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.

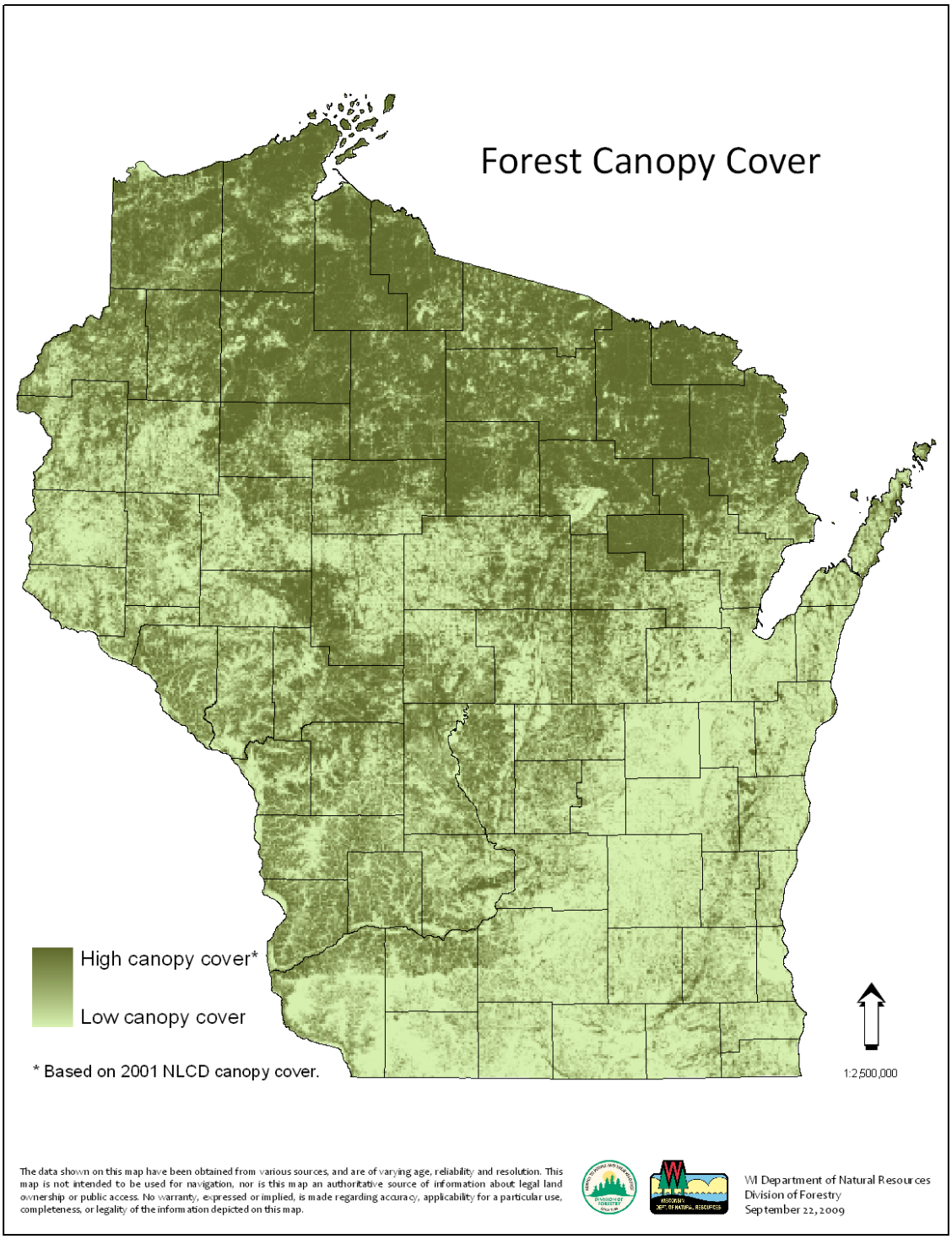
Table 1.a: Forest land area

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.



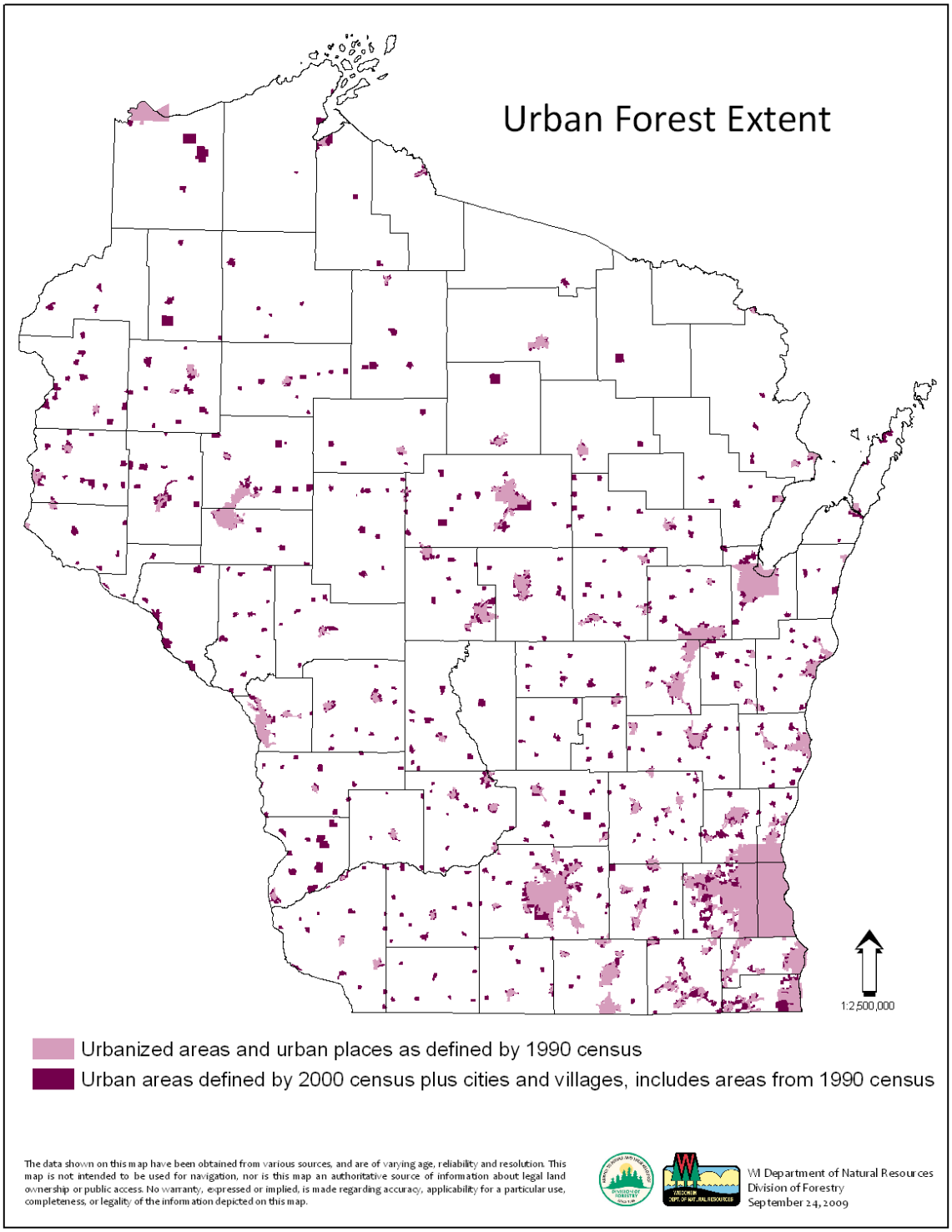
Map 1.a: Density of forest canopy cover

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.

Urban forest species composition and frequency

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.

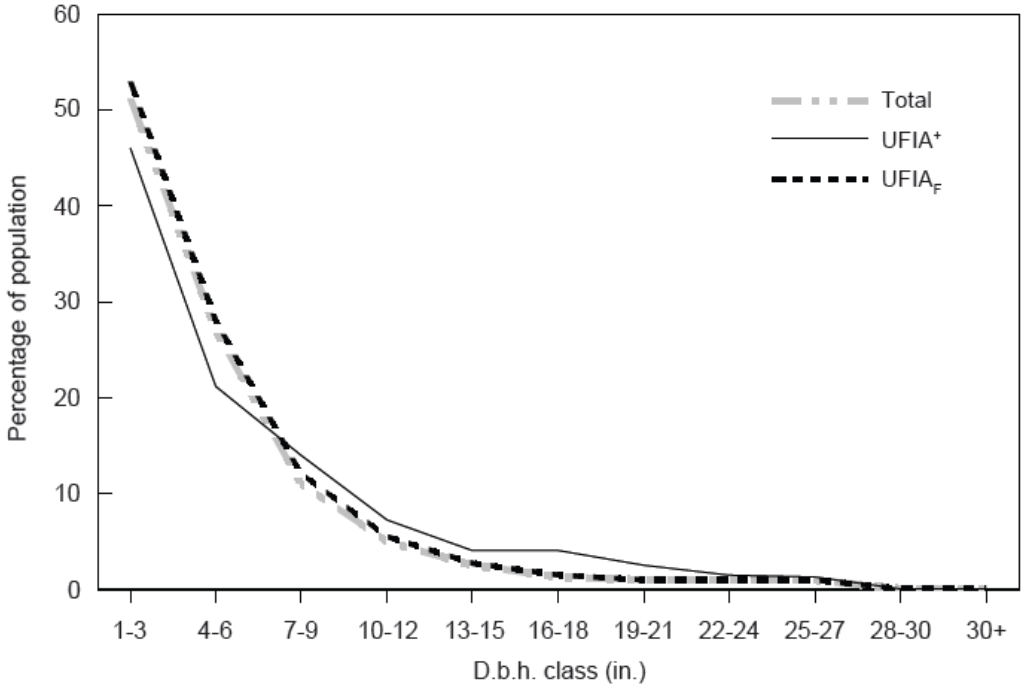


Figure 1.a: DBH distribution of urban trees in Wisconsin
(Cumming, et al, 2007)

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)					

Street tree size

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.

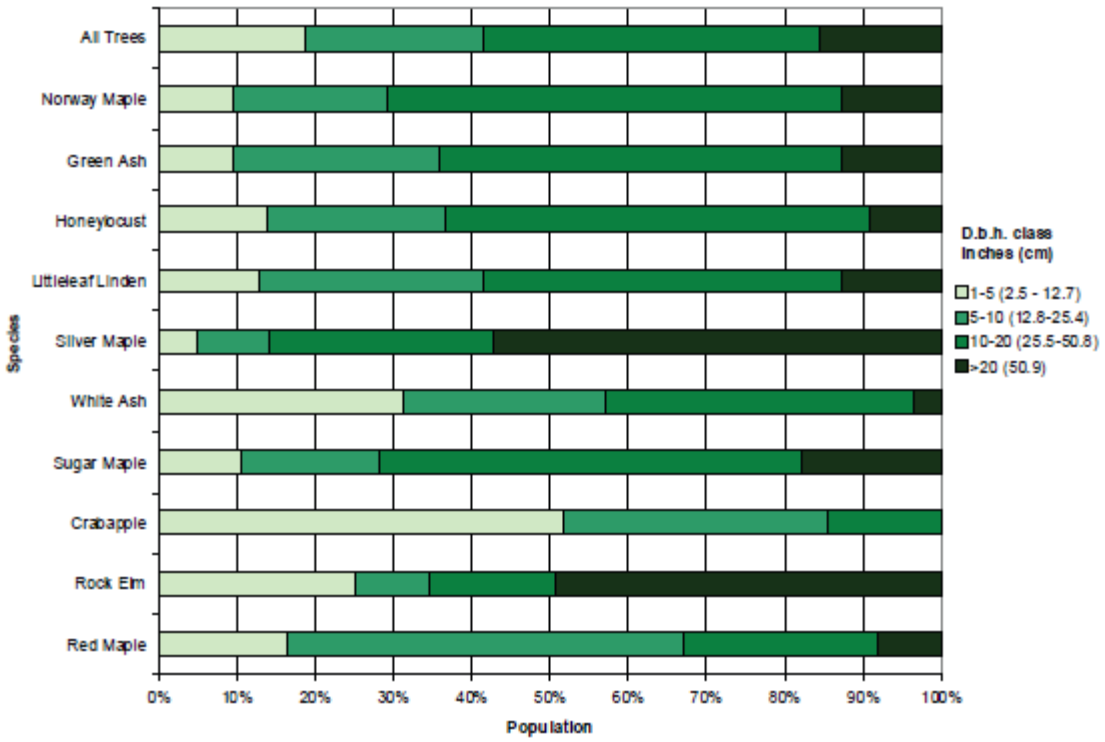


Figure 1.b: Diameter distribution within the 10 most common street tree species
(Cumming et al, 2008)