Arizona Urban Tree Map
Instruction Guide

Inventory and
Technical Manual

Collecting and Uploading

Field Data for Arizona's

Urban Tree Inventory

ARIZONA
19 66
FORESTRY

AN IMPORTANT NOTE ON PRINTING THIS GUIDE

This document contains both Landscape and Portrait page orientations. Follow these guidelines to print all pages in the correct orientation (instructions may vary depending on the program used to open the PDF).

- Select **Print** from File menu
- Under the Page Handling (or Page Sizing and Handling) section of the Print dialog box, check **Auto-rotate and scaling** or **Auto portrait/landscape**
- Under Page Scaling, check **Fit to Printable Area** or **Fit**
- If your printer supports double sided printing, select **Print on both sides**, **two-sided printing**, or **double sided printing** from either the main Print menu or under Properties.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES *(continued)*

I. INTRODUCTION

The materials presented in this manual are part of the Arizona Urban Tree Map (AZUTM) project, a collaboration of Arizona State Forestry, University of Arizona School of Natural Resources and the Environment and USDA Forest Service. Other products created for this project include three urban tree identification Field Guides specific to the climate regions found in Arizona, a guide to the common insects and diseases found in Arizona urban trees, inventory data sheet templates and an upload tool for data upload and analysis. These products have been created to facilitate the collection of urban tree inventory data for communities and Arizona State Forestry. The primary objective of the AZUTM project is to develop an accessible tool that can be used to compile statewide urban forest information in a single, integrated location. This information will be used to determine the economic and environmental value of Arizona's urban forests. A clear understanding of existing conditions will allow Arizona State Forestry, the USDA Forest Service, and local entities to identify the strengths and weaknesses of our forestry resources, and develop long-term goals for urban forests. Because the database can be easily updated, it will be of great benefit to forest managers in both the short and long-term.

A. What is an urban forest?

Urban forests are trees for people! Urban forests are the collection of trees in and around populated areas that occur naturally or have been planted and are typically managed. They are part of dynamic ecosystems that include humans. Urban forests provide important environmental services such as clean air, clean water and shade. Trees cool cities and save energy, reduce storm water runoff and provide sustenance to wildlife. They add form, structure, beauty and breathing room to urban design, reduce noise, separate incompatible uses, provide places to recreate, strengthen social cohesion, leverage community revitalization, and add economic value to communities. Urban forests can also include community orchards which are starting to emerge as trees become players in an international food security movement. Urban forests broadly include urban parks, street trees, landscaped boulevards, public gardens, river and coastal promenades, greenways, river corridors, wetlands, nature preserves, natural areas, shelter belts of trees and working trees at industrial brownfield sites. According to a study in Landscape and Urban Planning, they promote public health by increasing social connections and creating the walkable communities that are known to reduce obesity rates and increase the overall fitness of their inhabitants (Wolch et al., 2014).

B. What is an urban tree inventory?

An urban tree inventory is the gathering of accurate information on the density, distribution, diversity and health of the trees within an urban forest. How many street trees are there?

What kind? In what condition are they? A high quality tree inventory is an essential tool of good management and planning that will promote the success of these precious resources.

C. Why conduct an urban tree inventory?

"[Tree] inventories are an important part of the management program. If you don't know what you have, you can't manage it, or plan for the future. By at least establishing a baseline of data, you can measure progress and begin to plan strategically."
        - Richard Adkins, Forestry Supervisor, Phoenix Parks and Recreation Department

Inventories permit planned hazard reduction, budgeting, and work scheduling. A tree inventory is a powerful management tool because it:
- Provides an overview of the age, type, and condition of trees
- Assists in the development of regular maintenance schedules
- Facilitates priority setting for pruning and removal work
- Is an excellent tool for budget planning and negotiation
- Improves communication between tree managers and concerned homeowners
- Refines guidelines for new tree selection
- Reveals the economic and environmental benefits provided by a community's trees
- Identifies potential hazard trees in order to protect property and public safety
- Informs the direction of community urban forestry programming

D. Why upload your data to the AZUTM website?

The AZUTM website (www.azsf.gov/azutm/) provides the opportunity for your community's urban tree inventory data to be analyzed using the tools developed in the i-Tree Streets software package. Once your data is uploaded to the AZUTM site, Arizona State Forestry will use it to run an analysis in i-Tree Streets and provide you a report. For more information on i-Tree programs, visit www.itreetools.org.

Some items that may be included in the report:
- Number of trees in your inventoried region
- Percentage of canopy cover
- Most common tree species
- Quantity of carbon stored by your trees in tons
- Dollar value of the removal of carbon per year
- Estimate of the reduction in annual residential energy costs
- Total compensatory value of the trees

Urban forest ecosystem reports can assist in the development of funding and management strategies at the local level for the care of urban forests. In addition, the results will increase the understanding of how urban trees contribute to overall environmental quality at both the local and State levels. More information about the AZUTM data upload tool can be found in *Chapter VI. Using the Arizona Urban Tree Map (AZUTM) Website* (Pg. 37).

II. GETTING STARTED

A. Step 1: Do you have existing inventory data?

If your community has a recent tree inventory that includes data for an individual tree identifier (tree ID), species, DBH (Diameter at Breast Height), tree condition and presence or absence of insect/disease agents (see *Required Measurements,* Pg. 6), you can upload your information to the AZUTM website. The data needs to be formatted to match the AZUTM requirements (Table 4, Pg. 34), and saved as a Microsoft Excel spreadsheet. You can use the Excel spreadsheet template found under the Resources webpage at www.azsf.gov/azutm/ to format your existing data and upload it to the AZUTM website. Instructions on using the template can be found in *Chapter V. Storing Tree Inventory Data* (Pg. 23). Detailed instructions on uploading your data can be found in *Chapter VI. Using the Arizona Urban Tree Map (AZUTM) Website* (Pg. 37). If your inventory is not recent, you can still upload your information to AZUTM, however, the results you receive will not reflect existing conditions and you may want to consider conducting a new inventory.

B. Step 2: What type of inventory will you do?

There are two general types of resource inventories: *sample* and *complete*. Consider the specific objectives of your community before initiating data collection. The needs and resources of the community determine which inventory method is appropriate.

1. <u>Complete Inventory</u>: Every tree in the community or in an Inventory Area is measured. An Inventory Area is a discreet management unit within a community, such as a park, a street, property managed by an HOA, or a neighborhood. A complete survey of an Inventory Area includes measuring every tree in that management unit. Complete inventories collected for multiple Inventory Areas can be combined over time, which will produce a broader picture of the urban forest. A complete survey is time consuming and can be expensive but is very accurate. A complete inventory is best for day-to-day management activities.

2. <u>Sample Inventory</u>: A representative random selection of trees are measured and used to estimate properties of the whole community or urban forest. These surveys provide a cost-effective way to obtain a large-scale picture of an urban forest and its needs, from which a strategic plan to address management issues or enhance tree benefits can then be developed. Note that the data collected in a sample inventory is not useful for day-to-day management, though the data can be used later in a full inventory program. Refer to the i-Tree Streets User Manual on how to select samples for a Sample Inventory (www.itreetools.org/streets/sample_inv.php).

C. Step 3: What measurements will you take for each tree?

Because data collection is labor intensive, it is best to collect only data that will be put to use. There are five measurements (see Pg. 6) that are required in order for your tree inventory data to be analyzed in the AZUTM program. Additional measurements may be important for your community and can be included in any inventory. Template data forms and spreadsheets allow for inclusion of custom measurements and communities are encouraged to use the data collection process to meet their individual needs. However, the five required

fields described below are necessary for upload to the AZUTM website.

Required Measurements

There are five measurements required if the inventory is to be uploaded to the AZUTM website for analysis: individual tree identifier, scientific name/species code, condition, diameter at breast height, and insect/disease presence.

1. Individual Tree Identifier (Tree ID Number)

Accurate identification of individual trees in your inventory is an essential part of the inventory process. There are several ways to accomplish this task depending on the goals of your inventory. Permanent, long-term options include using a GPS location (see *Tree Location: GPS Coordinates*, Pg. 14) or tagging the tree with weather resistant tags. Short-term options include numbering trees on an aerial map or marking trees with flagging tape. Whichever option you choose, each tree is assigned a unique number to ensure accurate data collection and to reduce chances for duplication. Individual tree tagging also facilitates maintenance so the right tree gets the right service at the right time. Numbering can take the form of a unique number and/or letter combination, for example #2543 or #A-2543, where A is a clearly defined area that has stable boundaries – e.g. a street, wash, river, or park.

2. Scientific Name OR Species Code

Scientific names are generally italicized and include two parts: the genus (which is capitalized) and the species name (which is lower case). For example, the scientific name for Ponderosa pine is *Pinus ponderosa*, where *Pinus* is the genus and *ponderosa* is the species. Scientific names are standard and unique identifiers that are useful in distinguishing one plant species from another. Scientific name is preferred over common name because common names change more frequently over time and vary by region. In addition, multiple common names can exist for a single plant which can cause confusion. It is advisable to determine and use scientific names for the purposes of your inventory whenever possible. A list of plant name synonyms can be found at http://apps. cals.arizona.edu/arboretum/search.aspx. Providing the scientific name in the inventory allows the data to be corroborated if there is a question about a species code (or vice versa).

Species Code

The species code is an abbreviation for each species based on its scientific name. Most species codes consist of the first two letters of the genus name and the first two letters of the species name. For example, the species code for *Pinus ponderosa* (Ponderosa pine) is PIPO. Some species codes include a number to differentiate it from other codes that would otherwise be the same. For example, the code for *Pinus strobus* is PIST and the code for Pinus strobiformis is PIST2. The species codes listed in the AZUTM Field Guides are

consistent with those used in the i-Tree Streets software program.

For more information on how to identify trees in the field, see *Chapter III. How to Identify Trees: Using the AZUTM Field Guides* (Pg. 17).

3. Diameter at Breast Height (DBH)

Diameter at Breast Height, or DBH, is a measurement used to evaluate the growth, volume, yield and potential of trees. It measures the tree diameter at breast height, which is defined as 4.5 feet (1.37m) from the ground on the uphill side of the tree. For consistent and accurate results, care should be taken to measure at the correct position on the tree. Incorrect positioning will yield results that do not reflect the true size. DBH can be more challenging to measure if the tree is leaning or has multiple trunks. Figure 1 (Pg. 8) shows the proper method for measuring DBH under different scenarios. If a tree has multiple trunks that split above the 4.5 foot mark, measure the single trunk at 4.5 feet. If the forking occurs below the 4.5 foot mark, measure DBH of each stem separately. The DBH for the tree as a whole is then taken as the square root of the sum of all squared stem DBHs. For example, if there are three stems that are 12, 14 and 17 inches, the calculation for the tree's DBH would be:

$$\sqrt{[(12'')^2 + (14'')^2 + (17'')^2]} = \sqrt{629} = 25''$$

There are several tools that can be used to measure DBH. The most accurate tool is a diameter tape or D-tape. Other options include a traditional measuring tape, calipers or a Biltmore stick.

> Diameter tape (or D-tape)
> DBH is a measurement of the diameter of a tree. A D-tape is a measuring tape in which the graduations have been converted from circumference into diameter. Using a D-tape is a direct measure of DBH and no further calculations are required. Be aware that some D-tapes have regular inches on one side of the tape and DBH inches on the other. Be sure to record the DBH inches.
>
> Whether you use a D-tape or a standard measuring tape, follow these tips for accurate measurement:

- Measuring tapes come in different measurement units: inches, mm, or cm. The easiest D-tape to use is one with inches because DBH measurements can be entered directly into the spreadsheet with no conversion. If you use a D-tape with units other than inches, be sure to note on each data sheet which units are used. Measurements recorded in anything other than inches will have to be converted to inches prior to uploading the spreadsheet to the AZUTM website.
- Be sure the tape is pulled straight and tight around the tree trunk. A loose, hanging tape will result in a DBH value that is overestimated.
- Be sure that the tape is properly positioned. It is easy to accidentally hold the tape higher than 4.5 feet from the ground because it is easier to read. This error will result in
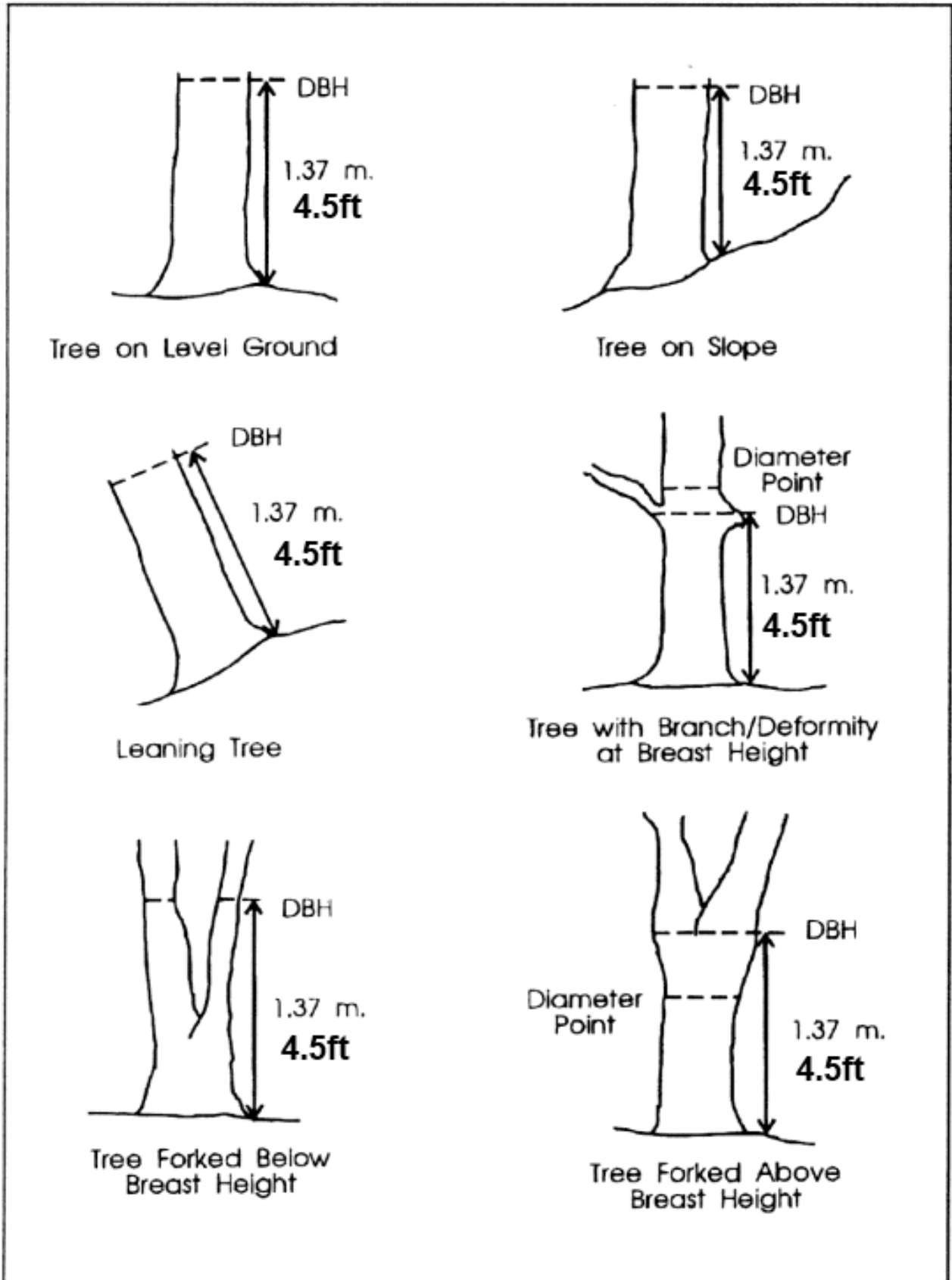
Figure 1. Proper method for measuring DBH (1.37m equals 4.5 ft).

an underestimation of DBH.
- We recommend using decimal notations rather than fractions and rounding to the nearest half inch to help speed transcription of data to the spreadsheet and to help reduce errors (e.g. a measurement of 2-3/8" can more easily be recorded as 2.5").

Standard measuring tape

A standard measuring tape will give the circumference of the tree, not the diameter. This measurement will need to be converted into diameter by dividing by 3.14 (the approximate value for π). For example, if the tree circumference measures 24 inches:

　　Diameter = circumference ÷ 3.14
　　Diameter = 24 ÷ 3.14
　　Diameter = 7.64

The tree has a DBH of approximately 7.64" which can be rounded to 7.5"

Calipers

Calipers are a measuring device that consist of two parallel arms, one of which is fixed and the other able to slide along a scale. Calipers are held at right-angles (or perpendicular) to the trunk with the arms on either side of the trunk. As with a D-tape measurement, calipers are held on an angle leaning with the tree if it is not upright. The diameter is the distance between the two arms of the calipers and can be read from the scale at its base. Precision can be improved when measuring non-circular stems by averaging two caliper measurements taken at right-angles from each other. The first measurement is taken at the point of the largest diameter followed by the measurement made at a right angle to the first (Figure 2). The average of the two measurements is recorded as the stem's DBH. Calipers are especially handy for trees with multiple stems or those with very small stems that a tape may be difficult to wrap around.
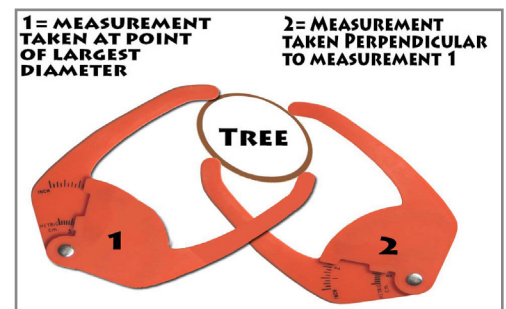

Figure 2. Measuring with calipers

Biltmore Stick

The Biltmore stick (Figure 3, Pg. 10) is a graduated measuring device, based on similar triangles, that allows quick estimation of diameter to the nearest 2 inches. The stick is held against the tree, at breast height (4.5 ft.), at a distance of 25 inches (arm's length for most people) from the eye. The zero-end of the stick is moved so that when you look along the end of the stick, you are looking at one side of the tree. WITHOUT MOVING YOUR HEAD, but only moving your eyes, glance to the other side of the tree. The diameter is the point on the stick where the line of site intersects the edge of the tree. You can purchase a Biltmore stick or make your own.

How to make a Biltmore Stick

Use a yardstick as your template. Attach a piece of paper tape to the length of the yardstick. Starting from the zero end, write the Biltmore equivalent number for tree diameter on the tape corresponding with the numbers (inches) on the stick (Table 1).
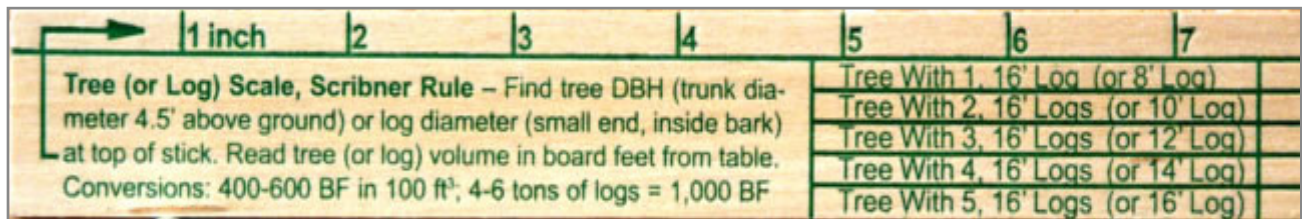

Figure 3. A Biltmore stick.

Table 1. Converting a standard yardstick into a Biltmore stick

# in Inches on Yardstick	# to Write on Tape (diameter in inches)	# in Inches on Yardstick	# to Write on Tape (diameter in inches)
$5\,^7/_{16}$	6	$17\,^1/_{16}$	24
7	8	$18\,^1/_8$	26
$8\,^7/_{16}$	10	$19\,^1/_4$	28
$9\,^7/_8$	12	$20\,^3/_{16}$	30
$11\,^3/_{16}$	14	$21\,^1/_8$	32
$12\,^7/_{16}$	16	$22\,^1/_8$	34
$13\,^{11}/_{16}$	18	23	36
$14\,^7/_8$	20	$23\,^7/_8$	38
16	22		

4. Condition

Tree condition is a measure of overall tree health and is determined using the percent of canopy cover that is healthy. In general, it is a measure of how much of the canopy is in leaf versus how much deadwood is present. The following scale was developed for the AZUTM project to evaluate tree condition:

Good: >75% healthy tree cover. The leafy canopy is mostly healthy; there are few dead branches.

Fair: 50-75% healthy tree cover. The leafy canopy is more than half of the volume of the total canopy; there are dead branches but they are less than half the total canopy.

Poor: 25-50% healthy tree cover. The leafy canopy is less than half of the total canopy; the dead branches are more numerous than live branches.

Dead/Dying: <25% healthy tree cover. The leafy canopy is a small portion of the total canopy; dead branches substantially outnumber live branches.

The condition scale above is different from the scale used in the i-Tree Streets software program. We chose this revised scale to simplify evaluation of canopy condition by volunteers during an inventory. For more details, see Appendix A (Pg. 43).

5. Insect and/or Disease

The insect and disease fields refer to the presence or absence of insect and/or disease agents on each tree and, if possible to identify, what type or species. Insect or disease identification can be challenging. Early detection is the best way to prevent insect and disease outbreaks in your urban forest. Therefore, the AZUTM project includes a guide to aid in insect and disease identification. The AZUTM Insect and Disease Field Guide can be found under the Resources webpage at www.azsf.gov/azutm/. If identification is not possible, but presence of an insect or disease agent is suspected, notes can be entered in a Comments field ("Comments" or "Notes" is a custom field that can be added to your data collection form). A qualified tree care specialist can then be directed to the tree in question for further assessment.

It is important to remember that most insects are beneficial rather than destructive and in most cases occur naturally in the ecosystem. Only a few insects are considered "invasive" and require specialized treatment. The mere presence of an insect or insects on a tree does not necessarily mean the tree is infested or stressed.

Optional Measurements

As a supplement to the required measurements described above, your community may have an interest in collecting additional data for the purposes of maintenance, planning or documentation. The most common tree inventory measurements are listed below and most are also pre-populated on the AZUTM data forms. AZUTM products have been designed to allow you to adapt them to meet your needs. Communities are encouraged to customize their data collection forms to maximize achievement of community goals.

1. Tree Height

Tree height is the vertical distance between the base of the tree and the tip of the highest branch on the tree. Measuring tree height can help determine if a tree is a sightline obstruction and can help catalogue your community's tallest trees. The length of the stem is an important part of the calculation of the total amount of wood contained in the tree. This is more commonly associated with silviculture and timber production, but can provide useful comparison information in an urban setting. The height of the tallest tree in the urban forest is the basis for measuring site productive capacity, or the site potential. This is important in an urban forest capacity because it allows the manager to ascertain whether the right tree is planted in the right place. Tree height is also important when determining the type of equipment to send out when pruning. For example, a 6 foot tall tree may only require a pole pruner and one individual, whereas an 80 foot tree may require either a tree climber or bucket truck and 2-5 people.
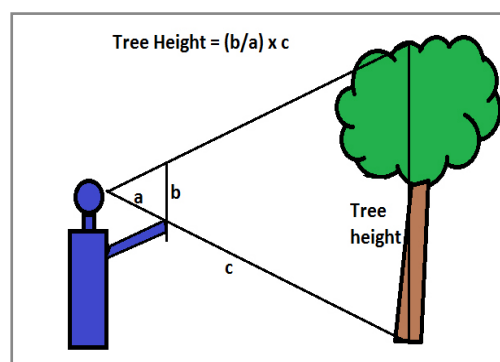
Figure 4. Measuring tree height: the distance from the base of the tree to the tip of the highest branch.

Height can be accurately measured using a clinometer, laser, hypsometer (a clinometer with a laser rangefinder) or other specialized tools. If these tools are not available, height can be estimated using the "stick method."

Stick Method
Find a straight stick or ruler. Hold the stick vertically at arm's length, making sure that the length of the stick above your hand equals the distance from your hand to your eye (Figure 5 Left). Then hold the stick vertically superimposed on the tree (Figure 5 Center). Walk backward away from the tree. Stop when the part of the stick at your hand is in line with the base of the tree and the top of the

Figure 5. Stick method for measuring tree height. Use a portion of a stick or ruler that is equal to the distance from your hand to your eye.

stick is in line with the top of the tree canopy. Measure the straight-line distance from your eye to the base of the tree (Figure 5 Right). Record that measurement as the tree's height to the closest foot.

Clinometer
A clinometer is an instrument that measures an angle with respect to gravity, such that a level surface has an angle of zero degrees. These devices can therefore indirectly measure the height of an object if the observer's distance to the object is known.

Clinometers are commonly used to calculate the height of trees, buildings and other vertical objects when direct measurement would be impractical. Basic clinometers require you to manually measure the distance to the object; while more advanced models include a range finder to perform this measurement automatically. For best results, please refer to manufacturer's instructions.

To use a basic clinometer, stand at a fixed distance from the base of the tree. Call the value of this distance D. The easiest distance is 100 feet from the base of the tree. If there is not enough room to stand 100 feet away, you can stand 50 feet from the tree and divide the height value by 2.

While keeping both eyes open, look at the top of the tree through the viewfinder with one eye. You may be able to get an accurate reading with both eyes open if your eyes are aligned with each other. Take a reading of the angle at which you are currently holding the clinometer. Typically, you'll see the percentage value of the angle on the right hand side and it will be superimposed on the tree through the viewfinder. Since you are looking at the top of the tree, the angle is an incline and should therefore have a positive value. Call the value of this angle A.

Record the percentage value of the angle while looking at the bottom of the tree in a

similar manner. This angle represents a decline, so this angle value <u>may</u> be negative.

Call the value of this angle B.

At 100 feet from the tree, the calcuation is simple:
If the bottom angle (B) is negative, add the two numbers: Height = (A + B)
If the bottom angle (B) is positive, subtract the two numbers: Height = (A - B)

At 50 feet from the tree, divide by two:
If the bottom angle (B) is negative: Height = (A + B) ÷ 2
If the bottom angle (B) is positive: Height = (A - B) ÷ 2

2. Crown Height

The crown of a tree is the area of live foliage/branches growing out from the trunk to the top of the tree, or the total height of the tree minus the height of the "bare" trunk. For example, some ponderosa pines may be 80 feet tall (tree height) but have a crown that is only a height of 30 feet. Crown height measurements are a way to ascertain biomass (in leaf canopy) of trees. This is important for carbon sequestration calculations because the larger the crown/canopy, the more carbon the tree is able to sequester. Like tree height measurements, crown height and canopy production is the basis for measuring site productive capacity, or the site potential. This is important in urban forest management because it allows managers to determine whether they have the right species in the right location. To determine crown height, measure the total height of the tree (see *Tree Height*, Pg. 11), then measure the height of the trunk up to the lowest branches of the live canopy. Subtract the height of the trunk from the total height of the tree.

3. Crown Spread

Measuring crown spread can be useful in determining a tree's shading capacity. It is often a required measurement for trees that are being submitted into tree registries such as Arizona's Magnificent Trees program. To determine a tree's average crown spread, find the widest point of the tree's crown (Figure 6). Walk around beneath the tree and visually determine where the tree's branches extend the farthest from the trunk. Mark this point on the ground with a stake or other marker. Next, follow an imaginary line that goes from the first marker to the opposite side of the crown; the line must pass through the center of the tree's trunk. Line yourself up with the outside of the crown (you may need two people for this measurement) and mark that point as well. Repeat this process for the point of the crown at a right angle to your first measurement. You have now marked two points

Figure 6. Measuring crown spread: the measurement of the widest point of the canopy and its right angle.

of the crown at right angles to each other. Measure the distance between the markers in feet. Calculate average crown spread by adding the numbers together and then dividing by two:

Crown Spread = (Widest Spread + Spread at Right Angle) ÷ 2

4. Tree Location: GPS Coordinates
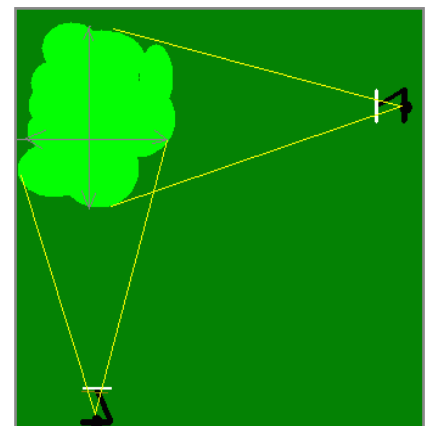
The Global Positioning System (GPS) is a system of satellites and receivers that allows people and devices to pinpoint their precise location on the Earth. Depending on how the GPS receiver is set up, you will either get the location in latitude and longitude or in UTMs (expressed as an Easting and a Northing). You can record these numbers directly on the data sheet in a custom field. Most smart phones are equipped with GPS and mapping programs but these devices are rarely accurate enough for pinpointing specific trees. For this reason, we do not recommend using them for tree inventories. If you decide to use GPS to record tree location, you can research online to find which professional GPS receiver is best for your budget and needs. Follow all instructions in the GPS manual to standardize your GPS' coordinate system, coordinate units, projection, and datum before collecting data.

5. Location Type

Examples of location type include <u>street</u>, <u>park</u>, <u>residential</u>, <u>commercial center, retention basin</u> and <u>other</u>. Recording location type may facilitate a quick estimation of the allocation of your management resources.

6. Ground Type

Examples of ground type include <u>natural</u>, <u>turf</u>, <u>decomposed granite</u> and <u>other</u>. Recording ground type in conjunction with tree condition may provide insight into the optimal ground conditions for each species in the managed landscape, and may assist with water conservation and landscape planning.

7. Concerns

Some common concerns observed during an urban tree inventory include:

- <u>Co-dominant trunk</u> - two stems that are about equal in size and form a 'v' shape on a tree. It is an indicator of structural weakness as the tree can easily split under stress.
- <u>Included bark</u> – a result and indicator of co-dominant trunks. Bark fills in the space between the two co-dominant stems. Included bark does not add structural support to the tree.
- <u>Trunk damage</u> – any kind of damage that indicates structural weakness.
- <u>Widowmaker</u> – broken off tree limb that is still attached and hanging on a tree.

1. Codominant trunk 2. Codominant trunk with included bark 3. Trunk damage 4. Widowmaker

8. Hazard Tree
Tree hazards include dead or dying trees, dead parts of live trees, or unstable live trees (due to structural defects or other factors) that are within striking distance of people or property (a target). Hazard trees have the potential to cause property damage, personal injury or fatality.

9. Conflicts
Common conflicts observed during an urban tree inventory include:
- Overhead wire – trees that are impinging on power lines.
- Sidewalk heaving – roots that are causing a trip hazard or lifting sidewalks.
- Encroaching – trees that are intruding on built structures, sidewalks or parking spaces.
- Sight line obstruction – trees or branches that are blocking street signage, walkways or traffic ways, or other important lines of sight.

1. Overhead wire   2. Encroaching   3. Sight line obstruction

10. Maintenance Needs
Proper pruning, with an understanding of tree biology, can maintain good tree health and structure while enhancing the aesthetic and economic values of our landscapes. Because each cut has the potential to change the growth of the tree, no branch should be removed without a reason. Common reasons for pruning are to remove dead branches, to remove crowded or rubbing limbs, and to eliminate hazards. Trees may also be pruned to increase light and air penetration to the inside of the tree's crown or to the landscape below. In most cases, mature trees are pruned as a corrective or preventive measure. Examples of maintenance needs include:

- Prune-routine small - This notation recommends the routine pruning and thinning of a smaller tree (height of 12 ft or less). The small designation is an indicator of the equipment needed to carry out the recommended work (e.g. ladder or hand tools).
- Prune-routine large - This notation recommends the routine pruning and thinning of a large tree (height greater than 12 ft). The large designation is an indicator of the equipment needed to carry out the recommended work (e.g. bucket truck or crane).
- Removal-Dead - This notation recommends the removal of dead, dying, or diseased branches to help thin a canopy and improve overall tree health.

- <u>Removal-Hazard</u> - This notation recommends the removal of a tree that has become a hazard. Pruning will not make this tree safer and so is not an option.

Because each tree is marked with an individual identification number or GPS coordinate, the tree inventory is a convenient place to record tree maintenance needs. Maintenance workers will be able to use the inventory to locate and service the tree.

11. Irrigation

Recording whether each tree is irrigated (yes or no) and by what method (drip or flood) can be useful for determining optimal watering schedules for each plant or species. These measurements can vary by location, ground type or other factors. Knowing what resources are being expended on each tree or location can also be helpful in economic analyses.

12. Planting Spaces
Using the inventory process as a landscape planning tool to enhance the urban forest makes good sense. The people conducting the survey are on the ground, in the forest, with an excellent vantage point for understanding current aesthetic and environmental needs. Recording potential planting sites is an excellent use of the inventory resource. Planting spaces is not pre-populated on the AZUTM paper data form, but can be easily added as a custom field.

13. Historic or Distinctive
Trees and groves that are meaningful to a community may be better celebrated and protected once they have been documented in an official context. Historic or Distinctive trees can create a sense of place for community members and promote interest from a tourism perspective. Recording location and condition for Historic or Distinctive trees can lead to easy mapping for outreach purposes and aid in maintenance. Historic or Distinctive is not pre-populated on the AZUTM paper data form, but can be easily added as a custom field.

D. Step 4: How will you collect the data?
Once you have decided what type of inventory you will do and where, you will need to decide how to collect the data in the field. The most common method is to record measurements on paper data forms. Template paper data forms can be found under the Resources webpage at www.azsf.gov/azutm/. Alternatively, data can be collected in the field using electronic methods (e.g. PDA or tablet). Regardless of the data collection method, the easiest way to <u>upload</u> the information to the AZUTM website is to use the preformatted Excel spreadsheet (also found under the Resources webpage). More information on the data forms and Excel spreadsheets can be found in *Chapter V. Storing Tree Inventory Data* (Pg. 23).

III. HOW TO IDENTIFY TREES: USING THE AZUTM FIELD GUIDES

Accurately identifying each tree to species (or species code) is essential for any tree inventory, maintenance plan and analysis. Therefore it is a required field for inclusion in the AZUTM project. More information on scientific name and species code can be found under *Required Measurements* (Pg. 6). Identifying a tree to species can be a challenge, especially for volunteers. To aid in accurate identification, three Field Guides have been created based on the mapped climate zones in the i-Tree Streets software package created by the USDA Forest Service. For more information on i-Tree Streets software and mapped climate zones, go to www.itreetools.org/streets/.

A. Climate Zones

Based on the i-Tree Streets software program, Arizona is divided into three regions catagorized by climate, each with its own tree palette. The regions are Southwest Desert, Interior West, and North (Figure 7). Individual tree guides for each region can be found under the Resources webpage at www.azsf.gov/azutm/. The regional guides simplify the identification task by eliminating tree species that are unlikely to occur in a particular region. Please consult the zone map to determine the appropriate guide for your community. You can also compare the species lists in each guide to the trees that typically occur in your community. Some communities may straddle zones and consequently may include trees from more than one. For more information on climate zones, see the community tree guides at www.itreetools.org/resources/archives.php under *i-Tree Streets Reference City Community Tree Guides*.

Figure 7. Arizona Climate Regions as defined by i-Tree Streets

Species Changes From i-Tree Streets
In order to keep the AZUTM products easy to use, the project team eliminated some tree species that are in i-Tree Streets from the AZUTM field guides because those species are not common in Arizona. If a tree species had no reported specimens in Arizona in the University of Arizona Campus Arboretum, SEINet, Northern Arizona University, and USDA PLANTS databases, it was removed from the AZUTM Field Guides (Table 2, Pg. 18).

Conversely, *Juniperus deppeana* (Common name: Alligator juniper; Species code: JUDE2) is not included in the i-Tree software package but is common in Arizona. For this reason, it was added to the North Field Guide and will be classified as a conifer during analysis.
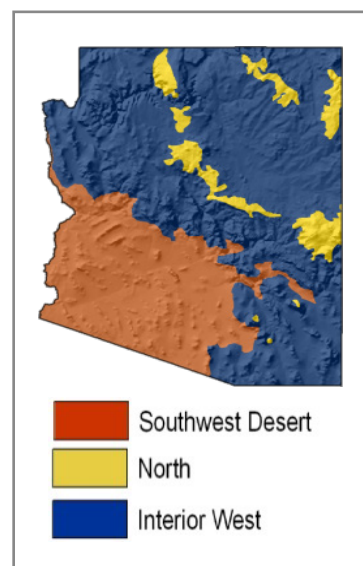
Table 2. i-Tree Streets listed tree species removed from AZUTM Field Guides

Scientific Name	Common Name	Species Code
Southwest Desert Field Guide		
Cupressus guadalupensis	Guadalupe cypress	CUGU
Pinus contorta 'bolanderi'	Bolander beach pine	PICO5
Machaerium tipu	Tipa	MATI
Pinus brutia	Turkish pine	PIBR2
Pinus roxburghii	Chir pine	PIRO
North Field Guide		
Pinus contorta 'bolanderi'	Bolander beach pine	PICO5

B. Customizing Field Guides

Inventory locations do not always fit neatly into the climate zones for which the tree guides were constructed. You may have trees that are not included in a particular guide. At the same time, it is rare that any given inventory site will have ALL the trees included in a guide. For these reasons, inventory managers have found it useful to create mini-guides for their volunteers to use during an inventory. Mini-guides are customized tree field guides that include species considered likely to occur in an inventory area. Mini-guides generally have fewer pages and are easier for volunteers to carry in the field. Mini-guides reduce printing costs, simplify the identification process and allow for the inclusion of species from different climate zones. You can customize your tree field guide to best represent the plants that occur in your community.

To simplify the process of creating a mini-guide, we have put together a Master List of Tree Species, which can be found under the Resources webpage at www.azsf.az.gov/azutm. The Master List of Tree Species is a table of every tree species included in the AZUTM Field Guides, listed in alphabetical order by scientific name, and referencing specific field guide, species code and page number.

The Master List can help you quickly determine which guide has pages representing the trees in your inventory area or community. Simply print the pages you need from each Field Guide and staple or clip them together.

Please note:
  • Although your mini-guide may have pages from different Field Guides, you will have to choose ONE climate zone for your community when uploading your data to the AZUTM website for analysis. More information about choosing climate zones can be found under *Climate Zones* (Pg. 17).
  • If you create a mini-guide from the larger Field Guide(s), the page numbers on the Dichotomous Leaf Key will no longer match specific tree pages. However, it may still be an asset for identifying tree species in your inventory. More information on the Dichotomous Leaf Key can be found under *Dichotomous Leaf Key: What is it and how do I use it*? (Pg. 20).

C. Printing Instructions

To print the Field Guides:

The Field Guides are in Landscape format. To optimize print quality, follow these guidelines (instructions may vary depending on the program used to open the PDF).

- Select **Print** from the File menu.
- Under Page Scaling, check **Fit to Printable Area** or **Fit**
- Under Properties, select **Draft** or **Normal** for Print Quality.
- If your printer supports double sided printing, select **Print on both sides**, **two-sided printing**, or **double sided printing** from either the main Print menu or under Properties. Also select **Flip on long edge**.

To print this Manual:

This document contains both Landscape and Portrait page orientations. Follow these guidelines to print all pages in the correct orientation (instructions may vary depending on the program used to open the PDF).

- Select **Print** from the File menu
- Under the Page Handling (or Page Sizing and Handling) section of the Print dialog box, check **Auto-rotate and scaling** or **Auto portrait/landscape**
- Under Page Scaling, check **Fit to Printable Area** or **Fit**
- If your printer supports double sided printing, select **Print on both sides**, **two-sided printing**, or **double sided printing** from either the main Print menu or under Properties.

D. Field Guide Organization

The field guides are designed to aid in the identification of trees commonly found in urban settings of Arizona. The guides do not contain information on natural setting (e.g. habitat, range, elevation) for each species because these guides are geared for tree identification where trees may have been planted, pruned or supplementally watered. Therefore the guides focus on tree characteristics such as form, leaf, fruit, flower and bark to aid in identification no matter the setting.

Figure 8. Leaf icon for clustered needles

Each tree page has a consistent structure to make it easier to locate pertinent information. A leaf icon (Figure 8) showing basic leaf type appears on the top right corner of each description box. The scientific name(s) are listed first in italics followed by common name(s) in parentheses. Scientific names with an 'x' in the name indicate that the species is a hybrid, or cross, between two other common tree species. Below species name is Family name and Species Code, which is a two to six letter/number code in all caps (scientific name and species code are required data fields for AZUTM; common name may be added as an optional entry). Below the tree name and species code is a list of information that can aid in tree identification, including typical height and width, form, leaf, bark, fruit, flower, and commonly associated insect and disease agents. A list of scientific names, common names and species codes appears in the Index at the end of each guide. Additional plant name synonyms can be found at http://apps.cals.arizona. edu/arboretum/search.aspx. An expanded guide to the most likely insect and disease
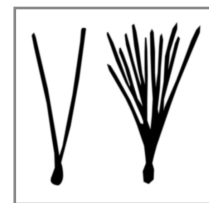
agents found in Arizona can be found in the Arizona Urban Tree Map Insect and Disease Field Guide under the Resources webpage at www.azsf.az.gov/azutm.

The tree guides are organized primarily by leaf type. Within each leaf type plants are listed alphabetically by scientific name. Each guide includes a dichotomous leaf key specific to that guide to help find trees based on leaf characteristics. The key is described in greater detail below. Once a tree is identified by leaf, other characteristics (e.g. fruit, flower, bark, and form) that can assist in its identification are available in photos and text on each plant page. Each guide includes descriptions of general tree categories that can be recorded during a tree inventory if no other identification can be made. These trees are separated into deciduous broadleaf, deciduous evergreen, conifers, and palms and then further divided by tree size (small, medium, large).

E. Dichotomous Leaf Key: What is it and how do I use it?

A dichotomous key (Figure 9) is a tool used to determine the identity of an item. Because it is dichotomous (divided in two parts), it guides the user through a series of questions each with only two possible outcomes. One of the two options is chosen at each step and eventually the user is led to a single category that includes the name of the item of interest.
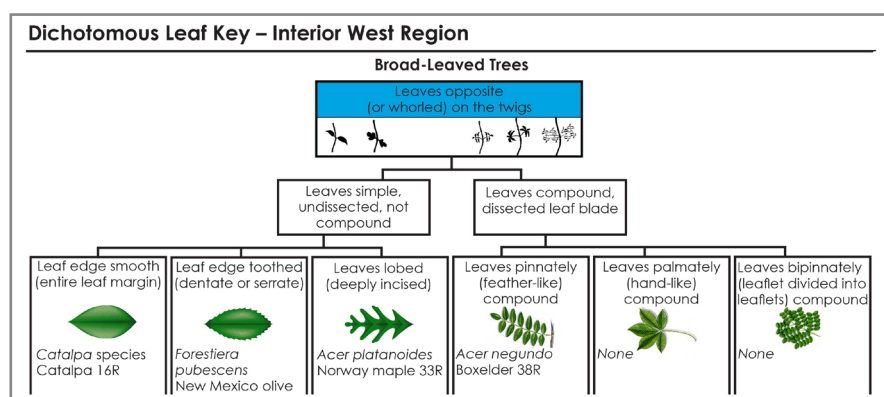
Figure 9. Portion of dichotomous leaf key from the Interior West Field Guide

Each AZUTM field guide includes a dichotomous leaf key created specifically for the trees found in that field guide. The keys use leaf and other characteristics to facilitate tree identification. These leaf keys do not always terminate in the name of a single species of tree, which would require more specialized character descriptions, but rather to a list of trees with common leaf characteristics and their corresponding page numbers. The list can help you to find the tree you are trying to identify, rather than searching through the entire guide.

To use the dichotomous leaf key, first determine if the leaf of the tree you are trying to identify is needle-like, scale-like, or broad. If it is needle-like, determine the number of fascicles (i.e. groups or clusters of needles). If the leaf is broad, determine if the leaves occur opposite each other on the stem or alternate along the stem. From there you will need to determine if the leaf is simple or compound. Definitions for these terms can be found in the Glossary at the back of each field guide.

IV. COLLECTING TREE INVENTORY DATA IN THE FIELD

By now you have determined what area you would like to inventory and what measurements you would like to collect. You have also familiarized yourself with the field guides and methods necessary to identify and measure your trees. You are ready to get started collecting inventory data.

A. Choose a Data Collection Form
Your staff and volunteers can collect tree data in the field on paper or through mobile devices. Using smartphones, tablets and laptops for inventories often requires significant upfront and maintenance costs, specialized training, and consistent internet access. In most cases, tree inventory data is collected on printed data forms and then transcribed to a tree inventory spreadsheet or database. Template data forms that meet AZUTM requirements are available for download in the Resources section at www.azsf.gov/azutm/. AZUTM template data forms are pre-populated with required measurements in light green boxes and space for optional measurements in white boxes. Fields in the white boxes can be customized to fit your inventory needs. *Chapter II: Getting Started* (Pg. 5) outlines required and optional measurements. Figures 10 and 11 are example data collection forms with optional measurements that show custom fields.

Arizona Urban Tree Inventory Data Collection Form – TEMPLATE, AZ Highlighted fields are required for inclusion in the AZ State Forestry Urban Tree Inventory program.				Page_____ of _____			
Inventory Area:			Surveyor Name:		Survey Date (MM/DD/YYYY)		

ONE TREE RECORD

Tree ID	Genus species OR Species Code		DBH (in)		Condition	Insect	Disease
					G | F | P | D	YES | NO	YES | NO
Tree Height (ft)	Crown Height (ft)	Crown Spread (ft)	GPS Coordinates			Ground Type	
		W1: W2:	Lat (DD): N Long (DD): E -			Natural | Turf | Mulch	
Location Type		Concerns		Conflicts		Maintenance	
Irrigation		Comments					
YES | NO - Drip | Flood							
Tree ID	Genus species OR Species Code		DBH (in)		Condition	Insect	Disease
					G | F | P | D	YES | NO	YES | NO
Tree Height (ft)	Crown Height (ft)	Crown Spread (ft)	GPS Coordinates			Ground Type	
		W1: W2:	Lat (DD): N Long (DD): E -			Natural | Turf | Mulch	
Location Type		Concerns		Conflicts		Maintenance	
Street | Park | Residential | Commercial | Basin | Other		Co-dominant | Included Bark | Trunk Damage | Widowmaker		Overhead | Heaving | Encroaching | Sight-line		Prune Small | Prune Large | Remove	
Irrigation		Comments					
YES | NO - Drip | Flood							

Figure 10. Template inventory data collection form. Required fields are in light green boxes and additional optional fields are in white boxes.

Although you can add as many fields as you need, you MUST capture the following required fields to receive an economic and environmental tree value analysis of your surveyed trees:

Required per data collection <u>form</u> (circled in red on Figure 10):
- Inventory Area within your community
- Survey Date

Required per <u>tree record</u> (All fields in green boxes):
- Individual Tree Identifier (Tree ID) – a unique identifier for the tree, location coordinates, or arbitrary but unique identification number
- Scientific Name (Genus/species) or i-Tree Streets Species Code
- Diameter at Breast Height (DBH) in inches

- Tree Condition – Good, Fair, Poor, Dead/Dying
- Insect and/or Disease – Yes/No and/or Type

B. Modifying the AZUTM Template Data Form
The AZUTM template data collection form is a <u>table</u> created in Microsoft Word and includes fields for all required measurements in light green boxes. Green boxes should not be modified. Optional measurement fields can be added in the white boxes. To add custom fields for optional measurements, open the template in Microsoft Word. Relabel fields in white boxes to fit your inventory needs. You can also add new fields by right clicking in any existing white box and choosing **Insert Row Below**. Depending on your version of Microsoft Word, you can also add new boxes by choosing **Insert Below** in the **Rows and Columns** section under the **Layout** tab.

Arizona Urban Tree Inventory Data Collection Form - Highlighted fields are required for inclusion in the AZ State Forestry Urban Tree Inventory program.						Page_____ of _____

ONE TREE RECORD

Project ID_____	Inventory Area_____		Surveyor Name_____			Survey Date (MM/DD/YYYY)_____
Tree ID	**Genus species OR i-Tree Species Code**		**DBH**	**Condition**	**Insect**	**Disease**
				G | F | P | D	YES | NO	YES | NO
Crown Spread	**Ground Type**	**Conflicts**	**Comments**			
W1: W2:	Nat. | Turf | Top D.					
Tree ID	**Genus species OR i-Tree Species Code**		**DBH**	**Condition**	**Insect**	**Disease**
				G | F | P | D	YES | NO	YES | NO
Crown Spread	**Ground Type**	**Conflicts**	**Comments**			
W1: W2:	Nat. | Turf | Top D.					

Figure 11. Inventory data collection form used in Bisbee, Arizona. The white fields are optional measurements chosen by The City of Bisbee.

V. STORING TREE INVENTORY DATA

Once an inventory has been completed you will need to prepare and submit the data to the AZUTM website. If you used paper data forms, your tree information needs to be transcribed to an Excel spreadsheet. Once in a spreadsheet, your data can be uploaded to the AZUTM website and an analysis will be returned to you. An Excel spreadsheet formatted for AZUTM upload is available at www.azsf.gov/azutm/. Figure 12 illustrates the work flow from data entry on a spreadsheet to the creation of an inventory report.

In addition to Excel spreadsheets, tree inventory data can be stored and managed in several formats. For example, a Geographic Information System (GIS) can provide maps and spatial analysis, or an Asset Management System can track tree maintenance over time, provide cost projections, and generate maintenance schedules. However, uploading tree data to the AZUTM website will be most efficient using the formatted AZUTM template spreadsheet.
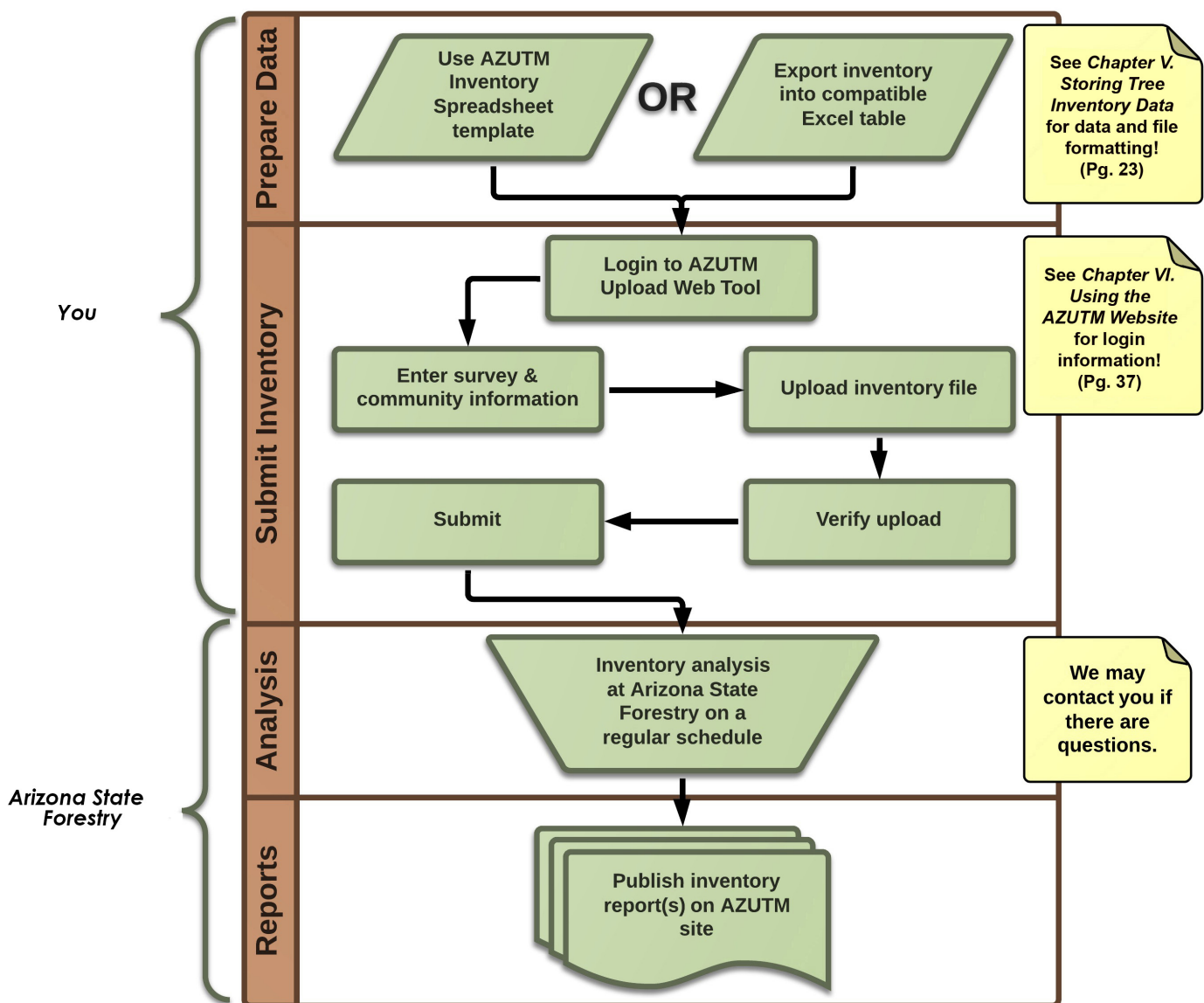
Figure 12. AZUTM data processing flow chart.

A. What is the Template Spreadsheet?

A template tree inventory spreadsheet (MS Excel 97) is included in the AZUTM package in the Resources section at www.azsf.gov/azutm/. Benefits to using the AZUTM spreadsheet include:

- pre-formatted columns for AZUTM required measurements
- easy customization for optional measurements
- automatic DBH calculator for up to 5 trunks
- drop down lists pre-populated with custom species names and species codes
- easy customization of drop down lists
- automatic population of genus and species columns with a correctly entered species code and vice versa (e.g. entering PIPO in the species code column automatically enters *Pinus* in the genus column and *ponderosa* in the species column)
- easy data upload on the AZUTM website

The AZUTM spreadsheet includes seven color-coded tabs (Figure 13, Table 3).

If the AZUTM template spreadsheet does not fit the needs of your community and you plan to create your own, or if there is an existing tree inventory in some other format, the data will still need to be exported in a simple but specific format for submission to AZUTM. When exported in the proper format, it will be eligible for analysis and your community will receive an economic and environmental tree value report. In order for your data to be uploaded to the AZUTM website, it must be in an MS Excel 97-2003 spreadsheet (XLS file) that includes the columns listed in Table 4 (Pg. 34).

B. Template Spreadsheet Tabs

The template spreadsheet includes seven tabs (Table 3, Figure 13). This section will outline what is on each of the tabs and how to customize, where possible.
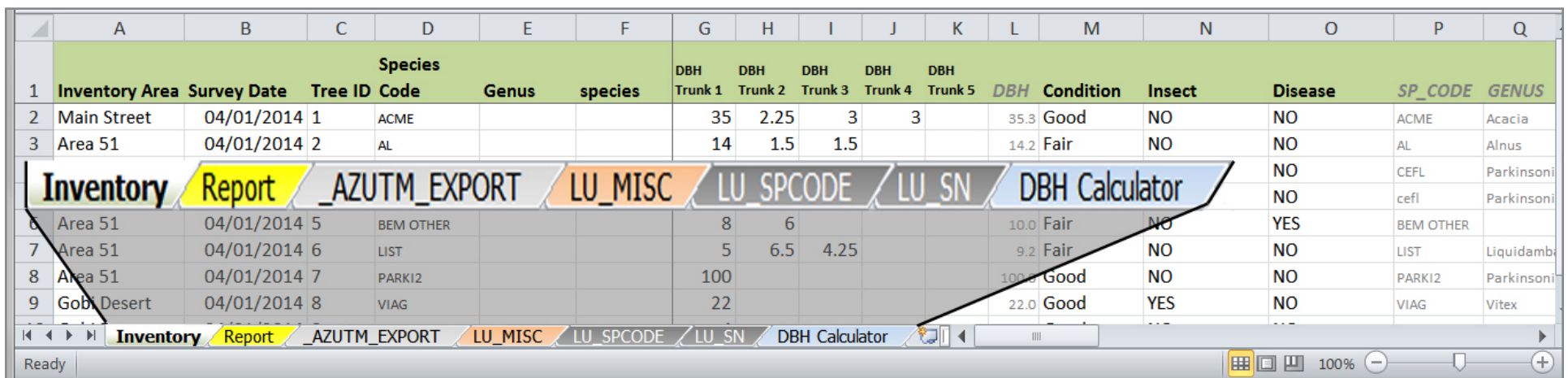
Figure 13. Color-coded tabs on the AZUTM spreadsheet.

Table 3. AZUTM spreadsheet tabs

Tab Label and Tab Color	Description	Page#
Inventory (Green)	Used to record data collected during an inventory. Includes all required fields as well as custom columns that the community has added.	25
Report (Yellow)	Provides a brief summary of the records entered into the inventory tab. Sorts, counts totals and gives the average DBH of the entered inventory data.	27
AZUTM_EXPORT (Light Gray)	Captures the data that will be uploaded to the AZUTM website (required fields).	29
LU_MISC (Salmon)	Contains the lookup tables that populate the drop down lists.	30
LU_SPCODE (Dark Gray)	Includes i-Tree Streets species code lookup table that populates scientific names.	32
LU_SN (Dark Gray)	Includes species name lookup table that populates species codes.	32
DBH CALCULATOR (Light Blue)	Automatically calculate DBH for trees with greater than five trunks.	33

1. Inventory Tab

The Inventory Tab is the primary spreadsheet tab in the template. This tab is where you will enter the tree records that were collected in the field on paper data forms. Figure 14 (Pg. 26) shows the required measurements in Row 1 and two drop down menus that have been pre-populated with Inventory Areas and Species Codes. There are 18 columns on this tab that correspond to required fields in the data forms (columns A through R). The grayed out columns (L, P, Q, and R) are automatically populated from species code and scientific name lookups. To simplify data entry, keying in an i-Tree Streets species code in the Species Code (D)

column will look up the scientific name for that tree and automatically populate the P, Q, and R columns. Similarly, entering a tree's scientific name in the Genus (E) and species (F) columns will look up the species code for that tree and automatically populate the P, Q, and R columns if a match is found. These columns can be followed by any number of your community's custom columns (column S and on). Figure 15 (Pg. 27) shows a customized spreadsheet with three columns for the optional measurements tree height, crown height and crown width.

How to customize the Inventory Tab

A. Unprotect the Inventory tab by clicking on the Review menu (depending on your Excel software version) and then the Unprotect button. Enter the password in the pop-up window: password.

B. Add or remove columns starting with Column S to record custom measurements and observations such as tree height or comments (Figure 15, Pg. 27). These columns are already labled with common inventory measurements. You can change the column labels to suit your inventory needs by clicking on the column header and typing over the text.

IMPORTANT

The header row for columns A thru R, shown below shaded in green, is required for AZUTM upload and analysis and should not be modified.

IMPORTANT

Deleting records on the Inventory Tab will break the formulas used in the spreadsheet and disrupt the export of your data. Instead of deleting, clear any records that you don't need by right clicking on the cell and choosing **Clear Contents**.

C. Clear items from sample rows on the Inventory Tab. DO NOT delete the row because deleting (removing) a cell or row will break automatic calculation, copy, and lookup formulas on the Inventory and _AZUTM_EXPORT tabs.

D. To add items to a drop down menu, see the *LU_MISC* section in this chapter (Pg. 30).

Figure 14. Inventory Tab of the AZUTM spreadsheet showing drop down lists. Drop down lists and scientific name lookup in columns P,Q, and R reduce transcription errors.

Figure 15. Inventory Tab showing optional fields in columns S,T and U.

E. Optionally, protect the sheet again to protect the formulas in columns P, Q, and R by selecting Excel's Protect Sheet action (found under the Review menu, depending on your Excel software version).

F. Save your template under a new file name to distinguish it from the generic template.

2. Report Tab
The Report Tab (Figure 16, Pg. 28) contains a data summarization table (Pivot Table) that provides a brief summary of tree records entered on the Inventory Tab. The report table automatically sorts, counts totals and gives the average DBH of the tree records stored on the Inventory Tab. After new data is entered on the Inventory Tab, the Report

Tab will need to be refreshed in order to see a summary of the new information.

- To refresh the Report Tab, select a cell inside the report table and simultaneously press the **Alt and F5 keys**.
- To calculate a report on a subset of tree records, you can filter (or limit) the inventory summary in two ways. First, you can filter the data by Condition, Insects, or Diseases using the drop down lists shown in the red box on Figure 16 (Pg. 28). For example, if you want to see a summary of the trees that are in good condition only, select the Condition drop down list, select **Good** and **OK** (Figure 17, Pg. 28). Second, you can filter the data by Genus, Species, or Species Code using the drop down lists circled in green on Figure 16 (Pg. 28). By default, "(All)" is selected for all filters.

Figure 16. Report Tab in the AZUTM spreadsheet.

IMPORTANT

No data will be entered on the Report Tab. Each cell and drop down list is populated automatically from data entered on the Inventory Tab.

Figure 17. Report Tab showing the Condition filter. There are 6 filters to choose from: Inventory Area, Condition, Insect, Disease, Genus, Species, and Species Code.

3. _AZUTM_EXPORT Tab

This tab contains the data from the Inventory Tab that is required for the AZUTM site to generate i-Tree Streets economic and environmental tree value reports. The data required for analysis is automatically moved from the Inventory Tab to the _AZUTM_EXPORT Tab (Figure 18). You will only see the required fields on this tab. The data on the _AZUTM_Export Tab, and ONLY this data, is shared with the AZUTM website after the spreadsheet is uploaded.

Any data that you enter in customized columns (i.e. Column S and on) will not be uploaded or analyzed because your custom fields are not necessary to create the environmental and economic report. The data from custom measurements are solely for your management needs and will not be included in the report.

Excel formulas on the _AZUTM_EXPORT Tab will automatically copy all changes from the required fields (or columns) on the

Inventory Tab. It is a good idea to make sure the _AZUTM_EXPORT Tab has all the records (i.e. rows) you want to upload before submitting your data as only data seen in the cells in this tab will be

IMPORTANT

You will not enter any data directly onto the _AZUTM_ Export Tab. Each cell is populated automatically from data entered on the Inventory Tab.

	A	B	C	D	E	F	G	H
1	DOWNLOADME	INVENTORYAREA	DATEINV	TREEID	SP_CODE	GENUS	SPECIES	DBH
2	1	Area 51	04/01/2014	1	ACME	Acacia	melanoxylon	35.328
3	1	Area 51	04/01/2014	2	AL	Alnus	spp.	14.16
4	1	Jurassic Park	04/01/2014	3	CEFL	Parkinsonia	florida	2.2361
5	1	Area 51	04/01/2014	4	cefl	Parkinsonia	florida	25.179
6	1	Area 51	04/01/2014	5	BEM OTHER			10
7	1	Area 51	04/01/2014	6	LIST	Liquidambar	styraciflua	9.2365
8	1	Area 51	04/01/2014	7	PARKI2	Parkinsonia	spp.	100

Inventory / Report / **_AZUTM_EXPORT** / LU_MISC / LU_SPCODE / LU_SN / DBH Calculator

Figure 18. _AZUTM_EXPORT Tab in the AZUTM spreadsheet.

4. LU_MISC TAB

The LU_MISC Tab holds lookup tables that populate the drop down lists on the Inventory Tab. Each column in the LU_MISC Tab corresponds to a drop down list on the Inventory Tab (Figure 19, Pg. 31). Therefore, entries added to columns on the LU_MISC Tab populate the drop down lists on the Inventory Tab. For example, adding the entry "Arizona Street" to column A (Inventory Area) on the LU_MISC Tab (Figure 20, Pg. 31) will automatically add "Arizona Street" to the drop down menu of column A (Inventory Area) on the Inventory Tab (Figure 21, Pg. 31). To better fit your needs, almost any lookup table can be customized to include entries appropriate to your inventory. The EXCEPTIONS are the Condition (B), Genus (F), Species (G), and SPCODE (H) columns. These columns cannot be modified and are grayed out on the LU_MISC Tab (Figure 20, Pg 31).

How to Customize the LU_MISC Tab
1. Unprotect the LU_MISC Tab by clicking on the Review menu (depending on your Excel software version) and then the Unprotect button. Enter the password in the pop-up window: *password*.

2. Add text to cells in Inventory Area (A), Insect (C) and/or Disease (D) columns that you want to be included in the drop down lists in the corresponding columns on the Inventory Tab.

3. Optionally, re-protect the sheet to avoid deleting columns by selecting Excel's Protect Sheet action (found under the Review menu, depending on your Excel software version).

4. Save your template under a new file name to distinguish it from the generic template.

You can create drop down lists for your custom measurements as well (i.e. Column S and on) by adding corresponding columns to the LU_MISC Tab. However, these new columns need to be enabled before they will create a drop down list on the Inventory Tab. For complete instructions on how to enable drop down lists, search for "Insert a Drop Down List in Excel" in your search engine (e.g. Google, Yahoo, etc).

In brief, drop down lists are enabled on columns in the Inventory Tab by selecting the column of interest, going to Excel's Data menu, selecting **Data Validation**, setting the selected column to **List** validation, and pointing the validation list to a column (minus the header cell) on the LU_MISC Tab. The drop down lists for the required measurements (Columns A, C and D) are already enabled for you and do not need this extra step.

IMPORTANT

Deleting text will break formulas on the LU_MISC Tab and disrupt the export of your data. Instead of deleting, clear any records (all fields in a row except for the gray ones) that you don't need by right clicking on the cell and choosing **Clear Contents**.

Figure 19. Inventory Tab showing the drop down list before Arizona Street is added as an Inventory Area.

Figure 20. LU_MISC Tab in the AZUTM spreadsheet showing the addition of Arizona Street as an Inventory Area circled in red.

Figure 21. Inventory Tab showing the addition of Arizona Street to the Inventory Area drop down list.

5. LU_SPCODE Tab

The LU_SPCODE Tab (Figure 22) includes the i-Tree Streets species code lookup table modified specifically for Arizona. It is used to automatically populate scientific names (columns P, Q and R) on the Inventory Tab.

Figure 22. LU_SPCODE Tab in the AZUTM spreadsheet.

IMPORTANT

No data will be entered on the LU_SPCODE or LU_SN tabs. There is no need to modify anything on these tabs.

6. LU_SN Tab

The LU_SN Tab (Figure 23) includes the species name lookup table used to automatically populate species codes (columns P, Q, and R) on the Inventory Tab. Highlighted cells refer to species that have been modified (yellow) or added to the i-Tree Streets list (pink) to meet horticultural uses in Arizona.

Figure 23. LU_SN Tab in the AZUTM spreadsheet showing species that have been modified from (yellow) or added to (pink) the i-Tree Streets list.

7. DBH Calculator Tab

The Inventory Tab will automatically calculate DBH (Diameter at Breast Height) for trees with up to 5 trunks (columns G through K on Figure 21, Pg. 31). You can use the DBH Calculator Tab to automatically calculate DBH for trees with more than five trunks. For more information on DBH and how it is calculated, see *Required Measurements* (Pg. 6). Enter each DBH into the rows in Column A of the DBH Calculator Tab (Figure 24). The total DBH for that tree will be automatically entered in red in column C. Copy and paste the red number into the first DBH column (G) on the Inventory Tab.

Figure 24. DBH Calculator Tab in the AZUTM spreadsheet. DBH measurements entered into column A are automatically calculated and totaled in column C.

C. Making Your Own Spreadsheet
If you choose to make your own spreadsheet instead of using the template AZUTM spreadsheet, you must use the column headers found in Table 4 in order to upload your data to the AZUTM website. In addition, the DOWNLOADME column must have a 1 in each cell (see Column A on Figure 18, Pg. 29).

Table 4. MS Excel 97-2003 spreadsheet format for uploading tree records into AZUTM website

Column Header (_AZUTM_EXPORT)	Description of Required Inventory Data
DOWNLOADME	Set to 1 in order for the AZUTM upload tool to import a record. AZUTM will ignore all rows that are not flagged with a 1.
INVENTORYAREA	A community's tree inventory area. Required to calculate tree cover per area and to run i-Tree Streets reports on separate areas within your community.
DATEINV	Inventory date. If your inventory took place over multiple days, enter the date the inventory was completed.
TREEID	Unique ID for a tree or tree record or a tree's geographic coordinates. Required to avoid double counting and to replace old tree records with updated ones.
SPECIES CODE	i-Tree Streets species code (e.g. PIPO) or tree type code (e.g. CEL OTHER). An abbreviation related to scientific name. Populate this field and/or the GENUS and SPECIES fields.
GENUS	Genus (e.g. *Pinus*) – the first part of a tree's scientific name. Requires the SPECIES field to be filled as well. Genus and Species OR an i-Tree Streets species code are required.
SPECIES	Species (e.g. *ponderosa*)– the second part of a tree's scientific name. Requires the GENUS field to be filled as well. Use "spp." if you don't know the exact species name.
DBH	Diameter at Breast Height. Provide one DBH value in inches per tree rounded to the nearest half inch.
CONDITION	Record Good, Fair, Poor, or Dead/Dying to describe canopy condition.
INSECT	Tree health – insects: Record NO or YES or insect type (e.g. Pine/ Conifer Sawflies).
DISEASE	Tree health – diseases: Record NO or YES or disease type (e.g. White Pine Blister Rust).

D. Tips for Tree Data Entry

Any text can be entered on a field with a drop down list (not just species names). To enter data into the tree inventory spreadsheet, follow the same guidelines as for entering data into the tree data paper form. Depending on the number of trees inventoried, maintenance jurisdictions, inventory year, etc., it may be easier to keep separate spreadsheets or you may keep one file for all your inventory areas. In any case, do not forget to save frequently and make backups! A few things to keep in mind:

> **IMPORTANT**
>
> The AZUTM template spreadsheets and i-Tree Streets do not support time series data (multiple records over time for the same tree).

DOs
- Do enter tree records in the Inventory Tab.
- Do use the drop down lists (if available) or type the species name into each cell.
- Do make sure every tree record in the same inventory area has a unique tree ID.
- Do use i-Tree Streets species codes (the AZUTM Field Guides list all species codes, see *Field Guide Organization,* Pg. 19) for quicker data entry. Using species codes also reduces typographical errors by taking advantage of the automatic scientific name lookup function.

DON'Ts
- Don't enter the same tree more than once. Update the existing tree record if you have new information for a single tree.
- Don't insert new rows in the Inventory Tab or you will lose Excel formulas for scientific name and species code lookup in the P, Q, and R columns.
- Don't insert or delete columns between column A and R or there will be errors on the _AZUTM_EXPORT sheet and any data uploaded to the AZUTM site may fail.
- Instead of deleting records, clear the records (all fields in a row except for the gray ones) that you don't need. To clear cells in Excel, right click on the cell and select **Clear Contents**.

Using the AZUTM spreadsheet template is not required as long as the tree data can be formatted like the _AZUTM_EXPORT sheet (Table 4, Pg. 34). Once it is formatted, upload your tree inventory to the AZUTM site to request a tree value report. Arizona State Forestry staff will process the uploaded data, generate reports, and provide them to your community through the AZUTM site. Reports are generated quarterly.

E. Using File Compression

In order to reduce file size for emailing or archival purposes, digital files and folders can be compressed into a single archival file (also known as a "compressed folder"). Various compression formats exist of which ZIP, 7z, and RAR are some of the most commonly used (http://en.wikipedia.org/wiki/Comparison_of_file_archivers). Windows has built-in support for ZIP compression and decompression.

Windows 98 and ME (https://support.microsoft.com/kb/259177?wa=wsignin1.0)
1. Click **Start**, point to **Programs**, and then click **Windows Explorer**.
2. In Windows Explorer, right-click the .zip file, and then click **Extract**.
3. Follow the instructions on the screen to finish the unzipping process.

Windows Vista, 7, 8, and 8.1 (http://windows.microsoft.com/en-us/windows/compress-uncompress-files-zip-files#1TC=windows-7)
1. Locate the compressed folder (or .zip file) that you want to extract files or folders from.
2. Do one of the following:
    - To extract a single file or folder, double-click the compressed folder (or .zip file) to open it. Then drag the file or folder from the compressed folder to a new location.
    - To extract the entire contents of the compressed folder (or .zip file), right-click the folder, click **Extract All**, and then follow the instructions.

VI. USING THE ARIZONA URBAN TREE MAP (AZUTM) WEBSITE

Upload your tree inventory data and receive an economic and environmental tree value analysis for your trees. There is no fee for using the AZUTM manuals or website. The AZUTM site (Figure 25) provides materials and services to help communities with the planning, execution, and analysis of urban tree inventories. Check the site regularly for updated and new resources. The following materials and services may be found through the site menu at www.azsf.gov/azutm:

Figure 25. AZUTM upload page.

Resources for download:
- Field guides for the identification of tree species, insects and diseases
- This instruction guide
- Template data collection forms and spreadsheets
- Final report and lessons learned for the AZUTM project

Upload your urban tree inventory:
- For an i-Tree Streets environmental and economic evaluation of your urban forest and to receive a report on the estimated yearly dollar value provided by your surveyed trees
- To help compile a statewide urban forest inventory and to inform the State's leadership of its combined economic and environmental value
- To inform statewide urban forest health trends and alert Arizona State Forestry of insect and disease outbreaks

Community Inventory results:
- i-Tree Streets economic and environmental estimation reports for all urban tree inventories that have been submitted
- An interactive webmap summarizing submitted urban tree inventories

Figure 26. AZUTM Community information page.

A. Uploading Your Urban Tree Inventory

If you are using an AZUTM inventory spreadsheet template, your data is ready for uploading. Otherwise, you may have to export your tree records into a compatible table format and Excel spreadsheet version (see *Chapter V. Storing Tree Inventory Data,* Page 23). The data submission is easy and you don't even have to register. Just follow these steps:

1. Login to the AZUTM website

Go to the **Upload** page at www.azsf.gov/azutm and enter the Username and Password provided for each County (Table 5). We have made the login and password universal so there is no complicated sign up process. This information is necessary, however, to make malicious uploads more difficult. The login is case sensitive, so make sure to enter it exactly as it appears in Table 5. Click on the **Add Inventory** button to complete the login process.

Table 5. Username and password login information for AZUTM website

Username	Password	Username	Password
Apache	1234	Mohave	1234
Cochise	1234	Navajo	1234
Coconino	1234	Pima	1234
Gila	1234	Pinal	1234
Graham	1234	Santa	1234
Greenlee	1234	Yavapai	1234
La Paz	1234	Yuma	1234
Maricopa	1234		

2. Enter Inventory and Community Information

Enter the following information about your community and its inventory (Figure 26, Pg. 37):

- **Contact Name** and **Contact Phone**: A way for us to contact your community if we have questions about the inventory and to improve analysis and reports.
- **Inventory Date**: The date the tree measurements were collected. Choose the last date if the submitted tree records were collected over several days.
- **Region**: Select the most representative i-Tree Streets Climate Zone for your inventory area(s). See *Chapter III. How to Identify Trees: Using the AZUTM Field Guides* (Pg. 17) for more information on the Climate Zones for Arizona.
- **County**: Your County should be selected if you logged in with it. We summarize submitted inventory data by County.
- **Community**: Your community's name (city or town).
- **Inventory Type**: Select **Complete** if you collected data on every tree in your Inventory Area. Select **Sample** if you collected data on a subset of trees. See *Chapter II. Getting Started* (Pg. 5) for more information on Inventory Type.
- **Percent Complete**: This should be left at 100% unless you are submitting a Sample Inventory. In the case of a Sample Inventory, enter the estimated percentage of trees surveyed within an Inventory Area.

3. <u>Upload Inventory File</u>
To upload your data file (Figure 27) click **Choose File** to select your inventory Excel spreadsheet or i-Tree Streets CSV file (you will have to navigate to the file on your computer) and then click **Upload Data**.

Note: Depending on your file size and bandwidth, this may take up to several minutes. Check your web browser's upload progress bar.

Do not click the Upload Data button more than once.

Figure 27. Upload Inventory file.

4. <u>Review Inventory Records</u>
Once the file is uploaded, you will see a preview table (Figure 28) of your tree records. AZUTM will accept almost any data that is uploaded but only properly formatted data will produce meaningful reports. Being certain that the data is formatted correctly will ensure that the results you receive are useful.

The contact information you provided above will be used if clarifications about the submitted inventory are necessary. The preview table may only show a small portion of the uploaded data but verify that the data is formatted correctly before confirming the upload.

Figure 28. Preview table.

5. Submit Inventory Records

Click **Save to Database** (Figure 29) if you are satisfied with your upload. At this point, AZUTM does a quick data validation and saves your records to the database. Depending on the number of records you submitted, this can take a few seconds.

B. When to Expect Results

Once you have submitted the tree records collected during the inventory process, Arizona State Forestry staff will

Figure 29. Submitting records.

download the collected data from the AZUTM website, prepare it for i-Tree Streets and other analysis, and generate reports. i-Tree Streets uses the data you upload to generate Excel Files that contain report tables and graphs on multiple tabs. For information about the format of your report and its contents we have prepared a guide called *Understanding Your Reports* which can be downloaded from the **Community Inventories** page on the AZUTM website, https://azsf.az.gov/azutm/communities.

Reports are generally prepared on a quarterly basis. Resulting community reports and summaries are then posted to the **Community Inventories** page at www.azsf.gof/azutm. You are encouraged to update your community contact information at least annually or as frequently as needed as you complete new or update existing inventories.

VII. CONTACT INFORMATION

It is our objective to support communities throughout Arizona in conducting urban forest inventories so that Arizona State Forestry can compile a database of local forest resource information. We hope these materials facilitate public involvement and result in a sustainable plan to enable long-term urban forest management. In return for your involvement your community will be able to quantify the value of annual environmental and aesthetic benefits of your urban trees. Although the benefits of trees are intuitive to many, we hope that this quantification will encourage and foster the ongoing care of these very important resources.

If you have questions about doing a tree inventory, any of the products included in the Arizona Urban Tree Map (AZUTM) package, or the AZUTM website, please contact us!

<div align="center">

Urban and Community Forestry
Office of the State Forester
1110 West Washington, Suite 100
Phoenix, AZ 85007-2935
UCF@azsf.gov
Office: (602) 771-1400

</div>

CREDITS AND REFERENCES

Photo and Figure Credits

Cover images: Background image, Susanne R. Kaplan; Top inset, Chris Erickson; Middle and bottom insets, Alix Rogstad

Page 3: Elm, Richard Adkins

Page 4: Mesquites on Old Ft Lowell Rd, Susanne R. Kaplan

Page 5: Bisbee pilot inventory, Wolfgang Grunberg

Page 6: Tree tag, www.uconn.edu

Page 7: Using D-tape, www.nrri.umn.edu/

Page 8: Figure 1. DBH measurement graphic, forestry.usu.edu/

Page 9: Figure 2. Measuring with calipers, Susanne R. Kaplan; Using a Biltmore stick, Isaac R Hammer;

Page 10: Figure 3 Biltmore Stick, Utah State University Extension Forestry

Page 11: Giant mesquite bugs, Susanne R. Kaplan; Figure 4. Tree height, Wikipedia commons

Page 12: Figure 5. Stick method, Isaac R. Hammer; Using a clinometer, Alix Rogstad

Page 13: Figure 6. Crown spread, www.nature1st.net/

Page 14: Leafy path, Susanne R. Kaplan; 1. Codominant trunk, 2. With included bark, 3. Trunk damage, 4. Widowmaker, Joseph O'Brien, USDA Forest Service, Bugwood.org

Page 15: Overhead wire, Susanne R. Kaplan; Encroaching and sigh line obstruction, Alan Shoults; Pruning, Joseph O'Brien, USDA Forest Service

Page 16: Irrigation line, Line of trees, Susanne R. Kaplan

Page 17: Figure 7. Arizona climate zones, i-Tree Streets User's Manual, www.itreetools.org

Page 19: Figure 8. Leaf icon for clustered needles, Susanne Kaplan

References

USDA Forest Service. i-Tree Streets User's Manual, www.itreetools.org

Wolch, Jennifer R., Jason Byrneb, Joshua P. Newell. 2014. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough.' University of California, Berkeley. Landscape and Urban Planning, 125, pp. 234–244.

Zelaya, Al. The Value of Your Urban Forest: i-Tree Tools, www.na.fs.fed.us/fhp/pubs/ hottopics/10/ppt/090930%2005%20Zelaya.pptx

APPENDIX A: I-TREE STREETS ANALYSIS VS. THE AZUTM DATA UPLOAD TOOL

The upload tool on the AZUTM website was developed using the i-Tree Streets software as a model. The AZUTM data upload tool includes only those features in i-Tree Streets that were necessary to create this inventory process. The following tables describe what information was included and compares the i-Tree Streets software to the AZUTM data upload tool. For more information on i-Tree Streets specific data fields, please refer to the i-Tree Streets manual (http://www.itreetools.org/resources/manuals.php).

CITY DEFINITIONS			
For per capita values for urban forest benefits and costs and for calculating several values related to canopy cover, enter the following information into i-Tree Streets.			
Data Fields	**Notes**	**i-Tree Streets**	**AZUTM Upload**
Climate Zone	Information specific to your community	required	required
Nation		required	n/a
State		required	n/a
County		required	required
City	Select city from a predefined list or select closest matching city	required	n/a
Community	Name of any urban forest community in Arizona (City, Town, HOA, etc.)	n/a	required
Total Municipal Budget ($)		optional	n/a
Population		optional	n/a
Total Land Area (sq mi)		optional	n/a
Average Sidewalk Width (ft)		optional	n/a
Total Linear Miles of Street (mile)		optional	n/a
Average Street Width (ft)		optional	n/a

PUBLIC/PRIVATE COST DEFINITIONS

Public and/or Private Annual Total Program Costs. If you are interested in annual tree costs and benefit-cost ratio of your urban forest, enter the following information into i-Tree Streets

Data Fields	Notes	i-Tree Streets	AZUTM Upload
Annual Planting ($)		optional	n/a
Annual Pruning ($)		optional	n/a
Annual Tree and Stump Removal and Disposal ($)		optional	n/a
Annual Pest and Disease Control ($)		optional	n/a
Annual Establishment /Irrigation ($)		optional	n/a
Annual Price of Repair /Mitigation of Infrastructure Damage ($)		optional	n/a
Annual Price of Litter/Storm Clean-up ($)		optional	n/a
Average Annual Litigation and Settlements due to Tree-related Claims ($)		optional	n/a
Annual Expenditure for Program Administration ($)		optional	n/a
Annual Expenditure for Inspection/Answer Service Requests ($)		optional	n/a
Other Annual Expenditures ($)		optional	n/a

BENEFIT PRICES DEFINITIONS

i-Tree Streets comes preloaded with unit prices for calculating urban forest benefits based on prices that are typical for your selected region. If you are interested in improving the estimates, consider updating the preloaded benefit values.

Data Fields	Notes	i-Tree Streets	AZUTM Upload
Electricity ($/Kwh)	i-Tree Streets provides default electricity estimates.	optional	n/a
Natural Gas ($/therm)	i-Tree Streets provides default natural gas estimates.	optional	n/a
CO2 ($/lb)	i-Tree Streets provides default Carbon Dioxide estimates.	optional	n/a
PM10 ($/lb)	i-Tree Streets provides default estimates.	optional	n/a
NO2 ($/lb)	i-Tree Streets provides default Particle Matter pollution estimates.	optional	n/a
SO2 ($/lb)	i-Tree Streets provides default Sulfur Dioxide estimates.	optional	n/a
VOC ($/lb)	i-Tree Streets provides default Volatile Organic Compounds estimates.	optional	n/a
Stormwater Interception ($/gallon)	i-Tree Streets provides default Stormwater Interception estimates.	optional	n/a
Median Home Resale Value ($)	i-Tree Streets provides default Median Home Resale Value estimates.	optional	n/a

TREE INFORMATION
Per urban tree survey information used to create reports and analysis on urban forest structure, function, and value in i-Tree Streets. The range of cost and benefit estimates depend on completeness of the City, Cost and Benefit Price definitions entered in i-Tree Streets.

Data Fields	Notes	i-Tree Streets	AZUTM Upload
Tree ID	Each tree must have a unique identifier. **i-Tree Streets** requires a unique number and will generate them automatically. **AZUTM** will accept any combination of numbers and letters for a tree that are unique to a survey area.	required	required
Species Type Code	**i-Tree Streets** (STRATUM) species code (e.g. PIPO) or tree type code (e.g. CEL OTHER). ***AZUTM** requires either an i-Tree Streets species/tree-type code or scientific name (Genus, species).	required	conditional*
Genus	***AZUTM** requires either an i-Tree Streets species/tree-type code or scientific name (Genus, species).	n/a	conditional*
species	***AZUTM** requires either an i-Tree Streets species/tree-type code or scientific name (Genus, species).	n/a	conditional*
DBH	Diameter at Breast Height. ***AZUTM** requires DBH in inches or in inch diameter ranges	required	required*
Management Zone	Called "Inventory Areas" in **AZUTM**'s upload spreadsheet. Selecting smaller inventory areas improve the rate of 100% survey completion.	optional	required
Street Segment	*Required by both i-Tree Streets and AZUTM for sample inventories but not for 100% complete inventories.	conditional*	conditional*
City managed	Public vs Private trees. Used by i-Tree Streets to calculate benefits and costs seperately.	optional	n/a
Condition	***In i-Tree Streets**: four classes (Dead/Dying, Poor, Fair, Good) of woody or foliage Replacement Factor Percent (RFP). "RFP values are used in calculating the replacement values of the trees using the Council of Tree and Landscape Appraisers (CTLA) method and reflect the relative structural integrity and health of a typical tree in the given condition." The condition value influences the replacement value and relative performance index reports. ***In AZUTM**: four classes (Dead/Dying, Poor, Fair, Good) of percent healthy tree canopy.	optional*	required*
Maintenance	Recommended maintenance and priority tasks used for prioritizing, planning and budgeting	optional	n/a

Land use		optional	n/a
Site type		optional	n/a
Conflicts	Sidewalk heaving and wire conflict are supported in i-Tree Streets	optional	n/a
Pest signs and symptoms	Currently under development in i-Tree Streets	optional	n/a
Tree Health - Insects	Presence of insects: YES/NO or type. Required by AZUTM for urban forest health assessment in Arizona.	n/a	required
Tree Health - Diseases	Presence of disease: YES/NO or type. Required by AZUTM for urban forest health assessment in Arizona.	n/a	required
Other 1, Other 2, Other 3	Three customizable i-Tree Streets data fields with up to 10 categories each	optional	n/a

INVENTORY DETAILS
Location and survey information associated with a survey or tree.

Data Fields	Notes	i-Tree Streets	AZUTM Upload
Street Address	Street address for a tree	optional	n/a
GPS latitude /longitude	Coordinates for each tree	optional	n/a
Contact Name	Contact name for AZUTM tree inventory submitter.	n/a	required
Contact Phone	Contact phone number for AZUTM tree inventory submitter.	n/a	required
Inventory Type	Tree survey type for AZUTM submission: Complete (100% for a survey area), Partial (<100% for a survey area), or Sample (street segment sample, random sample, etc.) survey.	n/a	required
Percent	Percent survey completeness for AZUTM submission.	n/a	required
Surveyor	Name of surveyor	optional	n/a
Survey date	Survey Date	optional	required
Location site -	Location of tree relative to building address front, rear, side-right, side-left, etc.	optional	n/a
Location number	Tree number for a particular streets address: number trees consecutively in the direction of traffic flow.	optional	n/a

Special thanks to the pilot inventory communities:

City of Bisbee
Lake Havasu City
City of Mesa
Town of Prescott Valley
Town of Pinetop-Lakeside
Arizona State Parks: Oracle State Park
University of Arizona Campus Arboretum