# Wisconsin Urban Forest Assessment
## WisUFA

## Current Status

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## Abstract

There has increasingly been a strong demand for timely, consistent, and reliable forest assessment and monitoring information for urban forests. The WDNR needs this information to set forest goals that will maximize benefits for present and future generations and to prioritize allocation of department resources to achieve the greatest progress towards those goals. Partners interested in urban forests want more recent information, covering a broader scope of urban forest attributes, with more analysis and reporting and easier access to program databases to achieve their management goals. In response, the WDNR Division of Forestry identified in its' Strategic Direction a need for the creation and support of an urban forest inventory and assessment with a focus on increasing sustainable urban forest canopy statewide. This scoping document outlines the development of an Urban Forests Assessment (WisUFA) program which will increase WDNRs capacity to collect, analyze and publish data on an annual basis for the urban forest resource and track progress towards statewide strategic and performance goals.

# Executive Summary of Program Updates

## March, 2018

### Urban Forest Inventory and Analysis (UFIA)
During the field season of 2017, another 178 urban FIA field plots were established across 78 different communities, bringing the total number of plots to 432.  Over the next 5 years approximately 850 additional plots will be installed.  We expect to have preliminary data in early 2019, once over half of the plots are established.

### Urban Tree Canopy (UTC)
Urban tree canopy data was released in March 2018 for all municipalities and Census-defined urban areas in the state. The data and information about canopy can now be accessed here. The data was derived from 1-m$^2$ NAIP imagery. It was submitted to i-Tree Landscape in October 2017, though it has not been incorporated into that tool as of March 2018.

### Urban Tree Data (UTD)
The Wisconsin Community Tree Map was released in August 2017. The database is a compilation of tree inventories across the state and allows users to learn what trees are growing nearby, make queries on the tree data and calculate some of the ecosystem services those trees provide. As of March 2018, 77 organizations have tree inventories in the system, representing 660,000 trees.

## January, 2017

### Urban Forest Inventory and Analysis (UFIA)
During the field season of 2016, another 179 urban FIA field plots were established across 96 different communities, bringing the total number of plots to 259.  Over the next 5 years approximately 950 additional plots will be installed.  We expect to have preliminary data in early 2019, once over half of the plots are established.

### Urban Tree Canopy (UTC)
Research partners at UW-Madison have developed the methodology to conduct a resource-efficient urban tree canopy assessment of communities in Wisconsin, using freely available NAIP imagery and open-source software.  Their work was first focused in Madison, and they are now applying the classification methodology to all incorporated cities and villages in the state.

The high-resolution urban tree canopy assessment for the City of Madison has been uploaded into i-Tree Landscape (i-TL).  We expect to have the rest of the state in i-TL by summer of 2017.

### Urban Tree Data (UTD)
A contractor was selected to develop a public-facing web-based software system to aggregate and analyze existing tree inventories.  Software development is complete and inventory data

are being uploaded into the system.  We expect the software to be publically available by spring of 2017.

# January, 2016

### Urban Forest Inventory and Analysis (UFIA)
Wisconsin has partnered with the US Forest Service to expand the FIA program to sample all census defined urban areas throughout the state.  Approximately 1,300 plots will be distributed across the state, at an intensity 5 times greater than that of the national effort.  Plots will be measured over a 7-year cycle and resulting data will provide statewide and regional estimates of our urban forest resources and their associated ecosystem services.

### Urban Tree Canopy (UTC)
Publically available aerial imagery from the National Agriculture Imagery Program (NAIP) will be used to conduct the urban tree canopy classification throughout the state.  Researchers have used open source software to complete the classification process from start to finish.  Images are being classified into the following land cover classes: tree canopy, other vegetation and impervious surfaces.  Water, wetlands and agricultural lands has been masked out.  This classification will be performed for all incorporated cities and villages and census urban areas in Wisconsin.  Data products are expected to be available 2016.

i-Tree Landscape was rolled out at the national Partners in Urban Forestry Conference in Denver. Dick Rideout has been chairing the NAASF steering committee that advises the Forest Service and Davey Institute on this tool's development.  i-Tree Landscape (i-TL) is a free web browser application that uses tree cover maps and other data to show tree canopy extent and to spatially estimate ecosystem services of urban trees. It can help map optimal locations to plant or protect trees in order to sustain or increase these services based on user-specified parameters. Users can identify priority areas to serve related to both canopy cover and socio-economic data from the US Census. Try it out at: https://landscape.itreetools.org/

### Urban Tree Data (UTD)
Web-based database systems are currently under review and we expect to have a web-based tool available in 2017.

# July, 2015

### Urban Forest Inventory and Analysis (UFIA)
The first set of 75 plots in the Madison and Milwaukee metro areas were established in June. This followed an in-depth training of our contract Lumberjack RC&D data collection crews put on by the Forest Service and DNR Forestry. The majority of the plots are within the city limits of Madison and Milwaukee, but one to two plots were also established in each of 24 surrounding communities. DNR produced a fact sheet describing the program for interested community residents and officials. It's available at: http://dnr.wi.gov/topic/UrbanForests/ufia/. Six more sets of plots will be established in the coming years.

**Urban Tree Canopy (UTC)**
Research by Dr. Phil Townsend's lab at UW-Madison continues on the best methods for statewide urban tree canopy measurement. Ground-truthing of the image classification methods they are developing will begin in August and final recommendations are expected in September.

Research by Dr. Nilesh Timilsina's lab at UW-Stevens Point has begun. This work is examining the validity of the national i-Tree value calculations under Wisconsin conditions. The results of this study could improve the accuracy of the values i-Tree produces for Wisconsin communities.

The prototype of i-Tree Landscape, the web-based UTC analysis program, has now been demonstrated to the State Urban Forestry Coordinators and the State Foresters of the 20 Northeastern states. Dr. Townsend's lab will be working with the developers to assure that Wisconsin's high resolution UTC base maps can be imported into the system allowing Wisconsin's communities to have much more accurate results compared with Landscape's national base maps.

**Urban Tree Data (UTD)**
Attributes of all 70 of the various urban tree inventories DNR has received from communities across the state have been summarized. The feasibility of creating common data fields across inventories is currently being evaluated as are existing systems for data aggregation, analysis and display.

# 1. Preliminary Purpose and Goals of WisUFA

The primary purpose of the WisUFA is to collect and **report on the condition of Wisconsin's urban forests in a statistically sound manner on an annual and periodic basis**. The information will be used to track the status and trends in urban forest canopy, extent, diversity, growth, mortality, habitat, and overall health. The information will also be used to identify and track the environmental, economic and social benefits and services that accrued. The urban forest inventory and assessment will provide unbiased, reliable information at multiple scales with the ability to **incorporate regional and statewide trends.** The inventory will assist in planning, management and monitoring.

**Inventory and Assessment Goals**
1. Provide information on the amount, composition, condition and health of the forest canopy and track changes over time,
2. Integrate effectively data, methods and tools in the planning, prioritizing and decision making processes,
3. Develop and maintain data input, models and methods for urban forestry analysis and planning,
4. Develop up-to-date and easy-to-use information products and services for land managers, industry and public use.

## 2. Preliminary Components of WisUFA, and Status

Not any one tool is sufficient to measure all the variables needed to meet the preliminary goals of WisUFA. Three components have been identified to help gather the data necessary to meet those goals. They include:

1. A plot based continuous inventory.
   > We are currently working with the Forest Service to begin plot measurements in Milwaukee and Madison beginning in spring of 2015. Once details are worked out, we will expand to other urban areas of the state in 2016.
2. A classified, remotely sensed data product.
   > We have recently contracted Dr. Phillip Townsend at UW-Madison to explore the best methods to quantify urban canopy cover, and assess changes over time. Completion date for this study is summer 2015.
3. A collated collection of existing public urban tree inventories.
   > We have begun collecting and preparing inventories to be loaded into UFORHIC, but UFORHIC is currently on hold. We need to explore the future of UFORHIC or design our own system.

## 3. Side boards

The annual inventory should include a consistent set of core measurements, collected on a standard field plot, with data managed, processed, analyzed, and reported uniformly. A statewide consistent set of core variables is needed to respond to legislative mandates and address stakeholder information needs across scales, each urban area should use the statewide definitions and measurement protocols established for the core variables on all urban forest land. The urban canopy assessment should accurately measure the amount of canopy, and be repeatable in a consistent manner such that change in canopy can be assessed with each periodic measurement. This canopy assessment will be used to measure the success of urban forestry initiatives in accordance with the Division of Forestry's Strategic Direction.

## 4. Location and Size of Inventory Unit

The pilot urban inventory covers areas defined by the U.S. Census as 'urban'. These areas are discreetly located statewide. The total acreage for the 119 urban areas is approximately 1,250,000 acres, the largest property being the City of Milwaukee metro area at approximately 360,000 acres and the smallest being the City of Oostburg at 650 acres. Added to assessment will be all incorporated cities and villages not already located within these urban areas, as well as some 'urban' townships that meet certain criterion. With those additions, the total inventory unit will be approximately 2,000,000 acres (Figure 1). The exact study area is currently being examined by the technical team, and determinations will be posted for public comment before implementation.
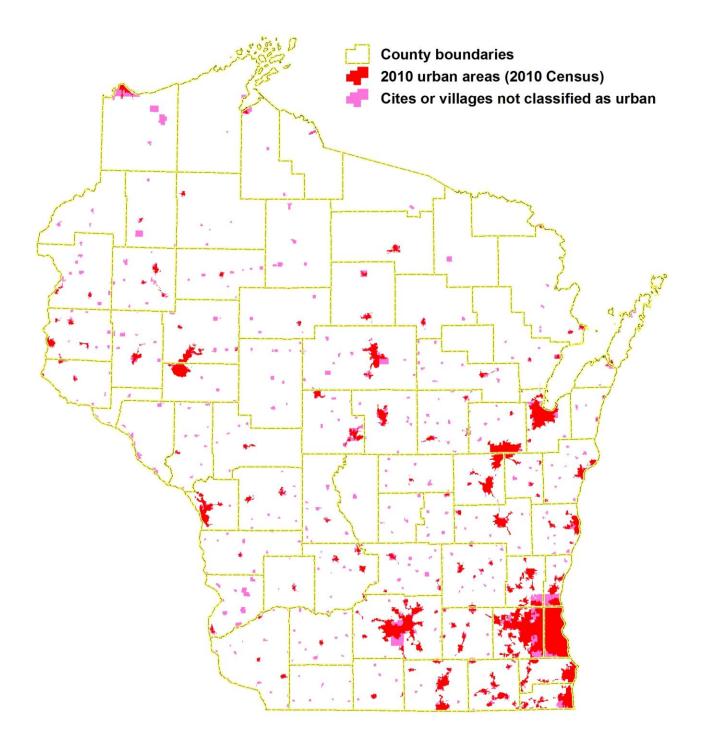
**County boundaries**
**2010 urban areas (2010 Census)**
**Cites or villages not classified as urban**

Figure 1. Location of urban areas.

# 5. Urban Tree Data on Private and Public Property

**2002 and 2012 Urban FIA pilot projects**
*A plot inventory system based on FIA methodology piloted in 2002 with approximately 140 plots statewide, and re-measured in 2012 with new plots added totaling 190.*

**Forest Inventory and Analysis**
*Federal Forest Inventory system using permanent plots on a systematic grid. Generally used to track trends on multi-county and state level. While this is not specifically an urban resource, many of the structures, guidelines, protocols and data backbone will be integral to this effort.*

**Forest Health Monitoring**
*Monitoring the presence and impacts of insect and disease using ground plots and aerial surveys. Specific uses of remote sensing to identify risk areas (e.g. gypsy moth, emerald ash borer etc.) are developed as needed.*

**Remotely Sensed Data**
*Urban foresters use a variety of remote sensing products for canopy scale and composition, forest health variables, etc.*

*The National Agriculture Imagery Program (NAIP) acquires aerial imagery during the agricultural growing seasons in the continental U.S. A primary goal of the NAIP program is to make digital ortho photography available to governmental agencies and the public within a year of acquisition.*

*The federal National Land Cover Dataset (NLCD) has a product that defines the percent canopy cover as well as the percent of impervious surfaces that will be useful.*

*Also, the new initiative to create a new land cover dataset for Wisconsin, WISCLAND, has potential to aid in this process.*

**Individual community street tree inventories**
*GIS based inventories of publically managed street and park trees, such as iTree or UFORHIC.*

### i-Tree
*i-Tree is a software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree Tools help communities by quantifying the structure of community trees and the environmental services that trees provide.*

### UFORHIC
*The Urban Forest Health Information Center (UFORHIC) is part of a national strategy for improving urban forest health monitoring.*

*UFORHIC will aggregate and analyze local tree inventory and pest detection information and provide a platform for easy upload of community tree inventory and i-Tree data, allowing for analysis, identification, and reporting of urban forest health trends and anomalies at local and regional scales.*

# 6. The "laundry list" of potential questions to be answered

Note: These questions do not directly identify variables to be collected to answer these questions. Also, this list is not exhaustive, and needs to be refined.

**Forest Productivity Questions**
- **What is the growth** by tree species, user defined area, age class and setting?
- What are **number of trees** by species, setting, age class?
- What is the **area** of forest canopy?
- What is the **net volume** of all live trees by species and setting?
- What is the **net volume** of growing stock by species group and diameter class?
- What is the **net volume** of saw timber by forest type, species group by diameter class?
- What species are increasing or decreasing in **net volume?**
- What is the total **merchantable volume,** and is it increasing or decreasing?
- What is the distribution of **merchantable volume** across the urban area?
- What species are increasing or decreasing in **merchantable volume?**
- Is the **net volume** increasing or decreasing?
- Does total net **growth exceed removals or mortality?**
- What is the **net growth to removal ratio** for each species?
- What is the **biomass** all live (aboveground) by species group and species?
- What is the overall **mortality rate?**
- What are the **mortality rates** for individual species?
- What are the contributions of the forest to **carbon storage and sequestration?**

**Biological Diversity Questions**
- Are tree species being replaced in the same relative density/frequency/abundance?
- What is the distribution of forest canopy across the urban landscape?
- What is the relative distribution of the urban landscape by stage of development (or age class) and how is it changing?
- What is the distribution of size classes across the urban forest?
- What is the density of old mature trees (of each species)?
- What is the density of snags?
- How is the distribution of trees by diameter class changing overall?
- What species are increasing or decreasing (by volume, trees/acres, etc)?
- What is the distribution of tree species across the urban landscape?
- What is the composition and diversity of the overstory species?
- What is the composition and diversity of the understory vegetation?

- What is the relationship between overstory and understory species composition?
- What is the composition of the ground layer?
- What percent of the ground is lawn?
- How much impervious surface is there?

**Forest Health Questions**
- What invasive plant species are present?
- How abundant are invasive plant species?
- What is the degree of invasive plant invasions?
- What is the extent of pest/pathogen invasion?
- What is the rate of recovery from pest/pathogen damage?
- What is the extent of pest damage by species?
- What is the risk of disease spread?
- What type and extent of damages are occurring?
- What is the level of crown die back?

**Land Class Questions**
- How many acres are canopied versus non-canopied?
- Is canopied acreage changing and what are the changes from use to use?
- What is the distribution of land by land use (e.g. commercial, residential, industrial, etc.)
- What needs to be collected on non canopied plots other than land use?
- Are we gaining or losing forest canopy and what type of changes are occurring?
- What portion of the urban forest is capable of producing timber?
- What are the projected future urban forests (volume and species)?

**Others of interest (TBD)**

# 7. Determining Attributes to Collect
The variables needed to be collected to answer the questions above (or objectives) need be identified after agreement on the objectives. Consideration must be given to provide common terminology and definitions to link WisUFA information with other inventory and monitoring systems.

# 8. Communications Plan

A communications Plan is under development. Input and feedback from external partners will be solicited through the Urban Forestry Council.