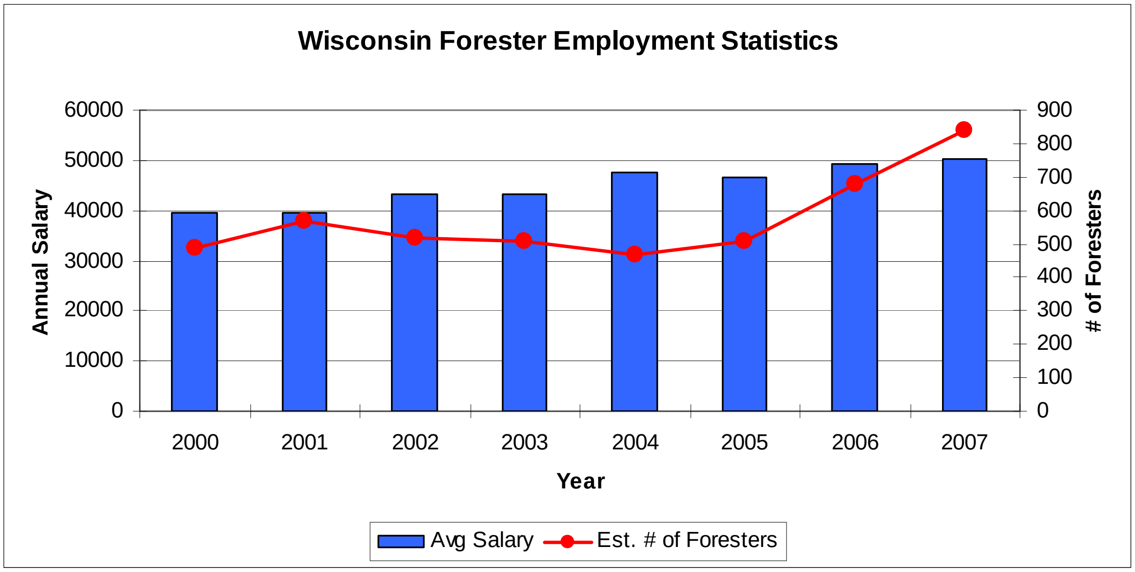


Figure 17.f: Wisconsin forester employment statistics
Source: WORKnet, 2009

While not every landowner will work with a forester, nearly every timber harvest involves a logger. Loggers are key players in the management of Wisconsin's forest resource. They are essential in delivering raw materials to the state's $20 billion forest products industry. Loggers also shape future forest productivity and provide valuable services to public and private landowners.

Employment of logging equipment operators and related log graders is shown in Figures 17.g and 17.h. A 2003 study of the status of the logging sector in Wisconsin and Michigan's Upper Peninsula found that the average logging firm has been in business for over 20 years and the average firm owner is 47 years old (Rickenbach, 2005). Unfortunately, there are relatively few new firms entering the sector. Most logging firms (62%) are organized as one person, owner-operator enterprises with no employees. The balance of firms (38%) employs approximately five full-time equivalent workers on average. Among firms with employees, over 85% reported difficulty finding skilled and reliable workers

Due to the relatively low pay, poor benefits, high capitol investments and risk associated with modern logging, many family-owned logging operators are discouraging their children from entering the profession, which could potentially lead to reduced future log supplies. The average wage for loggers in 2007 was less than $32,000 per year. Since most firms are structured as independent contractors without employees, loggers typically do not have workers compensation insurance. Those with employees report high workers compensation insurance premiums that do not recognize a differential for safer mechanized logging practices in Wisconsin. These factors, along with fluctuating market conditions, may lead to reduced numbers of independent professional loggers in Wisconsin, which is a major concern for the future.

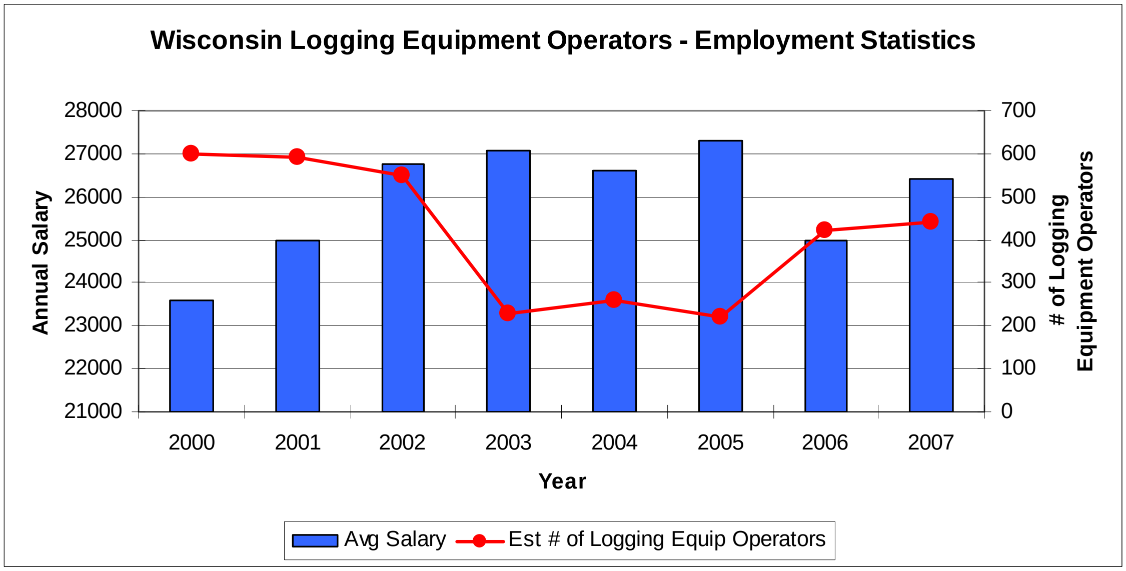


Figure 17.g: Wisconsin logging equipment operators – employment statistics
Source: WORKnet, 2009

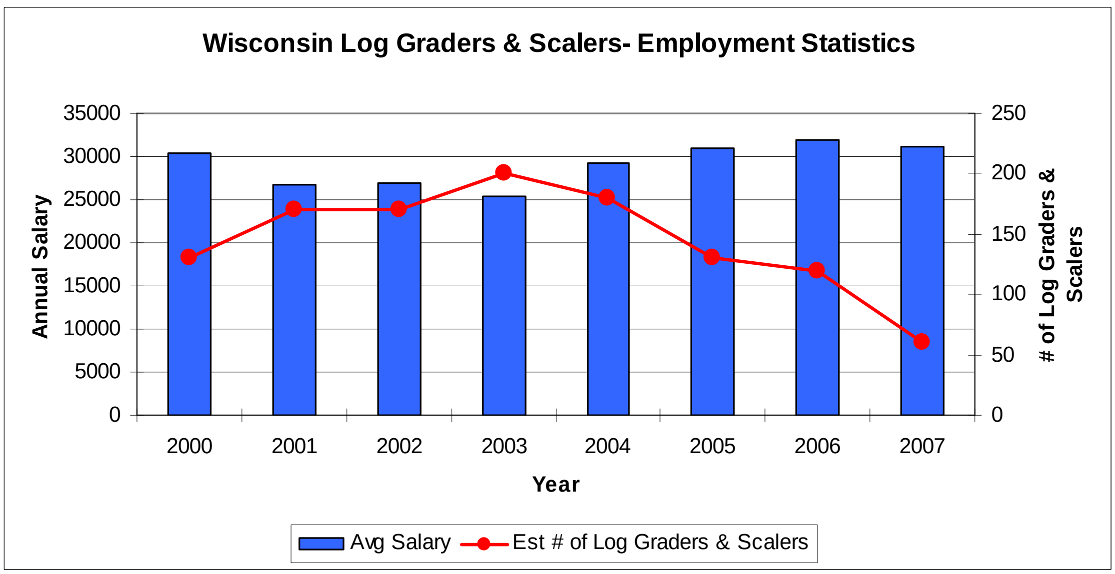


Figure 17.h: Wisconsin log graders and scalers – employment statistics
Source: WORKnet, 2009

<u>Academic and Research Employment</u>
The number of post-secondary forestry and conservation teachers (Figure 17.i) has been variable since 2000 (WORKnet, 2009). There were 150 university and technical school instructors in 2000, dropping to 70 positions in 2007. The average annual Wisconsin forestry educator wage was $76,430 in 2007.

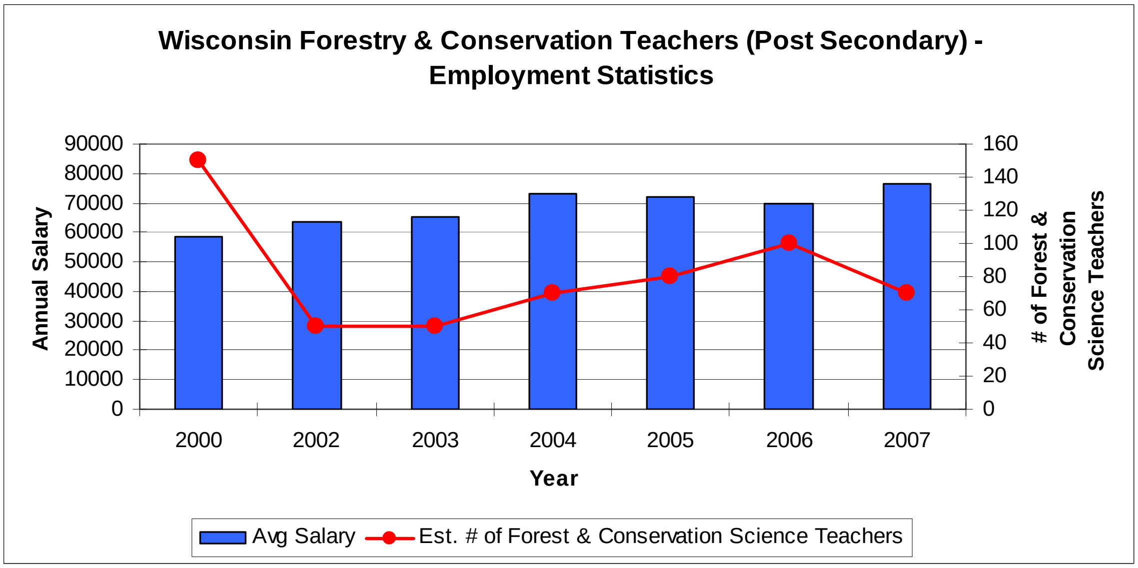


Figure 17.i: Wisconsin forestry and conservation teachers (post secondary) – employment statistics
Source: WORKnet, 2009

Detailed forestry professor employment and salary data for University of Wisconsin – Stevens Point (UWSP) is presented in Figure 17.j and 17.k. In 2008, UWSP had 10 forestry professors averaging $62,445.89 annual pay. After adjustment for inflation, the average annual wage for UWSP forestry professors dropped 22.34% between the years 2000 and 2008. This may be due to hiring of new, younger staff and retirements.

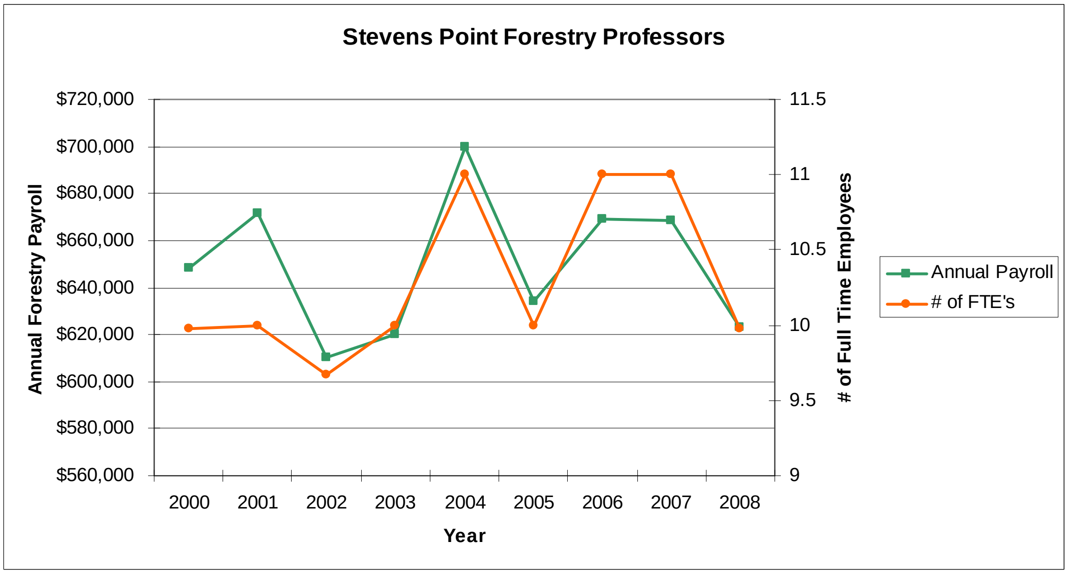


Figure 17.j: University of Wisconsin - Stevens Point forestry professors
Source: UWSP College of Natural Resources

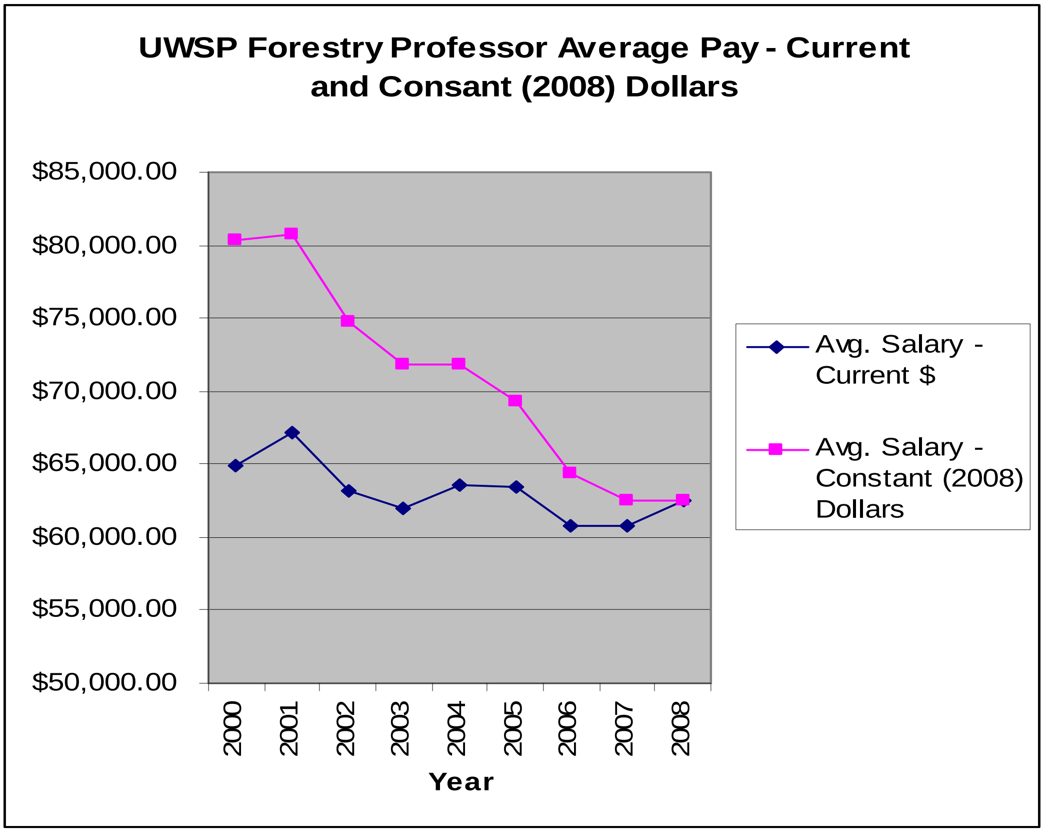


Figure 17.k: UWSP forestry professor average pay – current and constant (2008) dollars
Source: UWSP College of Natural Resources

Tabular data for UW-Madison in Table 17.a shows that forestry professor pay at that institution held relatively steady between the years 2003-2007. UWSP typically focuses on preparing students for future employment, whereas UW-Madison concentrates more on forestry research.

Table 17.a: UW-Madison Forestry Professor Payroll 2003-2007					
	2003	2004	2005	2006	2007
Total Payroll	$999,403	$1,014,520	$1,112,737	$1,157,341	$1,225,461
Full Time Employees	11	11	12	12	12
Avg. Salary	$90,855	$92,229	$92,728	$96,445	$102,122
Avg. Salary Adjusted for Inflation (2008 Dollars)	$105,277.89	$104,096.04	$101,231.53	$101,950.41	$104,955.55

Source: UW-Madison Dept. of Forest and Wildlife Ecology

Overall, Wisconsin successfully increased the availability of professional forester assistance in the state. While the number of forestry teachers remained relatively stable at the state's two largest forestry schools, UW-Madison and UWSP, pay issues may become a factor in retaining or attracting high-quality instructors. Competition for top teachers due to pay issues, however, is a concern across the UW System and not unique to forestry or natural resources. The weakest link in the responsible forestry chain is the status of the logging sector. Adjustments to state policy may be necessary to address the decline in the logging sector.

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Criterion 7: Legal and Institutional Framework for Forest Conservation and Sustainable Management

Overview

Sustainable forest management depends on social agreements dealing with a range of components: best practice codes, public participation, land tenure and indigenous peoples rights, high conservation-value lands, infrastructure to supply products, taxation, investment policies, and other accords. These may function through social institutions, economic incentives, or laws, regulations and policies. While legal and institutional structures may be the backbone of sustainable forest management, existing laws, policies, and standards do not alone ensure sustainability. To be effective, they must be adaptive to changing trends.

The institutional structures are the formal and informal rules that govern interactions between humans and resources (Ostrom et al., 1994). The major components of Wisconsin's legal structure include laws, policies, governance mechanisms, and resolution provisions through courts and mediated settlements. Institutions include groups such as bodies of government (state or tribal agencies, congress, local town councils, etc.), advocacy groups, advisory boards, businesses, and – most importantly in the case of forestry – landowners. Forest assessments and plans are where the legal and institutional structures often interact to effect change.

The analysis for this criterion uses qualitative data and looks at several indicators that have not previously been assessed. The objective is to present components of legal and institutional structures in Wisconsin as a whole. Planning tools currently used to assess the need for change and develop actions are discussed. In the future, analysis could consider components to strengthen, change, or reject.

There are several ways to assess the legal and institutional structures for forest management. The Forest Service's National Report 2010 uses a matrix to analyze the policy mechanism in place (e.g. voluntary, mandatory, educational, fiscal, or market based) by scale (national, state, local), and approach to implementing the policy (e.g. prescriptive, performance based, private enterprise). The Wisconsin assessment also uses a matrix, but it is categorized by major forestry components such as silviculture, water, fire, endangered species, etc. This is a common convention for certification systems and an easy way to comprehend numerous standards that address forestry. There is value to the methodology used in both the National and Wisconsin's Report. This is an area for further refinement.

Major Conclusions

1) Wisconsin has a well-balanced legal structure that addresses most forestry-related issues. Several components, however, are in constant revision to reflect evolving science, markets and social norms.

Currently, the forestry community (e.g., stakeholders, tribes, agencies, landowners) is focusing effort on at least a dozen topics. These topics could be described as quickly evolving and requiring new standards or legislation, standards needing revision, or issues that require more effort and collaboration to resolve. They include: biomass-bioenergy, climate change, wildland fire suppression and emergency response, invasive species, forest tax law incentives and other ecosystem services programs, deer management, forest certification, the forest economy, tribal relations, funding to acquire public lands and conservation easements, forest based recreation, and land use planning.

2) There is a growing demand for small private forest land management assessments and plans.

Overall, the growth in private lands planning is beneficial. Landowners are expressing desire to manage for new objectives such as carbon sequestration and biomass. Growth in private land plans comes with issues – increased workload for foresters requiring knowledge and expertise to write plans for new types of objectives.

- The advent of third-party certification increased the intensity of resource assessments and planning on both public and private forest lands. Landowners wanting the benefits of certification must document that they are managing in accordance with the standards.
- Two factors are increasing the number of DNR-reviewed management plans for landowners: the sale of land once owned by industry to small private forest owners and re-enrollment of landowners in MFL as their old agreements expire.
- Use of renewable fuel and harvesting of biomass involves a major paradigm shift, and landowners need advice from foresters on how to incorporate this into their management plans.

3) The number of community and statewide forest plans are growing.

Proactive planning prepares communities and the state for emergencies such as insect infestation (e.g. emerald ash borer) and wildfire. These assessments and plans provide citizens with greater process transparency and opportunities to participate.

- U.S. Forest Service, State and Private Forestry Stewardship Program is piloting a new focus on using landscape-scale plans in the northeastern area.
- A growing number of communities are creating management plans at the landscape level to protect themselves from wildfire, invasive pests such as the emerald ash borer and other problems.
- Across all land-holding agencies in Wisconsin, over 4.5 million acres (72%) of the over 6.3 million acres of public forest land in the state have forest cover type data used for management planning that was developed since 2000.
- While there was a steady increase in communities that have urban forest inventories over the last 16 years, two-thirds of Wisconsin communities still lack an inventory of their resource.

4) Statewide sustainable forestry is not just the responsibility of one group or agency, but requires partnerships with all members of the forestry community.

Landowners, agencies, industry, tribes and the public have various values and management goals for forests in the state. Divergent values and management goals may clash at times but collaboration focused on commonalities is needed to affect change and move programs and policies forward.

- Some Native American tribes have specific off-reservation treaty rights on public lands. The process of consultation between Wisconsin's 11 tribes and other governments evolved over the years and is proving productive, resulting in major agreements and coordinated resource management efforts. Continuing success will demand focused efforts by all parties.
- Information sharing and technology improvement is increasing between agencies, private foresters and landowners. These partnerships will be crucial in solving the costly needs for fire detection in areas overseen by the Division of Forestry and by partner agencies, including the Forest Service, Menominee Tribal Enterprises, and others.
- People and organizations in the forestry community are building partnerships to leverage each other's resources and niche expertise. Examples include: Volunteer Fire Departments building capacity to assist DNR wildfire suppression and Certified Plan Writers write MFL plans in cooperation with the DNR.
- The amount of land open under MFL has decreased. This suggests a need to revisit the adequacy of policies intended to encourage availability of land for public access and identify alternatives that may involve the range of landowners and agencies working together to reverse this trend or provide for public access elsewhere.
- The Council on Forestry has developed a set of research needs and is working to facilitate the various entities and align resources to obtain needed research in these areas. Due to limited resources, partnerships for research and coordination of efforts are all the more crucial.
- The urban forest is a mosaic of highly altered landscapes. They span properties, ownerships and jurisdictions. Municipalities, utilities, counties, the state and private individuals could all potentially own land in a very small area. Because of this, urban forest landscapes are best managed on various levels and require the partnering of various owners in an area.

Criterion 7 Indicators:

18. Extent to which the legal and institutional structure supports the sustainable management of forests

19. Forest-related planning and assessment

18. Extent to which the legal and institutional structure supports the sustainable management of forests

18.1 Types of forest management standards by category

Standards – constitutional provisions, federal and state statutes, local ordinances, case law, policies, guidelines, international law, certification standards, and others – are the rules society has agreed to follow with respect to all of the various facets of sustainably managed forests. Whether voluntary or regulatory, a standard indicates there is a structure in place to guide an aspect of forestry, and that society places a value on the specific resource issues associated with the law, policy or guideline. Existence of a standard does not presuppose its efficacy under current conditions.

There are many laws and policies that govern forestry in Wisconsin. They normally address a specific, focused program or forestry related goal, but the body of all laws and policies should be comprehensive as a whole. Evaluating the legal and institutional structure in Wisconsin can determine if there are areas of sustainable forestry not being addressed. Gaps identified here can be used to corroborate needs identified elsewhere in this report. Ideally, and potentially in the future, the existing laws/policies will be analyzed to determine their effectiveness.

Data collected for this indicator, available separately as Table 18.1a - Summary of Legal and Institutional Structures, shows that Wisconsin has at least 250 legal and institutional structures developed over the past 100 years in response to the unique challenges presented by the history of forestry in Wisconsin. These include specific federal and state constitutional provisions, laws, administrative codes, handbook provisions, guidelines, as well as international standards and laws that address specific metrics related to sustainable forestry. These legal and institutional structures have had remarkable success in developing the sustainable forest resource from the Cutover period in the late 19th century to the vibrant economic, ecological and recreational resource that exists today. There are, however, ongoing and emerging challenges identified below that may not be adequately addressed.

Table 18.1a[1] includes nine categories that broadly address sustainable forestry: silviculture, water/soil, wildlife/biodiversity, land laws, tenure and use rights of indigenous peoples, public involvement and education, planning and assessment, conservation of special environmental values, and taxation and fiscal incentives. Many topics are addressed in several categories. The Council on Forestry's 'Wisconsin's Sustainability Framework,' determined these categories are a good, across the board representation of the types of criteria found in other national and international forestry assessments and certification standards for determining forest sustainability.

Each category in Table 18.1a is subdivided into two columns. The first column states if the specific legal or institutional structure is mandatory or voluntary. The second column notes if the Standard identified has an associated monitoring component. Presence of a monitoring component means there is some mechanism, either implicit or explicit, in place to verify or review the implementation of the Standard. In addition to the nine categories, Table 18.1a contains 80 individual columns for indicators used in this assessment. Each standard is ranked

[1] For complete table, please see end of Criterion 7.

according to its relative impact on the indicator to which it is cross referenced if there is a correlation between the two. The numbering system in the table is as follows: 1=of high influence, 2=moderate influence and 3=some influence. Each of the identified standards and indicators in the data table could be expanded to consider thousands of code provisions, cases and policy interpretations, but the analysis was limited to a broad overview for practical reasons.

Table 18.1a (Example showing 4 of the 9 categories) (DNR, 2009)

	Silviculture		**Water/Soil**		**Wildlife / Biodiversity**		**Land/ PropertyLaws**	
Statute:	Mandatory or Voluntary	Monitoring Component?	Mandatory or Voluntary	Monitoring Component?	Mandatory or Voluntary	Monitoring Component?	Mandatory or Voluntary	Monitoring Component?
WSS Ch. 77; Subch. VI Managed Forest Land	M	Y	V	Y	M	N	M	Y

(Example showing relative influence of the standard on the Indicator)
1= high influence, 2= moderate influence, and 3= some influence

	Criterion 6, Indicator 13 – Wood & Wood Products Consumption, Production and Trade	
Statute:	13.1 Value of wood related products	13.2 Production of Roundwood
WSS Ch. 71 Income and Franchise Taxes	**3**	**3**
WSS Ch. 77; Subch. I Taxation of Forest Croplands		**2**
WSS Ch. 77; Subch. VI Managed Forest Land		**2**
WSS Ch. 82 Town Highways	**3**	**3**

An overall analysis of the data provided in the Summary of Legal and Institutional Structures table helps identify issues that involve Wisconsin's legal and institutional structures. Applicable questions include:

- Is the issue currently a focus or concern for the general public or a widespread concern in the forestry and forest products communities?
- Does the issue have the potential to significantly affect all areas related to forestry?
- Is there a gap in current Standards or are the Standards not fully developed with relation to the identified issue?

Brief summaries of a dozen outstanding issues apparent in the analysis:

1) Bioenergy and Biomass
While both the Federal government and the Wisconsin legislature have taken initial steps to address the use of bioenergy/biofuels in the context of broader national and state energy plans, there is a gap in the availability of current legal and institutional structures. Biofuels and biomass continue to be a focus of concern with the general public and the forestry community (see Criterion 7, Indicator 19), and both have the potential to dramatically effect the ecological and economic landscape of forestry. The underlying authority for the administration and implementation of these standards needs to be clarified on the national and state levels. The jurisdiction to implement biofuel and biomass standards in Wisconsin is divided between the state Department of Commerce (DOC) and Department of Natural Resources (DNR), with overlapping jurisdiction from the Department of Agriculture, Trade and Consumer Protection (DATCP) and the Public Service Commission (PSC). Without identifying Wisconsin's biofuels and biomass factors, the state may not be able to take full advantage of standards being developed on the national or international level. Another dimension of the biomass issue relates to the volume of wood waste going to Wisconsin landfills and structural changes to further restrict that practice.

2) Carbon Sequestration and Climate Change
While Table 18.1a identifies international standards related to carbon sequestration that are purely voluntary in the U.S., there will likely be movement on this issue based on the recent Environmental Protection Agency (EPA) decision to designate CO^2 as a threat to human health (May, 2009), Greenhouse gas reduction targets set by Governor Doyle's Global Warming Task Force (August, 2008) and the Midwest Governors Association's Energy and Climate Platform (December, 2008). Landowners in Wisconsin wanting to take advantage of ecosystem services including trading carbon offsets from forests are pushing for change, although the financial appeal of these offset markets could be lower than in other regions of the country (Brown et al, 2008)

Climate change mitigation options such as forest carbon offsetting are currently more developed and available than climate change adaptation measures. There is a great need for adaption tools to assist in policy setting and decision making. Institutions such as the Wisconsin Climate Change Institute (WICCI) are facilitating the necessary synergy between the various science and governing bodies that can develop the necessary adaptation measures. Public land may play a predominate role in testing adaptation strategies. The Chequamegon Nicolet National Forest is evaluating how to minimize their own contribution to climate change and to offset actions of others. A model forest pilot project to research climate change effects on the forest and then develop management actions to adapt is being tested.

3) Wildfire Suppression and Emergency Response
Forest fire control is one of the earliest statutory mandates for DNR and its predecessor, the Wisconsin Conservation Department. As land use and technology change with time, however, so do demands related to fire control. In a Wildland Fire Management Program study that was initiated in 2009, recommendations for a number of issues were being formulated. The study included a fire risk assessment based on fire landscapes derived from Geographic Information

System data (see Priority Landscapes and Issues section). An opportunity was identified to close the century-old Emergency Fire Warden program and replace it with a more effective Internet-based approach to burning permits. Other emerging issues that will call for change in institutional structures included expanded citation authority for Forest Rangers, stronger enforcement protocols for debris burning, a phase-out of burning barrels (being replaced by recycling programs), fire-related zoning regulations, and more.

4) <u>Invasive Species</u>
With the arrival of many invasive species harmful to forest health and sustainability, the general public and forestry community have responded with new standards aimed at addressing these threats (see Criterion 3). Overlapping jurisdiction, however, between the USDA Animal and Plant Health Inspection Service, U.S. Fish and Wildlife Service, the Wisconsin Department of Agriculture Trade and Consumer Protection, DNR and tribal governments on invasive species related to forest health, along with gaps in funding, may lead to a less than adequate landscape scale responses to these invasive threats.

5) <u>Forest Tax Law and other Ecosystem Services Incentives</u>
The Managed Forest Law (MFL) program combined with other private landowner grant and conservation easement programs advances sustainable forestry on private lands within the state. With over 44,000 orders of designation and 3 million acres, Wisconsin’s MFL program is the strongest and largest private forestry incentive in the country. Controversy over property access, tax rates, revenue, use rights including leasing, contractual language and indigenous peoples’ rights keeps the MFL program and other potential ecosystem services programs related to private forests in the forefront of the legislature and the minds of Wisconsin’s citizens. Recent statutory changes prohibiting the recreational leasing of MFL lands “closed” to public access heightened some of these concerns. Additional pressure points include alleged unequal property tax impacts, perceptions regarding DNR inflexibility on mandatory timber harvests, applicability of best management practices for water quality and invasives, and allowing “green” uses or other structures with perceived public benefits (like wind turbines, solar arrays or radio towers) on MFL lands. There is also concern that existing private forestry standards are not coordinated to address overall landscape and forest fragmentation concerns (see Criterion 1).

6) <u>Deer management</u>
Managing the deer herd in Wisconsin carries with it tremendous economic, social, ecological and emotional considerations. Public disagreement after the 2008 season, including the State’s management of the deer herd through the “earn a buck” program, highlights these concerns. Current deer population goals often result in deer population levels that negatively impact tree regeneration. Institutions external to the DNR, such as the Council on Forestry and the Wisconsin Conservation Congress, play an important role in keeping this issue in the forefront of the debate.

7) <u>Certification</u>
Wisconsin and neighboring Lakes States lead the rest of the country in adopting third-party forest certification standards such as SFI, FSC, Tree Farm, and others (see Criterion 6). Voluntary, broad commitments by the State of Wisconsin, Wisconsin County Forests and forest products industry to certification, place Wisconsin in a unique position to compete in the

emerging certified products market. Realizing related social, economic and environmental benefits and expanding certification will rely on adaptive institutional structures in Wisconsin and at the federal level. (see Criterion 6).

8) Forest economy
One of the main links to sustainable forestry is the forest products industry. How the industry operates and the various economic and social benefits that accrue from a healthy forest products industry highlight the importance of somewhat “dispersed” standards, such as sales tax, building codes, recycling and waste management, transportation regulations etc. Studies of the logging sector also forewarn of serious problems that include an aging workforce, lack of young people interested in logging and absence of basic health benefits that could severely constrain future supply lines. Additionally, the rise of ecosystem services presents a new element to the forest marketplace. While some ecosystem services like carbon sequestration have been in the limelight, others like preventing soil erosion and providing critical wildlife habitats are challenging to value, and so have not been adequately addressed.

9) Tribal relations
In 2004, Wisconsin Governor Jim Doyle issued Executive Order #39, which recognized the sovereignty of 11 tribal governments in Wisconsin and the unique government-to-government relationship that exists between the State and the tribes. Tribal relations with other governments remain important to sustainability of Wisconsin’s forests. Wisconsin’s consultation requirements and the Federal trust responsibility through BIA and Indian Trust Lands demand ongoing attention. Additional issues surround treaty rights in the “Ceded Territory” (approximately the northern 1/3 of Wisconsin) and tribes’ desires to consolidate reservation lands and add to their overall land base, will continue to present opportunities and challenges as both the tribes and other governmental bodies cooperate within current standards. The rise of national and international forest certification standards that require that indigenous peoples rights be recognized and respected has also emphasized the importance of tribal considerations.

10) Funding to Acquire Public Lands and Easements
The Wisconsin Legislature created the Knowles-Nelson Stewardship Program (Stewardship) in 1989 to preserve valuable natural areas and wildlife habitat, protect water quality and fisheries, and expand opportunities for outdoor recreation. Originally funded at $60 million per year, the program protected about 477,000 acres between its inception and 2007. In 2008, the Wisconsin Legislature reauthorized the Stewardship Program after intense debate for 2010-2020 at a level of $86 million per year. Controversy will likely continue in respect to how to prioritize lands to protect, maximize partnerships with land trusts and local governments, and to coordinate with long-range land use plans. Other federal and local land acquisition programs will also probably stir discussion.

11) Forest-Based Recreation
Demand for new ATV trails in Wisconsin is but one example of competing user groups demanding more access to the state’s forest resources. In 2007, meetings to consider new ATV routes on the Northern Highlands-American Legion State Forest drew 750 to 800 people and thousands of written comments. Although the State Natural Resources Board ultimately decided not to endorse any new trails there, other sites are continuously recommended or changes are

requested in types and width of vehicles permitted, fees, and related issues. The same sorts of questions come up regularly for bicyclists, hikers, horseback riders, campers, motorists and other user groups.

12) Land use planning
Land use planning standards are identified throughout the data in Table 18.1a. While several address either natural resource or forestry related issues as part of the standard, many are more broadly related to the overall balancing that each constituency consider to ensure that the public and private interests are being met. Land use planning affects all aspects of people's lives, and many standards are interdependent of each other. Although these standards are interdependent, they are not always effectively coordinated to balance resource needs against other societal interests and goals. As well, many of the local standards are not known. "Community Forestry Surveys" is a model to collate other local standards. The survey, run by DNR and UW – Stevens Point, track and share urban forest ordinances.

18.2 Statewide or regional statutory forest advisory committees

18.3 Statewide or regional forest-related organizations

Forest advisory committees and organizations are critical components of sustainable forestry, now, and in the future. These groups are influential at both local and statewide scales as they can influence the course of legislation and other policy. Noting the committees and organizations that exist provides the opportunity to assess whether there are forest issues with no representative body.

Table 18.a: Statewide or Regional Statutory Forest Advisory Committees and Mission

Statewide or Regional Statutory Forest Advisory Committees	
Name of Committee	**Purpose or Mission**
Wisconsin Council on Forestry	The Wisconsin Council on Forestry was created to advise the governor, legislature, Department of Natural Resources, Department of Commerce, and other state agencies on a host of forestry issues in the state, including: - Protection of forests from fire, insects, and disease - The practice of sustainable forestry, as defined in s. 28.04 (1) (e) - Reforestation and forestry genetics - Management and protection of urban forests - Public knowledge and awareness of forestry issues - Forestry research - Economic development and employment in the forestry industry - Marketing and use of forest products - Legislation affecting management of Wisconsin's forest lands - Staffing and funding needs for forestry programs conducted by the state
Wisconsin Natural Resources Board	The Wisconsin Natural Resources Board (NR Board) sets policy for the Department of Natural Resources and exercises authority and responsibility in accordance with governing statutory provisions.

Wisconsin Urban Forestry Council	The purpose of the Wisconsin Urban Forestry Council is to advise the Wisconsin Department of Natural Resources on the best ways to preserve, protect, expand and improve Wisconsin's urban and community forest resources. The Council works to develop, implement, monitor and revise the state urban forestry plan. It also plans activities to further understanding, appreciation and practice of urban forestry in Wisconsin. The Council strives to assist all parties involved in urban forestry to coordinate activities with the ultimate goal of the betterment of the urban forests in Wisconsin.
State Forest Stewardship Coordinating Committee	The primary objective of the Wisconsin Forest Stewardship Program is to encourage non-industrial private forest landowners to consider all resources in the management of their forest lands. Secondary objectives are to: - Encourage landowners to obtain a Forest Stewardship Plan to help meet their management objectives - Protect resources for future generations - Educate landowners and the general public on the importance of nonindustrial private (NIPF) lands.

There are four statutory forest advisory committees in the state (Table 18.a). Statutory is defined here as legislatively mandated. There are other advisory committees mandated by Natural Resource Rule or DNR Handbooks that include DNR representatives, tribes and stakeholders. These groups tend to be more specifically focused and cover a wide range of topics such as private lands management, BMP's for water quality, and Volunteer Fire Department wildfire assistance.

There are over 30 forest-related organizations represented in the state. Some of these are unique to Wisconsin (e.g. Wisconsin Family Forests) others are local units of a national group (e.g. The Nature Conservancy). As well, there are likely more than 30 organizations that don't have a forestry focused mission and yet without them, many forestry issues could not move forward. Often the use of forests is critical in achieving their mission (e.g. providing habitat for birds, or providing wooded trail riding experiences). Table 18.b lists some of these organizations in no priority order.

Table 18.b: Forestry organizations

Forestry Focused Organization	Forestry Partner Organization
Wisconsin Society of American Foresters	11 Native American Tribes
USDA Forest Products Lab and Northern Research Station	Great Lakes Indian Fish & Wildlife Commission
Forest Service (Region and Northeast Area)	Wisconsin Association of Land and Water Conservation Employees
Chequamegon Nicolet National Forest	Natural Resources Conservation Service

Wisconsin County Forests Association	Fish and Wildlife Service
Greening Milwaukee	River County RC&D
Wisconsin Consulting Foresters	Golden Sands RC&D
Association of Consulting Foresters	Lumberjack RC&D
WI Arborist Association	Pri-Ru-Ta RC&D
Lake States Lumber Association	Glacierland RC&D
WI Paper Council	Southwest Badger RC&D
Great Lakes Timber Professionals Association	CLUE - UW Stevens Point
UW- Madison, Dept of Wildlife and Forest Ecology; UW – Steven's Point, Dept of Natural Resources	WI Builders Association
Forest Industry Safety and Training Alliance, Inc.	Wisconsin State AFL-CIO
WI Nursery Association	Log Homes Builders Association
WI Family Forests	1000 Friends of WI
WI Tree Farm Committee	Gathering Waters
Great Lakes Forest Alliance	Izaak Walton League
Living Forest Cooperative	John Muir Chapter Sierra Club
Kickapoo Woods Cooperative	The Audubon Society - Madison
Hiawatha Sustainable Woods Cooperative	WI Assoc of Lakes
Partners in Forestry	National Wild Turkey Federation
Washington Island Timber Cooperative	Ruffed Grouse Society
Dovetail Partners	Wisconsin Deer Hunter Association
The Nature Conservancy	Whitetails Unlimited
Trees For Tomorrow	Wisconsin Trout Unlimited
Wisconsin Woodland Owners Association	WI Wildlife Federation
Walnut Council	Sigurd Olson Environmental Institute
Forest Products Society	UW-Extension (Basin Educators)
Aldo Leopold Foundation	Regional Planning Commissions
Forest Guild	Wisconsin Conservation Congress
	Wisconsin State Trails Council
Source: Organizations listed	

As internet access increases and web development services are more accessible and affordable, many citizen based organizations have greatly expanded their capacity to conduct outreach around the state and educate their members remotely. Forest-related organizations serve an important role in coalescing groups of individuals around topics of concern and bringing these forward for a public discussion. Whether they serve as watch-dog groups or advocate for a specific purpose, active groups keep forest issues in the public eye and provide a venue for the public to express their forest values.

Statutorily created forest advisory committees play an important role in supporting the advancement of forest issues, often to the level of new legislation. The advisory committees are made up of representatives from a range of the forest-related organizations. These committees are tasked with advising government agencies and other law makers on what the public wants. At this level, many issues require collaborative solutions but can break down when groups pursue their own agenda rather than seeking consensus.

19. Forest-related planning and assessment

Forest management plans, whether on public or private lands, provide the opportunity for a forest to be measured and analyzed, for the long-term objectives of the owner to be stated, and for sustainable management to be developed. A plan may also serve as a proxy to measure how well a forest is managed. Typically a plan includes involvement of natural resources professionals to determine future forest management needed to meet certain ecological standards. As more forest lands become third-party certified, management plans are being reviewed and monitored on a regular schedule.

A good public land planning process conducted in the public arena involves diverse stakeholders, analyzes alternative actions and incorporates ecosystem management principles. By stating what public land plans exist and how they are implemented, this indicator compares planning processes and evaluates their effectiveness. Assessments are critical to the planning process to provide the data necessary to analyze past practices and determine appropriate future projects.

This indicator will describe the various types of assessments and evaluate planning conducted by different types of landowners at different landscape scales and for different purposes. At a statewide level, the DNR conducts several types of statewide assessments and develops strategies to address various concerns such as communities at risk for wildfire, disease and insects. At a regional level, public land managers such as the U.S. Forest Service and County Forests develop plans for timber production, recreation and ecosystem services. Many private forest landowners such as forest products companies and family forest owners have detailed plans for their landholdings. This indicator reports on the number of known plans and addresses the issue of non-industrial land planning.

The following descriptions are organized by:

1. Assessments

    A. Statewide (forest health, private forest lands, urban and community forests, statewide forest resource)
    B. Public forests and Tribal lands (National, State, County, tribal)
    C. Community based (urban and community forests, Communities at Risk from Wildfire)
    D. Private forests (family owned non-MFL, family owned and industrial MFL, FCL)

2. Planning

    A. Statewide (DNR and partners)
    B. Public and Tribal lands (National, State, County, tribal)
    C. Community based (urban and community forests, Firewise, Community Wildfire Protection Plan)
    D. Private forests (family owned non-MFL, family owned and industrial MFL, FCL, Forest Legacy and other easements)

1. Assessments:

A. Statewide

At the statewide level, the DNR conducts the majority of assessments. Historically, the DNR has conducted assessments on forest health, private forest lands, urban forests, wildfire risk, and a statewide assessment of the general condition of all forest resources. One of the oldest statewide assessments on record was from 1962.

Over the years, the format of DNR assessments has changed. The first assessments focused on timber growth and removals. With each successive assessment, more comprehensive, ecosystem-based data was collected. In 2000, the Millennium Assessment analyzed the forest resource based on its ecological, economic, and social components, realizing the inter-connections and importance of all three.

As new technologies emerge, better resource data is available. Foresters and technicians now inventory with GPS units which facilitate the documentation and sharing of information. Although ecological data continues to grow, social data tends to be more difficult to obtain.

This statewide assessment (2010) is using a criteria and indicators framework based on the Montreal Process (http://www.rinya.maff.go.jp/mpci/). This is a very data intensive assessment. For a description of the process Wisconsin used to develop the criteria and indicators, see the introduction. This assessment utilizes a wider and more varied set of data than previous assessments.

Statewide Assessments cover a range of topics. Below are some of the main topic areas and assessments that address them.

- **Forest health:** The Department regularly conducts forest health risk assessments (see Criterion 3). Forest health reports are provided on-line at: http://dnr.wi.gov/forestry/Fh/.

- **Private forest lands:** In 2008, in accordance with a Forest Service State & Private Forestry requirement, the Department assessed spatially where private forest land is of greatest importance to protect resources such as water and where it is at greatest risk from land use changes like fragmentation and development. A GIS weighted overlay analysis was used to analyze 15 different values and risks to determine these areas (see Criterion 6).

- **Urban & community forests:** In 2004, the Forest Service and DNR conducted a statewide assessment of urban and community forests (see Criterion 1).

- **Statewide forest resource:** The DNR conducts statewide forest resource assessments, such as this Statewide Forest Assessment, every ten years. These decennial assessments include private and public lands, both rural and urban.

B. Public forests and tribal lands:
Assessments are conducted at the property level for public forest land and forests on Native American reservations. National, state, county, tribal, and municipal forests have detailed assessments as part of the long term planning process. Typical components of these assessments include describing and measuring forest characteristics, health concerns, recreation supply and capacity, threatened and endangered species and communities, conservation areas and the health

of the regional forest products industry. Yearly, many properties conduct more detailed inventories to continually update data.

C. Community based:

- **Urban and community forestry inventories**: Local governments around the state conduct inventories and assessments of various kinds to support their individual strategic and operational planning. These include street and park tree inventories, tree risk assessments, insect and disease surveys, storm damage assessments, urban tree canopy analyses and environmental services analyses. Table 19.a shows the trends in community tree inventories since 1992

Table 19.a: Percent of communities with tree inventories

Tree inventories	*1992*	*1999*	*2008*
Yes	12	22	33
No	88	78	63

(DNR Community Forestry Survey data, 2008)

While there was a steady increase in communities with urban forest inventories between 1992-2008, two-thirds of Wisconsin communities still lack an inventory of their resource.

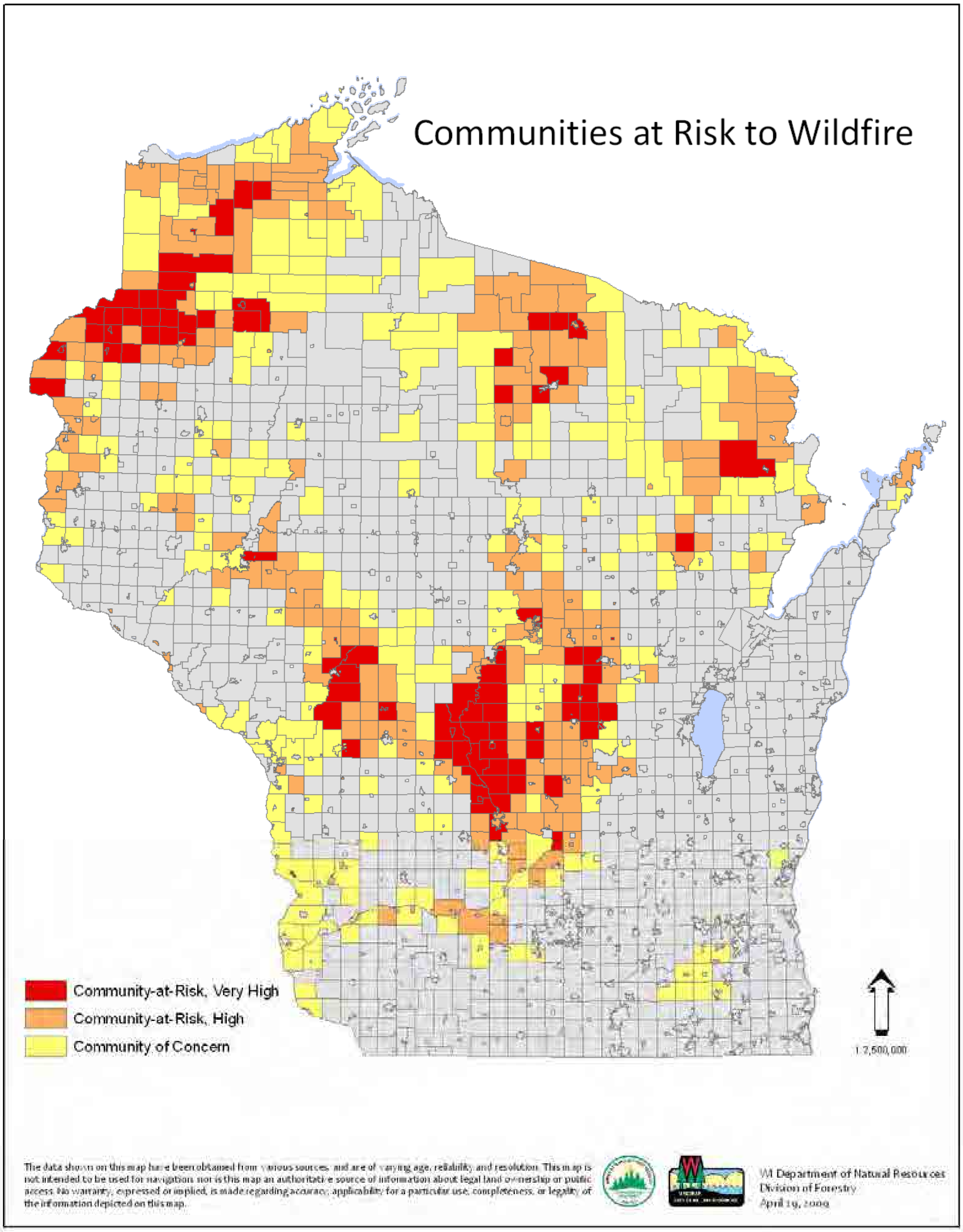
- **Communities at risk from wildfire:** An increased human presence in the wildland-urban interface presents a major challenge for protecting life, property and natural resources from destructive wildfires. As development expands into forested areas, there is an increase in wildfire risk due to human factors, particularly in parts of the state which have high fire potential. Since the majority of wildfires in Wisconsin are caused by humans, more people living and recreating in forested areas of the state will likely lead to a corresponding increase in the number of wildfires occurring in these areas. Some developments require additional services like police and fire protection that cost communities more than they receive from increased tax revenues.

  In 2008, the DNR completed a statewide assessment of Communities at Risk (CAR) to wildfire (see Map 19.a). The purpose of the CAR project was to identify areas of the state with relatively high risk to multiple structure loss due to wildfire. Communities at Risk were determined at the municipal civil division. Each of Wisconsin's 1,864 towns, villages, and cities were defined as a "community." Three hundred thirty-seven communities met the requirements for being "at risk." An additional 237 communities were named as Communities of Concern (CoCo). This category includes communities that may not be of high fire danger overall, rather they have a localized area of acute fire danger of at least 2 contiguous square miles. The break down of communities is as follows:

Table 19.b: Communities at Risk and Communities of Concern						
Risk Level	**Number**	**% of all WI communities**	**# cities**	**# villages**	**# towns**	**% of WI land area**
Very high	93	5	2	12	79	6
High	244	13	10	47	187	16
Concern (CoCo)	237	13	8	6	223	20
Totals	**574**	**31%**	**20**	**65**	**489**	**42%**

Source: DNR, 2009

The CAR assessment is used for subsequent wildfire prevention and preparedness activities. Communities with a very high, high, or concern rating are given additional planning and mitigation opportunities through Firewise Communities recognition, Community Wildfire Protection Plan creation, and education and hazardous fuels mitigation project funding through Forestry's Hazard Mitigation program.



Map 19.a: Communities-at-Risk (DNR, 2009)

D. Private forests
Private forest owners, whether industrial or family owned, assess their forests prior to long-term planning. Industrial lands conduct yearly assessments. A more formal process for industry lands is typical, whereas family forest owners may informally “cruise” or take stock of their property. Certification standards require certain types of assessments be conducted as a condition of their standard.

2. Planning:
A. Region and Statewide:
At a regional level, the Northeastern Area, State & Private Forestry (NA S&PF) unit collects data on the twenty northeastern area states. In 2007, data was collected following a criteria and indicators framework similar to this report. It provides a view of the whole region, and facilitates a comparison between the Great Lakes states.

Early statewide plans were focused on developing actions for the DNR to implement. Today, statewide plans are developed with the input and collaboration of partners and stakeholders with the recognition that not just one entity can singularly accomplish all actions. However, this can be time intensive and challenging to come to consensus on issues. Statewide plans are not interchangeable with property-based plans. Their strength is in determining the greatest issues across the state. These large scale issues often need the synergy of multiple partners to be successful. A good example is the Council on Forestry’s Initiatives. New rules and guidelines have been developed due to their support and advancement of issues. BMP’s for invasive species, biomass guidelines, shared research agenda, and the Sustainability Framework all were initiated or developed by the Council.

DNR programs supported by NA S&PF were previously required to have statewide plans. With the 2008 Farm Bill institutionalizing a redesigned S&PF, these programs (urban and community forestry, forest health, stewardship, fire, utilization and marketing) no longer have separate plans but are brought together in the Statewide Forest Strategies. Other broad advisory organizations such as the Urban Forestry Council have statewide plans focused on policy.

B. Public forests and tribal lands

- **National, State, County, Tribal Forests**

Forest plans for public lands define how the land will be managed, used, and developed well into the future. Forest plans include a vision for the property, goals and objectives that strive to reach a future desired condition based on the ecological opportunities and limitations of the landscape, economic and social factors. Public forest plans are highly participatory, encouraging public input. Up-to-date planning efforts across the state ensure that societal needs are considered in a timely manner, the best available science is guiding management decisions, and the most effective methods are being used for sustainable forest management.

There are two types of forestry planning on tribal lands. Federal regulations mandating Forest Management Planning (25 USC 3103) are administered by the Bureau of Indian Affairs. Tribes are also encouraged to undergo Integrated Resource Management Planning (IRMP), and IRMP creation is a tribal decision. Tribes may unilaterally determine the planning process, and at tribal discretion seek outside assistance to complete the plan. Tribal creation and use of their IRMP to develop and regulate land management facilitates self-governance and assures sovereign control of assets. (Moriarity, etal, 2006) Status of forestry planning on tribal lands is shown in Table 19.g.

The major public forest landowners in Wisconsin are the Chequamegon-Nicolet National Forest (CNNF) (1.5 million acres) Wisconsin County Forests (2.4 million acres), Department of Natural Resources (1.7 million acres) and tribal lands (350,000 acres). Over seventy percent of the public forest lands have forest reconnaissance data updated in the last 15 years, the typical planning timeframe for forest planning._The status of forest management planning for public lands follows.

National Forest

The Chequamegon-Nicolet National Forest (CNNF) is located in Wisconsin's northwoods, covering over a million and a half acres. Both forests were established by Presidential proclamation in 1933, and in 1993 the two Forests were administratively joined.

In April 2004, the CNNF released the Land and Resource Management Plan (Forest Plan), which was a revision and combination of the Chequamegon Forest Plan and Nicolet Forest Plan, both released in 1986. There were several issues managers and the public wanted to address in this plan. A priority was to plan for how to accomplish ecosystem restoration to bring the forest back to a more natural state as it was prior to the Cutover. This includes combating the spread of non-native invasive species and providing forest products sustainably. Another major goal was to plan for how to protect communities from wildfires, including fire suppression, fuels reduction, and prescribed burning. Unauthorized off-road travel needed to be addressed as well.

The Forest Plan provides guidance for all resource management activities on the CNNF. The plan establishes:

- forestwide multiple-use goals and implementing objectives
- forestwide management requirements (known as Forestwide Standards and Guidelines)
- Management Area direction, including area-specific standards and guidelines, desired future conditions and management practices
- identification of lands suited/unsuited for timber management
- monitoring and evaluation requirements
- recommendations to Congress for additional Wilderness.

State – Department of Natural Resources

The Department manages approximately 1.7 million acres scattered across the state. There are 10 statutorily designated State Forests totaling approximately 517,000 acres, and the remaining lands are wildlife, parks, natural areas and fisheries properties. Each property is required to have a property "master plan" that establishes goals and objectives and identifies how it will be managed and developed. These plans are designed to clearly communicate to the public how the property will look and what benefits it will provide.

A master plan for a property or group of properties includes the following:

- general property description
- general goals and objectives for management and use, and a description of how the property's statutory and other purposes and benefits will be realized
- management, acquisition, development and use plans, with appropriate maps showing the land management classifications
- supporting data and information, including:
  - summary of the property's resource capabilities and inventories
  - summary of the regional analysis for the property, and the issues considered; and
  - summary of background information on the property, including management and use history
- when appropriate, a communication plan describing any steps to be taken to periodically inform affected or interested parties about completed or proposed management activities
- master plans may include an environmental analysis as required by s. 1.11, Stats., and ch. NR 150.

In general, 50% of DNR lands have a master plan less than 15 years old. The remaining acres, mostly wildlife and fisheries properties and heavily developed parks either have a plan developed in the 1980's or have no plan at all.

Table 19.c: Status of master planning on DNR lands		
Decade Plan Approved	**Acres with Plans**	**Acres - No Plan**
No Plan	-	385,190
1960s	1,730	
1970s	116,142	
1980s	511,698	
1990s	78,765	
2000s	393,039	
Total	**1,101,374**	**385,190**

Source: DNR, 2009

DNR is currently working under a fifteen year program to have all property master plans updated or completed by 2024. To facilitate completing and updating property master plans to comply with standards in Chapter NR 44, Wisconsin Administrative Code, DNR assigned each of its properties to one of three master planning tiers:

Tier 1	56 properties	943,579 acres (includes State Forests)
Tier 2	430 properties	511,540 acres
Tier 3	936 properties	230,716 acres

Tier 1 plans are prepared individually for relatively large, complex properties. Tier 2 properties are intermediate in size and are grouped within DNR regions to share plans. Tier 3 properties are relatively small and typically receive a simpler management schedule. Even in the absence of full plans, property management objectives and broad program goals are listed for all properties on the DNR Master Planning Internet. Monitoring is also done annually to identify if any program objectives are not being met.

County Forests
Wisconsin's County Forests are managed by professional forestry staff of the counties with assistance from DNR foresters. Currently, there are county forests in 29 of Wisconsin's 72 counties, totaling more than 2.35 million acres.

Wisconsin's county forests are governed by the County Forest Law, which requires management in a sustainable manner for multiple uses, including timber production, recreation, wildlife habitat, and watershed protection. The county forests are required to update their forest plans every 15 years, a process that includes approval both by each forest's county board and the DNR. Currently, all 29 county forests have approved management plans which guide management for the years from 2006 to 2020.

Tribal
On Tribal lands, forest management inventory and planning include the following activities:
- scientific measurement of forest stocking
- determination of growth
- assessment of stand condition
- documentation of forest trends
- calculation of sustainable harvests
- vegetative mapping and forest acreage update
- determination of local issues and desirable management policy
- assessment of environmental and economic impacts on the reservation and surrounding communities.

Ninety-one percent of all trust lands are covered by a Forest Management Plan (FMP) and/or an Integrated Resource Management Plans (IRMP).

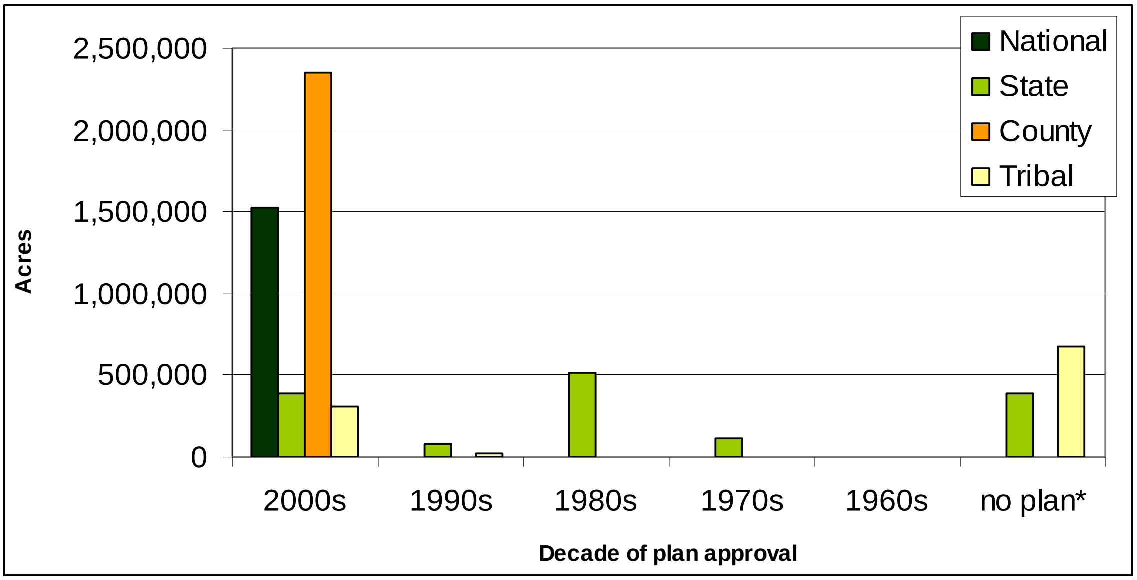
Table 19.d: Tribe management plans

Tribe	**Type of Plan**	**Status**
Bad River	IRMP	Approved 2001
Lac Courte Oreilles	IRMP	Approved 2000
Lac du Flambeau	IRMP	Approved 2008
Sokaogon (Mole Lake)	IRMP	In draft
Oneida	IRMP	Funded
Forest County Potawatomi	FMP	Approved 2000
Red Cliff	IRMP	Approved 2006
Stockbridge-Munsee	FMP	Approved 1996 (being updated)
St. Croix	IRMP	In draft
Ho-Chunk	Unknown	Unknown

Source: BIA, 2009

The management of public lands is very important to Native American tribes because they have specific off-reservation treaty rights on public lands. As well, state and local natural resource policy directly effects animal and plant populations tribes have an interest in (e.g. deer harvest goals). The process of consultation between tribes and other governments has evolved over the years and will continue to evolve. The effectiveness of these consultations and satisfaction of each party has not been measured. A concern with tribes and others is the trend of more MFL lands being entered as closed to public access; this directly affects the amount of land for tribe members to access.

When looking at the status of planning efforts across all land-holding agencies in Wisconsin, over 4.5 million acres (72%) of the over 6.3 million acres of public forest land have management plans developed in the 2000s (Figure 19.a). This positive accomplishment shows a majority of public lands within the state have up-to-date plans guiding future management.



** For tribal lands, plans identified as "funded", "in draft", or "unknown" were grouped into the 'no plan' category. It was not known whether the funded or in draft plans were updates to previous plans or first iterations for those tribes.*

Figure 19.a: Decade of management plan approval by owner and number of acres managed
Sources: DNR, BIA

C. Community based:

• Urban and community forestry plans
Local governments develop a variety of plans to manage urban forests. Table 19.e shows the trends in urban forestry plans since 1992 and Table 19.f shows the kinds of plans communities currently have.

Table 19.e: Percent of communities with tree management plans

Tree Plans	*1992*	*1999*	*2008*
Yes	26	22	32
No	74	78	68

(2008 DNR Community Forestry Survey data)

Table 19.f: Frequency of urban forest plan types

Plan Type	Communities with this plan	Communities developing this plan
Tree/urban forest management	88	11
Urban forest strategic	20	7
Emerald ash borer readiness	22	35
Land use management	57	9
Other:__________________)	6	0

(2008 DNR Community Forestry Survey data)

The number of communities with some type of urban forestry plan increased somewhat since 1992, however this still represents less than one-third of Wisconsin communities. Operations-oriented plans are the most common and there is a dramatic increase in emerald ash borer planning, which reflects the potential catastrophic impact EAB will have on community forests.

In addition to federal and state laws and rules, urban and community forests are regulated by local tree ordinances. These ordinances have developed as communities have planned for urban forests. Table 19.g shows types of provisions contained in community tree ordinances. Provisions relating to public safety are the most common. Provisions relating to sustainable management are much less common.

Table 19.g: Provisions included in community tree ordinances

Ordinance Provision	Number of local ordinances with this provision
Regulation of removal of dead or diseased trees	193
Abatement of hazardous or public nuisances	170
Regulation of species which may or may not be planted on the street	160
Definition of who performs tree maintenance	143
Insect/disease control	122
Street trees in new subdivisions	85
Permit system for tree work on public property	74
Replacement of all publicly owned trees that are removed	69
Regulation of species which may or may not be planted on private property	68
Preservation of trees during development	63
Noise or sight abatement around parking lots	29
Identification of formula for determining monetary value	18
Licensing of private tree care firms	11

(2008 DNR Community Forestry Survey data)

• **Firewise**

"Firewise" is a proactive community approach to wildfire readiness. In this approach, wildland fire control personnel and natural resource managers provide technical assistance through advice and recommendations. During a wildfire, they will provide emergency response when possible.

Yet ultimately, Firewise puts the primary responsibility for wildfire readiness on individual citizens and community infrastructure.

Individual homeowners are best situated to prepare their property for wildfire before one strikes. Firewise Communities USA is a recognition program for communities at the homeowner association level that work together to mitigate their collective wildfire hazards. The first step in achieving Firewise Communities USA recognition status is for an association to notify Firewise or the DNR Firewise liaison of their interest in enrolling in the program. Fire-prone communities can earn Firewise Communities USA status by meeting the following criteria:

1. DNR forestry staff and local fire department personnel complete a community assessment.
2. The community members appoint a Firewise Board to oversee the Firewise Communities USA process.
3. Based on the assessment, the Firewise Board creates an Action Plan that identifies agreed-upon achievable solutions to be implemented by the community.
4. Complete a local Firewise project each year.
5. Invest a minimum of $2.00 per capita annually in local Firewise projects. (Work by community members or other volunteers can be included, as can grants dedicated to that purpose.)
6. Submit an annual renewal form to Firewise that documents continuing compliance with the program.

Wisconsin's first Firewise Community was recognized in May 2004. As of April 2009, there were 17 recognized Firewise Communities in the state with numerous more working toward recognition status. To begin this process or to learn more about Firewise, community members are encouraged to visit www.firewise.org or contact their local DNR Forestry office.

• **Community Wildfire Protection Plans**

With the expanding wildland-urban interface and increased fire danger to people and property, many local governments are reacting by implementing zoning ordinances and creating plans that address wildfire issues. Zoning ordinances address concerns related to outdoor burning, outdoor wood furnaces, fireworks, emergency vehicle access, fire-resistant construction and roofing standards, signage, and vegetation management. A comprehensive guide to designing zoning standards, *Protecting Life and Property from Wildfire: An Introduction to Designing Zoning and Building Standards for Local Officials*, was created by the Great Lakes Forest Fire Compact and is a recommended reference document for communities in fire-prone areas that are considering creating wildfire-related ordinances.

There are planning documents that address wildfire hazards in whole or in part: County All Hazards Plans, Comprehensive Land Use Plans, and Community Wildfire Protection Plans (CWPP). The WDNR leads the facilitation of CWPPs for communities listed on the state's Communities at Risk list. There are currently 19 CWPPs in the state and more in development. A CWPP is created by a core team that includes the town government, local fire department, and DNR. Federal partners are included when federal land is in a community. Other "interested parties" may also be involved in the planning, such as representatives from emergency management, local homeowners associations, industrial forest owners, county forest managers, utilities, etc. CWPPs address things such as wildfire response, hazard mitigation, community preparedness, and structure protection. The creation of a plan helps a community organize projects for mitigating hazards, including timeframes for projects and who will be responsible for managing each project. Plans give fire-prone communities an incentive to develop and implement wildfire preparedness and hazardous fuels reduction projects; the USFS is giving funding priorities to communities that develop CWPPs.

Each year in Wisconsin, dozens of structures are destroyed by wildfires and hundreds more are threatened. Between 2000 and 2008, an average of 58 structures were lost to wildfire each year; during that same time, an average of 400 additional structures were threatened, yet ultimately saved (Table 19.h). The reality that structures will be threatened and possibly lost during wildfires has resulted in a WDNR initiative to map structure locations in high hazard areas.

Structure zone maps are an emergency response tool the WDNR creates for wildland-urban interface fires. The maps are generally organized at the county level and include the mapping of roads, water sources, and approximate housing locations at a minimum. The maps are used primarily by fire departments that protect structures during wildfires. Groups of houses are enveloped in named zones and firefighters are assigned to specific zones during the course of a wildfire. The maps have multiple benefits for emergency response as valuable tools for evacuation and recovery during other stochastic events, such as tornadoes. Structure zone map books can quickly become outdated. It is recommended map books be updated approximately every 5 years, areas with greater development may need to be updated sooner.

Table 19.h: Number of structures lost and saved from wild fire

Year	Structures Lost	Structures Saved
2000	75	445
2001	25	148
2002	21	108
2003	44	576
2004	37	179
2005	157	832
2006	66	497
2007	62	595
2008	31	219
Totals	**518**	**3,599**
Average	**58**	**400**
Source: WDNR Fire Report		

D. Private forests

- **Family owned forests (non-tax law)**

‘Forest Stewardship’ plans, as described here, are the plans private landowners have to manage their property or specifically in order to access aid such as cost-share. The Forest Stewardship plans discussed have federally required elements. Private landowners may have a management plan, generically called a stewardship plan, but these may not have the complete required elements. Forest Stewardship plans lay out strategies for achieving unique landowner objectives and sustaining forest health and vigor. Forest Stewardship plans motivate landowners to become more active in planning and managing their forests, greatly increasing the likelihood that their forests will remain intact, productive and healthy, and that the social, economic and environmental benefits of these lands will be sustained for future generations.

Wisconsin contributes a large portion of lands with an active Forest Stewardship plan in the northeastern United States (27%) and across the nation (15%). The majority of Wisconsin's Forest Stewardship plans are written for lands enrolled in the Managed Forest Law Program. Wisconsin's Managed Forest Law (MFL) tax incentive program requires a written management plan for program enrollment. MFL plans meet and exceed the federal requirements for a Forest Stewardship plan. Approximately 575,000 acres are owned by 9,100 landowners who have Forest Stewardship Plans, but are not in the MFL program. (Nadeau and Pingrey, 2008) The Division of Forestry is developing a GIS based inventory system to track both MFL and non-MFL Stewardship plans.

Changes in the number of Forest Stewardship plans written for a given year closely reflect fluctuations in MFL enrollment. MFL enrollment is driven by numerous factors. The strongest may be the landowner's incentive to join the program; often based on property tax values and property assessment values. The MFL program has undergone key changes in recent years which have affected the program's appeal to many landowners. These changes will continue to affect program enrollment for the next few years.

In 2011 the first wave of landowners enrolled in MFL for 25 years will be up for renewal. All landowners wishing to reenroll in the program will need to get a new management plan. This may lead to a dramatic increase in the number of Forest Stewardship plans written over the next 10 years. It is unclear at this point how many landowners will reenroll in the program and how many will get a new Forest Stewardship Plan.

Reenrollment to the program will hinge on many factors, including program incentives, landowner program satisfaction, availability of funds to cost-share management plans and other factors personal to each landowner. In 2007, the Wisconsin Forest Landowner Grant Program (WFLGP) received an additional $400,000 to help offset the increased costs due to privatization of MFL plan preparation. With this increase in funds and a reduction in the cost-share amount from 65% to 50%, the number of management plans and other practices funded by WFLGP increased dramatically. Budget cuts instituted in FY2010, however, will reduce available funds for the program to a level similar to 2001.

- **Industrial and family forests in the Wisconsin Forest Tax Laws:**

Forest management planning for privately owned lands is done as a condition of entry into Wisconsin's forest tax laws. The forest tax laws consist of the Forest Crop Law (FCL) and the Managed Forest Law (MFL).

Forest Crop Law (FCL)

Forest Crop Law was the first forest tax law, originating in 1927. The FCL program allows landowners to pay a reduced property tax while trees are growing and to pay the deferred property taxes at the time of harvest in the form of a severance tax. The severance tax is based on the species, size, and quantity of trees harvested from the property. Landowners must allow public access for hunting and fishing, and manage their lands for the production of timber.

Industrial ownership comprised the majority of lands enrolled under FCL. By the early 1980's approximately 1.2 million acres of industrial land were enrolled in FCL. Non-industrial private (NIPF) landowners added approximately 300,000 more acres.

Management planning on these lands was minimal in the early years since a management plan was not a requirement for lands to be enrolled in the program. A landowner filled out an application for entry and a map of the land was developed (often by DNR foresters) indicating the timber types. Harvests were largely established by industrial forestry staff for industrial lands and DNR foresters on NIPF lands.

In the 1980s, the DNR developed "harvest schedules" for all NIPF lands enrolled under the FCL program. A harvest schedule listed the dates in which harvest activities would occur for the remainder of the FCL contract, and it often included an inventory of current stand conditions. The backlog of FCL harvest scheduling was completed by 1990. Some of these harvest schedules are still in effect today.

Managed Forest Law (MFL)
In 1987, the Managed Forest Law (MFL) was created and land could no longer be enrolled into the FCL program. MFL required a management plan be developed before lands could be enrolled. The landowner had the choice of "open" or "closed" option under MFL. Open land allows public access for hiking, site seeing, and cross-country skiing, in addition to the hunting and fishing allowed on FCL lands. Or landowners can close their land to the public subject to an acreage limit depending on the year the land was entered. The MFL allows for management objectives compatible with timber production such as wildlife habitat enhancement, watershed protection, and aesthetics making it a multiple use program, but forest production must always be addressed.

On NIPF lands, DNR foresters developed management plans for each property. Management plan components have evolved over time, but generally include an inventory of the property showing current stand conditions, NHI occurrences, BMP issues, and often invasive species. Plans included both mandatory and non-mandatory practices. Mandatory practices include: harvesting of mature timber, thinning stands for merchantable products, releasing seedlings from competing vegetation, reforestation to meet minimum stocking levels, pre- or post- harvest site preparation to insure adequate regeneration and soil conservation practices necessary to control any soil erosion that may result from department approved forestry practices. Non-mandatory practices cover a wide range of proposed activities to help meet the landowner's objectives or improve some aspect of the forest resource (e.g., timber and wildlife habitat).

In 2004, MFL was amended to require landowners to hire certified plan writers (CPWs) to develop a management plan for enrollment in MFL. CPWs are private forestry consultants who have received training and displayed proficiency in developing management plans that meet the Department's minimum standards. In 2009, almost all management plans developed for lands entering into the MFL program were developed by CPW's and reviewed and approved by DNR staff.

The MFL presented a different set of issues when dealing with the large acreages of land enrolled by industrial landowners.

Wisconsin Administrative Code provides different management plan requirements for industrial landowners who met certain requirements. Landowners requesting to be treated as an industrial landowner must own more than 1,000 acres in two or more counties of the state and have access to competent professional forestry staff or consulting services. The landowner must have a management commitment that describes an underlying management plan (including resource inventories, harvest strategies, regeneration strategies, etc.) and the procedure used to update it. The management commitment is kept on file with the Department. The management plan can be reviewed or audited at the Department's request.

In 1996, the legislature developed rules to allow lands enrolled in FCL to be converted to MFL without penalty. DNR foresters were required to develop a management plan within three years of conversion for all NIPF landowners. All industrial owners were required to develop a management commitment approved by the Department if they didn't already have one. Owners were required to follow their management commitment on file. Although conversions continue, the majority of conversions occurred within the first three years. A breakdown of acres by ownership currently enrolled in either FCL or MFL is presented in Table 19.i. The table shows that of the 1.5 million acres of FCL in 1986, only 229,000 acres remain today. It also shows the majority of acres are enrolled under the MFL program with associated management plans and management commitments.

Table 19.i: Acres enrolled by owner type in MFL and FCL as of April 2009

Owner Type	FCL	MFL	
		Open Access	Closed Access
NIPF	125,513	418,634	1,858,804
Industrial	103,671	735,599	26,113

Source: DNR, 2009

Current Challenges for Wisconsin's Managed Forest Law & Planning
Many challenges face Wisconsin's forest tax law programs and management of private forested lands. With over 40,000 landowners encompassing more than 3 million acres of land, trying to balance the interests of the landowner with the interests of the citizens of the State of Wisconsin will invariably involve conflict. Some of the challenges facing Wisconsin are also evident throughout the United States.

<u>Ownership of industrial lands is decreasing</u>. Much of the industrial land was once owned by companies in the business of using raw forest resources to manufacture a product. Many of these companies have sold the land and the buyers have increasingly been organizations such as Timber Investment Management Organizations (TIMO's) or Real estate Investment Trusts (REITS). These investment owners look to the sale of land into smaller parcels as a means to maximize their returns on investment. This has accelerated parcelization at a faster than historic

pace. Figure 19.b shows the trend in amount of acres enrolled under the Wisconsin forest tax laws by industry from 1999 until 2007. Much of this reduction is due to the sale of lands to private non-industrial landowners.

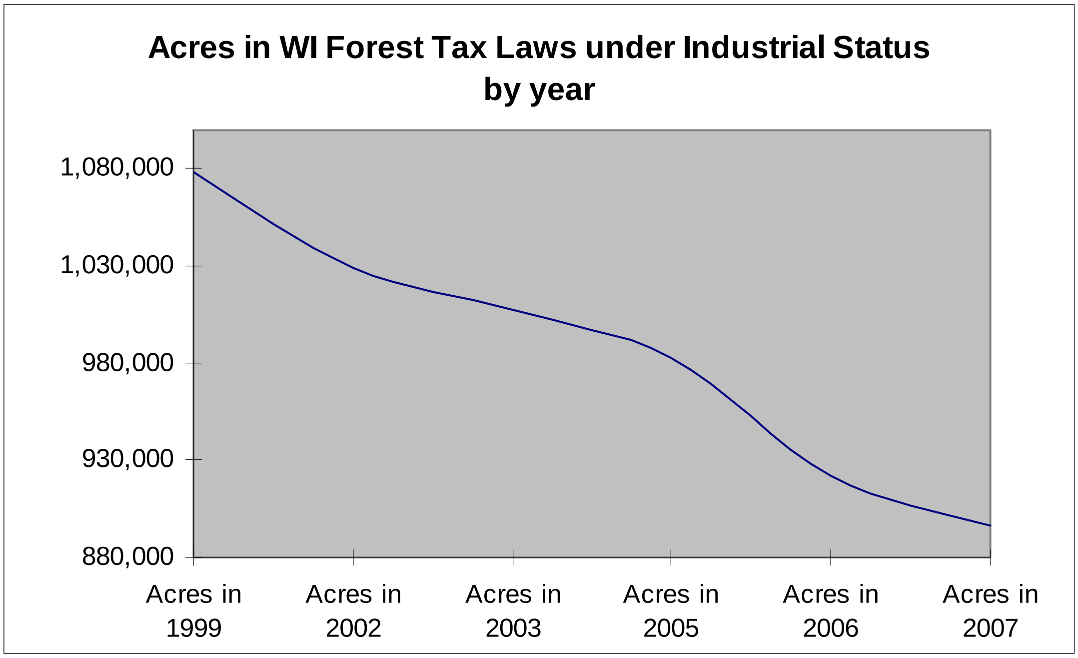


Figure 19.b: Acres in WI Forest Tax Laws under industrial status 1999 - 2007

Number of NIPF management plans is increasing. The sale of land once owned by industry to NIPF landowners has increased the number of DNR prepared management plans for new woodland owners. Since industrial lands do not have site specific management plans but management commitments, DNR foresters must develop the site specific management plan in order to guide landowners in implementing sound forest management practices.

Number of updated or new management commitments is increasing. Portions of larger industrial ownerships have been sold to new forestry investment groups. These groups have sought industrial status creating a need for development, review and approval of new management commitments. In 1999 roughly 69 owners were classified as industrial owners, in 2007 there were over 107 ownerships with that classification.

The number of parcels expiring from FCL and MFL is increasing. Lands enrolled in FCL or MFL are enrolled for 25 or 50 years. Landowners are given the opportunity to re-enroll lands into the MFL program at the expiration of their FCL contract or MFL order. A new management plan must be developed if the owner applies to re-enroll.

MFL was launched 1985, and so a stream of properties with 25-year agreements will be needing new management plans in the coming years. Figure 19.c shows the amount of acres of MFL that will expire by year. Many of these landowners will choose to re-enroll at least a portion of their properties and create a demand for development of new management plans. To help handle anticipated planning demand, DNR devised a computer-assisted management planning template that should be fully functional via an Internet-based data application in 2011.

A statute change in 2005 that ended free management planning assistance DNR foresters had provided for decades could also have a significant bearing on the re-enrollment rate of expiring MFL agreements. Although the average cost of about $1,000 per plan can be quickly recovered through property tax savings, the initial hurdle of paying a private plan writer could deter some landowners. Family forest organizations are concerned there will be a breakdown in long-term relationships between landowners and DNR foresters who prepared plans and assisted with plan implementation in concert with wildlife biologists and other agency specialists.

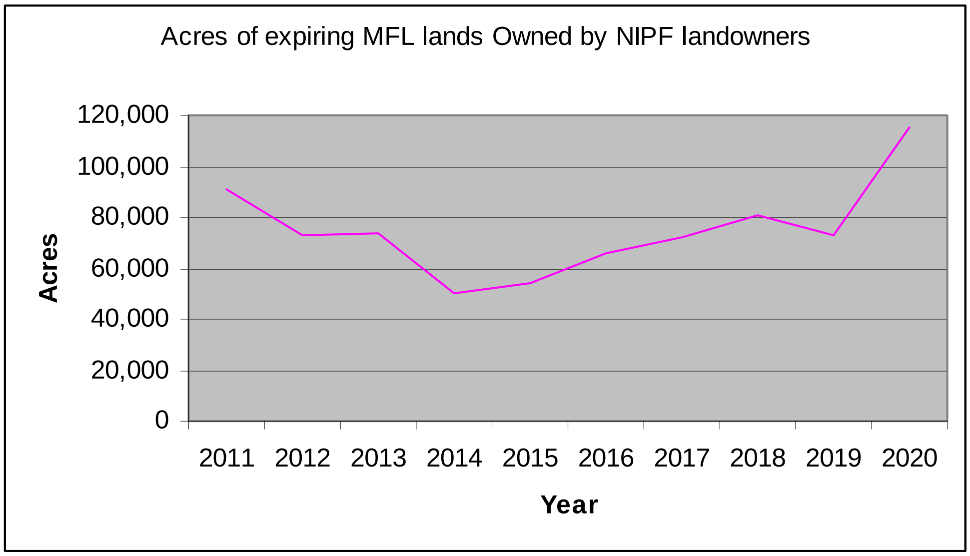


Figure 19.c: Acres of expiring NIPF lands enrolled under the MFL program by year of expiration.
Source: DNR, 2009

<u>Information sharing and technology improvement is increasing.</u> Because of the privatization of industrial lands, coupled with the expected increase in tax law management plan renewals, it is expected management planning needs will remain high in the coming years. The increasing use of CPWs has created a need to improve management planning consistency and efficiency both in plan writing and reviewing.

<u>Difficulties in providing public access to MFL lands is increasing.</u> One of the principle intents of both the MFL and FCL programs was to encourage more lands available to the public for recreation. Despite the intent, the amount of land open under MFL has not increased, but instead decreased. There are a multitude of reasons for the decline, but the commercialization of hunting in Wisconsin, the declining acreage under industrial ownership (most of which was open), and ever increasing land values have all played a role. Hunting traditions have also changed in ways that require closed lands. For example, there is more stationary hunting as compared to family drives, more quality deer management for trophy bucks, and more baiting. Some industrial owners are also closing land because they do not want to deal with road maintenance issues, vandalism, littering and other conflicts that come from public use.

In 2007 the Wisconsin Legislature amended the MFL program to prohibit leasing of MFL land for commercial recreation. It is unclear what affect this prohibition will have on future enrollments or re-enrollments, but it appears that the legislature's intent was to remove the financial incentive to close lands to the public and lease it. Figure 19.d shows the amount of land that is open vs. closed enrolled under the Managed Forest Law from 1997 to 2008.

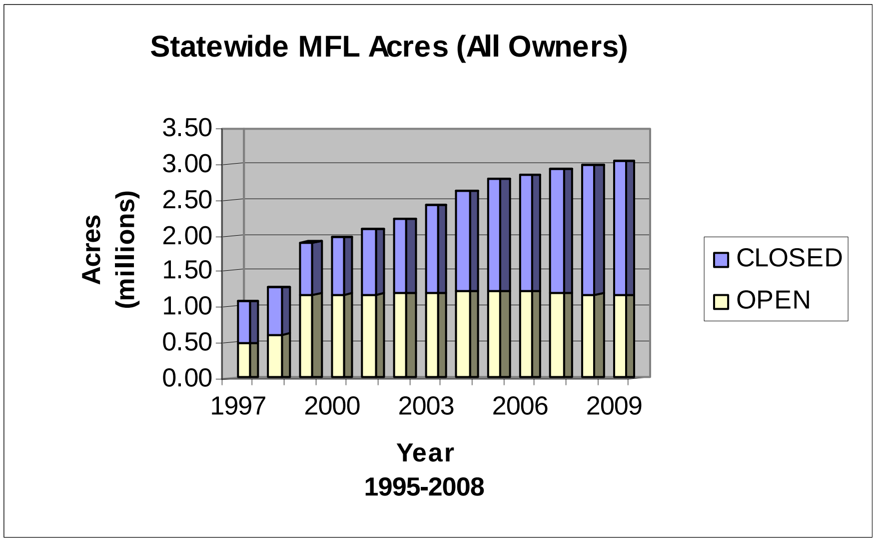


Figure 19.d: Acres of MFL open and closed from 1997 to 2008 for all ownership groups.
Source: DNR, 2009

Landowners who close MFL land pay the Department of Natural Resources an annual closed acreage fee per acre. The 2007 change in MFL created a grant program for the Department to award money to governmental and non-governmental units to purchase or lease lands for public recreation. The grant program could be funded by the MFL closed acreage fees. The new grant program has not been funded to date due to state budget shortfalls resulting from the 2008-2009 economic recession.

Interest in global warming and carbon sequestration is increasing. Landowners are becoming aware of the emerging markets in buying and selling carbon credits. Providing information to landowners on selling carbon credits and insuring that landowners remain in compliance with the forest tax law programs may require some adjustments to be made to MFL management plans and policies, however the impacts of the carbon credit market is not fully understood at this time.

Use of renewable fuel and harvesting of biomass is increasing. The desire to harvest biomass from Wisconsin's forest will pose operational and policy challenges. The DNR and forestry partners recently completed the development of statewide biomass harvesting guidelines. These guidelines are scheduled for phased-in implementation for all landowners under the FCL and MFL program in 2010. Determining severance and yield tax rates for harvesting fine woody material is a challenge the forestry community must work through.

Purchase and sale of conservation easements, development rights, and other rights is increasing. The concept of ownership is changing in Wisconsin as timber, development, and recreational and mineral rights are bought and sold separately in ever increasing amounts. This split in who owns individual rights and how they interact with each other will complicate the management planning process.

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Summary of Legal and Institutional Structures - Criterion 7, Indicator 18, Tabel 18.1a

1 = high influence, 2 = moderate influence, 3 = some influence

	Silviculture		Water/Soil		Wildlife / Biodiversity		Land/Property Laws		Indigenous People's Tenure and Use Rights		Public Involvement and Education		Planning and Assessment		Conservation of special environmental values		Taxation and Fiscal Incentives	
	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component
U.S. Constitution, Art. I, s. 8 - Commerce Clause																				
U.S. Constitution, 5th Amendment - Takings Clause							M													
Clean Air Act (CAA) (most recently amended 1990)	V	X																		
Clean Water Act (CWA) (1972)			M	X																
(1969)											M		M							
Endangered Species Act (ESA) (1973)					M										M					
(NEPCA) (1975)																				
(1987)																				
(APHIS)						X						X								
Court of the United States)																				
National Forests	M	X	M	X	M	X	M		V		M	X	M	X	M	X	M	X		
Resource Planning Act (RPA)(1974)		X		X		X		X			M	X	M	X		X				
National Forest Management Act (NFMA)(1976)																				
Forest Legacy Program (FLP)	V	X	V	X	V	X	V	X			M	X	M	X	V	X	V			
Nicolet National Forest													M							
2008 Lacey Act Amendment (Illegal Logging)		X						X									M	X		
Bureau of Indian Affairs (BIA)	V		V		V				M	X							M			
Lac Courte Oreilles Indians v. State of Wis, 775 F.Supp. 321 (W.D.Wis. 1991) (the Voigt case)					M	X	M	X	M	X					M	X				
(PCSD)																				
Biobased Products and Bioenergy																				
public use.							M										M			
uniform; income, privilege and occupation taxes.	V						M										M			
Improvements	V						M										M			
and lakes; navigable waters.			M				M													
public lands.							M										M			
WSS s. 1.055 National Forest							M													
WSS s. 1.056 State conservation areas							M													
environmental impact.											M		M							
WSS s. 1.12 State energy policy											V		V				V			
WSS s. 1.13 Land use planning activities							M				V		M				V			
commission	M	Y					M	X					M	X						
Emergency Medical Technician Service Award											M		M							
WSS s. 15.107(16) Wisconsin Land Council							M				M		M							
Board							M				M		M							
Council											M		M							
WSS s. 15.345(6) MFL Board							M				M		M							
WSS s. 15.347 Council on Forestry	V		V		V		V		V		M		M		V		V			
WSS s. 16.40(22) Sale of forest products at Fort McCoy.							M										M	X		
WSS s. 16.54(11) Acceptance of Federal Funds							M	X									M	X		
WSS Ch. 23 Conservation	M	X	M	X	M	X	M	X			M	X	X	X	M	X	M	X		
WSS s. 23.09 Conservation	M		M		M		M				M		M		M		M			
WSS s. 23.0915 Waren Knowles-Gaylord Nelson stewardship program							M	X				X			M	X	M	X		
WSS s. 23.0917 Waren Knowles-Gaylord Nelson stewardship 2000 program							M	X				X			M	X	M	X		
WSS s. 23.095 Protection of natural resources							M													
WSS s. 23.0953 Grants to counties for land acquisition.							M	X			M	X					M	X		
WSS s. 23.0956 Assistance for private conservation activities																				
WSS s. 23.0957(3) Annual grants to a nonstock, nonprofit corporation; urban land conservation.	V	X	V	X							V	X	V	X	V	X	M	X		

1 = high influence, 2 = moderate influence, 3 = some influence

	Silviculture		**Water/Soil**		**Wildlife / Biodiversity**		**Land/Property Laws**		**Indigenous People's Tenure and Use Rights**		**Public Involvement and Education**		**Planning and Assessment**		**Conservation of special environmental values**		**Taxation and Fiscal Incentives**	
	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component
WSS s. 23.097 Urban forestry grants	M	X															M	X
WSS s. 23.10 Conservation Wardens		X		X		X		X		X	M	X				X		
WSS s. 23.11 General Powers																		
WSS s. 23.113 Designation of chief state forester																		
WSS s. 23.114 Duties of Chief State Forester	M												M	X				
WSS s. 23.115 Designation of trails, etc																		
WSS s. 23.117 Use of trails by bicycles and electric personal assistive mobility devices.											M	X	M	X				
WSS s. 23.135 Forest land and inventory report	M	X									M	X	M	X			M	X
WSS s. 23.14 Approval required before new lands acquired.	V		V		V		M	X			V		M	X	V			
WSS s. 23.15 Sale of state-owned lands under the jurisdiction of the department of natural resources																		
WSS s. 23.16 Periodicals																		
WSS s. 23.165 Promotional activites; other publications																		
WSS s. 23.22 Invasive species																		
WSS s. 23.235 Nuisance weeds.					V						V							
WSS s. 23.26 Natural Areas Preservation Council	V		V		V		V				V		V		M			
WSS s. 23.27 Natural areas; definitions; importance; inventory; acquisition; sales.																		
WSS s.23.28 State natural areas; designated state natural areas.																		
WSS s. 23.29 Wisconsin natural areas heritage programs																		
WSS s. 23.30 Outdoor recreation program							V	X			M		M	X			M	X
WSS s. 23.305 Leasing of Departent land for recreation.							V	X			V							
WSS Ch. 24 Public Domain and the Trust Funds					M												M	
WSS Ch. 26 Forest Protection	M	X		X			M	X			M	X	M	X			M	X
WSS s. 26.01 Definition							M											
WSS s. 26.02 Council on Forestry	V	X	V	X	V	X	V	X	V	X	V	X	V	X	V	X	V	X
WSS s. 26.03 Harvest of raw forest products.	M	X					M	X									M	X
WSS s. 26.05 Timber theft							M										M	X
WSS s. 26.06 Enforcement, seizure and sale of materials.							M	X									M	X
WSS s. 26.09 Civil liability for unauthorized cutting, removal or transportation of raw forest products.							M	X									M	X
WSS s. 26.11 Forest fires; department jurisdiction; procedure.							M	X									M	X
WSS s. 26.12 Forest protection areas, organization, emergency fire wardens, county cooperation, setting fire.							M	X					M	X			M	X
WSS s. 26.13 Town fire wardens; duties, expenses.							M	X			M	X	M	X			M	X
WSS s. 26.14 Forest fires, authority of fire fighters, compensation, penalties, civil liability.							M	X									M	X
WSS s. 26.145 Fire suppression aids											V	X					M	X
WSS s. 26.18 District attorneys to prosecute																		
WSS s. 26.19 Destruction of forest protection equipment or notices.											M	X					M	X
WSS s. 26.20 Fire protection devices.							M	X									M	X
WSS s. 26.205 Tractors, spark arresters.																	M	X
WSS s. 26.21 Civil liability for forest fires.							M	X									M	X
WSS s. 26.30 Forest insects and diseases; department jurisdiction; procedure.	M				M	X	M	X			M		M	X			M	X
WSS s. 26.35 Forest productivity	V												M	X	M	X	M	X
WSS s. 26.36 Forest energy resources	V	X											M	X	M	X		
WSS s. 26.37 Lake states wood utilization consortium.													M	X			M	X
WSS s. 26.38 Forest grant program.	V	X	M	X	M	X	M	X					M	X	V		M	X
WSS s. 26.39 Forestry education and training			V								M	X					M	X
WSS s. 26.40 Forestry education grant program																		
WSS s. 26.97 Law enforcement and police power.		X		X		X		X								X	V	X
WSS Ch. 27 Public Parks and Places of Recreatoin	M		M		M		M				M		M		M			
WSS Ch. 28 Public Forests	M	X	M	X	M	X	M	X			M	X	M	X	M	X	M	X
WSS Ch. 29 Wild Animals and Plants	M		M		M	X	M				M		M		M		M	X

1 = high influence, 2 = moderate influence, 3 = some influence

	Silviculture		**Water/Soil**		**Wildlife / Biodiversity**		**Land/Property Laws**		**Indigenous People's Tenure and Use Rights**		**Public Involvement and Education**		**Planning and Assessment**		**Conservation of special environmental values**		**Taxation and Fiscal Incentives**	
	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component
WSS Ch. 30 Navigable Waters, Harbors and Navigation			M	X	M	X	M	X			M				M	X	M	
WSS Ch. 32 Eminent Domain							M						V				M	
WSS Ch. 36 University of Wisconsin Systen	V		V		V						M	X	V		V		M	
WSS Ch. 38 Technical College Systen	V		V		V						M	X			V			
WSS Ch. 59 Counties; Subch. VII Land Use, Information and Regulation, Environmental Protection, Surveys, Planning an Zoning	M		M				M						M	X			M	
WSS Ch. 60 Towns; Subch. VIII Land Use and Planning.	M						M						M				M	
WSS Ch. 61 Villages							M						M				M	
WSS Ch. 62 Cities							M						M				M	
WSS Ch. 66 General Municipality Law							M						M				M	
WSS Ch. 70 General Property Taxes							M										M	
WSS Ch. 71 Income and Franchise Taxes																	M	
WSS Ch. 77; Subch. I Taxation of Forest Croplands	M	X					M						M	X	V		M	X
WSS Ch. 77; Subch. VI Managed Forest Lanc	M	X	M	X	M		M	X					M	X	V		M	X
WSS Ch. 79 State Revenue Sharinc																	M	X
WSS Ch. 82 Town Highways																		
WSS Ch. 83 County Highways																		
WSS Ch. 84 State Trunk Highways; Federal Aid																		
WSS Ch. 85 Department of Transportatior																		
WSS Ch. 86 Miscellaneous Highway Provision:	M						M											
WSS Ch. 91 Farmland Preservatior			M				M										M	
WSS Ch. 92 Soil and Water Conservation and Animal Waste Management			M	X			M						M	X				
WSS Ch. 93 Department of Agriculture, Trade and Consumer Protection			M	X			M						M				M	
WSS Ch. 94 Plant Industry											M							
WSS Ch. 96 Agricultural Marketing Ac											M						V	
WSS Ch. 101 Department of Commerce - Regulation of Industry, Buildings and Safety																		
WSS Ch. 102 Worker's Compensation																	M	
WSS s. 157.70 Burial sites preservation																		
WSS Ch. 166 Emergency Management																		
WSS Ch. 167 Safeguards of Persons and Property																	M	X
WSS Ch. 213 Police and Fire Fighting Service								X										
WSS Ch. 227 Administrative Law																		
WSS Ch. 236 Platting Lands and Recording and Vacating Plats							M	X			M	X	M	X				
WSS Ch. 281 Water and Sewage			M	X			M	X					M	X			M	X
WSS Ch. 287 Solid Waste Reduction, Recovery and Recycling																	M	X
WSS Ch. 560 Department of Commerce																	M	X
WSS Ch. 700 Interests in Property							M											
WSS Ch. 703 Condominiums							M						M				M	
WSS Ch. 751 Supreme Court		X		X		X		X		X		X		X		X		X
WSS Ch. 752 Court of Appeals		X		X		X		X		X		X		X		X		X
WSS Ch. 753 Circuit Courts		X		X		X		X		X		X		X		X		X
WSS Ch. 755 Municipal Court		X		X		X		X		X		X		X		X		X
WSS Ch. 779; Subch. II Other Liens	M	X					M	X									M	X
WSS Ch. 840 Real Property Actions; General Provisions							M											
WSS Ch. 841 Declaration of Interest in Real Property							M											
WSS Ch. 842 Partition of Interest in Real Property							M											
WSS Ch. 843 Actions for Possession of Real Property; Damages for Witholding							M											
WSS Ch. 844 Interference with Interest; Physical Injury							M											
WSS Ch. 846 Real Estate Foreclosure							M											
WSS Ch. 847 Miscellaneous Real Estate Actions							M											
WSS Ch. 893; Subch. III Actions Concerning Real or Personal Property							M											
WSS s. 895.52 Recreational activities; limitation of property owners' liability.							M										M	
WSS Ch. 943 Crimes Against Property							M	X									M	X
WSS s. 995.225 Fire Prevention Week											M							

1 = high influence, 2 = moderate influence, 3 = some influence

	Silviculture		Water/Soil		Wildlife / Biodiversity		Land/Property Laws		Indigenous People's Tenure and Use Rights		Public Involvement and Education		Planning and Assessment		Conservation of special environmental values		Taxation and Fiscal Incentives	
	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component
WAC s. ATCP 21 Plant Inspection and Pest Control	M	X			M	X									M	X		
WAC s. ATCP 30 Pesticide product restrictions			M	X														
WAC s. ATCP 40 Fertilizer and Related Products			M	X														
WAC s. ATCP 50 Soil and Water Resource Management Program			M	X														
WAC s. ATCP 140 Agricultural marketing orders, marketing agreements and marketing boards																		
WAC s. ATCP 161 Agricultural development and market promotion																		
WAC s. Comm 7 Explosives and fireworks																		
WAC s. Comm 116 Rural economic development program							V						V	X			M	
WAC s. Comm 118 Agricultural development zone program							V						V	X			M	X
WAC s. EEB 2 Grants for environmental education programs					V	X					M	X					M	
WAC s. KB 1 Kickapoo Valley Reserve management	M	X			M	X	M	X					M	X				
WAC s. NR 12 Wildlife damage and nuisance control					M	X									M	X	M	X
WAC s. NR 13 Chippewa treaty rights participants					M	X	M	X	M									
WAC s. NR 27 Endangered and threatened species					M	X	M	X							M	X		
WAC s. NR 28 Wild plants					M	X									M	X		
WAC s. NR 30 Forest fire control																		
WAC s. NR 35 Zones for infestation of forest pests	M	X			M	X	M	X					M	X	M	X		
WAC s. NR 37 Lower Wisconsin state riverway aesthetic management specifications for cutting and harvest of timber	M	X	M	X			M	X					M	X				
WAC s. NR 44 Master planning for department properties	M	X			M	X	M	X	M		M	X	M	X	M	X		
WAC s. NR 45 Use of state property			M	X	M	X	M	X					M	X	M	X		
WAC s. NR 46 Forest tax program	M	X	M	X	M	X	M	X	M						V	X	M	X
WAC s. NR 47 Forestry grant and state aid administration	M	X			V	X	V	X							V	X	M	X
WAC s. NR 48 County forest withdrawa	M	X					M	X									M	X
WAC s. NR 50 Administration of outdoor recreation program grants and state aids	M	X															M	X
WAC s. NR 51 Administration of stewardship grants	M	X			M	X	M	X							V	X	M	X
WAC s. NR 55 Administration of federal payments in lieu of taxes (PILT)							M	X									M	X
WAC s. NR 58 Endangered resources grant programs					M	X									M	X	M	X
WAC s. NR 80 Use of pesticides on land and water areas of the state of Wisconsin			M	X			M	X										
WAC s. NR 100 Environmental protectior			M	X											M	X		
WAC s. NR 102 Water quality standards for Wisconsin surface waters			M	X														
WAC s. NR 103 Water quality standards for wetlands			M	X			M	X							M	X		
WAC s. NR 115 Wisconsin's shoreland management program			M	X			M	X					M	X				
WAC s. NR 117 Wisconsin's city and village shoreland-wetland protection program			M	X			M	X					M	X				
WAC s. NR 118 Standards for the Lower St. Croix National Scenic Riverway	M	X	M	X			M	X					M	X				
WAC s. NR 120 Nonpoint source pollution abatement program			M	X			V	X										
WAC s. NR 121 Areawide water quality management plans			M	X														
WAC s. NR 150 Environmental analysis and review procedures for department actions		X		X		X					M	X	M	X		X		
WAC s. NR 151 Runoff management			M	X														
WAC s. NR 152 Model ordinances for construction site erosion control and post-construction storm water management			M										M	X				
WAC s. NR 155 Urban nonpoint source water pollution abatement and storm water management grant program			M	X			M	X										

1 = high influence, 2 = moderate influence, 3 = some influence

	Silviculture		**Water/Soil**		**Wildlife / Biodiversity**		**Land/Property Laws**		**Indigenous People's Tenure and Use Rights**		**Public Involvement and Education**		**Planning and Assessment**		**Conservation of special environmental values**		**Taxation and Fiscal Incentives**	
	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component
WAC s. NR 185 Solid waste management planning criteria													M	X				
WAC s. NR 191 Lake protection and classification grants			M	X			V	X					M	X	M	X		
WAC s. NR 195 River protection grants			M	X			V	X					V	X	V	X		
WAC s. NR 297 Timber products processing																		
WAC s. NR 299 Water quality certification			M	X			M	X										
WAC s. NR 302 Management of Wisconsin's wild rivers			M	X											M	X		
WAC s. NR 341 Grading on the bank of navigable waterways			M	X			M	X										
WAC s. NR 401 Nonattainment areas													M	X				
WAC s. NR 429 Malodorous emissions and open burning							M	X										
WAC s. NR 502 Solid waste storage, transportation, transfer, incineration, air curtain destructors, processing, wood burning, composting and municipal solid waste combustors							M	X										
WAC s. PSC 118 Renewable resource credit tracking program																		
WAC s. PSC 137 Energy efficiency and renewable resource programs.																		
WAC s. RB 1 Lower Wisconsin state riverway mission goals, objectives and definitions	M	X	M	X														
WAC s. RB 2 Lower Wisconsin state riverway permit exclusions, exemptions and procedures	M	X	M	X			M	X					M	X				
WAC s. Tax 3 Income taxation, deductions from gross income, exclusions and exemptions																	M	X
WAC s. Tax 11 Sales and use tax																	M	X
WAC s. Tax 12 Property tax							M	X					M	X			M	X
WAC s. Tax 18 Assessment of agricultural property							M	X					M	X			M	X
WAC s. TCS 16 Technical and occupational program grants																		
WAC s. TCS 17 Training program grants											M	X					M	X
WAC s. Trans-RR 1 Rustic roads																		
WAC s. Trans 202 Wisconsin scenic byways program																		
WAC s. Trans 214 Town road bridge standards																		
WAC s. Trans 230 Permits for loads exceeding size, weight, and vehicle combination limits																		
WAC s. Trans 250 Oversize and overweight permits for vehicles and loads																		
WAC s. Trans 251 Vehicle weight authorized by multiple trip permits																		
WAC s. Trans 253 Multiple trip overweight and oversize permits for vehicles operating near the Wisconsin-Michigan border																		
WAC s. Trans 254 Single trip permits for oversize or overweight vehicles or loads																		
WAC s. Trans 255 Multiple trip permits for oversize or overweight vehicles or loads																		
WAC s. Trans 259 Raw forest products, fruits or vegetables permits																		
WAC s. Trans 278 Vehicle weight limit exceptions																		
WAC s. Trans 280 Roadside vegetation management																		
WAC s. Trans 316 Wood harvesting slashers																		
MC 1031.2 Wild Areas Restrictions Guidelines																		
MC 1463 National Forest Wilderness Areas Access																		
MC 1605.1Environmental Analysis/Review																		
MC 1606.1 Wisconsin Environmental Policy Act (WEPA) for All DNR Actions																		
MC 1724.5 Handbook; Endangered Resources					M	X												
MC 1750.2 - Natural Areas management	M	X			M	X	M	X										
MC 1752.1 Permits for Collecting/Doing Research on State Natural Areas					M	X												
MC 1805.1 Handbook; Ecological Landscapes					M	X												
MC 1810.1 Historic Preservation																		

1 = high influence, 2 = moderate influence, 3 = some influence

	Silviculture		**Water/Soil**		**Wildlife / Biodiversity**		**Land/Property Laws**		**Indigenous People's Tenure and Use Rights**		**Public Involvement and Education**		**Planning and Assessment**		**Conservation of special environmental values**		**Taxation and Fiscal Incentives**	
	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component	mandatory or voluntary	monitoring component
MC 2105.2 Feasibility Study/WEPA Analysis for Establishing or Modifying Property Boundaries													M	X				
MC 2106.4 Resource Conservation and Development Program					M	X												
MC 2112 Defining Forest-Wildlife Habitat Management Priorities	M	X			M	X												
MC 2112.1Forest Opening Maintenance and Construction	M	X																
MC 2205 Handbook; Land Acquisition and Sales							M	X										
MC 2212 Department Property Boundaries							M	X										
MC 2221.1 Road Discontinuances on State Properties																		
MC 2420.5 Handbook; Forestry Operations	M	X				X												
MC 2425.5 Handbook; Forestry Law Enforcement																		
MC 2431.5 Handbook; Silviculture	M	X	M	X	V	X					M	X						
MC 2450.5 Handbook; Forest Tax Law	M	X			V	X												X
MC 2460.5 Handbook; Public Forest Lands	M	X			M	X												X
MC 2461 Handbook; Timber Sale	M	X															M	X
MC 2465.4 Fuelwood Sale Permits on State-owned Lands	M	X																X
MC 2470.5 Handbook; Private Forestry	M	X																
MC 2480.5 Handbook; Old Growth & Old Forests	M	X			V	X												
MC 4105 Handbook; Law Enforcement																		
MC 4147.1 Reporting/Recording of Conservation Violations and Citizen Complaints		X		X		X												
MC 4190.5 Handbook; Environmental Enforcement		X		X		X												
MC 4305.1 Handbooks; Individual Forest Fire Report																		
MC 4310.5 Handbook; Fire Prevention																		
MC 4320.5 Handbook; Fire Presuppression																		
MC 4325.1 Handbook; Fire Management																		
MC 4360.5 Handbook; Prescribed Burn					V	X												
MC 4370.5 Handbook; Cooperative Fire Control																		
MC 8103 Policy on Natural Resources Research																		
MC 8104.1 Centralized Research Program																		
MC 8104.3 Non-Department Research Projects																		
MC 9155.1 Handbook; Forestry Training	M	X																
Forest Stewardship Council (FSC) certification	V	X	V	X	V	X			V	X	V	X	V	X	V	X	V	X
Sustainable Forestry Initiative (SFI) certification	V	X	V	X									V	X			V	X
International Organization for Standardization 14001 and 9001	V	X									V	X	V	X			V	X
The 1992 United Nations Conference on Environment on Development (UNCED) (Rio)	V	X																
The 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto)	V	X																

Summary of Legal and Institutional Structures - Criterion 7, Indicator 18, Table 18.1a

1 = high influence, 2 = moderate influence, 3 = some influence	Criterion 1: Conservation of Biodiversity																	Criterion 2: Maintenance of				
	1. Area of total land, forestland, and reserved forestland			2. Forest type, size class, age class, successional			3. Extent of forest land conversion, fragmentation, and parcelization							4. Status of forest/woodland communities and associated species of concern				5. Area of timberland	6. Annual growth and removals of forest products			
	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	4.1	4.2	4.3	4.4	5.1	6.1	6.2	6.3	6.4
U.S. Constitution, Art. I, s. 8 - Commerce Clause																						
U.S. Constitution, 5th Amendment - Takings Clause																						
Clean Air Act (CAA) (most recently amended 1990)																						
Clean Water Act (CWA) (1972)																						
National Environmental Protection Act (NEPA) (1969)			2																			
Endangered Species Act (ESA) (1973)				3	2	2				3	1			2	1	2	2			3		
National Energy Policy and Conservation Act (NEPCA) (1975)																						
Public Utility Regulatory Policies Act (PURPA) (1987)																						
Animal and Plant Health Inspection Services (APHIS)																						
Maine v. Taylor, 477 U.S. 131 (1986) (Supreme Court of the United States)																						
National Forests	1	3	1	3	2	2	2	2		1	1	2	2	2	1	2	2	1	2	2	1	
Resource Planning Act (RPA)(1974)																						
National Forest Management Act (NFMA)(1976)																						
Forest Legacy Program (FLP)	2		2				2	2	2	2	1		3	3	3	3	3	2	2	2		

2005 Travel Management Rule - Chequamegon-Nicolet National Forest												2										
2008 Lacey Act Amendment (Illegal Logging)																						
Bureau of Indian Affairs (BIA)																						
<u>Lac Courte Oreilles Indians v. State of Wis.</u>, 775 F.Supp. 321 (W.D.Wis. 1991) (the Voigt case)														3	3	3	1			2		2
President's Council on Sustainible Development (PCSD)																						
Executive Order Developing and Promoting Biobased Products and Bioenergy																						
Wis. Constitution, Art. I, s. 13 - Private property for public use.																						
Wis. Constitution, Art. VIII, s. 1 - Rule of taxation uniform; income, privilege and occupation taxes.	2						3	3	3									3	3	3	3	
Wis. Constitution, Art. VIII, s. 10 - Internal Improvements	1						1	3	1	2	1							2				
Wis. Constitution, Art. IX, s. 1 - Jurisdiction on rivers and lakes; navigable waters.																						
Wis. Constitution, Art. X, s. 7 - Commissioners of public lands.										3	1							3				
WSS s. 1.055 National Forest	1																					
WSS s. 1.056 State conservation areas	2																					
WSS s. 1.11 Governmental consideration of environmental impact.																						
WSS s. 1.12 State energy policy																				3	3	
WSS s. 1.13 Land use planning activities	3						3	3	3	3	2	3	3									
WSS s. 14.85 Mississippi River parkway commission			1				1				1	3								3		
WSS s. 15.105(26) Volunteer Fire Fighter and Emergency Medical Technician Service Award Board																						
WSS s. 15.107(16) Wisconsin Land Council																						
WSS s. 15.155(4) Rural Economic Development Board																						

WSS s. 15.157(13) Manufactured Housing Code Council																						
WSS s. 15.345(6) MFL Board																						
WSS s. 15.347 Council on Forestry		3																				
WSS s. 16.40(22) Sale of forest products at Fort McCoy.																						
WSS s. 16.54(11) Acceptance of Federal Funds																						
WSS Ch. 23 Conservation	2		2																			
WSS s. 23.09 Conservation	2		2				3		2		2			2	2	2	2	2	3	3	3	3
WSS s. 23.0915 Waren Knowles-Gaylord Nelson stewardship program	2		1				3	3	3	3	1			3	3	3	3	3			3	
WSS s. 23.0917 Waren Knowles-Gaylord Nelson stewardship 2000 program	2		1				3	3	3	3	1			3	3	3	3	3			3	
WSS s. 23.095 Protection of natural resources																						
WSS s. 23.0953 Grants to counties for land acquisition.																						
WSS s. 23.0956 Assistance for private conservation activities																						
WSS s. 23.0957(3) Annual grants to a nonstock, nonprofit corporation; urban land conservation.																						
WSS s. 23.097 Urban forestry grants							3					3	3									
WSS s. 23.10 Conservation Wardens															2		3					
WSS s. 23.11 General Powers																						
WSS s. 23.113 Designation of chief state forester																						
WSS s. 23.114 Duties of Chief State Forester																						
WSS s. 23.115 Designation of trails, etc.																						
WSS s. 23.117 Use of trails by bicycles and electric personal assistive mobility devices.																						
WSS s. 23.135 Forest land and inventory report																						
WSS s. 23.14 Approval required before new lands acquired.																						
WSS s. 23.15 Sale of state-owned lands under the jurisdiction of the department of natural resources																						
WSS s. 23.16 Periodicals																						
WSS s. 23.165 Promotional activites; other publications																						

WSS s. 23.22 Invasive species																						
WSS s. 23.235 Nuisance weeds.																						
WSS s. 23.26 Natural Areas Preservation Council																						
WSS s. 23.27 Natural areas; definitions; importance; inventory; acquisition; sales.																						
WSS s.23.28 State natural areas; designated state natural areas.																						
WSS s. 23.29 Wisconsin natural areas heritage programs																						
WSS s. 23.30 Outdoor recreation program																						
WSS s. 23.305 Leasing of Departent land for recreation.																						
WSS Ch. 24 Public Domain and the Trust Funds																						
WSS Ch. 26 Forest Protection	2			2	2	2													1		1	
WSS s. 26.01 Definition																						
WSS s. 26.02 Council on Forestry																						
WSS s. 26.03 Harvest of raw forest products.																						
WSS s. 26.05 Timber theft																						
WSS s. 26.06 Enforcement, seizure and sale of materials.																						
WSS s. 26.09 Civil liability for unauthorized cutting, removal or transportation of raw forest products.																						
WSS s. 26.11 Forest fires; department jurisdiction; procedure.																						
WSS s. 26.12 Forest protection areas, organization, emergency fire wardens, county cooperation, setting fire.																						
WSS s. 26.13 Town fire wardens; duties, expenses.																						
WSS s. 26.14 Forest fires, authority of fire fighters, compensation, penalties, civil liability.																						
WSS s. 26.145 Fire suppression aids.																						
WSS s. 26.18 District attorneys to prosecute.																						
WSS s. 26.19 Destruction of forest protection equipment or notices.																						
WSS s. 26.20 Fire protection devices.																						
WSS s. 26.205 Tractors, spark arresters.																						

WSS s. 26.21 Civil liability for forest fires.																						
WSS s. 26.30 Forest insects and diseases; department jurisdiction; procedure.																						
WSS s. 26.35 Forest productivity.																						
WSS s. 26.36 Forest energy resources.																						
WSS s. 26.37 Lake states wood utilization consortium.																						
WSS s. 26.38 Forest grant program.																						
WSS s. 26.39 Forestry education and training.																						
WSS s. 26.40 Forestry education grant program																						
WSS s. 26.97 Law enforcement and police power.																						
WSS Ch. 27 Public Parks and Places of Recreatoin																						
WSS Ch. 28 Public Forests	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1
WSS Ch. 29 Wild Animals and Plants	3	3	3	3	3	3	3	3	3	3	3			2	2	2	2	3		2		
WSS Ch. 30 Navigable Waters, Harbors and Navigation																						
WSS Ch. 32 Eminent Domain									3			1	3									
WSS Ch. 36 University of Wisconsin System																						
WSS Ch. 38 Technical College System																						
WSS Ch. 59 Counties; Subch. VII Land Use, Information and Regulation, Environmental Protection, Surveys, Planning an Zoning			3				2	2	1	2	2	2	1					2				
WSS Ch. 60 Towns; Subch. VIII Land Use and Planning.							2	2														
WSS Ch. 61 Villages							2	3														
WSS Ch. 62 Cities							3	3														
WSS Ch. 66 General Municipality Law																						
WSS Ch. 70 General Property Taxes							2	2		2												
WSS Ch. 71 Income and Franchise Taxes																						
WSS Ch. 77; Subch. I Taxation of Forest Croplands	2	2				2	1	2	2	1	1			3	3			2	2	2	2	
WSS Ch. 77; Subch. VI Managed Forest Land	2	2				2	1	2	2	1	1			3	2			2	2	2	2	
WSS Ch. 79 State Revenue Sharing	2	2					2	2	2	2												
WSS Ch. 82 Town Highways												1							3	3		
WSS Ch. 83 County Highways												1										

WSS Ch. 84 State Trunk Highways; Federal Aid												1										
WSS Ch. 85 Department of Transportation												1										
WSS Ch. 86 Miscellaneous Highway Provisions												1										
WSS Ch. 91 Farmland Preservation	3						3	3	3		3							3				
WSS Ch. 92 Soil and Water Conservation and Animal Waste Management																						
WSS Ch. 93 Department of Agriculture, Trade and Consumer Protection	3																					
WSS Ch. 94 Plant Industry																				3		3
WSS Ch. 96 Agricultural Marketing Act																						
WSS Ch. 101 Department of Commerce - Regulation of Industry, Buildings and Safety																				3		
WSS Ch. 102 Worker's Compensation																			3			
WSS s. 157.70 Burial sites preservation.																						
WSS Ch. 166 Emergency Management																						
WSS Ch. 167 Safeguards of Persons and Property																						
WSS Ch. 213 Police and Fire Fighting Service																						
WSS Ch. 227 Administrative Law																						
WSS Ch. 236 Platting Lands and Recording and Vacating Plats	2						2	2	2	1	2	2	1					3				
WSS Ch. 281 Water and Sewage																						
WSS Ch. 287 Solid Waste Reduction, Recovery and Recycling																			3	3	3	3
WSS Ch. 560 Department of Commerce						3													2	2	3	2
WSS Ch. 700 Interests in Property							1	1	1	1	1							1				
WSS Ch. 703 Condominiums	3						3	3	3	2	3	3	2					3				
WSS Ch. 751 Supreme Court																						
WSS Ch. 752 Court of Appeals																						
WSS Ch. 753 Circuit Courts																						
WSS Ch. 755 Municipal Court																						
WSS Ch. 779; Subch. II Other Liens																						
WSS Ch. 840 Real Property Actions; General Provisions																						
WSS Ch. 841 Declaration of Interest in Real Property																						
WSS Ch. 842 Partition of Interest in Real Property																						

WAC s. NR 30 Forest fire control																						
WAC s. NR 35 Zones for infestation of forest pests																						
WAC s. NR 37 Lower Wisconsin state riverway aesthetic management specifications for cutting and harvest of timber																						
WAC s. NR 44 Master planning for department properties	3	2																				
WAC s. NR 45 Use of state property																						
WAC s. NR 46 Forest tax program	2	2																		2		
WAC s. NR 47 Forestry grant and state aid administration	3																					
WAC s. NR 48 County forest withdrawal	2																					
WAC s. NR 50 Administration of outdoor recreation program grants and state aids																						
WAC s. NR 51 Administration of stewardship grants	3																					
WAC s. NR 55 Administration of federal payments in lieu of taxes (PILT)																						
WAC s. NR 58 Endangered resources grant programs																						
WAC s. NR 80 Use of pesticides on land and water areas of the state of Wisconsin																						
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WAC s. NR 102 Water quality standards for Wisconsin surface waters																						
WAC s. NR 103 Water quality standards for wetlands																						
WAC s. NR 115 Wisconsin's shoreland management program	3																					
WAC s. NR 117 Wisconsin's city and village shoreland-wetland protection program																						
WAC s. NR 118 Standards for the Lower St. Croix National Scenic Riverway	3																					
WAC s. NR 120 Nonpoint source pollution abatement program																						
WAC s. NR 121 Areawide water quality management plans																						
WAC s. NR 150 Environmental analysis and review procedures for department actions																						

WAC s. NR 151 Runoff management																						
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WAC s. NR 155 Urban nonpoint source water pollution abatement and storm water management grant program																						
WAC s. NR 185 Solid waste management planning criteria																						
WAC s. NR 191 Lake protection and classification grants																						
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WAC s. NR 502 Solid waste storage, transportation, transfer, incineration, air curtain destructors, processing, wood burning, composting and municipal solid waste combustors																						
WAC s. PSC 118 Renewable resource credit tracking program																						
WAC s. PSC 137 Energy efficiency and renewable resource programs.																						
WAC s. RB 1 Lower Wisconsin state riverway mission goals, objectives and definitions																						
WAC s. RB 2 Lower Wisconsin state riverway permit exclusions, exemptions and procedures	3																					
WAC s. Tax 3 Income taxation, deductions from gross income, exclusions and exemptions																						
WAC s. Tax 11 Sales and use tax																						
WAC s. Tax 12 Property tax	1																					

WAC s. Tax 18 Assessment of agricultural property	1																					
WAC s. TCS 16 Technical and occupational program grants																						
WAC s. TCS 17 Training program grants																						
WAC s. Trans-RR 1 Rustic roads																						
WAC s. Trans 202 Wisconsin scenic byways program																						
WAC s. Trans 214 Town road bridge standards																						
WAC s. Trans 230 Permits for loads exceeding size, weight, and vehicle combination limits																						
WAC s. Trans 250 Oversize and overweight permits for vehicles and loads																						
WAC s. Trans 251 Vehicle weight authorized by multiple trip permits																						
WAC s. Trans 253 Multiple trip overweight and oversize permits for vehicles operating near the Wisconsin-Michigan border																						
WAC s. Trans 254 Single trip permits for oversize or overweight vehicles or loads																						
WAC s. Trans 255 Multiple trip permits for oversize or overweight vehicles or loads																						
WAC s. Trans 259 Raw forest products, fruits or vegetables permits																						
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MC 1463 National Forest Wilderness Areas Access																						
MC 1605.1Environmental Analysis/Review																						
MC 1606.1 Wisconsin Environmental Policy Act (WEPA) for All DNR Actions																						
MC 1724.5 Handbook; Endangered Resources																						
MC 1750.2 - Natural Areas management	3																					

MC 1752.1 Permits for Collecting/Doing Research on State Natural Areas																						
MC 1805.1 Handbook; Ecological Landscapes																						
MC 1810.1 Historic Preservation																						
MC 2105.2 Feasibility Study/WEPA Analysis for Establishing or Modifying Property Boundaries																						
MC 2106.4 Resource Conservation and Development Program																						
MC 2112 Defining Forest-Wildlife Habitat Management Priorities																						
MC 2112.1Forest Opening Maintenance and Construction	3																					
MC 2205 Handbook; Land Acquisition and Sales																						
MC 2212 Department Property Boundaries																						
MC 2221.1 Road Discontinuances on State Properties																						
MC 2420.5 Handbook; Forestry Operations																						
MC 2425.5 Handbook; Forestry Law Enforcement																						
MC 2431.5 Handbook; Silviculture		2		1	1	1								2	2	2	2		2	2	2	3
MC 2450.5 Handbook; Forest Tax Law																						
MC 2460.5 Handbook; Public Forest Lands	3																					
MC 2461 Handbook; Timber Sale																						
MC 2465.4 Fuelwood Sale Permits on State-owned Lands																						
MC 2470.5 Handbook; Private Forestry																						
MC 2480.5 Handbook; Old Growth & Old Forests		2																				
MC 4105 Handbook; Law Enforcement																						
MC 4147.1 Reporting/Recording of Conservation Violations and Citizen Complaints																						
MC 4190.5 Handbook; Environmental Enforcement																						
MC 4305.1 Handbooks; Individual Forest Fire Report																						
MC 4310.5 Handbook; Fire Prevention	3																					
MC 4320.5 Handbook; Fire Presuppression	3																					
MC 4325.1 Handbook; Fire Management	3																					
MC 4360.5 Handbook; Prescribed Burn																						

MC 4370.5 Handbook; Cooperative Fire Control	3																					
MC 8103 Policy on Natural Resources Research																						
MC 8104.1 Centralized Research Program																						
MC 8104.3 Non-Department Research Projects																						
MC 9155.1 Handbook; Forestry Training																						
Forest Stewardship Council (FSC) certification	3				2	2	3	3	3		3			2	2	2	2	3	2	2	2	
Sustainable Forestry Initiative (SFI) certification	3				2	2	3	3	3		3			3	3	3	3	3	1	1	1	
International Organization for Standardization 14001 and 9001																						
The 1992 United Nations Conference on Environment on Development (UNCED) (Rio)	3																					
The 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto)	3																					

Summary of Legal and Institutional Structures - Criterion 7, Indicator 18, Tabel 18.1a

1 = high influence, 2 = moderate influence, 3 = some influence

	Criterion 3: Maintenance of Forest Ecosystem Health and Vitality										**Criterion 4: Conservation and Maintenance of Soil and Water Resources**									**Criterion 5: Carbon Cycles**			
	7. Area of forestland affected by potentially damaging agents					**8. Area and percent of forestland subject to levels of specific air pollutants that may cause negative impacts on forest ecosystems**	**9. Wildfire impacts on Forest Resource Sustainability**				**10. Soil and water quality in forested areas**						**11. Area of forestland adjacent to surface water and forest land by watershed**			**12. Forest ecosystem biomass and forest carbon pools**			
	7.1	7.2	7.3	7.4	7.5	8.1	9.1	9.2	9.3	9.4	10.1	10	10	10	11	11	11	11.2	11.3	12.1	12.2	12.3	12.4
U.S. Constitution, Art. I, s. 8 - Commerce Clause																							
U.S. Constitution, 5th Amendment - Takings Clause																							
Clean Air Act (CAA) (most recently amended 1990)					X		1			2													
Clean Water Act (CWA) (1972)																	3	3					
National Environmental Protection Act (NEPA) (1969)																							
Endangered Species Act (ESA) (1973)																				3			
National Energy Policy and Conservation Act (NEPCA) (1975)																							
Public Utility Regulatory Policies Act (PURPA) (1987)																							
Animal and Plant Health Inspection Services (APHIS)				1	1																		
Maine v. Taylor, 477 U.S. 131 (1986) (Supreme Court of the United States)				1																			
National Forests							2	3	2	2	3	2	3				2	2		2	2	2	
Resource Planning Act (RPA)(1974)																							
National Forest Management Act (NFMA)(1976)																							
Forest Legacy Program (FLP)																							
2005 Travel Management Rule - Chequamegon-Nicolet National Forest																							

2008 Lacey Act Amendment (Illegal Logging)																							
Bureau of Indian Affairs (BIA)																							
Lac Courte Oreilles Indians v. State of Wis., 775 F.Supp. 321 (W.D.Wis. 1991) (the Voigt case)					2						2	2	2	2	2	2				2	2	2	2
President's Council on Sustainible Development (PCSD)																							
Executive Order Developing and Promoting Biobased Products and Bioenergy																							
Wis. Constitution, Art. I, s. 13 - Private property for public use.																							
Wis. Constitution, Art. VIII, s. 1 - Rule of taxation uniform; income, privilege and occupation taxes.																							
Wis. Constitution, Art. VIII, s. 10 - Internal Improvements																							
Wis. Constitution, Art. IX, s. 1 - Jurisdiction on rivers and lakes; navigable waters.																	3	3	3				
Wis. Constitution, Art. X, s. 7 - Commissioners of public lands.																							
WSS s. 1.055 National Forest																							
WSS s. 1.056 State conservation areas																							
WSS s. 1.11 Governmental consideration of environmental impact.																							
WSS s. 1.12 State energy policy																				3	3	3	3
WSS s. 1.13 Land use planning activities																	3	3	3				
WSS s. 14.85 Mississippi River parkway commission																							
WSS s. 15.105(26) Volunteer Fire Fighter and Emergency Medical Technician Service Award Board							1			3													
WSS s. 15.107(16) Wisconsin Land Council																							
WSS s. 15.155(4) Rural Economic Development Board																							
WSS s. 15.157(13) Manufactured Housing Code Council																							
WSS s. 15.345(6) MFL Board																							
WSS s. 15.347 Council on Forestry																							

WSS s. 16.40(22) Sale of forest products at Fort McCoy.																							
WSS s. 16.54(11) Acceptance of Federal Funds																							
WSS Ch. 23 Conservation																							
WSS s. 23.09 Conservation		1	3	3	3	3					3	3	3	3	3	3	3	3		3			
WSS s. 23.0915 Waren Knowles-Gaylord Nelson stewardship program											3	3											
WSS s. 23.0917 Waren Knowles-Gaylord Nelson stewardship 2000 program											3	3											
WSS s. 23.095 Protection of natural resources																							
WSS s. 23.0953 Grants to counties for land acquisition.																							
WSS s. 23.0956 Assistance for private conservation activities																							
WSS s. 23.0957(3) Annual grants to a nonstock, nonprofit corporation; urban land conservation.																							
WSS s. 23.097 Urban forestry grants				3	3													3	2				
WSS s. 23.10 Conservation Wardens					1																		
WSS s. 23.11 General Powers																							
WSS s. 23.113 Designation of chief state forester																							
WSS s. 23.114 Duties of Chief State Forester																							
WSS s. 23.115 Designation of trails, etc.																							
WSS s. 23.117 Use of trails by bicycles and electric personal assistive mobility devices.																							
WSS s. 23.135 Forest land and inventory report																							
WSS s. 23.14 Approval required before new lands acquired.																							
WSS s. 23.15 Sale of state-owned lands under the jurisdiction of the department of natural resources																							
WSS s. 23.16 Periodicals																							
WSS s. 23.165 Promotional activites; other publications																							
WSS s. 23.22 Invasive species																							
WSS s. 23.235 Nuisance weeds.																							
WSS s. 23.26 Natural Areas Preservation Council																							

WSS s. 23.27 Natural areas; definitions; importance; inventory; acquisition; sales.																							
WSS s.23.28 State natural areas; designated state natural areas.																							
WSS s. 23.29 Wisconsin natural areas heritage programs																							
WSS s. 23.30 Outdoor recreation program																							
WSS s. 23.305 Leasing of Departent land for recreation.																							
WSS Ch. 24 Public Domain and the Trust Funds																							
WSS Ch. 26 Forest Protection		1		1	1																		
WSS s. 26.01 Definition																							
WSS s. 26.02 Council on Forestry																							
WSS s. 26.03 Harvest of raw forest products.																							
WSS s. 26.05 Timber theft																							
WSS s. 26.06 Enforcement, seizure and sale of materials.																							
WSS s. 26.09 Civil liability for unauthorized cutting, removal or transportation of raw forest products.																							
WSS s. 26.11 Forest fires; department jurisdiction; procedure.																							
WSS s. 26.12 Forest protection areas, organization, emergency fire wardens, county cooperation, setting fire.																							
WSS s. 26.13 Town fire wardens; duties, expenses.																							
WSS s. 26.14 Forest fires, authority of fire fighters, compensation, penalties, civil liability.																							
WSS s. 26.145 Fire suppression aids.																							
WSS s. 26.18 District attorneys to prosecute.																							
WSS s. 26.19 Destruction of forest protection equipment or notices.																							
WSS s. 26.20 Fire protection devices.																							
WSS s. 26.205 Tractors, spark arresters.																							
WSS s. 26.21 Civil liability for forest fires.																							
WSS s. 26.30 Forest insects and diseases; department jurisdiction; procedure.																							

WSS s. 26.35 Forest productivity.																							
WSS s. 26.36 Forest energy resources.																							
WSS s. 26.37 Lake states wood utilization consortium.																							
WSS s. 26.38 Forest grant program.																							
WSS s. 26.39 Forestry education and training.																							
WSS s. 26.40 Forestry education grant program																							
WSS s. 26.97 Law enforcement and police power.																							
WSS Ch. 27 Public Parks and Places of Recreatoin																							
WSS Ch. 28 Public Forests																	2	2		3	3	3	
WSS Ch. 29 Wild Animals and Plants																							
WSS Ch. 30 Navigable Waters, Harbors and Navigation											3						3	3	3				
WSS Ch. 32 Eminent Domain																			3				
WSS Ch. 36 University of Wisconsin System				3	3																		
WSS Ch. 38 Technical College System																							
WSS Ch. 59 Counties; Subch. VII Land Use, Information and Regulation, Environmental Protection, Surveys, Planning an Zoning																							
WSS Ch. 60 Towns; Subch. VIII Land Use and Planning.																							
WSS Ch. 61 Villages																							
WSS Ch. 62 Cities																							
WSS Ch. 66 General Municipality Law																							
WSS Ch. 70 General Property Taxes																							
WSS Ch. 71 Income and Franchise Taxes																							
WSS Ch. 77; Subch. I Taxation of Forest Croplands																				2	2		
WSS Ch. 77; Subch. VI Managed Forest Land																				2	2		
WSS Ch. 79 State Revenue Sharing																							
WSS Ch. 82 Town Highways																							
WSS Ch. 83 County Highways																							
WSS Ch. 84 State Trunk Highways; Federal Aid																							
WSS Ch. 85 Department of Transportation																							

WSS Ch. 86 Miscellaneous Highway Provisions																							
WSS Ch. 91 Farmland Preservation																3	3						
WSS Ch. 92 Soil and Water Conservation and Animal Waste Management																3	3						
WSS Ch. 93 Department of Agriculture, Trade and Consumer Protection				1	1																		
WSS Ch. 94 Plant Industry				1	1																		
WSS Ch. 96 Agricultural Marketing Act																							
WSS Ch. 101 Department of Commerce - Regulation of Industry, Buildings and Safety																							
WSS Ch. 102 Worker's Compensation																							
WSS s. 157.70 Burial sites preservation.																							
WSS Ch. 166 Emergency Management		1																					
WSS Ch. 167 Safeguards of Persons and Property																							
WSS Ch. 213 Police and Fire Fighting Service																							
WSS Ch. 227 Administrative Law																							
WSS Ch. 236 Platting Lands and Recording and Vacating Plats																							
WSS Ch. 281 Water and Sewage																3	3						
WSS Ch. 287 Solid Waste Reduction, Recovery and Recycling																			3	3	3	3
WSS Ch. 560 Department of Commerce																			3	3	3	3
WSS Ch. 700 Interests in Property																							
WSS Ch. 703 Condominiums																							
WSS Ch. 751 Supreme Court																							
WSS Ch. 752 Court of Appeals																							
WSS Ch. 753 Circuit Courts																							
WSS Ch. 755 Municipal Court																							
WSS Ch. 779; Subch. II Other Liens																							
WSS Ch. 840 Real Property Actions; General Provisions																							
WSS Ch. 841 Declaration of Interest in Real Property																							
WSS Ch. 842 Partition of Interest in Real Property																							
WSS Ch. 843 Actions for Possession of Real Property; Damages for Witholding																							

WSS Ch. 844 Interference with Interest; Physical Injury																							
WSS Ch. 846 Real Estate Foreclosure																							
WSS Ch. 847 Miscellaneous Real Estate Actions																							
WSS Ch. 893; Subch. III Actions Concerning Real or Personal Property																							
WSS s. 895.52 Recreational activities; limitation of property owners' liability.																							
WSS Ch. 943 Crimes Against Property		3																					
WSS s. 995.225 Fire Prevention Week		3																					
WAC s. ATCP 21 Plant Inspection and Pest Control																							
WAC s. ATCP 30 Pesticide product restrictions																							
WAC s. ATCP 40 Fertilizer and Related Products																							
WAC s. ATCP 50 Soil and Water Resource Management Program																							
WAC s. ATCP 140 Agricultural marketing orders, marketing agreements and marketing boards																							
WAC s. ATCP 161 Agricultural development and market promotion																							
WAC s. Comm 7 Explosives and fireworks																							
WAC s. Comm 116 Rural economic development program																							
WAC s. Comm 118 Agricultural development zone program																							
WAC s. EEB 2 Grants for environmental education programs																							
WAC s. KB 1 Kickapoo Valley Reserve management																							
WAC s. NR 12 Wildlife damage and nuisance control																							
WAC s. NR 13 Chippewa treaty rights participants																							
WAC s. NR 27 Endangered and threatened species																							
WAC s. NR 28 Wild plants																							
WAC s. NR 30 Forest fire control																							
WAC s. NR 35 Zones for infestation of forest pests																							

MC 1752.1 Permits for Collecting/Doing Research on State Natural Areas																							
MC 1805.1 Handbook; Ecological Landscapes																							
MC 1810.1 Historic Preservation																							
MC 2105.2 Feasibility Study/WEPA Analysis for Establishing or Modifying Property Boundaries																							
MC 2106.4 Resource Conservation and Development Program																							
MC 2112 Defining Forest-Wildlife Habitat Management Priorities																							
MC 2112.1Forest Opening Maintenance and Construction																							
MC 2205 Handbook; Land Acquisition and Sales																							
MC 2212 Department Property Boundaries																							
MC 2221.1 Road Discontinuances on State Properties																							
MC 2420.5 Handbook; Forestry Operations																							
MC 2425.5 Handbook; Forestry Law Enforcement																							
MC 2431.5 Handbook; Silviculture	2			2							3												
MC 2450.5 Handbook; Forest Tax Law																							
MC 2460.5 Handbook; Public Forest Lands																							
MC 2461 Handbook; Timber Sale																							
MC 2465.4 Fuelwood Sale Permits on State-owned Lands																							
MC 2470.5 Handbook; Private Forestry																							
MC 2480.5 Handbook; Old Growth & Old Forests																							
MC 4105 Handbook; Law Enforcement																							
MC 4147.1 Reporting/Recording of Conservation Violations and Citizen Complaints																							
MC 4190.5 Handbook; Environmental Enforcement																							
MC 4305.1 Handbooks; Individual Forest Fire Report																							
MC 4310.5 Handbook; Fire Prevention																							
MC 4320.5 Handbook; Fire Presuppression																							

MC 4325.1 Handbook; Fire Management																							
MC 4360.5 Handbook; Prescribed Burn																							
MC 4370.5 Handbook; Cooperative Fire Control																							
MC 8103 Policy on Natural Resources Research																							
MC 8104.1 Centralized Research Program																							
MC 8104.3 Non-Department Research Projects																							
MC 9155.1 Handbook; Forestry Training																							
Forest Stewardship Council (FSC) certification					3						2	2								2			
Sustainable Forestry Initiative (SFI) certification					3						2	3								2			
International Organization for Standardization 14001 and 9001																							
The 1992 United Nations Conference on Environment on Development (UNCED) (Rio)																							
The 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto)																				3	3	3	3

Summary of Legal and Institutional Structures - Criterion 7, Indicator 18, Table 18.1a	Criterion 6: Socioeconomic Benefits of Forests and their Ecosystem Services																										
1 = high influence, 2 = moderate influence, 3 = some influence	13. Wood and wood products production, consumption, and trade						14. Outdoor recreational participation and facilities					15. Investments in forest health, management, research, education, and wood processing							16. Forest ownership, land use, and specially designated areas							17. Employment and wages in forest-related sectors	
	13.1	13.2	13.3	13.4	14	13.6	14.1	14.2	14.3	14.4	14.5	15.1	15	15	15.4	15.5	15.6	15.7	16.1	16.2	16.3	16.4	17	17	16.7	17	17.2
	2	2	2	2	2	2																					
U.S. Constitution, Art. I, s. 8 - Commerce Clause																											
U.S. Constitution, 5th Amendment - Takings Clause																											
Clean Air Act (CAA) (most recently amended 1990)																											
Clean Water Act (CWA) (1972)																											
												1															
National Environmental Protection Act (NEPA) (1969)																											
Endangered Species Act (ESA) (1973)																											
	3				2																						
National Energy Policy and Conservation Act (NEPCA) (1975)	3				2																						
Public Utility Regulatory Policies Act (PURPA) (1987)																											
														2													
Animal and Plant Health Inspection Services (APHIS)																											
<u>Maine v. Taylor</u>, 477 U.S. 131 (1986) (Supreme Court of the United States)																											
	3	2	2				1	1	2	1	1	1		1						1	1						3
National Forests																											
												2		2													
Resource Planning Act (RPA)(1974)																											
National Forest Management Act (NFMA)(1976)		3	3				2					1	1						2	1			1				
Forest Legacy Program (FLP)																											
2005 Travel Management Rule - Chequamegon-Nicolet National Forest	3	3	3			2																					

2008 Lacey Act Amendment (Illegal Logging)																											
Bureau of Indian Affairs (BIA)							3	3													3						
<u>Lac Courte Oreilles Indians v. State of Wis.</u>, 775 F.Supp. 321 (W.D.Wis. 1991) (the Voigt case)																											
President's Council on Sustainible Development (PCSD)																											
Executive Order Developing and Promoting Biobased Products and Bioenergy																											
									2	2				2									3				
Wis. Constitution, Art. I, s. 13 - Private property for public use.	3	3	3										1		3				3	2			2	1	1		
Wis. Constitution, Art. VIII, s. 1 - Rule of taxation uniform; income, privilege and occupation taxes.								2					1						3	2	1	1	2		1		
Wis. Constitution, Art. VIII, s. 10 - Internal Improvements							1																				
Wis. Constitution, Art. IX, s. 1 - Jurisdiction on rivers and lakes; navigable waters.																				2	1	2					
Wis. Constitution, Art. X, s. 7 - Commissioners of public lands.																											
																				1	1						
WSS s. 1.055 National Forest																											
WSS s. 1.056 State conservation areas																											
WSS s. 1.11 Governmental consideration of environmental impact.	3		3		3	3								3	3												
WSS s. 1.12 State energy policy	3																		3	3	3	3		3			
WSS s. 1.13 Land use planning activities							2															1	2				
WSS s. 14.85 Mississippi River parkway commission																											
WSS s. 15.105(26) Volunteer Fire Fighter and Emergency Medical Technician Service Award Board																					3						
WSS s. 15.107(16) Wisconsin Land Council		3																								3	3
WSS s. 15.155(4) Rural Economic Development Board	2		3																								
WSS s. 15.157(13) Manufactured Housing Code Council																					3	3	1				
WSS s. 15.345(6) MFL Board																											
WSS s. 15.347 Council on Forestry																											

WSS s. 16.40(22) Sale of forest products at Fort McCoy.																					3						
WSS s. 16.54(11) Acceptance of Federal Funds																											
WSS Ch. 23 Conservation							3	3	2	2				2		2				3	2	2	2	2	2		
WSS s. 23.09 Conservation		3	3				2	2		2			2							3		1	1				
WSS s. 23.0915 Waren Knowles-Gaylord Nelson stewardship program		3	3				2	2		2			2							3		1	1				
WSS s. 23.0917 Waren Knowles-Gaylord Nelson stewardship 2000 program																											
WSS s. 23.095 Protection of natural resources																											
WSS s. 23.0953 Grants to counties for land acquisition.																											
WSS s. 23.0956 Assistance for private conservation activities																											
WSS s. 23.0957(3) Annual grants to a nonstock, nonprofit corporation; urban land conservation.													1						3	3							3
WSS s. 23.097 Urban forestry grants							1			2																	
WSS s. 23.10 Conservation Wardens																											
WSS s. 23.11 General Powers																											
WSS s. 23.113 Designation of chief state forester																											
WSS s. 23.114 Duties of Chief State Forester																											
WSS s. 23.115 Designation of trails, etc.																											
WSS s. 23.117 Use of trails by bicycles and electric personal assistive mobility devices.																											
WSS s. 23.135 Forest land and inventory report																											
WSS s. 23.14 Approval required before new lands acquired.																											
WSS s. 23.15 Sale of state-owned lands under the jurisdiction of the department of natural resources																											
WSS s. 23.16 Periodicals																											
WSS s. 23.165 Promotional activites; other publications																											
WSS s. 23.22 Invasive species																											
WSS s. 23.235 Nuisance weeds.																											
WSS s. 23.26 Natural Areas Preservation Council																											
WSS s. 23.27 Natural areas; definitions; importance; inventory; acquisition; sales.																											

WSS s.23.28 State natural areas; designated state natural areas.																											
WSS s. 23.29 Wisconsin natural areas heritage programs																											
WSS s. 23.30 Outdoor recreation program																											
WSS s. 23.305 Leasing of Departent land for recreation.																											
WSS Ch. 24 Public Domain and the Trust Funds	2	2	2										1				3	3									3
WSS Ch. 26 Forest Protection																											
WSS s. 26.01 Definition																											
WSS s. 26.02 Council on Forestry																											
WSS s. 26.03 Harvest of raw forest products.																											
WSS s. 26.05 Timber theft																											
WSS s. 26.06 Enforcement, seizure and sale of materials.																											
WSS s. 26.09 Civil liability for unauthorized cutting, removal or transportation of raw forest products.																											
WSS s. 26.11 Forest fires; department jurisdiction; procedure.																											
WSS s. 26.12 Forest protection areas, organization, emergency fire wardens, county cooperation, setting fire.																											
WSS s. 26.13 Town fire wardens; duties, expenses.																											
WSS s. 26.14 Forest fires, authority of fire fighters, compensation, penalties, civil liability.																											
WSS s. 26.145 Fire suppression aids.																											
WSS s. 26.18 District attorneys to prosecute.																											
WSS s. 26.19 Destruction of forest protection equipment or notices.																											
WSS s. 26.20 Fire protection devices.																											
WSS s. 26.205 Tractors, spark arresters.																											
WSS s. 26.21 Civil liability for forest fires.																											
WSS s. 26.30 Forest insects and diseases; department jurisdiction; procedure.																											
WSS s. 26.35 Forest productivity.																											
WSS s. 26.36 Forest energy resources.																											
WSS s. 26.37 Lake states wood utilization consortium.																											
WSS s. 26.38 Forest grant program.																											

WSS s. 26.39 Forestry education and training.																											
WSS s. 26.40 Forestry education grant program																											
WSS s. 26.97 Law enforcement and police power.																											
WSS Ch. 27 Public Parks and Places of Recreatoin		2	2		1	1	1	1	1	1	1		1	1			2	2	2	2	1				1	2	2
WSS Ch. 28 Public Forests							1																				
WSS Ch. 29 Wild Animals and Plants							1																				
WSS Ch. 30 Navigable Waters, Harbors and Navigation																											
WSS Ch. 32 Eminent Domain													3	2			1	1								1	1
WSS Ch. 36 University of Wisconsin System													1	2			1	1								1	1
WSS Ch. 38 Technical College System								1	2	1											1						
WSS Ch. 59 Counties; Subch. VII Land Use, Information and Regulation, Environmental Protection, Surveys, Planning an Zoning								3													3						
WSS Ch. 60 Towns; Subch. VIII Land Use and Planning.								3													3						
WSS Ch. 61 Villages								3													3						
WSS Ch. 62 Cities																											
WSS Ch. 66 General Municipality Law																											
WSS Ch. 70 General Property Taxes	3	3	2	3																							
WSS Ch. 71 Income and Franchise Taxes		2				1		1					1						1	1				1		2	2
WSS Ch. 77; Subch. I Taxation of Forest Croplands		2				1		2					1						1	1				1	1	2	2
WSS Ch. 77; Subch. VI Managed Forest Land																			2	2				2			
WSS Ch. 79 State Revenue Sharing	3	3	3																								
WSS Ch. 82 Town Highways																											
WSS Ch. 83 County Highways																											
WSS Ch. 84 State Trunk Highways; Federal Aid																											
WSS Ch. 85 Department of Transportation																											
WSS Ch. 86 Miscellaneous Highway Provisions																											
WSS Ch. 91 Farmland Preservation																											
WSS Ch. 92 Soil and Water Conservation and Animal Waste Management													3	3													
WSS Ch. 93 Department of Agriculture, Trade and Consumer Protection													3	3													
WSS Ch. 94 Plant Industry					3																						

WSS Ch. 96 Agricultural Marketing Act	2	2				2								3												1	
WSS Ch. 101 Department of Commerce - Regulation of Industry, Buildings and Safety		2	2																								1
WSS Ch. 102 Worker's Compensation																											
WSS s. 157.70 Burial sites preservation.																											
WSS Ch. 166 Emergency Management																											
WSS Ch. 167 Safeguards of Persons and Property																											
WSS Ch. 213 Police and Fire Fighting Service																											
WSS Ch. 227 Administrative Law																			3	3							
WSS Ch. 236 Platting Lands and Recording and Vacating Plats																											
WSS Ch. 281 Water and Sewage	3				3																						
WSS Ch. 287 Solid Waste Reduction, Recovery and Recycling	3				3								3	3													
WSS Ch. 560 Department of Commerce																			1	1	3	2	2				
WSS Ch. 700 Interests in Property																			3	3							
WSS Ch. 703 Condominiums																											
WSS Ch. 751 Supreme Court																											
WSS Ch. 752 Court of Appeals																											
WSS Ch. 753 Circuit Courts																											
WSS Ch. 755 Municipal Court	1	3	3			2																					
WSS Ch. 779; Subch. II Other Liens																				1							
WSS Ch. 840 Real Property Actions; General Provisions																				1							
WSS Ch. 841 Declaration of Interest in Real Property																				1							
WSS Ch. 842 Partition of Interest in Real Property																				1							
WSS Ch. 843 Actions for Possession of Real Property; Damages for Witholding																				1							
WSS Ch. 844 Interference with Interest; Physical Injury																				1							
WSS Ch. 846 Real Estate Foreclosure																				1							
WSS Ch. 847 Miscellaneous Real Estate Actions																				1			1				
WSS Ch. 893; Subch. III Actions Concerning Real or Personal Property							1	1												1							
WSS s. 895.52 Recreational activities; limitation of property owners' liability.																				2							
WSS Ch. 943 Crimes Against Property																											
WSS s. 995.225 Fire Prevention Week																											

MC 2212 Department Property Boundaries																											
MC 2221.1 Road Discontinuances on State Properties																											
MC 2420.5 Handbook; Forestry Operations																											
MC 2425.5 Handbook; Forestry Law Enforcement	3	3	3			2																					
MC 2431.5 Handbook; Silviculture																											
MC 2450.5 Handbook; Forest Tax Law																											
MC 2460.5 Handbook; Public Forest Lands																											
MC 2461 Handbook; Timber Sale																											
MC 2465.4 Fuelwood Sale Permits on State-owned Lands																											
MC 2470.5 Handbook; Private Forestry																											
MC 2480.5 Handbook; Old Growth & Old Forests																											
MC 4105 Handbook; Law Enforcement																											
MC 4147.1 Reporting/Recording of Conservation Violations and Citizen Complaints																											
MC 4190.5 Handbook; Environmental Enforcement																											
MC 4305.1 Handbooks; Individual Forest Fire Report																											
MC 4310.5 Handbook; Fire Prevention																											
MC 4320.5 Handbook; Fire Presuppression																											
MC 4325.1 Handbook; Fire Management																											
MC 4360.5 Handbook; Prescribed Burn																											
MC 4370.5 Handbook; Cooperative Fire Control																											
MC 8103 Policy on Natural Resources Research																											
MC 8104.1 Centralized Research Program																											
MC 8104.3 Non-Department Research Projects																											
MC 9155.1 Handbook; Forestry Training																											
	2					1																			1		
Forest Stewardship Council (FSC) certification	2					1																			1		

Sustainable Forestry Initiative (SFI) certification																											
International Organization for Standardization 14001 and 9001																											
The 1992 United Nations Conference on Environment on Development (UNCED) (Rio)	3				3																						
The 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto)																											

Summary of Legal and Institutional Structures - Criterion 7, Indicator 18, Tabel 18.1a

1 = high influence, 2 = moderate influence, 3 = some influence

	Criterion 7: Legal and Institutional Framework for Forest Conservation and Sustainable Management						
	18. Extent to which the legal and institutional structure supports the sustainable management of forests			**19. Forest-related planning and assessment**			
	18.1	18.2	18.3	19.1	19.2	19.3	19.4
U.S. Constitution, Art. I, s. 8 - Commerce Clause							
U.S. Constitution, 5th Amendment - Takings Clause							
Clean Air Act (CAA) (most recently amended 1990)							
Clean Water Act (CWA) (1972)							
							1
National Environmental Protection Act (NEPA) (1969)							
Endangered Species Act (ESA) (1973)							
National Energy Policy and Conservation Act (NEPCA) (1975)							
Public Utility Regulatory Policies Act (PURPA) (1987)							
Animal and Plant Health Inspection Services (APHIS)							
Maine v. Taylor, 477 U.S. 131 (1986) (Supreme Court of the United States)							
National Forests							
Resource Planning Act (RPA)(1974)							
National Forest Management Act (NFMA)(1976)							
Forest Legacy Program (FLP)							
2005 Travel Management Rule - Chequamegon-Nicolet National Forest							
2008 Lacey Act Amendment (Illegal Logging)							
Bureau of Indian Affairs (BIA)							2

Lac Courte Oreilles Indians v. State of Wis., 775 F.Supp. 321 (W.D.Wis. 1991) (the Voigt case)							
President's Council on Sustainible Development (PCSD)							
Executive Order Developing and Promoting Biobased Products and Bioenergy							
Wis. Constitution, Art. I, s. 13 - Private property for public use.				1	2	1	
Wis. Constitution, Art. VIII, s. 1 - Rule of taxation uniform; income, privilege and occupation taxes.				1			
Wis. Constitution, Art. VIII, s. 10 - Internal Improvements							
Wis. Constitution, Art. IX, s. 1 - Jurisdiction on rivers and lakes; navigable waters.							
Wis. Constitution, Art. X, s. 7 - Commissioners of public lands.							
WSS s. 1.055 National Forest							
WSS s. 1.056 State conservation areas				1			
WSS s. 1.11 Governmental consideration of environmental impact.							
WSS s. 1.12 State energy policy				3	3	3	3
WSS s. 1.13 Land use planning activities				3	3		3
WSS s. 14.85 Mississippi River parkway commission							3
WSS s. 15.105(26) Volunteer Fire Fighter and Emergency Medical Technician Service Award Board				3			
WSS s. 15.107(16) Wisconsin Land Council			2				
WSS s. 15.155(4) Rural Economic Development Board							
WSS s. 15.157(13) Manufactured Housing Code Council					3	3	2
WSS s. 15.345(6) MFL Board							
WSS s. 15.347 Council on Forestry							
WSS s. 16.40(22) Sale of forest products at Fort McCoy.							1
WSS s. 16.54(11) Acceptance of Federal Funds							
WSS Ch. 23 Conservation	1	1	1	1	3		3
WSS s. 23.09 Conservation							

Priority Landscapes & Issues

This section describes priority landscapes and issues the state has identified in order to meet a Farm Bill requirement. It begins with a description of what priority landscapes and issues are, how they were developed, and what the intent of these areas is. The Wisconsin priority areas are described followed by the multi-state priority areas and issues.

Farm Bill requirement
The Farm Bill requires states to describe areas or regions of the state that are a state priority and any multi-state areas that are a regional priority. We must identify, describe, and spatially define (if possible and appropriate) forest landscape areas or issues where outreach and activity will be emphasized. Identification of these priority areas is intended to (1) enable the efficient, strategic, and focused use of limited resources; (2) address current state and national resource management priorities; and (3) produce the most benefit in terms of critical forest resource values and public benefits. Regional and multi-state priority landscapes or issues are where states can share resources to address regional threats and opportunities.

The Forest Service developed three national themes with associated objectives to identify where and how the USDA Forest Service, State & Private Forestry Unit (S&PF) resources should be focused in order to make the most significant progress in providing diverse and sustainable public benefits from trees and forests. (For more information on the themes and how they relate to the "Assessment" & "Strategy", see: http://www.fs.fed.us/spf/redesign/index.shtml) The three national themes are set in law as national priorities and the State Assessments and Strategies are required and are central to S&PF program delivery. Each national priority has several objectives and performance measures on which states need to report.

The national priorities are:
1. Conserve and manage working forest landscapes for multiple values and uses.
2. Protect forests from threat.
3. Enhance public benefits from trees and forests.

Each of the goals and strategies in the "Strategy" implement one or more of the national priorities and achieve the objectives. Recognizing the importance of the national priorities and the goals in the Statewide Forest "Strategy", the Division of Forestry identified six issues that could be USED TO prioritize strategies and actions (not all geospatially). The priority landscapes can then be used to focus action and achieve state and national objectives.

Application of priority landscapes and issues
Using regional or landscape-level prioritizations is not a new concept in Wisconsin. Several models and programs already exist, such as the Wisconsin Wildlife Action Plan, which identifies prioritized areas to conserve species of greatest conservation need. Another example is the Forest Legacy Program, which prioritizes and protects

environmentally important forest areas that are threatened by conversion to non-forest uses through acquisition of conservation easements or fee title. With limited resources, it is necessary to prioritize areas or issues to address. By prioritizing landscapes and issues, people working on forest issues in the state are better prepared to identify areas where implementing particular strategies and actions would be most effective.

Wisconsin DNR's Division of Forestry receives funds from the S&PF to assist the state in delivering urban and community forestry, health, fire, and private forest stewardship programs. Many of the strategies identify possible actions these programs can implement. Priority areas will assist these programs and their partners in focusing where federal dollars are spent. Each of these maps can assist in identifying where to implement multiple strategies that have different but complementary objectives. The following are examples from the urban, fire, and forest management maps.

1) The map, 'Increasing Urban Forest Canopy Cover,' could be used to identify areas that need to increase their canopy as well as areas that have greater than average canopy and require management assistance to support it.
2) The map, 'Reducing Wildfire Risk Across the State,' could be used to identify areas where the greatest suppression efforts are needed as well as areas of less risk that might benefit from increased training of local fire departments to be able to respond when needed.
3) The map, 'Actively and Sustainably Managing Forests,' could be used to identify large forest patches that can provide needed recreation opportunities for a region as well as small forest patches that are a part of a Conservation Opportunity Area (as identified in the Wildlife Action Plan).

Through a S&PF competitive grant program, states can receive additional federal funding. The projects funded with these grants should demonstrate that federal funds are being spent on projects that address both nationally and regionally significant issues or landscapes, as described by the National Priorities, and that hold the greatest promise for success. Projects may be on any combination of land ownerships except federal lands. Projects funded are based on an analysis within the state or region that identifies the issue or landscape being addressed as a priority in the "Assessment" and "Strategy". Other state or regional assessments and plans, including those completed by other agencies or partners, will also be used to help identify priority issues or landscapes.

Developing priority landscapes

We show, through a combination of maps and narrative descriptions, how Wisconsin is prioritizing landscapes and issues that our "Strategy" will address. It's important to remember that some of the issues we face in the state are not landscape or geospatially based (e.g., remaining competitive in a global forest industry market). Not all of our issues can be mapped (e.g., parcel size due to lack of geospatial data).

Criteria were selected to prioritize each issue. Almost all of these criteria have been used in recent prioritizations the Division or partners have done. The Division of

Forestry's Fire Assessment and a federally initiated project called the Spatial Analysis Project that identified priority private lands for stewardship potential used many of the criteria in the following maps. These criteria have been vetted by many specialists as part of these and other projects. The narratives that accompany each map explain the criteria used to prioritize the areas.

When looking at the maps of priority landscapes, it is important to remember that not all variables can be mapped and there may be more areas than those shown on the map. The elements that could not be mapped do not have geographical data. These are described in the narrative. Furthermore, within one map, areas may be prioritized for different reasons.

A basic explanation for how each map was developed is included in the narrative for each priority landscape. Generally, maps were developed in one of three ways: 1) criteria are weighted by the percent of influence (e.g., fire analysis), 2) criteria are presented on the map where they exist without adding weights or points (e.g., urban canopy cover), and 3) each criterion is given a score (e.g. 1- 3 points, 3 being the highest value) and if an area represents one or more criterion, then the scores are added together and the area's final point total is represented on the map (e.g., economic benefits). Detailed GIS methodology is available on request.

The following are six issues that we have identified priority landscapes for.

1. Managing and reducing threats to forest and ecosystem health

2. Urban forests:
    (a) Increasing urban forest canopy cover
    (b) Improving communities urban forest management

3. Wildfire
    (a) Reducing wildfire risk across the state
    (b) Assisting communities at risk of wildfire

4. Actively and sustainably managing forests

5. Managing for ecosystem services

6. Maintaining and enhancing economic benefits from forests.

Wisconsin priority landscapes

1. Managing and reducing threats to forest and ecosystem health.

Throughout the state, Wisconsin's forests are at risk of mortality from both native and exotic insects and diseases, invasive plants, deer, damaging storms, climate and air pollutants. The threats to forest trees have long played an important role in forest succession, reducing tree density in overstocked stands, creating openings in the canopy that encourage successful regeneration and providing down woody material. In some cases, tree diseases or insect infestations can cause such high levels of mortality that a species may be reduced to only a few individuals on a site or over an extensive area. This map, considered with other information from research, surveys and monitoring, helps determine which issues are the most critical to address.

The following criteria identify areas at risk of experiencing 25% or more tree mortality over 15 years from a combination of insects and diseases.

Insects and Disease: Native forest insects and diseases contributing to risk of mortality include forest tent caterpillar, jack pine budworm, red pine pocket mortality and pine bark beetle. Exotic insects and diseases contributing to risk of mortality include gypsy moth, hemlock woolly adelgid, beech bark disease, sudden oak death, oak wilt and emerald ash borer.

In order to evaluate risk for any particular insect or disease, a list of contributing factors needs to be determined. Factors are different for each insect and disease. Sources of input factors include census data (population density, median housing value, density of campgrounds), species density maps (normal range, canopy cover or basal area maps), climate data (mean annual temperature or precipitation), historical presence of the particular disease or insect in the area, and habitat type. Once these factors are weighted, every acre of land then has a value representing the overall risk of the particular disease or insect occurring on that acre.

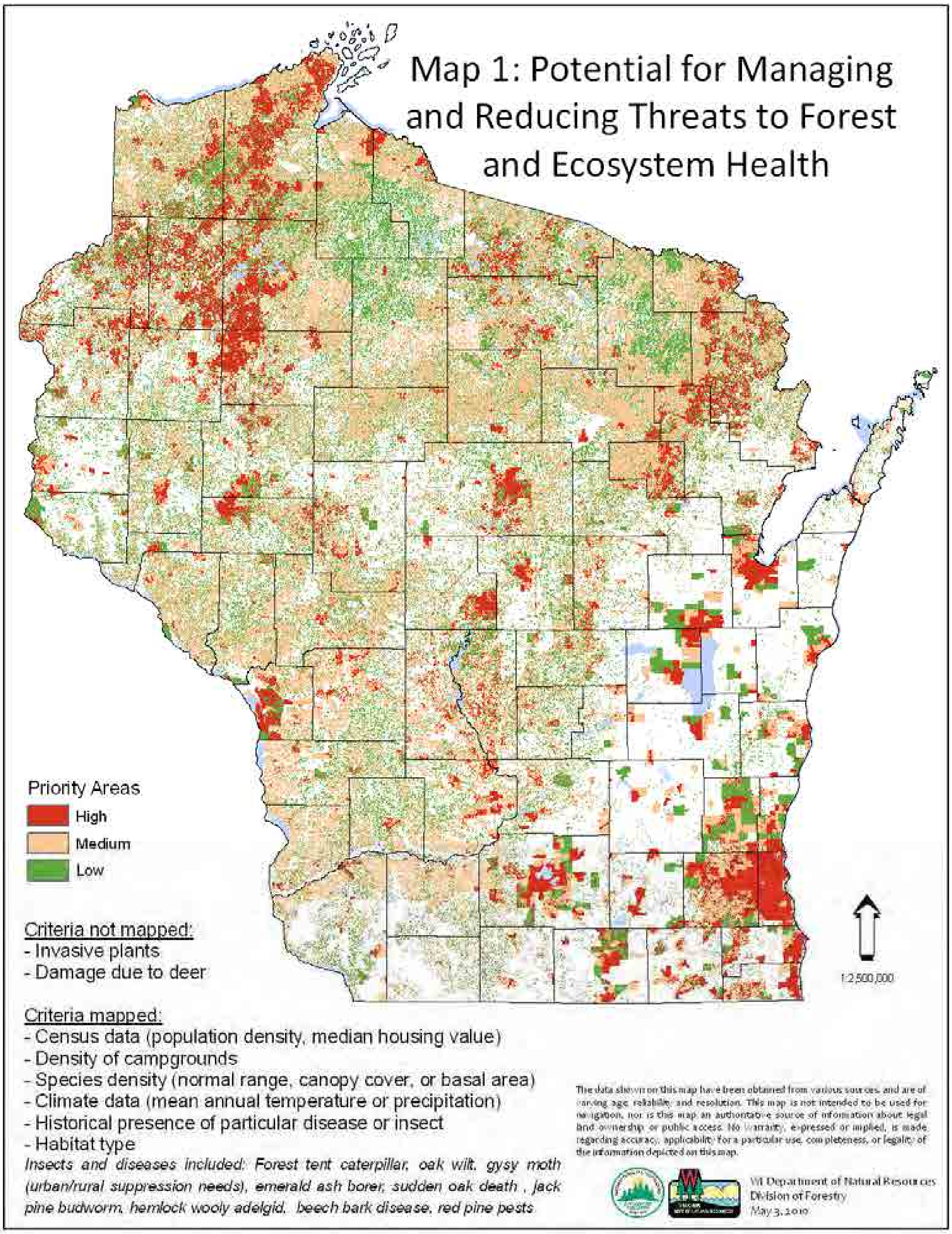
Invasive Plants (not mapped): Some threats, such as invasive plants, have not been consistently mapped to date. Efforts are underway for a coordinated database of species present and their location. There are three basic principles that apply to invasive plant prioritization efforts: prevention, rapid response, and control. Depending on what species and threat to a location is being considered, the action and area for addressing the species will be different. At this point in time, these are difficult variables to map.

Invasive Species Identification, Classification and Control rules (NR40) act as a prioritization tool in that the two regulatory categories, prohibited and restricted, determine the course of action upon discovery. Prohibited species are intended to be controlled and ideally eradicated, whereas restricted species are not, although control is encouraged. Similarly, if an invasive species is detected in an area not previously found, rapid response to attempt to eradicate or at least manage the population is important to limit the spread.

Prioritization of control efforts for a particular invasive plant species is based on the potential threat to a site, as follows.

- State Natural Areas
- Conservation lands- those owned and managed by Federal, State, County and Local governments and agencies.
- Critical plant community types under greatest threat of spread (i.e. barrons, black spruce swamp, etc).
- Populations along rivers for those species that easily spread via water.

Deer (not mapped): Another criterion that is difficult to map is deer damage to forest regeneration due to over-browsing. There are several trials across the state that have documented the connection between deer and forest health but no statewide data exist. Possible proxy data to use are locations where deer populations are over goal (See a map of over population areas at: http://dnr.wi.gov/org/land/wildlife/hunt/deer/post_hunt_pop.pdf). Deer can cause forest damage anywhere, but over-populated areas could have a greater impact on forest regeneration.



Map 1: Potential for Managing and Reducing Threats to Forest and Ecosystem Health
Priority Areas
High
Medium
Low
1:2,500,000
Criteria not mapped:
- Invasive plants
- Damage due to deer
Criteria mapped:
- Census data (population density, median housing value)
- Density of campgrounds
- Species density (normal range, canopy cover, or basal area)
- Climate data (mean annual temperature or precipitation)
- Historical presence of particular disease or insect
- Habitat type
Insects and diseases included: Forest tent caterpillar, oak wilt, gysy moth (urban/rural suppression needs), emerald ash borer, sudden oak death , jack pine budworm, hemlock wooly adelgid, beech bark disease, red pine pests
The data shown on this map have been obtained from various sources, and are of varying age, reliability and resolution. This map is not intended to be used for navigation, nor is this map an authoritative source of information about legal land ownership or public access. No warranty, expressed or implied, is made regarding accuracy, applicability for a particular use, completeness, or legality of the information depicted on this map.
WI Department of Natural Resources
Division of Forestry
May 3, 2010

2. Urban forests:

(a) Increasing urban forest canopy cover

(b) Improving communities urban forest management

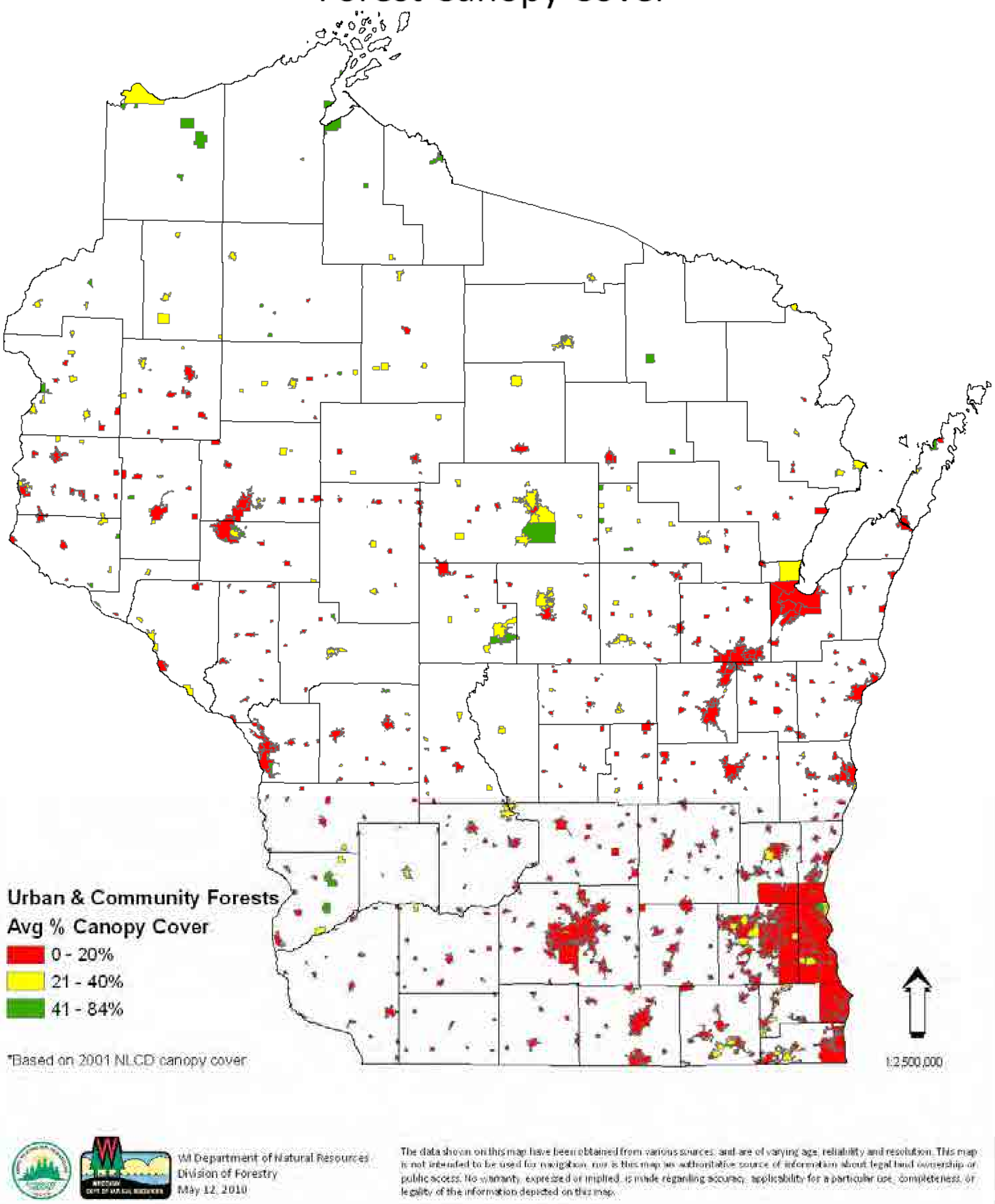
Wisconsin's urban forests are a significant resource. They cover about 5% of the state's land area and are home to about 80% of the state's population as measured in 2002. The amount of urban forest is increasing as agricultural and forest lands are converted to development. Forecasts predict urban land in the state will grow to 8.3% of the land area by 2050.

<u>Canopy cover:</u> The average urban tree canopy statewide is low compared to many other states with similar ecotypes. There is an opportunity to fill vacant planting space and manage existing trees to increase canopy cover in urban forests. Map 2 (a) shows average canopy cover in urban communities across the state. The national benchmark for canopy cover is 40%. This map highlights areas under 40% that should be prioritized for increased canopy cover. Canopy cover can fluctuate with changes in land use. Conversion of agricultural or other open land to development will initially decrease average canopy statewide, but these areas offer the greatest opportunity for planting and increasing overall tree canopy over time. Conversion of forest land to urban forest will increase overall average urban tree canopy at the expense of rural forests.

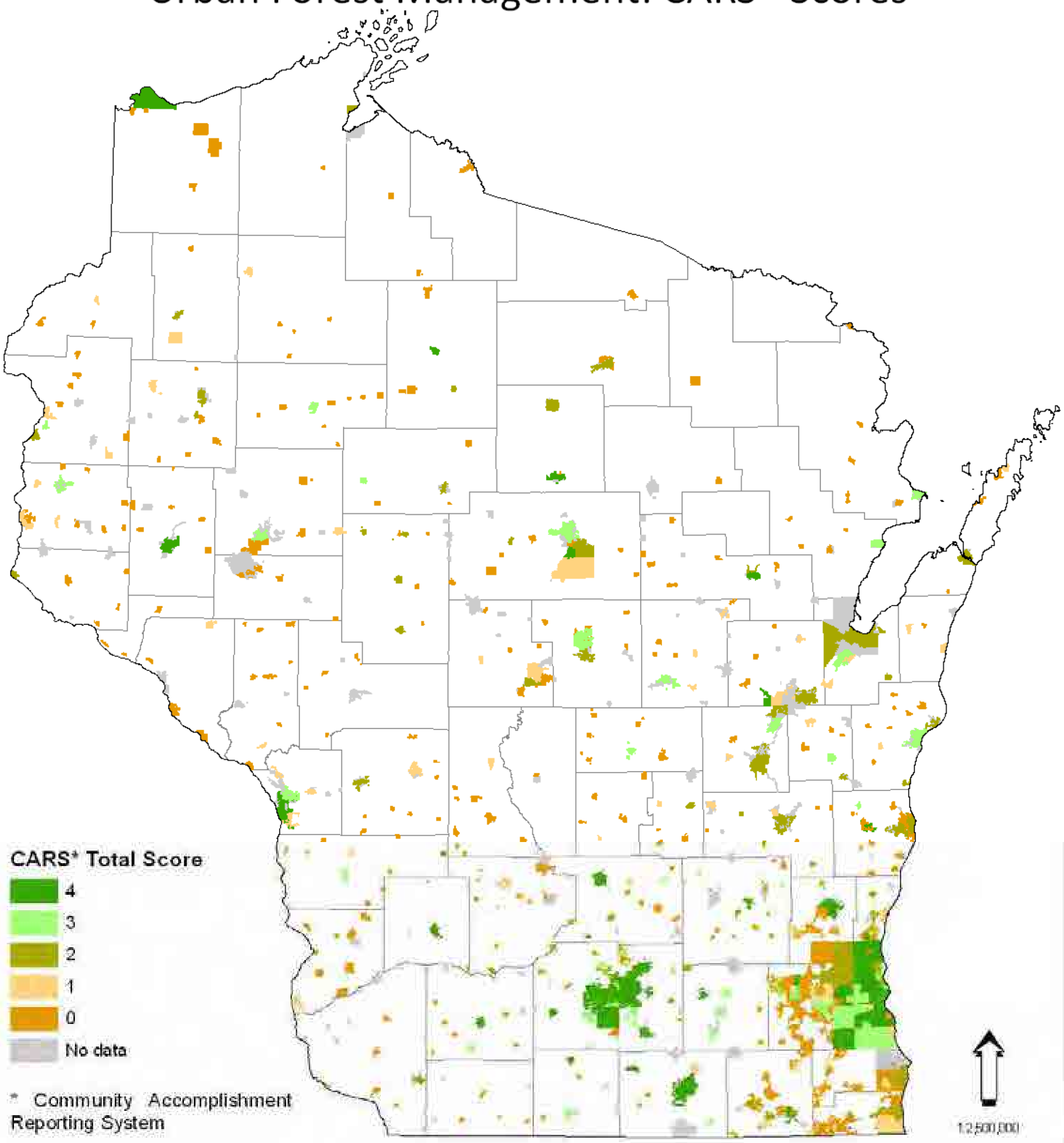
<u>Urban forest management</u>: Good urban forest management includes up-to-date inventories that support operational plans. While there has been a steady increase in communities that have urban forest inventories over the last 16 years, two-thirds of Wisconsin communities still lack an inventory of their resource. The number of communities with some type of urban forestry plan increased somewhat since 1992, however this still represents less than one-third of Wisconsin communities.

Map 2 (b) shows urban and community 'Accomplishments Reporting System' (CARS) scores. This national scoring system identifies communities that have one or more of the following attributes: an active urban and community tree and forest management plan; a professional forestry staff; ordinances or policies that focus on planting, protecting and maintaining their urban and community trees and forests; and an Advisory Organization that advocates or advises on urban forestry related issues within the community. A score of one means they have any one of the attributes, and a score of four means they have all. Depending on a community's score, and which attribute is missing, this map assists prioritizing different strategies for different areas.

Map 2 (a): Potential for Increasing Urban Forest Canopy Cover



Map 2 (b): Potential for Improving Communities Urban Forest Management: CARS* Scores



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3. Wildfire

(a) Reducing wildfire risk across the state

(b) Assisting communities at risk of wildfire

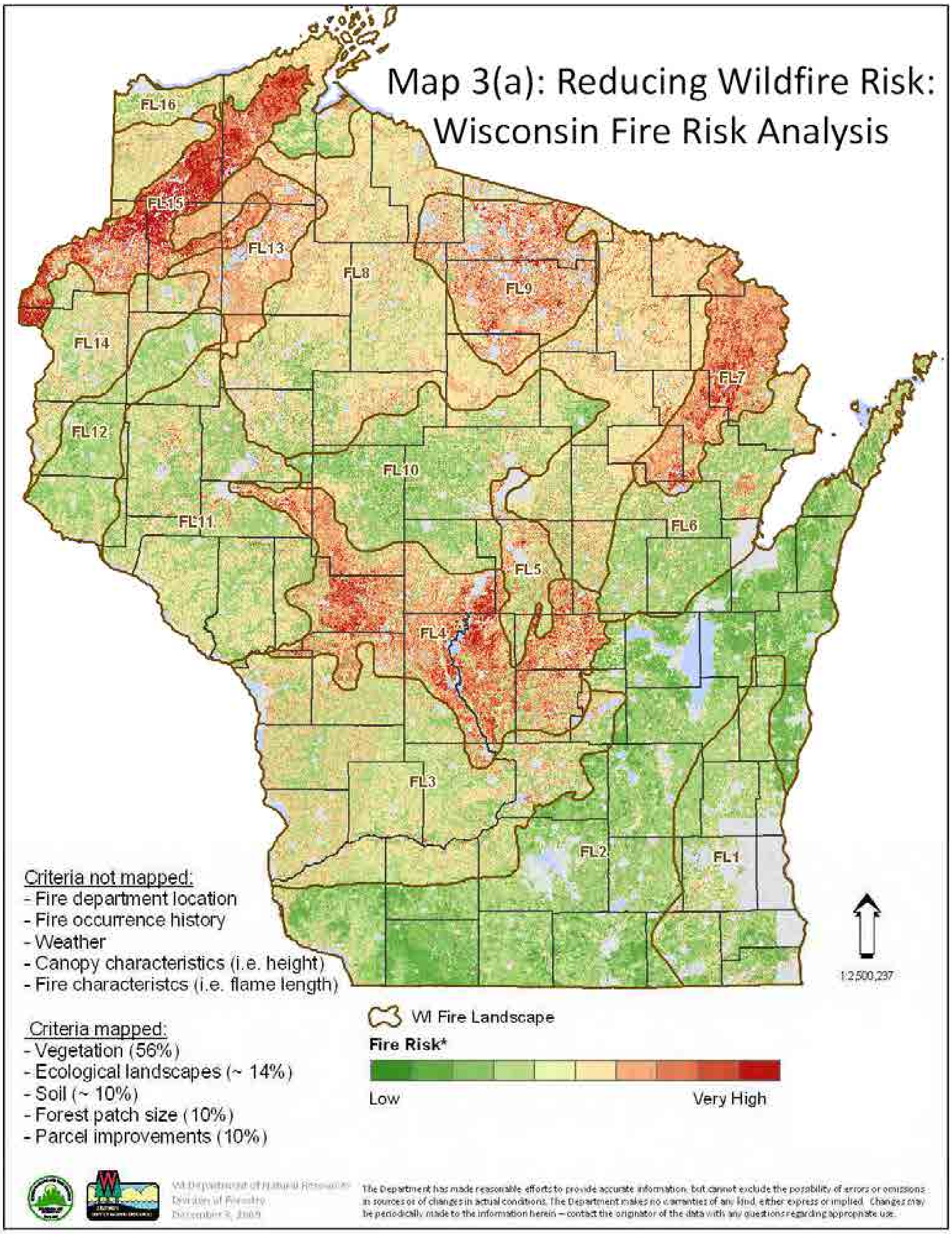
Wisconsin DNR Forestry is statutorily responsible for suppressing wildfires across a significant portion of the state. We utilize various methods, such as partnerships with fire departments and other agencies, to protect human life and property and natural resources. We prioritize how and where state and federal resources will be spent based on fire risk within areas that are designated as DNR protection areas or areas where we work cooperatively with partners (Map 3 (a)). Statewide, we prioritize areas for hazard mitigation with our Communities-at-Risk analysis (Map 3 (b)).

<u>Wildfire risk</u>: The Fire Risk Analysis (Map 3 (a)) conducted in 2010 developed levels of fire suppression risk for the state based on elements that could be used to determine the level of suppression need. This in turn helps DNR Forestry make resource decisions regarding facilities, prevention education, communications, and other suppression and detection needs. The Analysis was conducted by overlaying data considered instrumental in predicting fire hazard (vegetation, ecological landscapes, soil, forest patch size, and parcel improvements). Wisconsin DNR cooperates with local fire departments (municipal and volunteer), tribes, and other agencies as part of our statewide fire suppression mandate. The Analysis is one tool that can be used to award vital funding for local fire departments.

There are several datasets that are not included in this analysis that would benefit the analysis. These include: fire department locations, fire occurrence history, canopy characteristics, fire characteristics, and weather data. Statewide data sources for fire department locations are difficult to obtain due to legal issues. Fire occurrence data only exists for part of the state. Canopy characteristics and fire characteristics data is variable and not consistent. Weather data

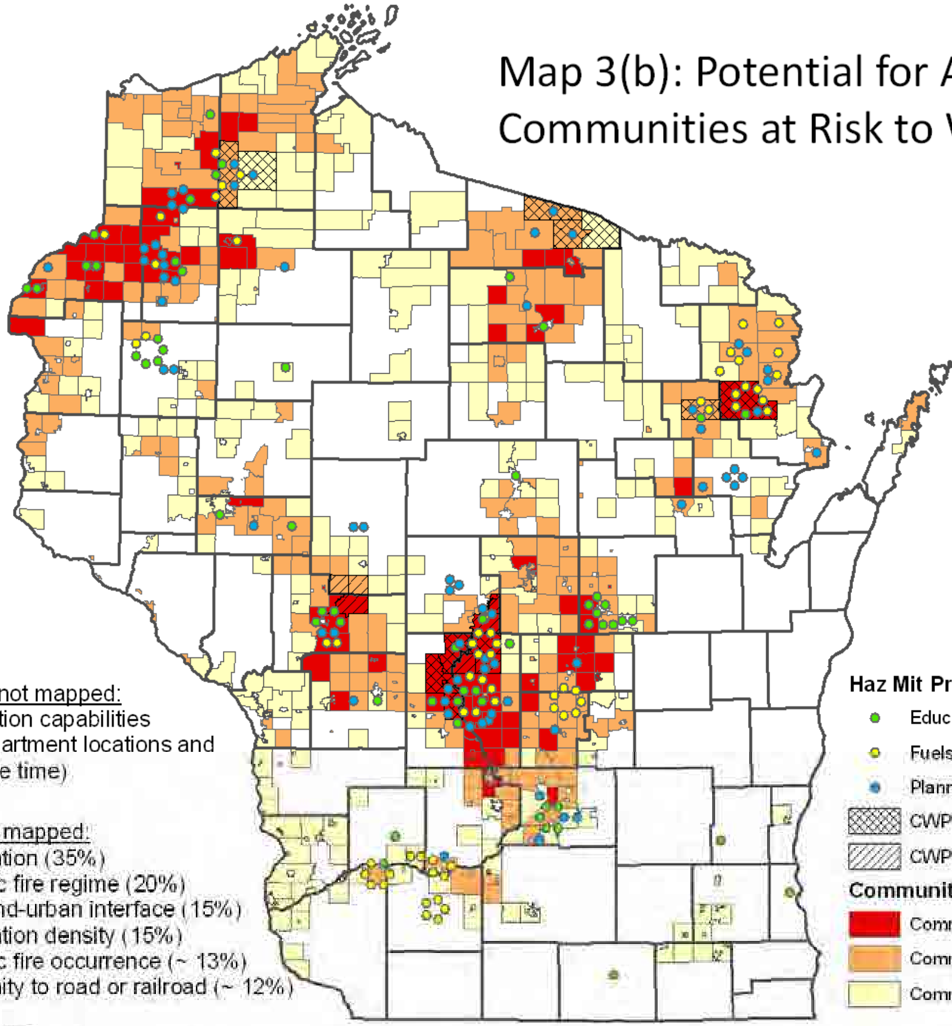
<u>Communities-at-Risk:</u> The federal initiative "Communities-at-Risk" (Map 3 (b)) helps Wisconsin prioritize areas for hazard mitigation. This includes projects for planning (e.g., Firewise), education, and fuels reduction. There are currently over twenty Firewise communities and nineteen Community Wildfire Protection Plans (CWPP) either created or in development. Communities-at-Risk are identified by community/population weighted criteria (vegetation, historic fire regime, wildland-urban interface, population density, historic fire occurrence, and proximity to road or railroad). Communities identified as a Community-at-Risk, or Community-of-Concern are prioritized to receive hazard mitigation funds based on their geographic location as well as non-geospatial criteria that measure a project's individual merits.

As with Map 3 (a), locations for fire departments across the state is difficult to obtain and is not included in Map 3 (b). Fire departments response time is another valuable piece of data that would be used for Communities-at-Risk if it were available.



Map 3(a): Reducing Wildfire Risk:
Wisconsin Fire Risk Analysis
FL16
FL15
FL13
FL8
FL9
FL14
FL7
FL12
FL10
FL11
FL6
FL5
FL4
FL3
FL2
FL1
Criteria not mapped:
- Fire department location
- Fire occurrence history
- Weather
- Canopy characteristics (i.e. height)
- Fire characteristcs (i.e. flame length)
Criteria mapped:
- Vegetation (56%)
- Ecological landscapes (~ 14%)
- Soil (~ 10%)
- Forest patch size (10%)
- Parcel improvements (10%)
WI Fire Landscape
Fire Risk*
Low
Very High
1:2,500,237
The Department has made reasonable efforts to provide accurate information, but cannot exclude the possibility of errors or omissions in sources or of changes in actual conditions. The Department makes no warranties of any kind, either express or implied. Changes may be periodically made to the information herein – contact the originator of the data with any questions regarding appropriate use.

Map 3(b): Potential for Assisting Communities at Risk to Wildfire



Criteria not mapped:
- Protection capabilities (fire department locations and response time)

Criteria mapped:
- Vegetation (35%)
- Historic fire regime (20%)
- Wildland-urban interface (15%)
- Population density (15%)
- Historic fire occurrence (~ 13%)
- Proximity to road or railroad (~ 12%)

Location	# of Projects
Adams County	4
Amberg	1
Armenia	1
Athelstane	4
Barnes	9
Barron	1
Barron County	1
Big Flats	3
Black River Falls	4
Bridge Creek	1
Brule	1
Buena Vista	2
Casey	5
Clark County	2
Columbia County	3
Conover	1
Crivitz	1
Crystal Lake	7
Cumberland	7
Dayton	1
Dodgeville	5
Dunbar	1
Easton	1
Eau Claire	1
Eau Claire County	1
Farmington	2
Friendship	4
Germantown	1
Grantsburg	2
Hartford	1
Hayward	1
Jackson County	2
Janesville	1
Juneau County	4
Ladysmith	1
Land O Lakes	1
Lind	2
Manchester	2
Marinette County	2
Marquette County	1
Milwaukee	1
Minong	1
Monroe County	1
Mountain	1
Muscoda	6
Necedah	1
Oconto County	4
Oneida County	1
Pembine	1
Peshtigo	1
Poynette	6
Quincy	6
Rhinelander	1
Richland Center	1
Riverview	4
Rome	10
Saratoga	1
Sawyer County	1
STATEWIDE	36
Stephenson	7
Swiss	2
Tomah	1
Trego	1
Underhill	1
Vilas County	1
Wascott	6
Washburn County	1
Waupaca	2
Wausau	1
Wausaukee	1
Waushara County	1
Webster	2
Wescott	1
West Marshland	1
Weyauwega	2
Wisconsin Rapids	2
Wood County	3
Woodruff	1
Total	225

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4. Actively and sustainably managing forests

This map and narrative describe relative potential for active and sustainable management on a geographic basis. This does not only refer to production of forest products, but also includes areas that benefit from sustainable management such as improving forest habitat in Conservation Opportunity Areas identified in the Wildlife Action Plan or Outstanding and Exceptional Resource Waters that benefit from forested riparian areas. This map will help focus where to implement strategies to address issues as diverse as parcelization, composition and structure, climate change, and recreation opportunities.

The following criteria identify forests that have desirable conditions for actively and sustainably managing forests and also forests that would benefit from management. An area that has multiple criteria will have a higher score.

<u>Forest patch size</u>: The benefits of large forest patches include but are not limited to wildlife habitat for species that need remote interior forest, wilderness aesthetics, recreation activities, and producing economies of scale for timber management. The minimum patch size mapped is 10 acres. This is the typical limit for possible management. Patch size in the northern and southern ecological province (NHFEU[1]) are rated with different scales. In the north, patch size of greater than 500 acres is given the highest ranking and in the south, patch size of greater than 100 acres is given the highest ranking.
(Weight: one to three points, with three points going to the larger patch sizes.)

<u>Proximity to protected and conserved land</u>: This layer includes forested lands that are managed for various objectives and in a legal status that will keep the forest as forest. This includes public forest land (national, state, county), State Natural Areas, publicly held forest easements on private land, Board of Commissioners of Public Land, Native American lands, private lands enrolled in the Managed Forest Law and Forest Crop Law, and Forest Legacy Areas. These are forests that will remain forests for an extended period of time and have a management plan. Lands in close proximity to these are important because if they are actively and sustainably managed, they essentially make the protected areas larger.

Communities that zone working forest areas in their jurisdiction provide another category of protected land that keep forests as forests. We do not have geospatial data for these and so they are not included in this map but are considered a potential area for active and sustainably managed forest.
(Weight: one to three points, with three points going to protected, conserved, and public lands and their immediate, less than .25 miles, surrounding area.)

<u>Wildlife Action Plan – Conservation Opportunity Areas (COA's) in forested habitats</u>: The Wildlife Action Plan identified COA's to protect native Wisconsin species of greatest

[1]For information on the NHFEU, see:
http://www.dnr.state.wi.us/forestry/GIS/Data_Maps/map_gallery/existing_maps/map_descriptions.htm

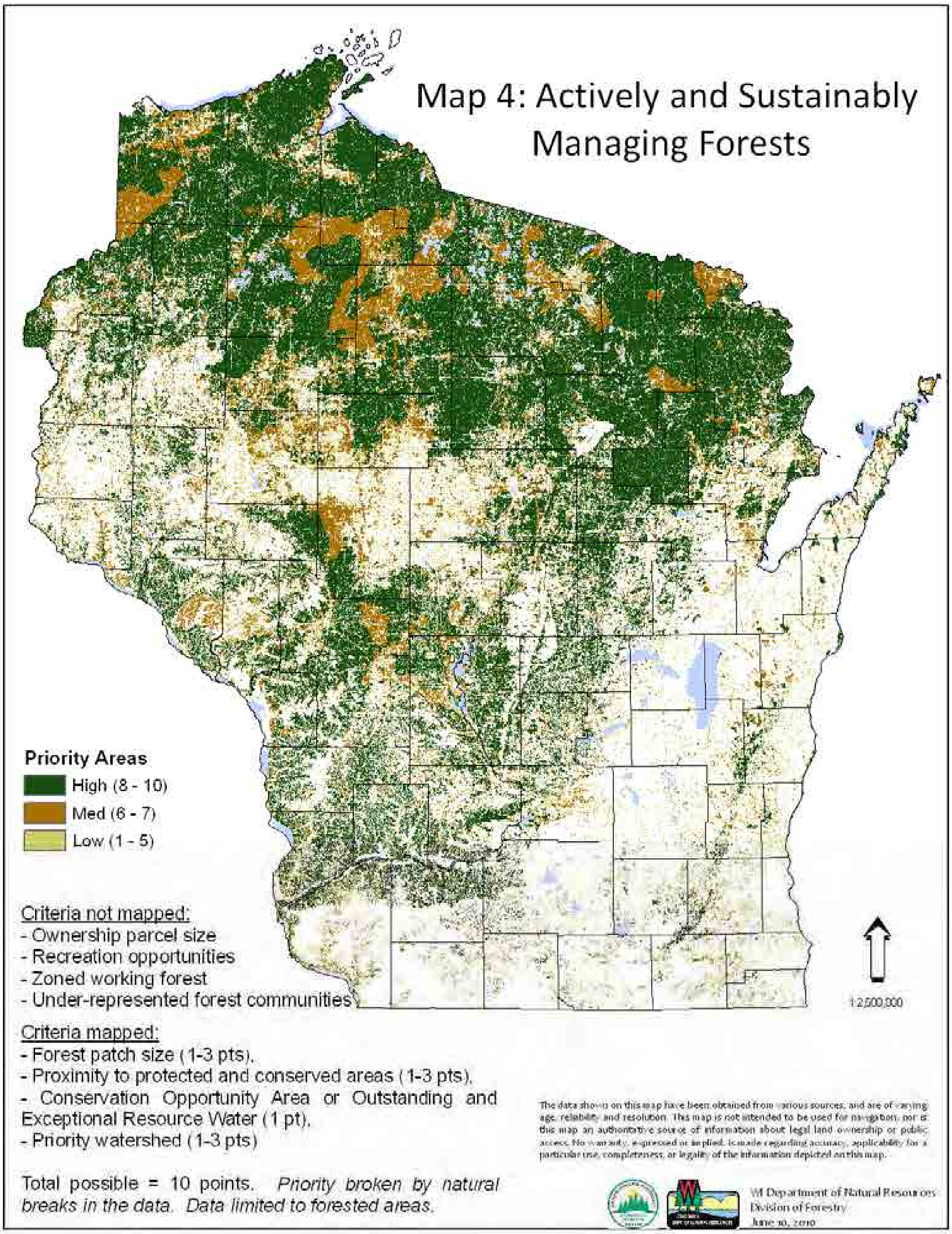
conservation need. Some of these species require forest habitat which could benefit from management. COA's that are forested are shown on the map. Forest communities that are under-represented in the state are also of special concern and will be considered when prioritizing areas for management. These are difficult to map and are not shown. For a complete description of COA's, please see: http://dnr.wi.gov/org/land/er/wwap/implementation/.
(Weight: one point for forest within a COA.)

Outstanding and Exceptional Resource Waters (OERW): Wisconsin's OERW designation is designed to maintain the water quality in Wisconsin's cleanest waters. An outstanding resource water is defined as a lake or stream having excellent water quality, high recreational and aesthetic value, high quality fishing and being free from point source or non-point source pollution. Exceptional resource water is defined as a stream exhibiting the same high quality resource values as outstanding waters, but with existing or potential impact by point source pollution or future discharge from a small sewer community. Sustainably managed forests assist in keeping these waters clean by the use of best management practices and other management considerations.
(Weight: one point for forested OERW's unless it is also a classified as part of a COA.)

Priority watersheds: Forests play a critical role in preserving clean water supplies by maintaining a protective forest floor that prevents soil erosion, and filters and infiltrates water. This map layer identifies watersheds that have large areas of private forests that are important for maintaining clean water and in need of protection from development pressures. Low scoring watersheds either have a large percentage of protected forest land, low percentage of private forest land, low development pressure, or low ability to produce clean water. A low score does not mean a watershed is unimportant; rather depending on why it is ranked low, it may be an example of a successfully managed and protected forested watershed or it may be a priority for reforestation and other efforts.
(Weight: one to three points, with three points going to the highest priority watersheds.)

Ownership parcel size (not mapped): Average forest parcel size has decreased over time and the number of private landowners has increased. In 1997, the statewide average parcel was 37 acres. In 2006, the average dropped to 28 acres. Smaller forest ownerships can make it difficult to manage a forest. We do not have geospatial data on forest parcel size and therefore it is not represented on this map. Depending on the strategy, either areas that show the greatest decrease in parcel size, or the largest will be prioritized.

Recreation opportunities (not mapped): Forests provide a myriad of recreation opportunities. Areas where more forested recreation is needed and would have minimal impacts to the ecosystem will be important to consider. There is currently no geospatial data on these recreation opportunities.


Map 4: Actively and Sustainably Managing Forests
Priority Areas
High (8 - 10)
Med (6 - 7)
Low (1 - 5)
Criteria not mapped:
- Ownership parcel size
- Recreation opportunities
- Zoned working forest
- Under-represented forest communities
Criteria mapped:
- Forest patch size (1-3 pts),
- Proximity to protected and conserved areas (1-3 pts),
- Conservation Opportunity Area or Outstanding and Exceptional Resource Water (1 pt),
- Priority watershed (1-3 pts)
Total possible = 10 points. *Priority broken by natural breaks in the data. Data limited to forested areas.*
1:2,500,000
The data shown on this map have been obtained from various sources, and are of varying age, reliability and resolution. This map is not intended to be used for navigation, nor is this map an authoritative source of information about legal land ownership or public access. No warranty, expressed or implied, is made regarding accuracy, applicability for a particular use, completeness, or legality of the information depicted on this map.
WI Department of Natural Resources
Division of Forestry
June 10, 2010

5. Managing for ecosystem services

This map and narrative describe potential areas for managing for ecosystem services such as water quality, air quality, carbon sequestration, and habitat for threatened or endangered species. All forests provide ecosystem services in different amounts. The areas identified as high in this map represent multiple attributes. This map does not show where ecosystem services could be improved or enhanced, rather where we want to keep managing for the ecosystem services provided. For example, this map does not include marginally productive agricultural lands. While they are lands that have the potential to provide greater ecosystem services if they were planted with trees, they do not currently provide such services.

Several of the following criteria are the same as those for Map 4 ‘Potential for Actively and Sustainably Managing Forests.’

Forest patch size: (see description for Map 4)

Proximity to protected and conserved: (see description for Map 4)

Wildlife Action Plan – Conservation Opportunity Areas in forested habitats: (see description for Map 4)

Outstanding and Exceptional Resource Waters (OERW): (see description for Map 4)

Threatened and endangered species or NHI forested community[2]: This input shows forested habitat where threatened and endangered species have been observed and where there are forested communities of concern. The presence of one or more rare species and natural communities in an area can be an indication of the area's health and ecological importance. Similarly, maintaining these features also sustains habitat for common and perhaps other rare species and maintains the larger complex of which the natural community or feature is a part. All are important elements of biodiversity which is an ecosystem service.
(Weight: one to two points depending on forest community and species of concern overlap.)

Priority watersheds: (see description for Map 4)

Forested wetlands: Wetlands provide habitat for more species of plants and animals than any other type of landscape in Wisconsin. Habitat is not their only functional value. Wetlands can also store water to prevent flooding, purify water, protect lake and stream shores from eroding and provide recreational opportunities for wildlife watchers, anglers, hunters, and boaters. Forest management is an important tool to support the benefits wetlands provide.
(Weight: one point for areas classified as a forested wetland type.)

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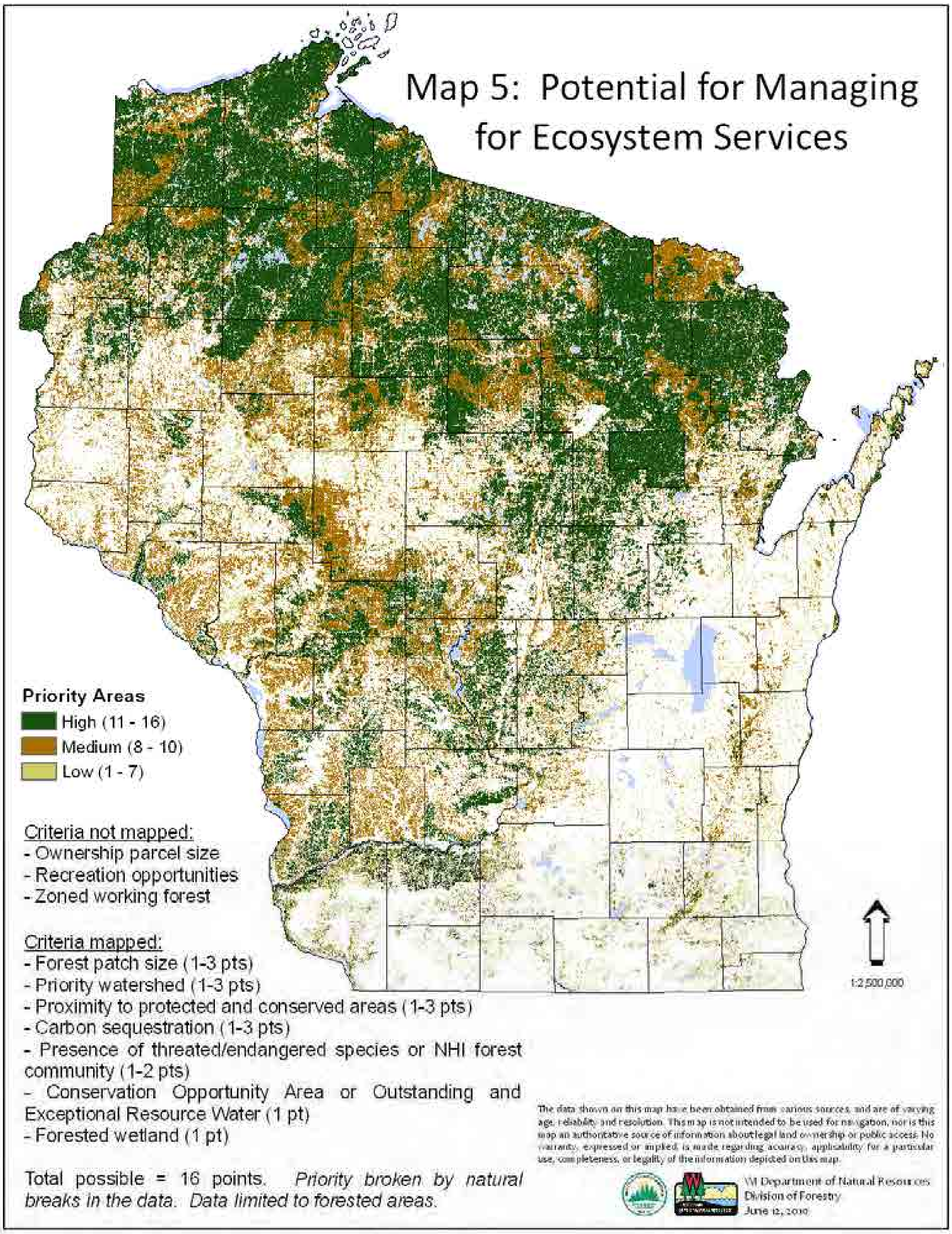
[2] For more information on the Natural Heritage Inventory and forested communities, see: http://dnr.wi.gov/org/land/er/communities/

Carbon sequestration: Forests sequester carbon in different amounts depending on a wide variety of factors. Carbon sequestration can be managed for anywhere, but there are certain areas where sequestration is greatest. It is represented as biomass in this map and areas that have more biomass are scored higher. By county, the amount of biomass (as proxy for carbon) will be ranked high, medium, and low.
(Weight: one to three points, with three points going to counties with the largest amount of biomass.)

Ownership parcel size (not mapped): (see description for Map 4)

Recreation opportunity areas (not mapped): (see description for Map 4)



Map 5: Potential for Managing for Ecosystem Services
Priority Areas
High (11 - 16)
Medium (8 - 10)
Low (1 - 7)
Criteria not mapped:
- Ownership parcel size
- Recreation opportunities
- Zoned working forest
Criteria mapped:
- Forest patch size (1-3 pts)
- Priority watershed (1-3 pts)
- Proximity to protected and conserved areas (1-3 pts)
- Carbon sequestration (1-3 pts)
- Presence of threated/endangered species or NHI forest community (1-2 pts)
- Conservation Opportunity Area or Outstanding and Exceptional Resource Water (1 pt)
- Forested wetland (1 pt)
Total possible = 16 points. Priority broken by natural breaks in the data. Data limited to forested areas.
1:2,500,000
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WI Department of Natural Resources
Division of Forestry
June 12, 2010

6. Maintaining and enhancing economic benefits from forests.

This map and narrative describes potential areas for maintaining and enhancing economic benefits from forests. Forests provide a variety of economic benefits including, but not limited to, traditional forest products. Many communities in forested areas depend heavily on forest industry and forest based recreation and tourism dollars. Ecosystem services are beginning to be monetarily quantified as research can assess impact costs or alternatives that produce the same benefits. These will be important to consider as markets are established.

To identify priority areas for maintaining and enhancing economic benefits from forests, the following criteria are used:

Proximity to protected and conserved: (see description for Map 4)

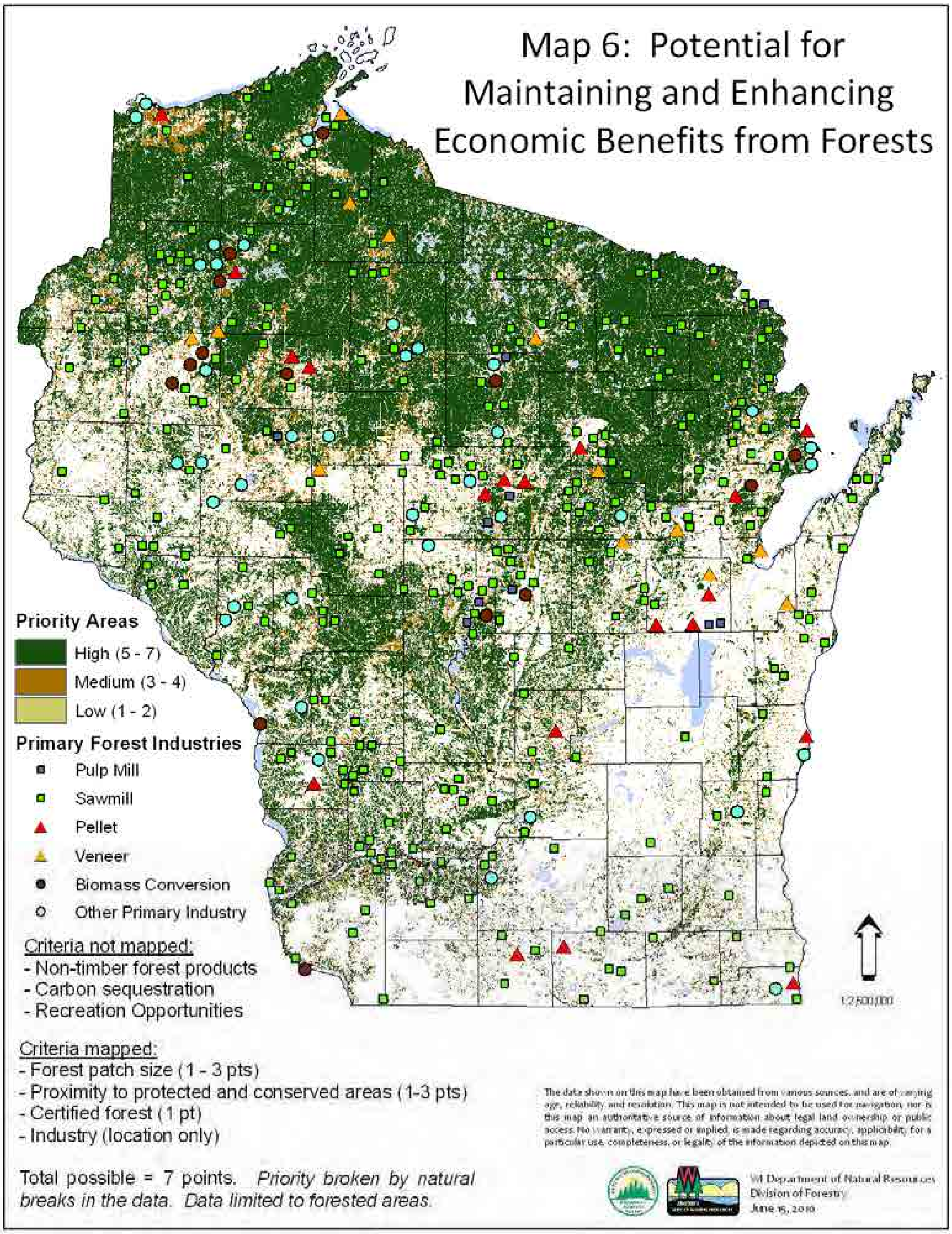
Third party certified forests: A requirement of some ecosystem markets is that lands be 3rd party certified as sustainably managed. When a forest is certified, it can open up more economic opportunities for the landowner. Forest lands (all ownerships) that are certified are presented on this map.
(Weight: one point for lands that are certified.)

Forest industry: Forests that are near a forest products company or a utility using renewable material are likely to be able to sell forest products easier due to their proximity to these companies. Wisconsin's primary wood-using industry consists of firms that manufacture logs and pulpwood into value-added wood products. Locations of the following are displayed on the map but are not included in the analysis: pulp mills, sawmills, pellet makers, veneer plants, biomass conversion facilities and as well as companies that manufacture such products as composite panels, log cabins, and treated wood. This data is routinely updated and new data will be available late summer, 2010.

Recreation opportunity areas (not mapped): (see description for Map 4)

Areas with high rates of carbon sequestration (not mapped): Carbon can be managed for in any forest, but certain types of management in certain stands can sequester at higher rates. The two ways to sequester carbon for the least cost in Wisconsin are by extending the rotation age in softwoods and increasing the stocking of under-stocked stands (Winrock, 2008). Geospatial data to show where these forests are is difficult to obtain and is not shown in this map but will be considered as priority areas. (Note: Map 4 shows amount of carbon. This criterion is where there is the greatest economic opportunity to sequester carbon.)

Non-timber forest products (not mapped): Products such as balsam boughs and birch bark support local economies. There is not much geospatial data to represent non-timber forest products and their economic potential. This criterion will be used to prioritize but cannot be spatially mapped at this time.


Map 6: Potential for Maintaining and Enhancing Economic Benefits from Forests
Priority Areas
High (5 - 7)
Medium (3 - 4)
Low (1 - 2)
Primary Forest Industries
Pulp Mill
Sawmill
Pellet
Veneer
Biomass Conversion
Other Primary Industry
Criteria not mapped:
- Non-timber forest products
- Carbon sequestration
- Recreation Opportunities
Criteria mapped:
- Forest patch size (1 - 3 pts)
- Proximity to protected and conserved areas (1-3 pts)
- Certified forest (1 pt)
- Industry (location only)
Total possible = 7 points. Priority broken by natural breaks in the data. Data limited to forested areas.
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Division of Forestry
June 15, 2010

Multi-state priority landscapes and issues

Wisconsin worked with neighboring states and the USDA Forest Service to develop the list of multi-state priority landscapes and issues. These are not listed in any significant order. Currently, the multi-state landscapes and issues that Wisconsin has identified for possible coordination with Minnesota, Michigan, and depending on the issue, some combination of Iowa, Illinois, Missouri and Indiana are:

1. Climate change
2. Ecosystem services (e.g. carbon markets)
3. Forestation/reforestation
4. Driftless Area Initiative
5. Fire (Great Lakes Fire Compact)
6. Sustaining forest industry and markets
7. Great Lakes Restoration Initiative
8. Invasive species
9. Lake States branding (timber products, certification)
10. Upper Mississippi Forest Partnership
11. Great Lakes Forest Alliance
12. Promoting sustainable active management of private forests (e.g. Call before you cut)
13. Increase urban FIA (improve urban inventory data)
14. Upper Midwest and Great Lakes Landscape Conservation Cooperative (UMGL LCC)

St. Paul Field Office Service Area

1. Climate Change

Important questions exist about the impact that potential changes in climate will have on forest resources in the future. How will a rise in temperature or change in timing and extent of precipitation affect the continued viability of the existing forest ecosystems? How will these changes affect the existing forest industry? Will both ecosystems and industry be able to respond quickly enough to changing conditions to prevent the collapse of either?

States: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Wisconsin

Issues:

- Uncertainty exists over the extent temperatures might rise, and precipitation might vary from historic norms, in the future. This uncertainty makes long-term planning difficult because future climatic conditions are not known.

- Forestry and the forest products industry are important contributors to the economy of the region, particularly in the northern states. Climatic change may alter the tree species that make up the various forested regimes in the region, their rate of growth and how they can be sustainably managed.
- Tourism is also a major industry in the region and the forested landscapes of the north make this area a prime destination. Changes in the forested condition of this region might impact its appeal as a tourist destination.
- Mitigation and adaptation strategies will be challenging to develop and implement.
- Trees under stress due to a changing climate would be increasingly vulnerable to insect and disease infestation.
- As federal and/or regional regulation of greenhouse gas emissions becomes regulated, states will need to quantify the amount of carbon being sequestered and well as emitted due to changes in land use. Developing accurate systems to do so is complex and expensive and generally beyond the expertise of state forest agencies.

Opportunities for partnership, cooperation, and projects:
Natural resource agencies within the region should collaborate and share information in order to produce assessments that will provide managers and policy makers the information needed to decide on a response to climate change impacts on our environment. The Forest Service effort could foster a network of science professionals within state agencies, universities and other research organizations to work at a regional scale and cooperate with their out of state counterparts. A template for this type of organizations could be built upon the Wisconsin Initiative on Climate Change Impacts (WICCI). Funding could be provided to support research and collaboration (i.e. administrative support and travel expenses for meetings).

2. Ecosystem Services
(For more information and reference for the following text, see: http://www.fs.fed.us/ecosystemservices/)

Healthy forest ecosystems are ecological life-support systems. Forests provide a full suite of goods and services that are vital to human health and livelihood, natural assets we call ecosystem services.

Many of these goods and services are traditionally viewed as free benefits to society, or "public goods" - wildlife habitat and diversity, watershed services, carbon storage, and scenic landscapes, for example. Lacking a formal market, these natural assets are traditionally absent from society’s balance sheet; their critical contributions are often overlooked in public, corporate, and individual decision-making.

When our forests are undervalued they are increasingly susceptible to development pressures and conversion. Recognizing forest ecosystems as natural assets with economic and social value can help promote conservation and more responsible decision-making.

States: Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, Indiana

Issues:
Climate change, pollution and land-use change are some of the drivers of ecosystem loss, as well as resource challenges associated with globalization and urbanization. The 2005 Millennium Ecosystem Assessment, prepared by a group of over 1300 international experts, found that 60 percent of ecosystem services assessed globally are either degraded or being used unsustainably. Land use change is an immediate issue in the United States. Today, the nation is experiencing a loss of open space and a decline in forest health and biodiversity, particularly on private lands.

Recent trends in parcelization and divestiture of private lands in the United States suggest that private landowners are commonly under economic pressures to sell their forest holdings. Rising property values, tax burdens, and global market competition are some of the factors that motivate landowners to sell their lands, often for development uses. The loss of healthy forests directly affects forest landowners, rural communities, and the economy. As private lands are developed, we also lose the life-supporting ecosystem services that forests provide.

The ability to capture the financial value of ecosystem services may help landowners who currently do not benefit from the true value of their land and all of the goods and services forests provide. Because most ecosystem services are not traded and do not have a “price,” landowners are not typically compensated for the critical benefits forests naturally deliver to the public. New natural revenue streams might help forest owners cover the costs of owning forestland and provide them with incentives to hold onto their land and practice sustainable forest management. Valuing ecosystem services will encourage forest restoration and may provide a new means to finance reforestation, afforestation, and management activities. Valuing forests as natural assets will increase society’s appreciation and support of lands that are already protected and healthy.

Opportunities for partnership, cooperation, and projects:
Mechanisms are needed by which private forest landowners can seek returns on their forestland *in addition* to those commonly associated with commercial forest products.

Due to the national nature of markets, the Forest Service is in the best position to explore national opportunities to advance markets and payments for ecosystem services. With help from their partners and others, they could help encourage broader thinking and collaboration that stimulates market-based conservation and stewardship.

Academia and the Forest Service could partner to provide data which substantiates the value of ecosystem services in order to provide a basis for developing markets.

3. Forestation-Reforestation

Healthy diverse forests are essential for providing a broad range of goods and services from our forested ecosystems. Maintaining a balance of the many forest-types within the landscape is increasingly difficult due to the many and diverging interests of various forestland owners/managers. Further, many forest-types are becoming increasingly harder to maintain and/or regenerate due to a variety of factors including climate, disease, insect activity, lack of fire disturbance, deer herbivory, and invasive plants to name a few.

States: Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, and Indiana

Issues:

- Invasive plants such as garlic mustard, Japanese stilt grass and reed canary grass have literally taken over the understory on many locations out-competing the native vegetation, including tree seedlings, reducing or eliminating natural regeneration on these sites.
- Extremely high deer populations reduce natural regeneration or shift species composition by favoring some tree species as browse over another. This has contributed to a trend towards increasing amounts of red maple (less favorable browse) in some areas and a complete lack of white cedar (highly preferred browse) regeneration in other areas.
- The low-land hardwood forest type has been severely impacted by the loss of American elm due to Dutch elm disease. Now the Emerald Ash Borer threatens to eliminate ash species, especially black ash that is another important low-land hardwood species.
- Specific stressors could have significant impact on future urban tree mortality. In Wisconsin, Emerald Ash Borer poses a mortal risk to 20% of urban trees. The high percentage of several other tree species makes them susceptible to other invasive species which have not yet arrived in Wisconsin. For example, Asian Long Horned Beetle could decimate the even higher percentage of maple trees in our urban areas and the prevalence of butt and stem decay is likely to result in substantial urban tree removal.
- Oak regeneration has proven to be extremely difficult to achieve on many sites that have historically been oak dominated systems.
- Historically, large-scale forest disturbance patterns initiated forest regeneration, these include fire, tornadoes/wind. Fire suppression has virtually eliminated large-scale fire as a disturbance agent. Large scale-wind events are still with us;

however their impact on the landscape is often tempered by forest fragmentation and land-use patterns.

- Climate change is forcing us to rethink our notion of species range. As temperatures rise, many tree species may no longer be able to thrive in locations where they existed historically.
- The long term impacts to site productivity as a result of increased harvest levels due to biomass harvesting are relatively unknown.
- Forest fragmentation has created many smaller blocks of forest and greatly increased the amount of forest "edge" than has existed historically. Edges tend to favor sun-loving species where shade tolerant species may have once dominated.
- Many forest tree nurseries in the region have closed or are producing at greatly reduced capacities. Adequate stocks of planting material may be an issue with reduced capacity.

Opportunities for partnership, cooperation, and projects:

- Wildlife habitat considerations drive many reforestation efforts. By partnering with wildlife agencies and non-governmental wildlife interests, forest managers might increase opportunities for mutually beneficial tree planting efforts.
- Water quality issues provide opportunities for non-traditional partnerships. Establishment and expansion of riparian forest buffers provide opportunities to increase tree cover while providing the benefit of clean drinking water.
- The current interest in carbon markets and carbon sequestration creates an opportunity to increase tree cover and provide other ecosystem benefits while achieving the goal of increasing carbon storage and sequestration.
- The ability of urban forests to mitigate climate change through carbon sequestration and reducing energy consumption and thus reduction in greenhouse gas emissions provides opportunities for non-traditional partnerships and an alternate funding mechanism (carbon markets).
- NRCS offers a variety of programs to off-set the costs of forest establishment for a variety of purposes including enhancing wildlife habitat and active forest management

4. Driftless Area Initiative

States: Illinois, Iowa, Minnesota, Wisconsin

Issues associated with the area:

- Cold water, spring fed streams that are sensitive to non-point source pollution due to the karst geology.
- Maintenance of a high value recreational resource.Trout Unlimited has estimated that anglers generate an annual $1.1 billion economic benefit.
- Forest fragmentation impacting forest-interior bird habitat.
- Lack of forest management related to limited market accessibility.
- Forest invasives decreases sunlight to understory plants as they die off bare soil on steep slopes is subject to soil erosion.

Opportunities for partnership, cooperation, and projects:

- The Driftless Area Initiative is a partnership of 6 RC&D Areas in four states; maintaining a high quality forest resource is a priority.
- Several watersheds in the Driftless Area have been designated as priority watersheds for the Upper Mississippi Forest Partnership.
- The Root River watershed has been selected as a priority watershed for several initiatives: Upper Mississippi Forest Partnership, NRCS Mississippi River Basin Initiative, and the Midwest Natural Resources Group.

5. Wildfire (Great Lakes Forest Fire Compact – (http://www.glffc.com/content/)

The Great Lakes Forest Fire Compact (GLFFC) is made up of 3 U.S. States and 2 Canadian Provincial Natural Resources agencies. They have created a formal association in order to promote effective prevention, pre-suppression and control of forest fires in the Great Lakes Region of the United States and adjacent areas of Canada. Their purpose is to promote effective prevention, presuppression and control of forest fires in the Lake States region of the U.S. and adjacent areas of Canada by the member agencies by providing mutual aid in prevention, presuppression and control of fires.

States: Minnesota, Michigan, Wisconsin, Iowa, Missouri, Indiana, Illinois, Canadian Provinces of Ontario and Manitoba

Issues:

- Fire regime condition class change has been occurring over the decades. Vegetative cover and fuel loading has changed due to change in the land management practices and settlement patterns.
- Prescribed burning and its use as a multi-purpose land management tool. There are common issues in the states regarding training, qualifications and the number of people available for burning as well as the environmental issues associated with prescribed fire.
- Significant weather events which have damaged the forest and change fuel composition.
- Community Wildfire Protection Planning – Successful community planning efforts can mitigate losses and the impacts of wildfire to the ecosystems. Planning to reduce fire risk can be incorporated into overall land management planning or specifically identified for communities at risk of wildfire.
- Aging of personnel - an overall problem for all the states as the workforce ages which will result in a decrease in the fire management program's capacity.

6. Sustaining Forest Industry and Markets

The loss of forest products industries and markets constrains opportunities to manage forests and diminishes options for the production and enhancement of an array of ecosystem services

States: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Wisconsin

Issues:

- Competition for forest resources amongst various industrial users of low quality wood likely to increase as biomass markets (e.g., pellet production) grow rapidly.
- New state and federal energy/climate policies will increasingly stimulate demand for forest resources. For instance, proposed federal Renewable Energy Standards are already catalyzing coal fired power plants to co-fire with wood.
- Requests for resource information (inventory and timber product outputs) will increase as resource use patterns change.

- Due to the increased demand on the resource due to renewable energy and fuel standards, a more complex assessment, as compared to that historically provided for traditional wood products, of the availability of the wood resource is needed in order to ensure forest continue to be sustainabily managed. Such analysis needs to include: existing demands, other proposed demands, impacts on the resources (i.e. soil nutrients) and availability both in terms of ease of access and extraction. Currently, there is not sufficient research on the long term impacts of increased harvest levels such as that associated with biomass.
- Systems need to be developed which easily and accurately enable businesses to verify the wood they are purchasing is coming from a sustainable source especially wood being used for renewable energy or fuel.
- Methods need to be developed for harvesters to easily determine if the amount of materials left after harvest is sufficient to meet biomass harvesting guidelines.
- Though still a very large part of US demand for wood, pulp production has declined for more than 10 years. Acute shortage of loggers as boomers retire and industry fails to recruit new entrants.
- Discussion and information needs regarding forest products production and bioenergy application impacts on carbon lifecycles will increase
- Housing. Softwood lumber demand associated with homebuilding has been off dramatically. Predictions are a return to normal housing starts of 1.5-1.7 million starts by 2012.[3] Homeowner improvements and remodeling are expected to begin a gradual rebound in 2010. [4] Some suggest a trend towards smaller homes with less use of hardwoods for flooring and millwork as homebuyers try to economize on housing costs.
- Hardwood, solid wood products. Recent years have seen outsourcing of furniture, kitchen cabinets, millwork and flooring production to China and other Asian countries has caused many companies to close with a permanent loss of 25-35% of productive capacity nationally. Indexed prices since 2004 show decline in all graded hardwoods with only lumber prices for pallets and railroad ties remaining stable or increasing slightly.
- Green building is experiencing significant interest and is one of the few areas in forest products trending upward. Currently, green building volume as a proportion of the market remains rather low.

[3] National Association of Homebuilders. March 24, 2010. Urs Buehlman, Virginia Tech personal communication
[4] Harvard Joint Center for Housing Research. Urs Buehlman, Virginia Tech personal communication

7. Great Lakes Restoration Initiative

The President's 2010 Budget provides $475 million in EPA's budget for a new Environmental Protection Agency-led, interagency Great Lakes restoration initiative, which will target the most significant problems in the region, including invasive aquatic species, non-point source pollution, and contaminated sediment.

This initiative will use outcome-oriented performance goals and measures to target the most significant problems and track progress in addressing them. EPA and its Federal partners will coordinate State, tribal, local, and industry actions to protect, maintain, and restore the chemical, biological, and physical integrity of the Great Lakes.

The Initiative builds upon 5 years of work of the Great Lakes Interagency Task Force (IATF) and stakeholders, guided by the Great Lakes Regional Collaboration Strategy.

States: Illinois, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, New York, Wisconsin, Canadian Province of Ontario

Issues associated with the area:

- Aquatic invasive species
- Habitat and species loss
- Coastal health
- Areas of Concerns (related to sewer overflow discharges)
- Nonpoint source pollution
- Contaminated sediments and toxic pollutants
- Coordination of data collection and communication
- Development of Indicators for measuring the health of the Great Lakes
- Need for sustainable development

Opportunities for partnership, cooperation, and projects:

- Partner with land trusts, conservation organizations, local communities and state agencies to protect or restore riparian forests and upland habitats.
- Partner with state water quality regulatory agencies to promote the use of urban forests for storm water reduction and on-site infiltration.

8. Invasive Species

Non-native invasive species have the potential to reduce forest diversity and cause huge economic and ecological damage to forests. Insect species such as the Emerald Ash Borer, Gypsy Moth and Asian Long Horned Beetle have already caused major damage in forests and in urban areas in the Midwest. Non-native disease causing organisms, typically fungi, that cause mortality such as those that cause White Pine Blister Rust, and Dutch Elm Disease are well documented historically. More recent examples include Beech Bark Disease and Sudden Oak Death. Dozens of invasive plants species spread and flourish in both urban and rural forested areas. Resource agencies must have evolving and adaptive responses to detect and reduce the potential for the introduction and spread of new invasive species.

States: Iowa, Illinois, Indiana, Michigan, Minnesota, Missouri, Wisconsin

Issues:

- Prevention of invasive insects and plants is time consuming and costly. Eradication efforts are very expensive. Doing nothing has far-reaching cost consequences. The lack of consistency and accuracy of invasive plant data and the methods used to collect the data, makes analyzing the extent and condition of invasives extremely difficult and unreliable.
- Invasive plant populations influence, and are influenced by, environment and co-occurring plant and animal species. An integrated ecosystem-based approach is therefore essential but difficult to achieve.
- There is a varying level of awareness about invasive species and their impacts. In addition to general awareness and education, there is also a need to provide guidance that is more nuanced and site-specific.
- Quarantines on timber product movement placed on states in infested areas cause economic hardship as well as difficult utilization and marketing challenges.
- The loss of forest diversity reduces the ecological stability of forests.
- Control techniques and methodologies need to be developed, shared and implemented for new invaders.

- The inability to effectively control plants introduced via the horticultural industry allows many problem plants to continue to be bought and sold in the marketplace.
- A changing climate may make our forests more susceptible to invasive species.

Opportunities for partnership, cooperation, and projects:
States realize that a cooperative approach to costly survey, detection and eradication efforts that focus on those infestations which pose the greatest threats to natural resource values are the highest priority. Developing invasive species best management practices, educating and instructing foresters, landowners and land managers to detect and control invasive species can be completed and shared across the 7 states. Cooperating to conduct coordinated survey and detection work is a multi-year task. Monitoring for spread of insects and plans as well as evaluating the threat to natural resources can be shared across landscapes. Rehabilitation of lands and forests adversely impacted by invasive plants and insects is crucial.

9. Lake States Branding
The Wisconsin, Minnesota and Michigan have made significant investments in encouraging certification of public and private lands to encourage sustainable management and in effort to maintain and develop diverse forest markets to enable forest management.

The three states contain 53.28% of FSC certified acres, and 25.8% of the SFI certified acres and 8.39% of the American tree farm acres in the United States. In Wisconsin and other lake states there is a high percentage of certified forestlands and a well recognized forest ethic. In Wisconsin alone, 44 percent of its forestland is certified through the FSC, SFI, and American Tree Farm Programs. This is 7,095,083 acres of certified forestland of the 16,274,000 acre total. The certified land includes private non-industrial, private industrial, state, and county owned lands. Of the certified land, 55.70% is public land and 44.30% is private ownership. These certified forestlands assure consumers of sustainable management, but also document that the timber is legally harvested which has become increasingly important with recent amendments to the Lacy Act.

By developing a branding program, regional producers would have a brand identity as well as professional marketing material to promote their product locally, nationally, and globally. Other groups, such as the Appalachian hardwood producers, have has success with regional branding efforts. The combination of well managed forestlands and high quality hardwoods would make a similar branding effort in the Lake States a sure success.

States: Wisconsin, Michigan, Minnesota.

Issues:

- Some companies may hesitate to adopt a regional brand because of competition among states or the need to use products from outside of the Lake States to fill some orders.
- Improve markets for forest products and diversification of forest industries in the three states.
- There is a need to provide information on the economic impact information and effectiveness of a branding/promotion program.
- Provide an assessment of the economic benefit of the efforts certify public and private lands.
- A general design and structure of branding\promotional program that could be used by other regions.

Opportunities for partnership, cooperation, and projects:

- Stakeholders such as state planners, state marketing specialist, and managers of certified forests collaborate to develop a regional wood branding program.
- A collaborative process could be used to develop marketing and informational documents which emphasize the areas that will aid in ecological objectives of the state assessments.
- Development of promotional materials through a consensus process with the industry, state planners, marketing specialist, extension specialist, and forest certification specialist.

10. Upper Mississippi Watershed

States: Illinois, Indiana, Iowa, Minnesota, Missouri, Wisconsin

Issues associated with the area:

Water Pollution--Sediment, nitrogen and phosphorus are the main pollutants in the Upper Mississippi watershed. A significant portion of sediment, nitrogen and phosphorus loads to the Mississippi River comes from human activities: runoff and groundwater from farming, discharges from sewage treatment and industrial wastewater plants, and

stormwater runoff from city streets. The delivery of high amounts of nitrogen to the Gulf of Mexico causes a hypoxia zone (abnormally low levels of dissolved oxygen in bottom waters) to expand each summer. About 90% of the nitrate load to the Gulf of Mexico comes from nonpoint sources, and over 31% of that load comes from the Upper Mississippi River.

Loss of Migratory Bird Habitat--The north-to-south orientation of the Upper Mississippi River and its contiguous habitat make it critical to the life cycles of many migratory birds. It is a globally important migratory flyway for 40 percent of all North American waterfowl and 60 percent of all the bird species in North America. The loss of more than 50% of historic floodplain and valley hardwood forests creates a problem for many waterfowl, raptors, songbirds, and shorebirds.

Forest Loss and Fragmentation--Forests and prairies are the most beneficial land use in the Upper Mississippi River Basin in terms of protecting watersheds and water quality. Nearly all of the prairies and about 70 percent of the forest land have been converted to agriculture and urban land uses. The remaining forest land is critical to watershed health and clean water. The ability of forests to produce abundant clean water declines as they are broken up (fragmented) and eventually lost. Fragmentation is a process where large, contiguous forest landscapes are broken into smaller, more isolated pieces, often surrounded by human-dominated uses. The loss and continued break up of forest land increasingly impairs water flow and quality, forest health and diversity, and other economic and recreational benefits.

Opportunities for partnership, cooperation, and projects:

There are many overlapping initiatives in the Upper Mississippi Basin. Recently the Northeastern Area and the Upper Mississippi Forest Partnership participants analyzed where several major initiatives have set priorities, trying to find areas of overlap where efficiencies may exist. The initiatives included in this analysis are:

- Upper Mississippi Forest Partners GIS analysis,
- Northeastern Area, Stewardship Analysis Project,
- Northeastern Area, Forest-Water-and People,
- NRCS, Mississippi River Basin Initiative,
- State Wildlife Plan-conservation opportunity areas,
- Audubon Society-Important Bird Areas.

Through this analysis and talking to local partners a list of priority watersheds for the Upper Mississippi Forest Partnership was completed. A map of these selected watersheds attached.

Also the National Fish and Wildlife Foundation manage an Upper Mississippi Watershed Fund for the Upper Mississippi Forest Partnership. An annual RFP is a sent out to about 250 potential partners.

11. Great Lakes Forest Alliance

Great Lakes Forest Alliance

Difficult and complex forestry issues often span political boundaries. In many cases, the best approach to addressing these issues and opportunities involves a concerted effort that exceeds the reach of individual state forestry organizations and their partners.

States: Michigan, Wisconsin, Minnesota

Opportunities for partnership, cooperation, and projects:

The Great Lakes Forest Alliance, (GLFA) is a non-profit organization whose mission is to advance and promote healthy, sustainable forests in the upper Midwest. The GLFA has a diverse membership from Michigan, Wisconsin, Minnesota, and Ontario. Members include public land managers at the federal, provincial, state, and county level; non-industrial private forest landowners; forest industry; academia; and conservation organizations. The GLFA is uniquely positioned to help address issues and opportunities that span Michigan, Wisconsin, and Minnesota.

Past and existing efforts:
The GLFA recently completed a series of workshops to inform the retail forest products sector of green building principles, trends, and terminology so that they could better promote and take advantage of the “green” movement in the construction trade. Also, the GLFA is preparing to conduct a series of workshops and a regional conference to inform non-industrial private forest (NIPF) landowners of potential opportunities available to them in new “ecosystem markets.” By informing landowners of these new markets they might more actively manage their land. The subject of new markets may also foster increased communication between NIPF owners and the professional forestry community.

12. Promoting Sustainable & Active Private Forest Management
The Upper Midwest contains a large proportion of private forestland ownership in the nation. A significant amount of these private forestlands may be unmanaged or undermanaged. This represents an untapped resource. By promoting sustainable active management of these forestlands, the productivity of the regions’ forestlands could be enhanced. Active forest management can help to off-set the rising costs of forest ownership, while contributing to the health and resiliency of the regions forests.

States: Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, Indiana

Issues:

- Most land owners own woodlands for reasons unrelated to forest management. Typically private citizens own forests for hunting, recreation, or aesthetic reasons.
- Engaging effectively with private forest landowners is challenging due to the lack of systems and processes to contact these landowners. An outreach and education strategy which would include the creation of systems to identify, contact and reach-out to landowners is necessary to provide information and technical assistance on sustainable forest management practices.
- Landowner turnover rates are increasing due to the aging demographic of current forest owners. This creates opportunities to engage these new landowners who may be more receptive to active forest management.
- Average woodland parcel size is decreasing which leads to increasing the numbers of woodland owners. This creates a capacity issue for those agencies charged with providing landowner assistance.
- Rising land values, and associated property tax rates, are making woodland ownership less appealing to many would-be landowners. Existing landowners may be increasingly tempted to sub-divide large holdings for financial benefit or to reduce their tax burden.
- Many woodland owners are not knowledgeable about forest management and are not aware of programs or cost-share opportunities that might enable them to take an active role in the management of their woodlands.

Opportunities for partnership, cooperation, and projects:

- Most states have non-governmental woodland owner organizations that encourage woodland stewardship and provide educational opportunities for woodland owners. Supporting or otherwise partnering with these organizations can help to increase their effectiveness.
- Cooperation with forestry extension could be expanded to help reach and educate landowners and to inform them of landowner assistance opportunities with the state and federal agencies.
- Peer-to-peer networks of forest landowners have proven very effective at conveying forest management information to private woodland owners who might otherwise be reluctant to take advantages of opportunities presented by well-intentioned “strangers”.

- Forest Service could facilitate/fund the development of a consistent methodology of using tax information data combined with remote sensing data to identify forest landowners by name and address.
- Call Before You Cut – Several Midwestern states have partnered together to create the "Call Before You Cut" campaign. The effort is targeted at those forest landowners who do not have a forest management plan, but are at the point of undertaking a harvest activity. It encourages these folks to seek out the help of a professional forester before making management decisions. The effort shares the same name and slogan despite operating in multiple states and they share a common website where landowners can find contact information. http://www.callb4ucut.com/

13. Increase Urban Forest Inventory and Analysis
The Forest Service's Forest Inventory and Analysis (FIA) Program provides the information needed to assess America's forests. FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. The Forest Service has significantly enhanced the FIA program by changing from a periodic survey to an annual survey, by increasing capacity to analyze and publish data, and by expanding the scope of data collection to include soil, under story vegetation, tree crown conditions, coarse woody debris, and lichen community composition on a subsample of our plots.

States: Wisconsin and possibly others.

Issues:

- Continuous inventory data is currently lacking for urban forests, thus limiting the ability of state and regional managers to track conditions and trends.

Opportunities for partnership, cooperation, and projects:

- Partner with neighboring states that share contiguous urban areas for funding and data collection.

Existing efforts:

- Pilot projects were completed in Indiana, Wisconsin, and New Jersey in 2001, 2002, and 2003, respectively. Reports can be found at: http://na.fs.fed.us/urban/monitoring_projects.shtm
- Pilot projects have also been completed (4 panels over 4 years) in Colorado and Tennessee.

14. Upper Midwest and Great Lakes Landscape Conservation Cooperative (UMGL LCC)

States & Provinces: Minnesota, Iowa, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York and Vermont, Manitoba, Ontario and Quebec.

Landscape Conservation Cooperatives are management-science partnerships that inform integrated resource management actions addressing climate change and other stressors within and across landscapes. They will link science and conservation delivery. LCCs are true cooperatives, formed and directed by land, water, wildlife and cultural resource managers and interested public and private organizations. Federal, state, tribal, local government and non-governmental management organizations are all invited as partners in their development. (http://www.fws.gov/science/shc/lcc.html) The Fish & Wildlife Service is initiating the cooperatives around the country.

The UMGL LCC area includes unparalleled deepwater habitats, beaches, coastal wetlands, more than 35,000 islands, major river systems, boreal forests, and prairie-hardwood transition zones. These habitats provide for extensive resident and non-resident game populations, fish and many other aquatic resources, waterfowl, colonial waterbirds, marshbirds, and neotropical migrant landbirds.

Appendix

Appendix A: Ecological History of Wisconsin's Forests

Introduction
Natasha Kassulke[1]

Between 1832 and 1866, United States government contractors surveyed lands that would become the State of Wisconsin for the purpose of subdividing and selling land to timber companies, speculators and settlers. The survey also was needed to make land grants to railroad and canal companies to finance construction.

Over 100 surveyors worked in Wisconsin over the survey period. The survey was systematically carried out, with survey posts (wooden posts or stones) set every half mile along a grid of one mile square blocks of land called sections. Surveyors were joined by chainmen who stretched out and the measuring chain, and sometimes by axmen, flagmen or markers and general laborers. Surveying crews carried tools, camping supplies and sometimes even canoes.

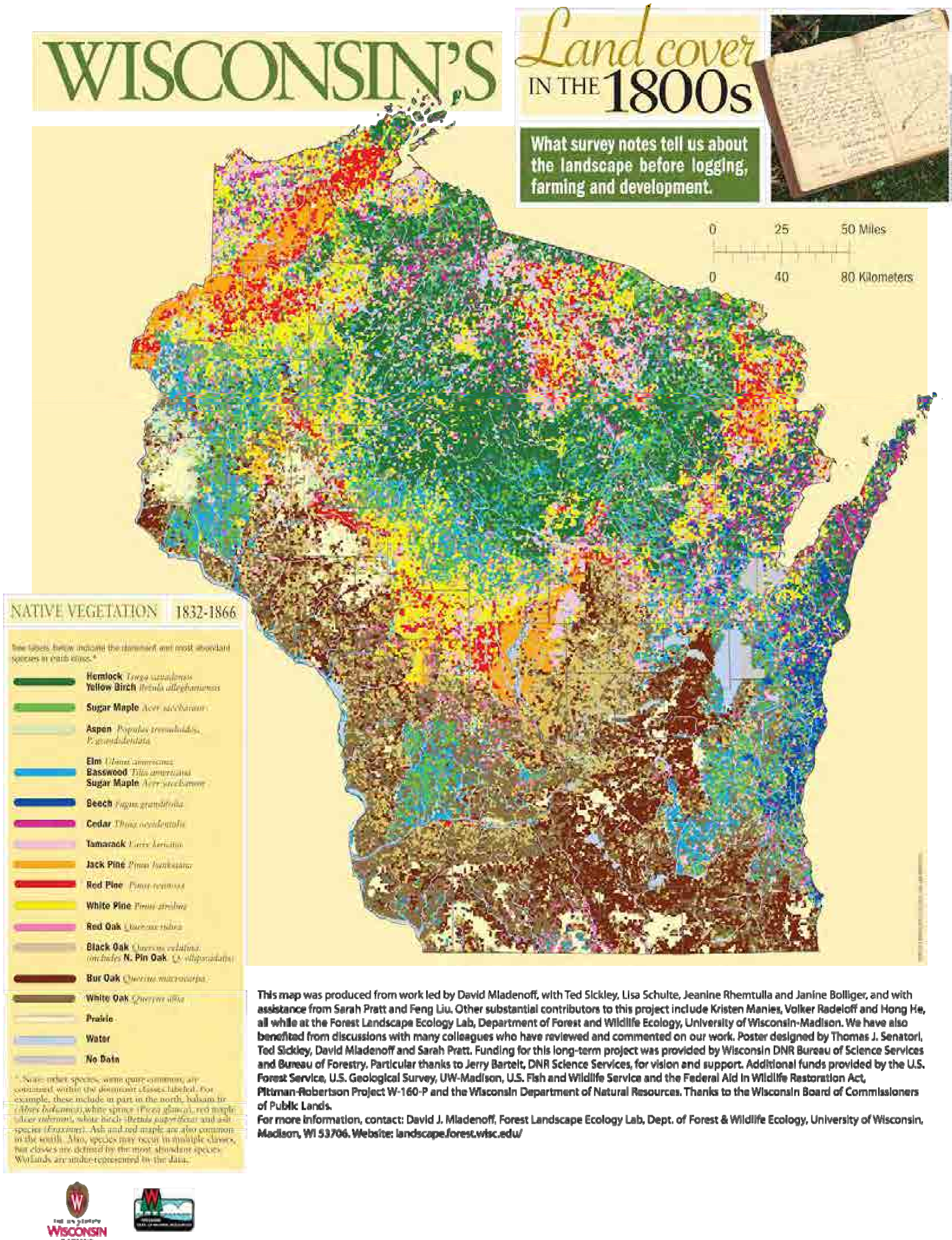
Although this was a land survey rather than a botanical survey or inventory, at each section surveyors noted the location, species and size of between two and four “witness trees” (or bearing trees). These trees were scribed with the corner identification, and vegetative information for each mile surveyed. In areas without trees such as prairies and marshes, mounds of earth or stone were constructed to mark the corners location. With each section corner, a brief description of the vegetation, soils and other noteworthy observations including fire and windthrow locations were summarized for the last mile of survey run.

The original surveyors’ notebooks, which are about 150-years-old, are held by the Office of the Commissioners of Public Lands for Wisconsin in Madison. From microfilms of these notebooks, University of Wisconsin researchers have extracted ecological information and compiled a computerized, statewide tabular database of Wisconsin's 19th century vegetation. David Mladenoff began the project in 1994 with a graduate student, GIS scientist Ted Sickley, and hired students.

The Wisconsin DNR produced a geographic information system (GIS) database of statewide PLSS corners, to which the tabular data could be attached. This then allowed for information mapping and spatial analysis as represented in Map A1. This was a more than 12 year ongoing project with several partners including DNR Science Services and Forestry programs staff.

Changes during the last 150 years due to logging, farming, reforesting and development have made it difficult to otherwise assess what the pre-settlement ecosystem looked like in Wisconsin. Cessation of prairie fires occurred in southern Wisconsin as early as the 1830s, which allowed open landscapes to quickly revert to brush and forest. Logging started around 1850 and loggers were followed by catastrophic fires and settlers changing the landscape in a period known as the Cutover.

[1] Natasha Kassulke is creative products manager *for Wisconsin Natural Resources* magazine. This article is adapted from a special insert on pre-settlement vegetation that was published in August 2009.



Map A.1: Wisconsin's Native Vegetation 1832-1866

The big advantage of the current GIS database is that it can be analyzed with many other mapped data sets, or classified at different levels of detail. Large or small areas can be selectively mapped and analyzed for many uses such as understanding the relationship of vegetation to soil type and understanding how landscape patterns, forests and wildlife habitats have changed over time, as well as identifying priorities and locations for restoring ecosystems. For example, looking at this map, it is clear that vegetation is not randomly distributed statewide. The vegetation pattern is a product of interaction among climate, soils, and Native American use. Disturbances such as natural fires, and especially windstorms, also occurred and were important in shaping the forests.

This database development project was primarily funded by the Wisconsin Department of Natural Resources and the U.S. Fish and Wildlife Service to understand relationships between locations of historical vegetation and potential wildlife habitat management. However, the data have much broader implications and contributions were also received from the U.S Forest Service, U.S. Geological Survey, and the UW-Madison.

The goal of the project was never to suggest restoration of the state to pre-settlement conditions. That is not desirable or possible. The goal was to understand where in the state are the best places to manage different habitat types based on where they occurred naturally in the past. Management plans will be most effective when they respect the natural variability of the area and work within its boundaries and constraints.

Interpreting the Map[2]
David J. Mladenoff

Vegetation changes constantly; slowly with gradual climate change, or faster with fire or human use. Wisconsin's vegetation has changed constantly since de-glaciation approximately 10,000 years ago, as climate warmed, cooled, and warmed again, and plant species migrated north at different rates.

Wisconsin vegetation of the 1800s was the product of climate interaction, soil types, topography and Native American activity. Euro-American activity existed for 200 years before this, but was highly localized at a few Great Lakes and major river sites.

While any vegetation map from one period is static, there is some constancy to the picture of the 1800s in Wisconsin. All tree species had migrated into the state by about 3,000 years ago. Change occurred during warmer and cooler periods, and with the different amounts of fire. For example, we know that the extent of prairie varied with warm and cool periods, as did the relative amounts of pine and oak on the northwest sand plain. But studies of fossil pollen show that the basic pattern we see at the scale of this map had been relatively constant, with some shifting abundance, for several thousand years.

Climate is the broadest gradient, warmer to the south and southwest, and colder to the north. Lakes Michigan and Superior modify extremes. Warmer climate and more frequent dry

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[2] Technical scientific publications on these issues and other research using the data can be found at Mladenoff's Forest Landscape Ecology web site http://landscape.forest.wisc.edu/

conditions contributed to conditions suitable for burning, likely largely due to greater Native American populations in the south.

Resulting vegetation was largely a gradient of open prairie to savanna, to open woodland in the southern part of the state. A noteworthy mesic[3] forest island, predominately sugar maple, basswood, oak, and other species, occurred in the southwest along the Kickapoo River, which served as a fire break from fires being driven by prevailing southwesterly winds. Black oak was most abundant in the central areas on sandy soils. White oak and bur oak were more abundant to the west and east, respectively, but common throughout.

More closed canopy mesic forest, with beech a major component, occurred along Lake Michigan, with sugar maple and other species, and more northern white cedar and hemlock on the Door County peninsula in Lake Michigan. Beech abruptly reaches its western range limit just a few counties in from Lake Michigan.

Especially away from Lake Michigan, this mosaic in the south was the result of dominant use of fire, interacting with climate, soils and topography.

Wetlands do not map well in the south based on the Public Land Survey System data because of the density of the PLSS survey points on the landscape, and because wetlands are often small and patchy, or long and narrow and were missed by survey points.

While we usually think of the prairies as being more southerly, there were several noteworthy large open prairie areas in west central Wisconsin. Survey notes suggest that these likely differed somewhat in vegetation with those further south having more brush and aspen.

In the north, cooler climate with less frequent drought favored more conifers species, and less fire than in the south. Lightning fire, and likely more commonly, fire caused by Native Americans, was most frequent in the sandy outwash plains in the north. These can be located by noting the concentration of pines in these plains in the northwest, north central and northeast, as well as the sandy former glacial Lake Wisconsin lakebed in the central part of the state. Red oak was common with pine.

Pine concentrations also can be seen along the border of the southern oak savannas and northern forests, where fires were also more common than generally in the north, and along the major river valleys, which often have glacial outwash channels with sandier soils. The three species of pines generally indicate a gradient of greater fire frequency and poorer, sandier soil, from white, to red, to jack pine. This is visible in the variability of the three northern sand plains. The north central and northeast plains also had more variable topography and more lakes to act as fire breaks than the northwest plain. Aspen (often with paper birch) occurred most often with pine on the fire prone sand plains and along the savanna border in the west central area.

The PLSS data have shown that white pine especially was more common than we had thought along Lake Superior, often on clay soils with a mix of boreal conifers and white birch. Similarly, yellow birch was even more common than believed, and often the leading dominant, in the mesic

[3] Moderately moist

forest region with sugar maple and hemlock. Hemlock and yellow birch reach the edge of there range east of the northwest sand plain, except for a few scattered infrequent occurrences further west and in the western edge of Minnesota.

Many areas of lowland forested wetlands were often dominated by tamarack and white cedar, with spruce, fir, and black ash, also visible. Many more, smaller areas also occurred in the north, but are too small to be mapped well by the density of the survey points on the landscape.

In a wide arc around and in between the pine plains, the northern mesic forest of sugar maple, hemlock, and yellow birch constituted the largest and most abundant forest type, on better soils and very infrequent fire. Again, contrary to common assumptions, this was the most abundant forest type in northern Wisconsin, followed by pine. In fact, sugar maple, yellow birch, and hemlock trees were all more abundant than white pine, though white pine was a close fourth.

Vegetation Change

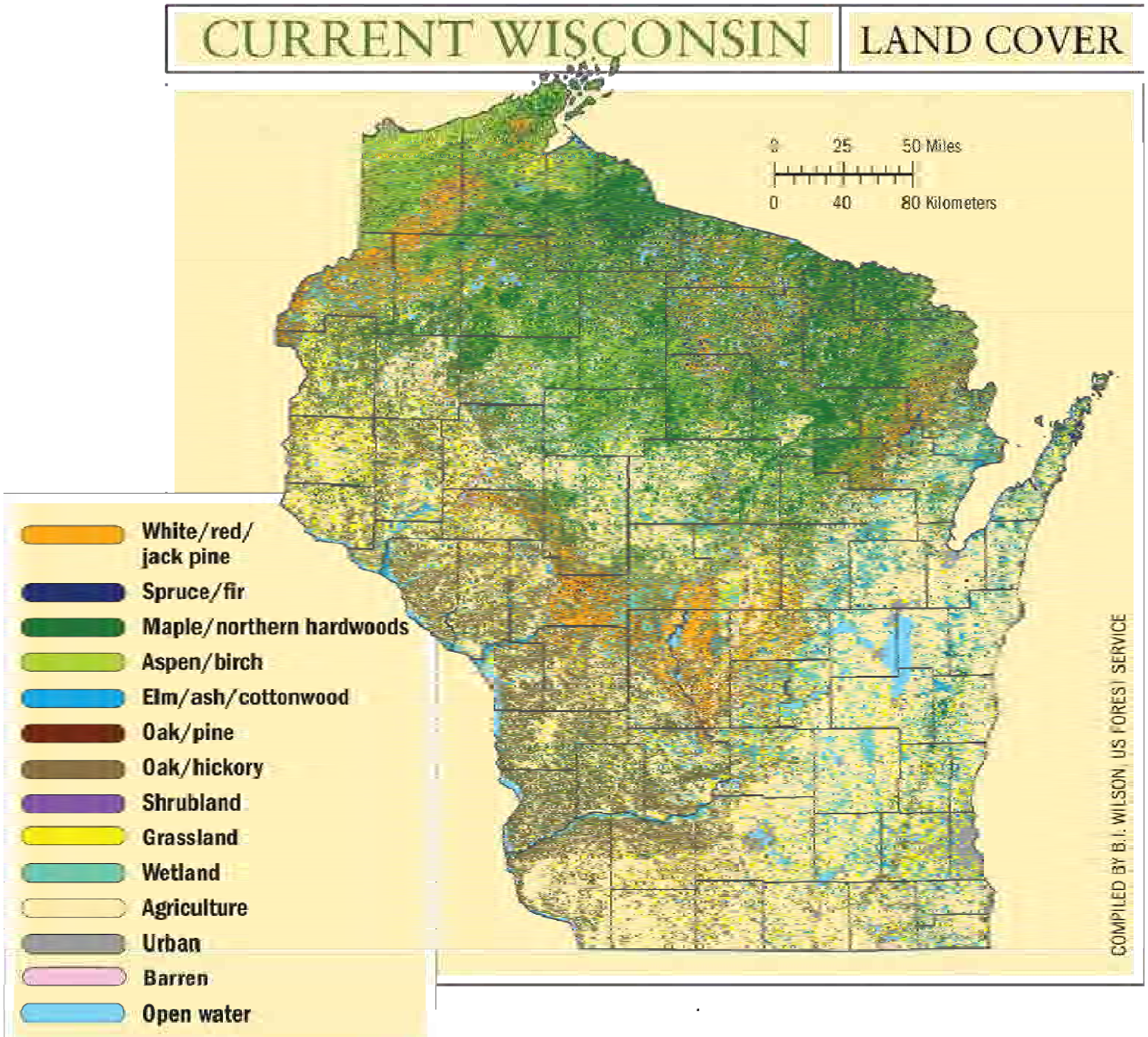
While vegetation change is indeed constant, the change from the 1800s to the present has been unprecedented. Besides elimination of most prairie, savanna and pine ecosystems, fossil pollen studies show us that relative abundances of species changed about five times as much since the 1800s as changes in the preceding 3,000 years.

The most striking change in the 19th century map and the present vegetation map (Map A2) is due to agriculture. Nearly all prairies, savanna, and the eastern mesic forest with beech have been replaced by agriculture. Those remnant areas of oak savanna not concerted to agriculture grew into closed forest following fire suppression. The majority of wetlands in the south, poorly mapped with this data source, have been eliminated by agricultural drainage and development.

In the north, the big change has been large declines in the evergreen conifers in the uplands, the pines and hemlock. White pine is only five percent of its level in the 1800s, and hemlock less than 0.5 percent. In the north the major cause of these declines is logging that occurred from the mid-1800s to the early 1900s, followed by extreme, repeated slash fires. Significant agriculture followed logging and still exists in the south central area of northern Wisconsin.

On the other hand, the cessation of more varied, natural and Native American caused fires has eliminated the open pine savannas and open pine woodlands that occurred in the 1800s, largely on and around the three outwash plains. These are probably among the ecosystems with the greatest lost, even more than the closed pine forests forest.

Research shows that contrary to common belief, less agriculture was attempted than often assumed in the north. Following the fires, aspen was favored in the north and became the dominant forest type for the first half of the 20th century, and the most important commercial species. Those areas in the north that did not burn, largely on the better soils, became dominated by a simplified mesic forest of predominantly sugar maple. This also increased slowly, replacing some aspen, since the 1950s, but has stopped increasing. Yellow birch was largely lost from these forests as a dominant, as was hemlock.



Map A.2: Current Wisconsin Land Cover

Ironically, the satellite map of today's vegetation cannot show the detailed species and genus level forest changes that we can derive from the survey data. Commonly available Landsat satellite data while of detailed spatial resolution, cannot distinguish tree types well, beyond evergreen and broadleaved deciduous.

Wetlands have not been lost in the north to the degree they have in the south, especially forested wetlands. However, northern wetlands dependent on frequent fire have likely declined significantly.

Less visible with maps of this coarse scale, are continuing changes to the vegetation of the state due to very high deer abundance. This continues to affect both understory plants, as well as browse sensitive tree species, inhibiting their recovery. These include hemlock, northern white cedar, yellow birch, and white pine, especially in the north. In the south, oak regeneration is affected by browsing as well as the lack of fire, which favors maple invasion.

Overall, changes have been driven by human use that directly eliminates ecosystems, such as agriculture and development, especially in the south, and logging followed by extreme fire in the north. Commercial forestry is more important in the north, but also can either maintain types, such as aspen, or prevent forest succession to other types. Recent forest inventory data suggest though, that white pine is notably increasing in the north. The end of varied, natural fires has affected ecosystems in both north and south.

Future change

Future changes are perhaps less likely to be characterized by recovery than we have assumed. Loss of seed sources for trees such as pine, hemlock, yellow birch and cedar, along with deer browsing, will be the reason for some of this. Climate warming directly, and broader global change-caused effects, such as new insect and disease pests arriving due to global commerce, will undoubted have an effect and already are. Research using computer modeling also suggests that northern forest species may decline with warming and some at the southern edge of their range may be lost over the next century. Our biggest challenge now is uncertainty associated with what future changes will be from climate to land use change.

Interestingly, even with great change in the recent past and likely in the future, the data on the vegetation of the 1800s continue to be of great value. First, because of high future uncertainty and concern for biodiversity loss, a conservative approach to conserve what we have had is prudent. Second, as paleo-ecological research continues to increase our knowledge about past climates that produced the vegetation of the 1800s, it helps us to better understand species-climate relationships in general.

Appendix B: Cultural History of Wisconsin's Forests

Wisconsin's forests are reservoirs of vast ecological, economic, and social wealth. Throughout Wisconsin's history, forests have played a primary role in supporting the people who lived here. The forests of Wisconsin are dynamic, living systems that change with the human demands placed on them as well as through natural occurrences such as succession, severe weather events, fire, insect infestations, and disease.

Forests before European-American settlement

At the time of European-American settlement (1825–1880), most of the area that would become the State of Wisconsin was forested. Forests covered 22-30 million acres, or 63%-86% of the state. A complex array of habitats supported wildlife, plants, and humans [Curtis, 1959].

The last glaciers receded from northern Wisconsin between 10,000 and 12,000 years ago. Their departure opened the area for colonization by plants, animals, and humans.

There are two major forest divisions in Wisconsin, the Northern Mixed Forest and the Southern Broadleaf Forest, with several ecosystems represented in each [Wisconsin Department of Natural Resources, 1995].

The native vegetation of the northern region is more cold tolerant. Pine, spruce, and tamarack are more abundant. Before European settlement, sugar maple, hemlock, and yellow birch dominated the mesic forests of northern Wisconsin. Various pine species were also important. Aspen and white birch were important successional species that followed natural disturbance across northern Wisconsin. Acid bogs were a significant ecosystem in the northern Wisconsin forest. Pine forests and barrens were important on the sandy soils of central and northwest Wisconsin. In the southern part of the state, oak-hickory and maple-basswood forests were especially prevalent. The southern and western parts of the state also supported oak savanna and prairie habitats. Forested and non-forested wetlands were found throughout the state [Finley, 1976].

Early human influence

There is evidence of human presence in Wisconsin as early as 11,000 years ago.
The post-glacial ecology of Wisconsin was influenced by humans from its very beginning.

New research indicates that before European contact beginning in 1492, there were up to 100 million people living in North America. In Wisconsin, fifteenth century population is estimated at 60,000–70,000. Between 1492 and 1634, the population was reduced to as few as 4,000 individuals, primarily as a result of introduced European diseases and war [Gartner, 1997].

Especially prior to this population collapse, native people profoundly influenced the land and ecology of Wisconsin in areas where they lived. Perhaps most significant was their use of fire. It is thought that native people used fire throughout the state to varying degrees to encourage the establishment of favored plant and animal communities. Prairie and savanna were likely maintained by these natural and manmade fires [Gartner, 1997].

Hunting and trapping were major influences of the ecological communities of the area that later became Wisconsin. Native people hunted a broad spectrum of animals. Deer and elk were the cornerstone of the Woodland Indians' diet, but mussels, birds, fish, and over 25 other mammal species were utilized as well [Gartner, 1997].

Nuts and fruits were also important to native people, and there is evidence that they planted orchards to ensure a supply. There are accounts from early European explorers describing the "planted tree groves" of chestnuts, locusts, oaks, ashes, basswoods, beeches, cottonwoods, maples, pecans, medlars, mulberries, and plums. These "orchards" may have resulted in the forest islands seen on the prairies by early European explorers. Sugar maple and paper birch provided important products. [Gartner, 1997]

Foraging also influenced the ecology of Wisconsin. Some plants collected by Indians were dispersed into the environment. It was said of wild rice by the Menominee, "whenever the Menomini [sic] enter a region the wild rice spreads ahead, whenever they leave it the wild rice passes." [Gartner, 1997]

Agriculture and placement of settlements and trails in pre-contact times had a large impact on the landscape. Many of our major highways began as roads between native people's settlements hundreds of years ago [Gartner, 1997].

When early explorers arrived in Wisconsin in the 1630s, they found a greatly reduced population. Because of this, until recent archeological research contested the belief, it was assumed that there were very few people living in Wisconsin before European settlement. The forest early European explorers saw had likely changed as a result of the decrease of human population. Many areas which had been maintained by fire as grassland or early successional forest were now mature forests as there was no longer either the need or the capacity to burn or clear the land.

The tribes living in Wisconsin in the mid-1600s included the Winnebago, Ojibwe, Menominee, Dakota, Illinois, Sauk, Fox and Cheyenne. However, some of these groups have stories of migrating from other areas to Wisconsin. For example, the Ojibwe tell of their migration from the eastern ocean in the 1400s. This era corresponds to the "Little Ice Age," a period of significant cooling of the North American continent [Sultzman, 1998]. Temperature between 1450 and 1850 averaged 1.5 degrees Fahrenheit cooler than today.

Forests since European-American settlement

Today, Wisconsin's forests are significantly different than those before European-American settlement. A variety of historical reasons can account for this.

Exploration and settlement

In 1634, Frenchman Jean Nicolet landed on the southern shore of Green Bay to arrange a truce between the Winnebago and their enemies so that the French fur trade would be protected, a task at which he succeeded. This was the first direct European influence felt on the land that would become the state of Wisconsin [Sultzman, 1998]. However, for two hundred years, the forests remained sparsely settled while providing for the lucrative fur trade and continuing to support native people [Wisconsin Conservation Department (WCD), 1955].

Various treaties in the early 1800s, which either removed or confined native populations, opened up Wisconsin to intensive European-American settlement [Sultzman, 1998]. With the dramatic increase in human population came increasing demands on resources. Much of the southern part of the state was converted to agriculture. The fertile soil in this area, including much that was previously forested, became the base for some of the most productive farms in the growing nation. During this process, southern forests were cut and burned to aid in clearing the land and to create nutrient-rich ash to fertilize crops.
Timber was not a major economic contributor until the 1870s [WCD, 1955].

The Cutover

In the late 1860s, following the Civil War, logging became an important component of Wisconsin's economy. By 1893 Wisconsin had reached its logging zenith and was a world leader in lumber production with over 3.5 billion board feet produced annually. Pulpwood consumption was about 211,000 cords. Sawmills sprang up everywhere along Wisconsin's many rivers, which transported logs to the mill and the finished products to the burgeoning cities to the south and west. Eight million acres of forest were cut by 1898, the height of Wisconsin's Cutover.

In 1898 the federal government conducted and published a survey of Wisconsin's northern forests. By this time, a first wave of cutting was well underway, and a second beginning. In the survey's introduction, B. E. Fernow estimates the 1850s pine (red and white pine) volume at 130 billion board feet. By 1898, all but 17 billion had been removed, and cutting was continuing at a rate of 2 billion board feet per year. Fernow wrote, "In almost every town in this region logging has been carried on and 8,000,000 of the 17,000,000 acres of forest are 'cut over' lands largely burned over and waste brush lands, and one-half of it as nearly desert as it can become in the climate of Wisconsin."
[Roth, 1898]

By the 1930s, most of the valuable timber in the northern area of the state had been removed or destroyed by fire. The harvest occurred in two waves; the pines were harvested first and floated down the rivers to cities to the south. When railroad shipping became available, valuable hardwoods were cut and taken by train to the south. Then the other, less economically desirable trees were cut.

Harvest techniques varied in Cutover lands. Some lands were clear-cut, but most were high-graded. The largest and most valuable trees were removed, many times leaving species and individuals less dominant to re-seed an area. At the time of the first statewide inventory in 1936, the approximately 16 million acres of forest land in the state was primarily young, early succession second growth.

The Cutover led to a variety of problems for contemporary and future residents. Not least among the challenges was the wave of forest fires that cinched the destruction of millions of acres of trees and took thousands of human lives. Slash (wood residue from logging operations) burned easily and quickly. Fires spread over large areas, leaving ashes in their path.

Another result of the Cutover was the land boom of the early 1900s. In northern Wisconsin, logging companies sold sizable tracts of cut over land to speculators who then sold smaller farms to the immigrant population arriving in Wisconsin, enticed by the promise of land. Farmers diligently removed stumps left from the Cutover, sometimes disposing of them through fire, which further contributed to the frequent and intense forest fires of the era. Rivers transported much of the timber cut from Wisconsin's forests in the late 1800s.

Conservation

This degradation of Wisconsin's forests did not go unnoticed. An era of forest conservation was about to begin. One of the most persistent advocates of conservation was E. M. Griffith, appointed the first state forester in 1904. With the help of people as disparate as Senator Robert LaFollette, Sr., lumber baron Frederick Weyerhaeuser, and University of Wisconsin President Charles R. Van Hise, Griffith pieced together land into state-owned forest preserves. He also oversaw construction of the first state nursery at Trout Lake near Minoqua, implemented new fire control strategies, and was influential in locating the U.S. Forest Products Laboratory in Madison.

Unfortunately, neither the public nor the Wisconsin Supreme Court was ready for such innovations. County governments were concerned about the loss of land from the tax rolls and also contended that Griffith and his cohorts were trying to turn northern Wisconsin into a 'playground' for the rich at the expense of the farmers becoming established in the area. The Supreme Court found that the land was purchased for the forest preserves under the authority of an improper amendment to the state constitution. Griffith resigned in 1915, and the reforms that he tried to promote were not implemented for another decade.

Finally, in the late '20s and 30s, some of Griffith's goals were realized. A new concern for conservation and an understanding that the forest resource is finite informed new decisions regarding Wisconsin's forests. Farmers in the north realized that the land and climate were not well-suited to agriculture. Many of them abandoned the land, bankrupt. This land reverted to forest.

The State Constitution was amended in 1924 to allow state funds to go to acquisition, development, and preservation of forest resources. The Northern Highland State Forest, still the largest state forest, was the first created under the new amendment. The Forest Crop Law, a precursor to the current Managed Forest Law, was passed in 1927, making it easier for private landowners and counties to conserve forest resources for future use. County forests were created from much of the tax delinquent land of failed farms. In 1928, the first national forest land was purchased in Wisconsin, creating what is now known as the Chequamegon-Nicolet National Forest.

After 50 years of pervasive forest fires, made worse because of the ready availability of fast-burning slash from the extensive harvesting, the public began to value fire control. Human life, farms, buildings, and forests were protected with new fire prevention and control measures. With Smokey Bear's advent in 1944, the public embraced a commitment to fire prevention and forest conservation in Wisconsin.

In the '30s and early '40s, a notable influence on Wisconsin's forests was the Civilian Conservation Corps (CCC). As in other areas, the "CCC boys" fought fires, planted trees, built park buildings, and worked on other conservation projects. Reforestation efforts commenced across the state, with the goal being to renew the forests. Many of Wisconsin's older pine plantations originated with CCC efforts.

The Cutover era had dramatically changed the composition, structure, and function of Wisconsin's forests. The extensive logging and large fires allowed species like quaking aspen and paper birch to become prevalent, encouraging large populations of whitetail deer and other wildlife that thrive in early successional habitat.

A forest inventory of Wisconsin was conducted in 1936. It revealed a very young forest, with aspen-birch being by far the most prevalent forest type.

Many years passed before the Cutover forests recovered sufficiently for harvest. Fortunately, by this time there was a better understanding of the need to conserve forest resources and employ sound forest management. In many instances, professional foresters from forest products companies and government agencies worked together to bolster the growing forests.

Since the Cutover era, Wisconsin's forests have recovered dramatically. The state now supports a wide array of healthy forest ecosystems. Ecological, economic, and social benefits have grown with the growing forest. There are also challenges that face Wisconsin's forests including environmental issues, economic demands, and changing expectations among people who use and own the forests. This assessment will discuss the current state of Wisconsin's forest resources as well as issues and trends that will affect the forests' future.

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Appendix E: Criterion One Additional Data

Figure E.1: Sections and subsections of Wisconsin (WDNR 2002)
(This figure applies to information presented in Indicator One)

National Hierarchical Framework of Ecological Units (NHFEU)
List of Map Units for Sections and Subsections of Wisconsin

200 – Humid Temperate Domain
210 – Warm Continental Division
212 – Laurentian Mixed Forest Province

212I – Lake Superior Section
212Ic – Apostle Islands Subsection

212J – Southern Superior Uplands Section
212Jb – Penokee-Gogebic Iron Range Subsection
212Jc – Winegar Moraines Subsection

212K – Western Superior Uplands Section
212Ka – Bayfield Sand Plains Subsection
212Kb – Mille Lacs Uplands Subsection

212O – Lake Michigan Section
212Ob – Green Bay Subsection

212Q – North Central Wisconsin Uplands Section
212Qa – St. Croix Moraine Subsection
212Qb – Lincoln Formation Till Plain, Mixed Hardwoods Subsection
212Qc – Lincoln Formation Till Plain, Hemlock-Hardwoods Subsection
212Qd – Rib Mountain Rolling Ridges Subsection

212T – Northern Great Lakes Section
212Ta – Green Bay Lobe Stagnation Moraine Subsection
212Tb – West Green Bay Till Plain Subsection
212Tc – Athelstane Sandy Outwash and Moraines Subsection
212Te – Green Bay Sandy Lake Plain Subsection
212Tf – Door Peninsula Subsection

212X – Northern Highland Section
212Xa – Glidden Loamy Drift Plain Subsection
212Xb – Northern Highlands Pitted Outwash Subsection
212Xc – Brule and Paint Rivers Drumlinized Ground Moraine Subsection
212Xd – Central/Northwest Wisconsin Loess Plains Subsection
212Xe – Perkinstown End Moraine Subsection
212Xf – Hayward Stagnation Moraines Subsection
212Xg – Crystal Falls Plains and Hill Subsection

212Y – Southwest Lake Superior Clay Plain Section
212Ya – Superior/Ashland Clay Plain Subsection

212Z – Green Bay-Manitowoc Upland Section
212Za – Outagamie Loamy Till and Silty Lake Plain Subsection
212Zb – Green Bay Clayey and Silty Lake Plain Subsection
212Zc – Manitowoc Till Plain Subsection

200 – Humid Temperate Domain
220 – Hot Continental Division
222 – Eastern Broadleaf Forest (Continental) Province

222K – Southwestern Great Lakes Morainal Section
222Kb – Central Wisconsin Moraines and Outwash Subsection
222Kc – Lake Winnebago Clay Plain Subsection
222Kd – South Central Wisconsin Prairie and Savannah Subsection
222Ke – Southern Green Bay Lobe Subsection
222Kf – Geneva/Darien Moraines and Till Plains Subsection
222Kg – Kenosha/Lake Michigan Plain and Moraines Subsection
222Kh – Rock River Old Drift Country Subsection

222L – North Central U.S. Driftless and Escarpment Section
222La – Menominee Eroded Pre-Wisconsin Till Subsection
222Lb – Melrose Oak Forest and Savannah Subsection
222Lc – Mississippi/Wisconsin River Ravines Subsection
222Ld – Kickapoo/ Wisconsin River Ravines Subsection
222Le – Mineral Point Prairie/Savannah Subsection

222M – Minnesota and Northeast Iowa Morainal Section
222Md – Rosemont Baldwin Plains and Moraines Subsection

222R – Wisconsin Central Sands Section
222Ra – Central Wisconsin Sand Plain Subsection
222Rb – Neilsville Sandstone Plateau Subsection

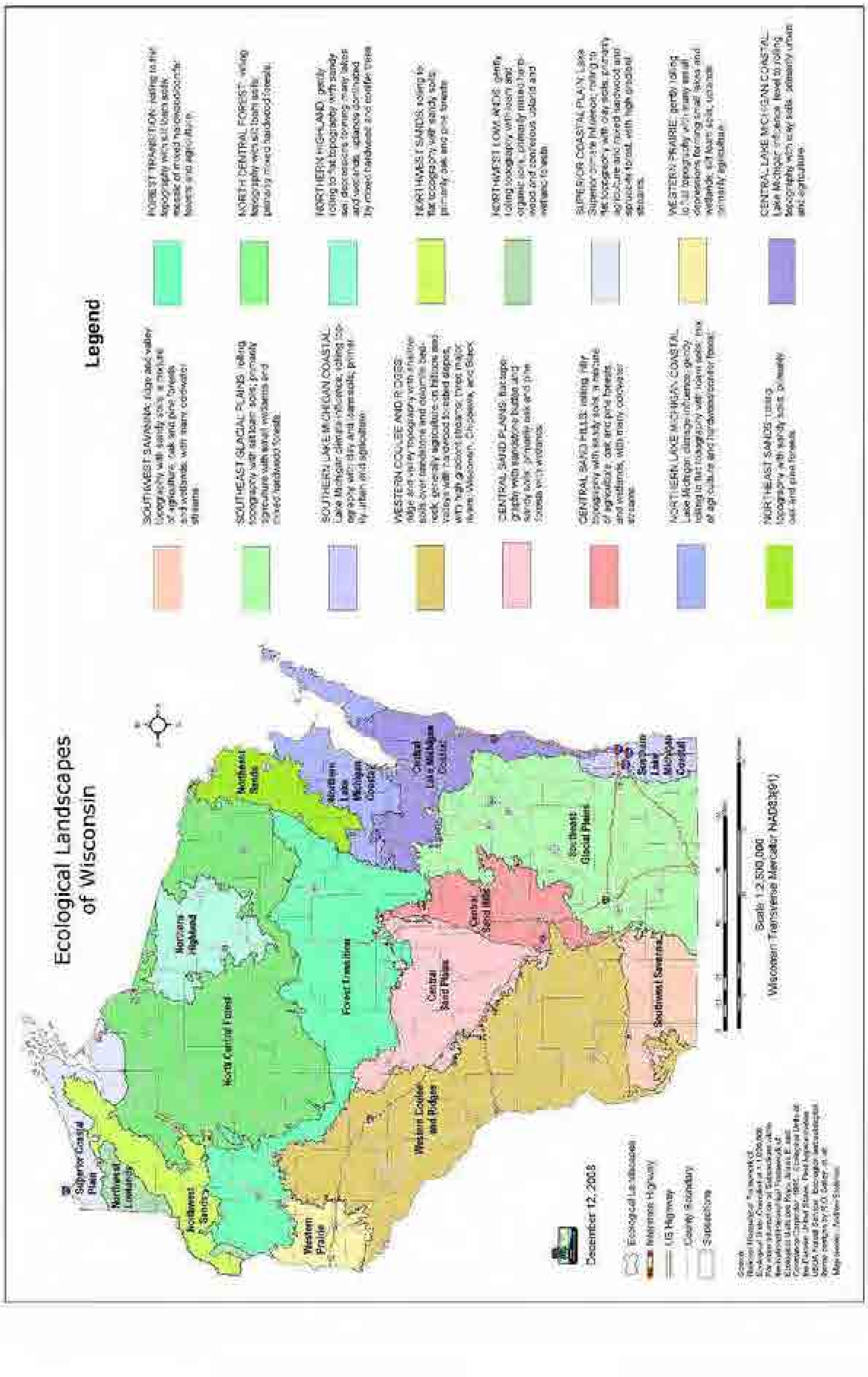

Figure E.2: Ecological Landscapes of Wisconsin (WDNR 2001)
(This figure applies to information presented in Indicator 4)

Appendix F: Criterion Four Additional Data

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.

The sampling intensity is one plot to 96,000 acres and these plots are referred to as the FIA Phase 3 plots. Data was obtained from the USDA Forest Service, Forest Inventory and Analysis Program through a special request. The FIA soils protocols were designed for use with soils models for regional and national analysis. Since the sampling is not intensive enough to measure spatial distribution (expansion factors were not developed), data is reported in the tables below by the percentage of plots.

Soil carbon is assessed through soil sample collections, which are submitted to a regional laboratory for analysis. Soil carbon is analyzed for three depths: forest floor, 0-10 cm (0-4 inches), and 10-20 cm (4-8 inches). Total soil carbon (carbon at all three depths) is reported in Table E.1. The soil carbon results are based on 125 plots collected from 2001-2004.

Table F.1: Total soil carbon in Wisconsin forest land

Percent of total soil carbon on plots	Percent of plots
10% - 25%	1%
26% - 50%	37%
51% - 75%	40%
76% - 100%	17%
101% - 400%	5%

Estimates of bare soil are made visually, in four subplots within each plot. Percent bare soil is reported in Table E.2. Bare soil was visually estimated on 163 plots from 2001-2004.

Table F.2: Estimated bare soil in Wisconsin forest land

Percent bare soil	Percent of plots
0%	15%
.1% - 1.0%	26%
1.1% - 10.0%	41%
10.1% - 20.0%	9%
20.1% - 50.0%	8%
50.1% - 75.0%	1%

Bulk density is assessed through the collection of soil samples, which are submitted to a regional laboratory for analysis. Bulk density is analyzed for two depths: 0-10 cm (0-4 inches) and 10-20 cm (4-8 inches). Bulk density at the 0-10 cm depth is reported in Table E.3. Bulk density samples were collected on 106 plots from 2001-2004.

Table F.3: Bulk density at 0-10 cm soil depth in Wisconsin forest land

Bulk density (grams per cubic centimeter)	Percent of plots
<1.00	45%
1.01 – 1.25	31%
1.26 – 1.50	20%
1.51 – 1.75	4%

Calcium and aluminum are assessed through the collection of soil samples, which are submitted to a regional laboratory for analysis. Calcium and aluminum are analyzed for two depths: 0-10 cm (0-4 inches) and 10-20 cm (4-8 inches). The ratio of calcium to aluminum (at 0-10 cm) is reported in Table E.4. Calcium and aluminum samples were collected on 85 plots from 2001-2004.

Table F.4: Calcium – aluminum ratio at 0-10 cm soil depth in Wisconsin forest land

Calcium – aluminum ratio	Percent of plots
0 – 0.2	6%
0.3 – 0.5	12%
0.6 – 1.0	8%
1,1 – 1.5	4%
>1.5	71%

10.4 Mining activities

Mining activities are regulated by state and local authorities. Environmental concerns include air quality, water quality, soil erosion, and site reclamation.

Mining has long played a role in Wisconsin's development. From 4000 BC to 1000 BC, during the Old Copper Culture, Native Americans mined copper along the shores of Lake Superior to use for spear points, knives, axes and other implements. More recently, the first permanent European settlers in Wisconsin were miners and prospectors who sought out deposits of lead and zinc in southwestern Wisconsin.

There are no metal mines operating in Wisconsin, but deposits of iron ore are still found in Jackson, Ashland and Iron counties. In addition, sulfide deposits containing copper and zinc are documented in northern Wisconsin. The sulfide deposits in Forest County are believed to include one of the largest supplies of zinc ever discovered in North America.

There are an estimated 2,500 to 3,000 active nonmetallic mines in the state. Nonmetallic mines are generally rock quarries and gravel pits. Sand and gravel deposits can be found throughout the state. Small gravel pits are commonly found on state and county forests for road surfacing and other projects. In addition, when purchasing new lands or conservation easements, ownership of mineral rights is investigated. On state forests, the mineral rights are retained by the State.

Appendix G: Criterion Six Additional Data

Table G.1: Percent change in population, 1990-2008

(This table references information presented in Figure 16.b)

Source: U.S. Census Bureau, 1990 and 2000 Censuses of Population (corrected), and 2008 county estimate files.

County	Pop. 1990	Pop. 2000	Pop. 2008	Change 1990-2000	Change 2000-08	Change 1990-2008
Adams	15682	19920	20325	27.00%	2.00%	29.61%
Ashland	16307	16866	16295	3.40%	-3.40%	-0.07%
Barron	40750	44963	45590	10.30%	1.40%	11.88%
Bayfield	14008	15016	14926	7.20%	-0.60%	6.55%
Brown	194594	226660	245018	16.50%	8.10%	25.91%
Buffalo	13584	13804	13741	1.60%	-0.50%	1.16%
Burnett	13084	15674	16196	19.80%	3.30%	23.78%
Calumet	34291	40631	44727	18.50%	10.10%	30.43%
Chippewa	52360	55197	60456	5.40%	9.50%	15.46%
Clark	31647	33557	33553	6.00%	0.00%	6.02%
Columbia	45088	52467	55196	16.40%	5.20%	22.42%
Crawford	15940	17245	16885	8.20%	-2.10%	5.93%
Dane	367085	426526	482705	16.20%	13.20%	31.50%
Dodge	76559	85898	87912	12.20%	2.30%	14.83%
Door	25690	27961	27771	8.80%	-0.70%	8.10%
Douglas	41758	43287	43774	3.70%	1.10%	4.83%
Dunn	35909	39858	42688	11.00%	7.10%	18.88%
Eau Claire	85183	93140	98286	9.30%	5.50%	15.38%
Florence	4590	5088	4652	10.90%	-8.60%	1.35%
Fond du Lac	90083	97296	99453	8.00%	2.20%	10.40%
Forest	8776	10024	9846	14.20%	-1.80%	12.19%
Grant	49266	49597	49238	0.70%	-0.70%	-0.06%
Green	30339	33647	36090	10.90%	7.30%	18.96%
Green Lake	18651	19105	18566	2.40%	-2.80%	-0.46%
Iowa	20150	22780	23604	13.10%	3.60%	17.14%
Iron	6153	6861	6197	11.50%	-9.70%	0.72%
Jackson	16588	19100	19904	15.10%	4.20%	19.99%
Jefferson	67783	75767	80792	11.80%	6.60%	19.19%
Juneau	21650	24316	26633	12.30%	9.50%	23.02%
Kenosha	128181	149579	164465	16.70%	10.00%	28.31%
Kewaunee	18878	20187	20388	6.90%	1.00%	8.00%
La Crosse	97904	107120	112627	9.40%	5.10%	15.04%
Lafayette	16074	16137	15871	0.40%	-1.60%	-1.26%
Langlade	19505	20740	20165	6.30%	-2.80%	3.38%
Lincoln	26993	29641	29499	9.80%	-0.50%	9.28%
Manitowoc	80421	82893	80641	3.10%	-2.70%	0.27%
Marathon	115400	125836	130962	9.00%	4.10%	13.49%
Marinette	40548	43384	42288	7.00%	-2.50%	4.29%
Marquette	12321	14552	15060	18.10%	3.50%	22.23%
Menominee	4075	4562	4571	12.00%	0.20%	12.17%
Milwaukee	959212	940165	953328	-2.00%	1.40%	-0.61%
Monroe	36633	40896	43350	11.60%	6.00%	18.34%

County	Pop. 1990	Pop. 2000	Pop. 2008	Change 1990-2000	Change 2000-08	Change 1990-2008
Oconto	30226	35652	37529	18.00%	5.30%	24.16%
Oneida	31679	36772	36031	16.10%	-2.00%	13.74%
Outagamie	140510	161089	174993	14.60%	8.60%	24.54%
Ozaukee	72894	82317	85874	12.90%	4.30%	17.81%
Pepin	7107	7213	7357	1.50%	2.00%	3.52%
Pierce	32765	36804	40254	12.30%	9.40%	22.86%
Polk	34773	41319	44270	18.80%	7.10%	27.31%
Portage	61405	67182	68744	9.40%	2.30%	11.95%
Price	15600	15820	14278	1.40%	-9.70%	-8.47%
Racine	175034	188833	199510	7.90%	5.70%	13.98%
Richland	17521	17924	17982	2.30%	0.30%	2.63%
Rock	139510	152307	160213	9.20%	5.20%	14.84%
Rusk	15079	15347	14389	1.80%	-6.20%	-4.58%
St. Croix	50251	63155	82487	25.70%	30.60%	64.15%
Sauk	46975	55225	59013	17.60%	6.90%	25.63%
Sawyer	14181	16197	17117	14.20%	5.70%	20.70%
Shawano	37157	40664	40972	9.40%	0.80%	10.27%
Sheboygan	103877	112656	114561	8.50%	1.70%	10.29%
Taylor	18901	19680	19308	4.10%	-1.90%	2.15%
Trempealeau	25263	27010	27790	6.90%	2.90%	10.00%
Vernon	25617	28054	29090	9.50%	3.70%	13.56%
Vilas	17707	21033	21919	18.80%	4.20%	23.79%
Walworth	75000	92005	100749	22.70%	9.50%	34.33%
Washburn	13772	16035	16712	16.40%	4.20%	21.35%
Washington	95328	117509	129477	23.30%	10.20%	35.82%
Waukesha	304715	360752	380629	18.40%	5.50%	24.91%
Waupaca	46104	51825	51858	12.40%	0.10%	12.48%
Waushara	19385	23066	24760	19.00%	7.30%	27.73%
Winnebago	140320	156763	162111	11.70%	3.40%	15.53%
Wood	73605	75557	73756	2.60%	-2.40%	0.21%
Statewide	4891954	5363708	5627967	9.64%	4.93%	15.05%

Table G.2: Percentage change in Wisconsin forest land sale prices 1990 to 2007
(This table references information presented in Figure 16.d)

Source : USDA National Agricultural Statistics Service

County	1990 Average Forest land Sale Price Per Acre	2007 Average Forest land Sale Price Per Acre	Percentage Change in Value between 1990 – 2007
Adams	$458	$2,848	521.83%
Ashland	$171	$1,143	568.42%
Barron	$213	$1,975	827.23%
Bayfield	$213	$1,611	656.34%
Brown	$769	$3,737	385.96%
Buffalo	$148	$3,857	2506.08%
Burnett	$256	$2,360	821.88%
Calumet	$355	$3,241	812.96%
Chippewa	$193	$1,681	770.98%
Clark	$220	$1,874	751.82%
Columbia	$516	$3,915	658.72%
Crawford	$252	$2,394	850.00%
Dane	$897	$8,503	847.94%
Dodge	$396	$2,470	523.74%
Door	$603	$3,860	540.13%
Douglas	$159	$1,517	854.09%
Dunn	$213	$2,192	929.11%
Eau Claire	$253	$2,252	790.12%
Florence	$344	$1,619	370.64%
Fond du Lac	$652	$3,734	472.70%
Forest	$211	$1,649	681.52%
Grant	$234	$2,662	1037.61%
Green	$256	$3,013	1076.95%
Green Lake	$572	$3,876	577.62%
Iowa	$421	$3,726	785.04%
Iron	$163	$1,364	736.81%
Jackson	$265	$2,488	838.87%
Jefferson	$554	$5,920	968.59%
Juneau	$359	$2,759	668.52%
Kenosha	$1,593	$22,034	1283.18%
Kewaunee	$407	$3,086	658.23%
La Crosse	$609	$4,153	581.94%
Lafayette	$234	$3,107	1227.78%
Langlade	$261	$1,865	614.56%
Lincoln	$235	$1,883	701.28%
Manitowoc	$478	$2,796	484.94%
Marathon	$322	$2,452	661.49%
Marinette	$334	$2,235	569.16%
Marquette	$510	$3,656	616.86%
Milwaukee	$2,117	No Data	No Data
Monroe	$269	$3,433	1176.21%
Oconto	$362	$2,608	620.44%

County	1990 Average Forest land Sale Price Per Acre	2007 Average Forest land Sale Price Per Acre	Percentage Change in Value between 1990 – 2007
Oneida	$333	$2,678	704.20%
Outagamie	$528	$5,026	851.89%
Ozaukee	$1,532	$17,213	1023.56%
Pepin	$250	$3,964	1485.60%
Pierce	$377	$4,291	1038.20%
Polk	$328	$2,837	764.94%
Portage	$629	$2,997	376.47%
Price	$142	$1,467	933.10%
Racine	$1,300	$6,800	423.08%
Richland	$234	$2,845	1115.81%
Rock	$849	$7,405	772.20%
Rusk	$148	$1,440	872.97%
Sauk	$397	$4,122	938.29%
Sawyer	$204	$1,744	754.90%
Shawano	$427	$2,890	576.81%
Sheboygan	$552	$3,941	613.95%
St. Croix	$610	$3,656	499.34%
Taylor	$183	$1,428	680.33%
Trempealeau	$192	$2,833	1375.52%
Vernon	$256	$2,850	1013.28%
Vilas	$463	$2,497	439.31%
Walworth	$1,629	$5,640	246.22%
Washburn	$233	$2,106	803.86%
Washington	$1,345	$7,823	481.64%
Waukesha	$2,824	$14,787	423.62%
Waupaca	$550	$3,370	512.73%
Waushara	$567	$3,078	442.86%
Winnebago	$512	$3,926	666.80%
Wood	$369	$1,806	389.43%
State	$311	$2,438	682.72%
Annual Compound Percentage Rate Increase Over 17 Year Period 1990 - 2007			12.87%
US Annual Compound Inflation Rate Over Same Period			2.76%

Table G.3: Conservation and recreational lands in Wisconsin
(This table references information presented in Table 16.b)

Conservation and Recreational Land in Wisconsin					
	Acres by Ownership (March 5, 2009 – DNR Land Records)				
County	**Forest and Wild Rivers Acres**	**Natural and Park Acres**	**Fisheries and Wildlife Acres**	**Other Acres**	**Total Acres**
Adams	0.00	6,772.17	8,818.96	639.51	16,230.64
Ashland	755.95	5,812.25	7,086.71	122.44	13,777.35
Barron	59.57	342.87	7,357.24	47.07	7,806.75
Bayfield	49.29	11,577.05	11,741.93	214.30	23,582.57
Brown	0.00	678.33	2,553.71	89.60	3,321.64
Buffalo	0.00	815.41	13,187.33	0.00	14,002.74
Burnett	15,257.08	238.87	55,495.76	222.15	71,213.86
Calumet	0.00	1,271.07	10,582.63	18.26	11,871.96
Chippewa	0.00	6,808.73	4,476.21	85.21	11,370.15
Clark	223.54	0.00	657.75	0.97	882.26
Columbia	116.09	1,067.50	21,104.44	12.01	22,300.04
Crawford	7,977.07	3,094.89	8,097.05	275.45	19,444.46
Dane	4,384.63	3,478.75	15,427.45	263.54	23,554.37
Dodge	0.00	220.15	25,032.99	291.51	25,544.65
Door	0.00	12,218.11	3,654.01	119.15	15,991.27
Douglas	47,172.99	4,281.95	7,797.42	500.10	59,752.46
Dunn	0.00	3,396.41	12,721.19	0.00	16,117.60
Eau Claire	0.00	578.30	2,578.20	50.10	3,206.60
Florence	47,777.49	8,603.42	126.38	45.42	56,552.71
Fond Du Lac	10,696.64	507.09	17,149.39	111.88	28,465.00
Forest	6,231.45	524.81	4,037.77	1.52	10,795.55
Grant	14,466.59	3,976.81	1,589.84	303.37	20,336.61
Green	0.00	1,554.27	4,148.91	0.00	5,703.18
Green Lake	0.00	429.37	18,156.63	0.00	18,586.00
Iowa	10,108.35	7,281.56	4,587.58	146.20	22,123.69
Iron	71,003.49	2,958.24	10,776.29	171.90	84,909.92
Jackson	67,762.69	718.56	7,993.80	165.74	76,640.79
Jefferson	3,579.50	548.53	16,183.08	4.25	20,315.36
Juneau	0.00	5,985.57	5,675.77	52.84	11,714.18
Kenosha	0.00	4,971.97	2,168.86	26.00	7,166.83
Kewaunee	0.00	492.71	2,708.71	0.00	3,201.42
La Crosse	3,027.49	432.21	4,311.11	0.00	7,770.81
Lafayette	0.00	1,643.83	4,772.43	0.00	6,416.26
Langlade	18,514.86	632.62	16,904.07	211.85	36,263.40
Lincoln	22,503.24	2,896.24	7,567.32	236.48	33,203.28
Manitowoc	2,943.09	630.67	6,578.64	826.50	10,978.90
Marathon	1,723.64	2,681.75	24,097.84	8.92	28,512.15
Marinette	19,574.96	4,642.92	10,221.09	1,015.59	35,454.56
Marquette	0.00	1,293.28	10,990.20	2.00	12,285.48
Menominee	0.00	0.00	0.00	16.06	16.06
Milwaukee	303.82	106.99	2.65	65.93	479.39
Monroe	0.00	1,606.52	4,424.75	97.72	6,128.99

Conservation and Recreational Land in Wisconsin					
	Acres by Ownership (March 5, 2009 – DNR Land Records)				
County	**Forest and Wild Rivers Acres**	**Natural and Park Acres**	**Fisheries and Wildlife Acres**	**Other Acres**	**Total Acres**
Oconto	632.40	1,029.51	5,419.64	203.85	7,285.40
Oneida	94,030.01	7,222.25	8,483.74	196.43	109,932.43
Outagamie	0.00	1,829.18	9,719.99	41.80	11,590.97
Ozaukee	0.00	2,350.98	931.23	50.07	3,332.28
Pepin	0.00	1,814.63	3,680.78	0.00	5,495.41
Pierce	0.00	1,854.71	1,568.49	882.70	4,305.90
Polk	5,399.47	3,777.35	15,001.38	104.10	24,282.30
Portage	0.00	1,102.28	30,030.59	204.68	31,337.55
Price	9,066.15	262.99	9,965.83	19.76	19,314.73
Racine	0.00	109.26	3,564.71	37.22	3,711.19
Richland	6,831.97	2.00	5,421.95	0.00	12,255.92
Rock	0.00	530.18	7,617.62	112.22	8,260.02
Rusk	15,289.16	0.00	3,434.79	147.65	18,871.60
Sauk	5,544.05	19,431.23	4,962.69	1,142.27	31,080.24
Sawyer	79,402.58	657.67	9,218.20	345.23	89,623.68
Shawano	0.00	1,188.13	14,193.82	90.54	15,472.49
Sheboygan	15,978.74	1,016.78	5,109.84	58.62	22,163.98
St. Croix	0.00	3,017.17	7,852.77	713.10	11,583.04
Taylor	0.00	266.46	8,288.75	80.77	8,635.98
Trempealeau	58.00	1,618.30	5,483.40	43.04	7,202.74
Vernon	51.86	4,178.12	2,327.44	877.25	7,434.67
Vilas	140,246.96	3,708.22	7,754.62	81.67	151,791.47
Walworth	6,989.48	2,125.84	6,199.23	105.00	15,419.55
Washburn	155.48	942.53	5,992.07	158.46	7,248.54
Washington	4,933.93	629.46	7,494.20	81.72	13,139.31
Waukesha	11,786.43	638.80	5,326.24	66.17	17,817.64
Waupaca	0.00	1,919.54	9,038.20	89.58	11,047.32
Waushara	0.00	1,278.16	17,887.44	258.60	19,424.20
Winnebago	0.00	406.39	12,948.04	125.75	13,480.18
Wood	172.92	14.00	15,627.50	43.67	15,858.09
DNR Total:	**772,783.10**	**182,694.87**	**654,089.28**	**12,823.46**	**1,622,390.71**

Board of Commissioners of Public Lands (1)					**75,400.00**
County Parks and Forests (2)	---	---	---	---	**2,594,625.00**
Federal Government Lands (1)	---	---	---	---	**2,335,000.00**
All Public Lands	---	---	---	---	**6,627,415.71**

(1) Informational Paper 60, Wisconsin Legislative Fiscal Bureau, 2009

(2)Wisconsin Blue Book, 2007

Appendix H: Data Gaps

Reference	Item & Description
Indicator 1	**Data for passively managed forests** Need better statewide estimations of acres, distribution, and type of passively managed forest lands, those managed to achieve native community habitat goals and older forests. It is difficult to judge the biodiversity that these types of forests provide when limited data is available for them statewide.
	Map of private forest land by legal and administrative definition A map of private lands delineated by legal and administrative definition is needed to judge how lands are protected and for how long under different legal parameters such as contracts, easements, trusts, purchased development rights, etc.
	Urban Forest Assessment Need a continuation of the Urban Forest Inventory pilot study conducted by FIA and WI DNR. This is the only statewide data source for urban forests.
Indicator 2	**Tree Species Models** Need better models to assess size and age class, and successional stage for individual tree species; better hardware/software to complete this.
	Stand Structure Models Need models that analyze stand structure. A model specifically for old growth is needed. This can be linked to biodiversity if monitoring changes over time, investigating why things are changing and how that is affecting forest biodiversity.
	Statewide Estimations Consistent statewide estimations of acres, distribution, and types of older forests are needed as well as better statewide estimations of acres and distribution of passively managed forest lands and those adaptively managed to achieve native community habitat goals are needed.
Indicators 2 and 12	**LIDAR (optical remote sensing technology)** An increased frequency of LIDAR can increase the statistical reliability of some forest cover type species like hemlock; could also provide better information on biomass by species.
Indicators 2, 3, and 10	**WISCLAND** An increased frequency of WISCLAND could provide better data to forest cover type groups reported by species (Indicator 2); This data could be used in place of NLCD data for fragmentation (I3); this could provide information on the area of forest land adjacent to surface water and the amount of forest land by watershed (I10).
Indicator 3	**Forest Fragmentation** Ensure the updating of NLCD every 10 years at minimum to provide data needed to assess forest fragmentation. Actual extent and impacts of identified conditions and concerns.
Indicator 4	**Natural Heritage Inventory (NHI)** Implement systematic monitoring specific to NHI. Need assessment directly related to forest and woodland communities and forest associated species of concern. WDNR-ER does this inventory, but they are not funded adequately to ensure a monitoring system that will show trends over time
	Native American species of concern Native American Tribes have species they are specifically concerned about that are not necessarily on the NHI list. These should be represented and recognized. A comprehensive list from all the tribes should be compiled

	Amphibians Create a monitoring system for forest-related amphibian species of concern. Amphibians can be excellent indicators of ecosystem health. Choosing a few species of concern and monitoring populations over time can be an indicator of forest health.
	Improved statewide inventory and monitoring of: Species of greatest conservation need, community type (e.g. old-growth pine forest) representation, composition, and structure; forest based species life histories, habitat requirements, and population ecology; Indirect and cumulative effects (e.g. unintended consequences) of changes in biodiversity, habitat, and environment; Management regimes and impacts on community composition and structure.
	Sustaining native biological diversity Our knowledge of most plant and animal species' life history traits, habitat associations, population sizes, distributions, trends, and response to disturbance or environmental change is significantly lacking. There are not enough available data to evaluate whether or not Wisconsin's forests are sustaining native biological diversity.
Indicator 6	**Non-Timber Forest Products** Need database created on removals of non-timber forest products
	Timber Product Output (TPO) Report Increase TPO to an annual survey and expand it to include non-forest industry wood fiber consumers and producers (bio-energy). The TPO is an excellent way to track the amount and type of removals. By increasing the frequency and expanding to bio-energy, it will be a much better source of data than FIA.
Criterion 3 Indicator 7	**Invasive Plants** A lack of consistent and accurate invasive plant data and the methods used to collect the data, makes analyzing the extent and condition of invasives extremely difficult and unreliable. Need to create a common database for organizations to share for tracking invasive plants. This would then be used in combination with FIA surveys that report on invasive woody and shrub data.
	Animal Damage (deer browse) Need analysis that links browse surveys to deer management units and population to understand animal damage to the forest
	Herbaceous Plant Survey A mid- and under-story herbaceous plant survey would be an ideal compliment to animal damage data. Need a habitat classification type with mid- and under-story herbaceous plant survey. Changes in the understory could be seen more quickly than tracking tree data.
	Catastrophic events monitoring Data on the impact of flooding and wind events on Wisconsin's forests has not been consistently collected. Methodology for capturing the impact of catastrophic events on Wisconsin's forests should be developed and implemented.
Indicator 8	**FIA - Damage Type** Expansion of FIA plots for damage type (P3 plots). Essentially this is looking at crown dieback and transparency as a proxy for forest health. Tracked over time, natural mortality vs. mortality from damaging agents can be seen.
	Intensify ozone FIA and Forest Health Management plots Currently forest damage data due to ozone is collected on 31 plots in the state. Quadrupling the intensity would increase the chances of finding problems early. It would also increase the validation on a statewide scale.

Indicator 9	**Cooperative forest protection areas data** Forest fire suppression on non-federally owned lands in Wisconsin is shared between the WDNR and local fire departments. There is a significant data gap in fire occurrence information for parts of the state (cooperative areas) that are primarily protected by fire departments.
	Controlled burn data Additional research on the timing, intensity, and effectiveness of different types of controlled burn activities
Criterion 4 Indicator 10	**Index of Biological Integrity (IBI)** Increase the monitoring intensity of IBI in forested settings. Currently information on IBI is collected on different streams across the state depending on funding and priorities.
Criterion 5 Indicator 12	**Global Carbon Cycling** Need better metrics to measure the contribution of forest products to the global carbon cycle. A few of the larger private companies are tracking this information already, but is it not available on a larger statewide scale.
	Biomass Need better metrics for remote sensing tree volumes (biomass) by species. This would ensure information on forest ecosystem biomass that is currently lacking. Use LIDAR as a source of data.
Criterion 6	**Environmental Services** Essentially provide a list of the environmental services that forests provide.
Indicator 13	**Bioenergy Report** Consistent statewide analysis of energy production and consumption needs to be completed and the implications analyzed.
	Non-Timber Forest Products Need database created on the value of non-timber forest products.
Indicator 14	**Forest Recreation Survey** More intensive recreational survey needed that focuses specifically on forest lands that spans social, ecological, and economic effects of recreation.
	Mapping Forest Recreation Trails Map of trails on forest land (motorized and non-motorized, all uses). Need more data collection and then multiple partners' data sets combined into GIS.
	Recreation User Satisfaction/Conflict Need data on recreation user satisfaction/conflict regarding multiple use on forest land.
Indicator 15	**Education Scholarships** Need basic evaluation of what scholarships are being provided over time.
	Research program Establish a research program that cooperates across agencies and focus on some priorities; get a program with UW and DNR going
Criterion 7 Indicator 19	**Forest Planning** Need evaluation to determine if forest plans are being carried through to effectively meet the goals stated.
	Legal and institutional standards evaluation A review and evaluation of key standards needs to occur in order to understand their efficacy.

Appendix I: Methodology

The following section describes several different methodologies used in the Assessment.

Forest Inventory and Analysis (FIA)

The Forest Inventory and Analysis (FIA) Program of the U.S. Forest Service provides the information needed to assess America's forests. FIA is a continuous forest census and projects how forests are likely to appear 10 to 50 years from now. FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership.

FIA is managed by the Research and Development organization within the USDA Forest Service in cooperation with State and Private Forestry and National Forest Systems.

Vissage (2002) described the annualized inventory methods for Wisconsin. Since the 1996 inventory, several changes in FIA methods have improved the quality of the inventory and have met increasing demands for timely forest-resource information.

The most significant change between inventories has been the shift from periodic to annual inventories. Historically, FIA inventoried each state on a cycle that averaged about 12 years. However, the need for timely and consistent data across large geographical regions along with national legislative mandates resulted in FIA implementing an annual inventory. This system was initiated in Wisconsin in 2000.

With the NRS-FIA annual inventory system, approximately one-fifth of all field plots are measured in any single year. After 5 years, the entire inventory is completed. After this initial 5-year period, NRS-FIA will report and analyze results using a moving 5-year average. For example, NRS-FIA will be able to generate inventory results for 2000 through 2005 or for 2001 through 2006.

Other significant changes between inventories include implementing new remote-sensing technology as well as a new field-plot configuration and sample design, and gathering additional remotely sensed and field data. The use of new remote-sensing technology allows NRS-FIA to use classifications of Multi-Resolution Land Characterization data and other remote-sensing products to stratify the total area of Wisconsin and to improve estimates.

New algorithms were used in 2000-04 to assign forest type and stand-size class to each condition observed on a plot. These algorithms are being used nationwide by FIA to provide consistency from state to state and will be used to reassign the forest type and stand-size class of every plot in the 1996 inventory when it is updated. As a result, changes in forest type and stand-size class will reflect actual changes in the forest and not changes due to differences between algorithms.

The list of recognized forest types, groupings of these forest types for reporting purposes, models used to assign stocking values to individual trees, definition of nonstocked (stands with a stocking value of less than 10 percent for all-live trees), and names given to the forest types changed with the new algorithms. As a result, comparisons between the published 2000-04 results and those published for the 1996 inventory may be invalid. Contact NRS-FIA for additional information on the algorithms used in both inventories.

Sampling phases

The 2004 Wisconsin inventory was conducted in three phases. In the first phase, satellite imagery was used to stratify the State and aerial photography was used to select plots for measurement. The second phase entailed measuring the traditional suite of mensurational variables; the third phase focused on a suite of variables related to forest health. Land that could not be sampled included private tracts where field personnel were unable to obtain permission to measure a Phase 2 plot and plots that were inaccessible because of a hazard or danger to field personnel. The methods used in preparing this report were adjusted to account for such sites.

Phase 1

For the Wisconsin inventory, FIA used a classification of satellite imagery for stratification.
The imagery was used to form two initial strata: forest and nonforest. Pixels within 60 m (2-pixel widths) of a forest/nonforest boundary formed two additional strata: forest edge and nonforest edge. Forest pixels within 60 m of the boundary on the forest side were classified as forest edge and pixels within 60 m of the boundary on the nonforest side were classified as nonforest edge. All strata were divided into public or private ownership based on information available in the Protected Lands Database (DellaSala et al. 2001). The estimated population total for a variable is the sum across all strata of the product of each stratum's area (from the pixel count) and the variable's mean per unit area (from plot measurements) for the stratum.

Phase 2

Phase 2 of the inventory consisted of the measurement of an annual sample of field plots in
Wisconsin. Current FIA precision standards for annual inventories require a sampling intensity of one plot for about every 6,000 acres. FIA has tessellated the entire United States using nonoverlapping hexagons, each of which contains 5,937 acres (McRoberts 1999). An array of field plots was established by selecting one plot from each hexagon based on the following rules: (1) if an Forest Health Monitoring (FHM) plot (Mangold 1998) fell within a hexagon, it was selected as the grid plot; (2) if no FHM plot fell within the hexagon, the existing NRS-FIA plot nearest the hexagon center was selected as the grid plot; and (3) if neither FHM nor existing NRS-FIA plots fell within the hexagon, a new NRS-FIA grid plot was established (McRoberts 1999). This array of plots is designated the Federal base sample and is considered an equal probability sample; its measurement in Wisconsin is funded by the Federal government. In 2003, two additional plots were established and measured in each

hexagon. In 2000-02 and 2004, an additional plot was established and measured in each hexagon. The measurement of this intensified sample was funded by the State. The total Federal base sample was divided systematically into five interpenetrating, nonoverlapping subsamples or panels. Each year, the plots in a single panel are measured and panels are selected on a 5-year, rotating basis (McRoberts 1999). For estimation purposes, the measurement of each panel of plots can be considered an independent random sample of all land in the State. Field crews measured vegetation on plots forested at the time of the last inventory and on plots classified as forest by trained photo-interpreters using aerial photos or digital orthophotoquads.

Phase 3

NRS-FIA has two categories of field measurements: Phase 2 and Phase 3 (formerly FHM) field plots. Both types are distributed systematically geographically and temporally. Phase 3 plots are measured with the full array of vegetative and health variables as well as the full suite of measures associated with Phase 2 plots. Phase 3 plots must be measured between June 1 and August 30 to accommodate measurement of nonwoody understory vegetation, ground cover, soils, and other variables. The complete 5-year annual inventory of Wisconsin includes 165 forested Phase 3 plots. On the remaining plots, only variables that can be measured throughout the entire year are collected. In Wisconsin, the complete 5-year annual inventory includes 6,478 forested Phase 2 plots. Of these, 6,375 plots were established on timberland and 47 plots were established on reserved forest land. The national FIA four-subplot cluster configuration (Fig. 71) was first used for data collection in Wisconsin in 2000 and will be used in subsequent years. The national plot configuration requires mapping all forest conditions on each plot. Due to the small sample size each year, precision associated with estimates of components of change such as mortality will be relatively low. Consequently, we report estimates of components of change only after multiple annual panels have been measured. With completion of the annual inventory in 2004, the full range of change estimates now is available. The overall plot layout for the new configuration consists of four subplots. The centers of subplots 2, 3, and 4 are located 120 feet from the center of subplot 1. The azimuths to subplots 2, 3, and 4 are 0, 120, and 240 degrees, respectively. The center of the new plot is located at the same point as the center of the previous plot if a previous plot existed at the location. Trees that are 5 inches and larger in d.b.h. are measured on a 24-foot-radius (1/24-acre) circular subplot. All trees less than 5 inches d.b.h. are measured on a 6.8-foot-radius (1/300- acre) circular microplot located 12 feet due east of the center of each of the four subplots. Forest conditions on each subplot are recorded. Factors that differentiate forest conditions are changes in forest type, stand-size class, land use, regeneration status, reserved status, ownership, and density. Each condition that occurs on one of the subplots is identified, described, and mapped so long as the area of the condition is at least 1 acre. Field-plot measurements are combined with Phase 1 estimates in the compilation process and table production. The number of tables presented here is limited but others can be generated at http://fiatools.fs.fed.us. For additional information, contact:

Program Manager, Northern Research Station, Forest Inventory and Analysis
1992 Folwell Avenue

St Paul, MN 55108.

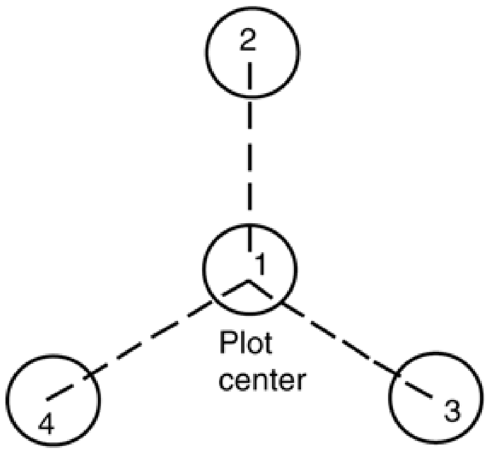

Figure I.1: Current NRS-FIA field-plot design

Timber Outputs Survey

The timber products inventory study was a cooperative effort between the Wisconsin Department of Natural Resources (WIDNR) and the Northern Research Station (NRS) (Reading and Whipple 2007). The WIDNR canvassed all primary wood-using mills within the State using mail questionnaires supplied by the NRS and designed to determine the size and composition of Wisconsin's primary wood-using industry, its use of roundwood, and its generation and disposition of wood residues. The WIDNR then contacted nonresponding mills through additional mailings, telephone calls, and personal contacts until a nearly 100-percent response was achieved. Completed questionnaires were forwarded to NRS for compilation and analysis. As part of data processing and analysis, all industrial roundwood volumes reported on the questionnaires were converted to standard units of measure using regional conversion factors. Timber removals by source of material and harvest residues generated during logging were estimated from standard product volumes using factors developed from previous NRS logging utilization studies. Data on Wisconsin's industrial roundwood receipts were added to a regional timber removals database and supplemented with data on out-of-state uses of State roundwood to provide a complete assessment of Wisconsin's timber product output.

National Woodland Landowner Survey

The National Woodland Landowner Survey is conducted annually by the USDA Forest Service to increase our understanding of private woodland owners—the critical link between society and forests. Each year, questionnaires are mailed to individuals and private groups who own the woodlands where NRS-FIA has established inventory plots (Butler et al. 2005). Twenty percent of these ownerships (about 50,000 nationwide) are contacted each year with more detailed questionnaires mailed in years that end in 2 or 7 to coincide with national census, inventory, and assessment programs. The target accuracies of the data are plus or minus 10 percent at the state level.

Ozone bioindicator species and survey history

Several bioindicator species have been tested in both laboratory and field settings over several decades and have proven to be reliable indicators of ground-level ozone stress. These include white ash, black and pin cherry, dogbane, milkweed, big leaf aster, and blackberry. In Wisconsin, the annual ozone biomonitoring by FIA began in 1994. A revised national grid emphasizing ozone exposures and forested acreage was activated in 2002. Foliar injury can be related to seasonal exposures as well as peak concentrations. Seasonal exposures measure ozone stress by summing hourly concentrations above a threshold concentration over a period of several months. For example, a common growing-season exposure index (SUM06) is the sum of all daylight hourly ozone concentrations greater than 0.06 parts per million (ppm) between June 1 through August 31. Ozone can lead to leaf damage at levels exceeding 8 ppm-hours, and the growth of seedlings in natural forest stands is affected at 10 to 15 ppm-hours (Heck and Cowling 1997). SUM06 values in Wisconsin ranged from about 3 to 24 ppm-hours during 2001-05. Presettlement seasonal SUM06 values probably would have been in the range of 0.5 to 2 ppm-hours.

GIS Methodology

For detailed methodology on how the GIS were developed, please contact Rebecca Gass, Forest Planner, Division of Forestry (rebecca.gass@wi.gov)

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Appendix J: Review and Comment Process

The Assessment was first reviewed by DNR staff across Divisions and regions. It was then presented to forestry partners, technical experts and the public for review. Reviewer's comments were reviewed by the Statewide Forest Assessment Guidance Team (see Appendix L for the members of this DNR interdisciplinary team). The team determined whether or not to make edits to the document based on the comments. Rationales for why certain comments will/will not be used will be recorded and on file with the Division of Forestry.

Over 300 stakeholders were sent the Assessment and invited to review the document. This included outreach to federal land managers (e.g., FWS, national forests, S&PF, Forest Products Lab), conservation organizations (e.g. TNC), local units of government (e.g., Land and water conservation), landowner associations (e.g., WWOA), advisory boards, councils (e.g., Urban Council), professional organizations (e.g., SAF), and businesses (e.g., consulting foresters, paper industry).

Meetings were held with the following partner groups to gather input and discuss the Assessment:
Forest Stewardship Committee, Council on Forestry, Council on Urban Forestry, Wildlife Action Plan (WAP) representatives (Bureau of Endangered Resources), Chequamegon-Nicolet National Forest, Wisconsin County Forest Association, Wisconsin Woodland Owners Association, Voigt Task Force, Great Lakes Indian Fish and Wildlife Commission, BMP Water Advisory Committee, NRCS – State Technical Committee, Wisconsin Consulting Foresters.

Appendix K: Acronym Dictionary

ATFS	American Tree Farm System
BBS	Breeding Bird Survey (North American)
BMP	Best Management Practice
CBI	Conservation Biology Institute
C&I	Criteria and Indicators
CN-NF	Chequamegon-Nicolet National Forest
CSREES	Cooperative State Research, Education & Extension Service (USDA)
EMAP	Environmental Monitoring & Assessment Program (EPA)
EPA	US Environment Protection Agency
FCL	Forest Crop Law
FHP	Forest Health Protection Unit (DNR)
FIA	Forest Inventory & Analysis Program (USFS)
FIDO	Forest Inventory Database Online (USFS)
FLP	Forest Legacy Program (USFS)
FSC	Forest Stewardship Council
GLTPA	Great Lakes Timber Professionals Association
HUC	Hydrologic Unit Classification
IBI	Index of Biological Integrity
IMPLAN	Impact Planning Software
LCA	Life Cycle Analysis
LIDAR	Light Detection and Ranging (optical remote sensing technology)
MFL	Managed Forest Law
MRLC	Multi Resolution Land Characteristics Consortium
NAASF	Northeastern Area Association of State Foresters
NASF	National Association of State Foresters
NASS	National Agricultural Statistics Service
NHD	National Hydrography Dataset
NHI	Natural Heritage Inventory
NLCD	National Land Cover Dataset
NOAA	National Oceanic & Atmosphere Administration
NRCS	Natural Resources Conservation Service (USDA)
NRI	Natural Resources Inventory
NVCS	National Vegetation Classification System
PDSI	Palmer Drought Severity Index
SAF	Society of American Foresters
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SFI	Sustainable Forest Initiative
TNC	The Nature Conservancy
TPO	Timber Product Output
USDA	United States Department of Agriculture
USFS	U.S. Forest Service
NA S&PF	Northeastern Area State and Private Forestry (a unit of the USFS)
WBCI	Wisconsin Bird Conservation Initiative

DATCP	Wisconsin Department of Agriculture, Trade, and Consumer Protection
DNR	Wisconsin Department of Natural Resources
DNR-ER	Wisconsin Department of Natural Resources-Endangered Resources
DNR-FR	Wisconsin Department of Natural Resources-Forestry
DNR-PR	Wisconsin Department of Natural Resources-Parks
DNR-WT	Wisconsin Department of Natural Resources-Water
DNR-WL	Wisconsin Department of Natural Resources-Wildlife
DOA	Wisconsin Department of Administration
DOR	Wisconsin Department of Revenue
DOT	Wisconsin Department of Transportation
WLC	WISCLAND Land Cover
WISCLAND	Wisconsin Initiative for Statewide Cooperation on Landscape Analysis & Data

Appendix L: References

Criterion One

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Appendix M: Index

Locations listed are "Criterion.Indicator" (e.g. 4.10 = Criterion 4. Indictor 10)