Science Education Collection

Tree Identification: How To Use a Dichotomous Key

URL: https://www.jove.com/science-education/10070

Overview

Source: Laboratories of Margaret Workman and Kimberly Frye - Depaul University

A dichotomous key is a tool that identifies items in nature, such as leaves. This method is based on the idea of choosing between two characteristics. The word dichotomous comes from two Greek words that mean “to divide into two parts.” In a dichotomous key for leaf identification, each pair of phrases describes different features of the leaf. Only one of the phrases correctly applies to the leaf being keyed out. The correct phrase leads to the next pair of phrases, or states the name of the tree from which the leaf came. Using a field guide to trees and the iTree National Tree Benefits Calculator helps to identify trees in a field investigation, which shows the significance of trees in terms of their environmental benefits, such as storm water management, increasing property value, energy efficiency, air quality, and carbon sequestration.

Principles

Examining leaves is one of the most common ways to identify trees. Leaves are very characteristic of a particular tree species. There are many clues to look for on a leaf to help identify the tree from which it came. These include leaf shape, leaf arrangement, and leaf margins.

Broadleaf trees are very common in the United States (**Figure 1**). These trees have leaves with wide blades exposing a large surface area for photosynthesis (*e.g.* oaks and maples). Mostly, these trees are deciduous and drop their leaves in autumn.

The other type of tree is an evergreen tree. These have needlelike or scalelike leaves. Trees like pines and spruces have needlelike leaves, and trees like junipers and cedars have scalelike leaves. Generally, these leaves stay on the tree for more than a year.

Needlelike leaves have very little surface area; therefore, they are not able to capture much sunlight for photosynthesis. Needlelike leaves also have a thick coating to prevent excessive water loss. Trees with needlelike leaves are well suited to sites where water conservation is very important for survival. Because these needles last several years on a tree while broadleaves only live for one growing season, trees with needles have an advantage over broadleaf trees, in that the metabolic cost of leaf production can be recovered with photosynthesis over several growing seasons.

The shape of a tree’s leaves form over the course of a tree species’ evolutionary history. The shape gives the tree its best chance of survival based on the environmental factors in the ecosystem. A leaf’s task is to capture sunlight for photosynthesis, producing food for the tree. In this process, the leaf also receives heat. The shape of the leaf has therefore developed over time to balance these needs: maximizing sunlight but minimizing heat absorption and/or water loss.

Heart shaped leaves look exactly as the name implies – the leaf is in the shape of a heart (**Figure 2**). Obovate leaves are broadest above the middle and longer than they are wide. Elliptical leaves are broadest in the center and taper near the ends. Ovate leaves are broadest below the middle and longer than they are wide. Like the heart shaped leaves, the triangular leaves look as the name implies – the leaf is in the shape of a triangle. Lance leaves are much longer than they are wide (typically 4x longer), and although generally the same width throughout, they may be slightly wider in the middle.

There are other leaf shapes, depending on the source used. However, the ones mentioned are some very common, simple shapes.

Leaves can be arranged on a twig in one of three ways (**Figure 3**):

Opposite – leaves occurring in pairs at the nodes.
Alternate – leaves staggered or not directly across from each other.
Whorled – leaves occurring three or more on a single node.

The arrangement of the leaves minimizes the overlap between one leaf and another. This maximizes availability of sunlight and air. Opposite leaves usually have the adjacent tiers cross at right angles to minimize overlap. Alternate leaves are generally distributed in a spiral.

Most trees have alternate arrangement of leaves, making trees with the other two arrangements a limited group. In order to see the leaf arrangement, the leaves must be observed while still on the twig.

The margin of the leaf is the name for the shape of the edge of the leaf (**Figure 4**). A leaf that is smooth all the way around with no teeth or undulations has a smooth leaf margin. A leaf with a wavy or bumpy edge in the plane of the leaf is called rounded or sinuate. A margin with continuous, sharp teeth on the edge is finely serrated.

Leaf teeth serve as clues in the process of leaf identification of a tree. In environments with sufficient water and nutrients, the percentage of toothed leaves correlates negatively with temperature, *i.e.* the higher the temperature, the lower the percentage of trees with teethed leaves. Therefore, in cold climates, leaves have larger and more teeth. Paleobiologists often use this in paleoclimate reconstruction.

When looking at a leaf with a broadleaf shape (as opposed to needlelike or scalelike), the next thing to look for is whether it is simple or compound (**Figure 5**). A simple leaf has one leaflet, a petiole (stalk) and a bud at the base of the petiole. A compound leaf has two or more leaflets and a bud at the base of the petiole. A once pinnately compound leaf has one main petiole and leaflets arranged pinnately on each side of the petiole. A twice pinnately compound leaf has one main petiole and then secondary petioles arranged on each side of the main petiole. The difference between a leaf and a leaflet can be checked where the leaf attaches to the stem. If there is no bud, then it is a leaflet and not a leaf.

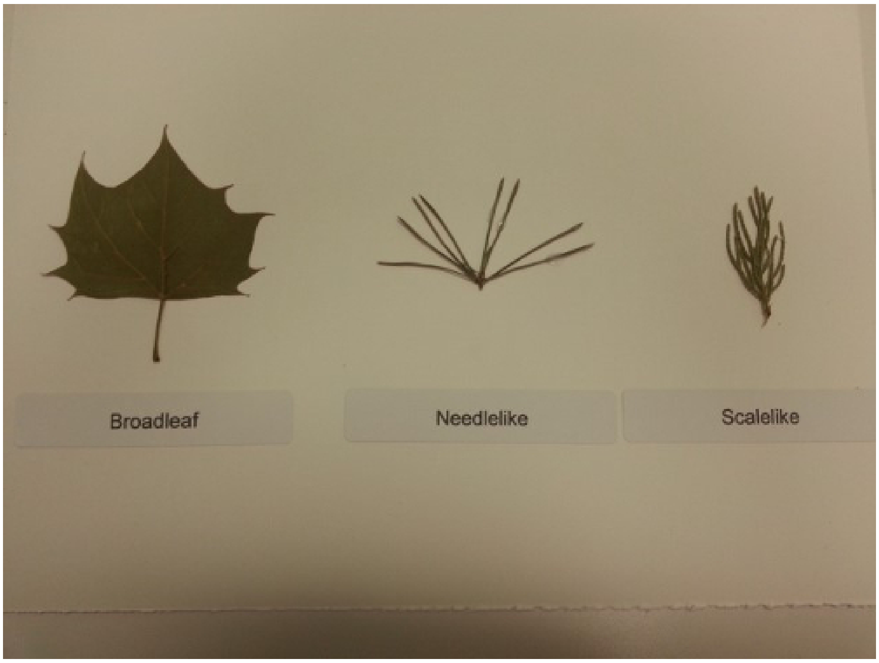


Figure 1. Examples of broadleaf, needlelike, and scalelike leaves.

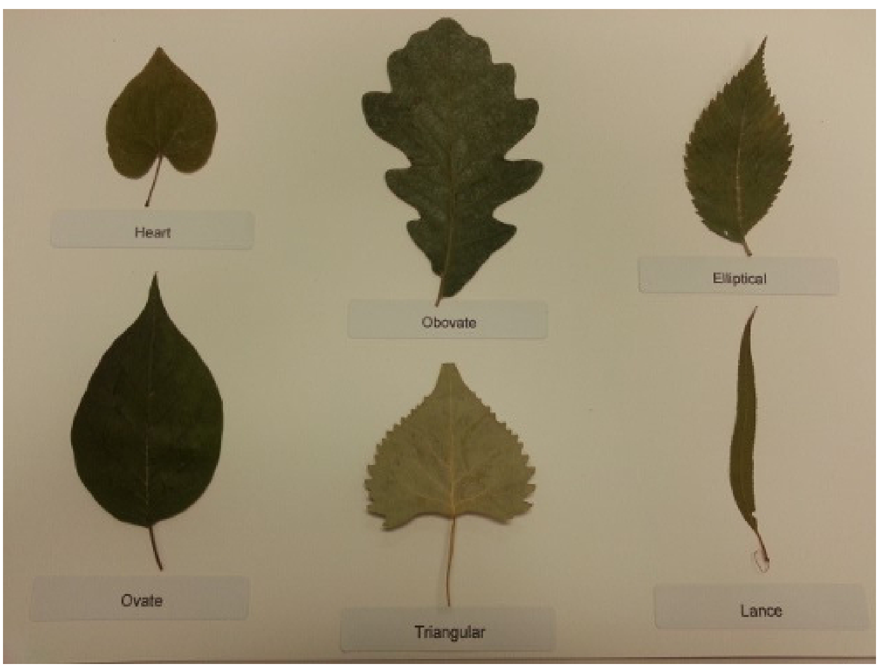


Figure 2. Examples of heart shaped, obovate, elliptical, ovate, triangular, and lance leaves.

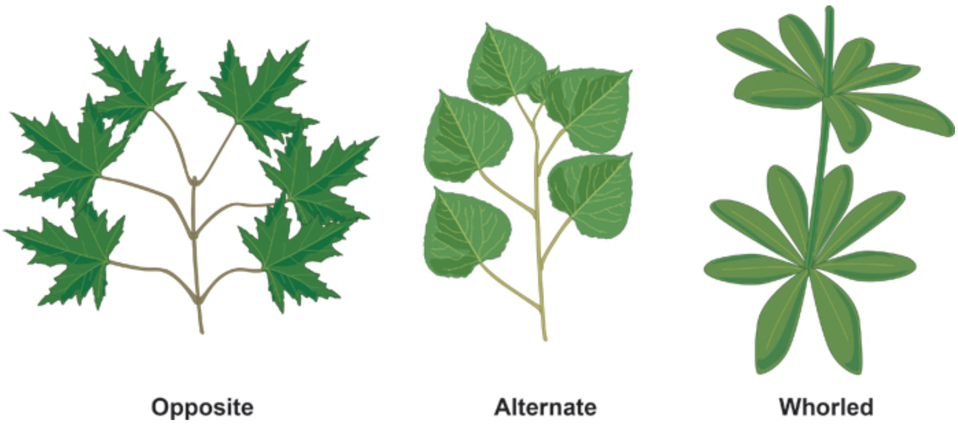


Figure 3. Examples of opposite, alternate, and whorled leaf arrangements.

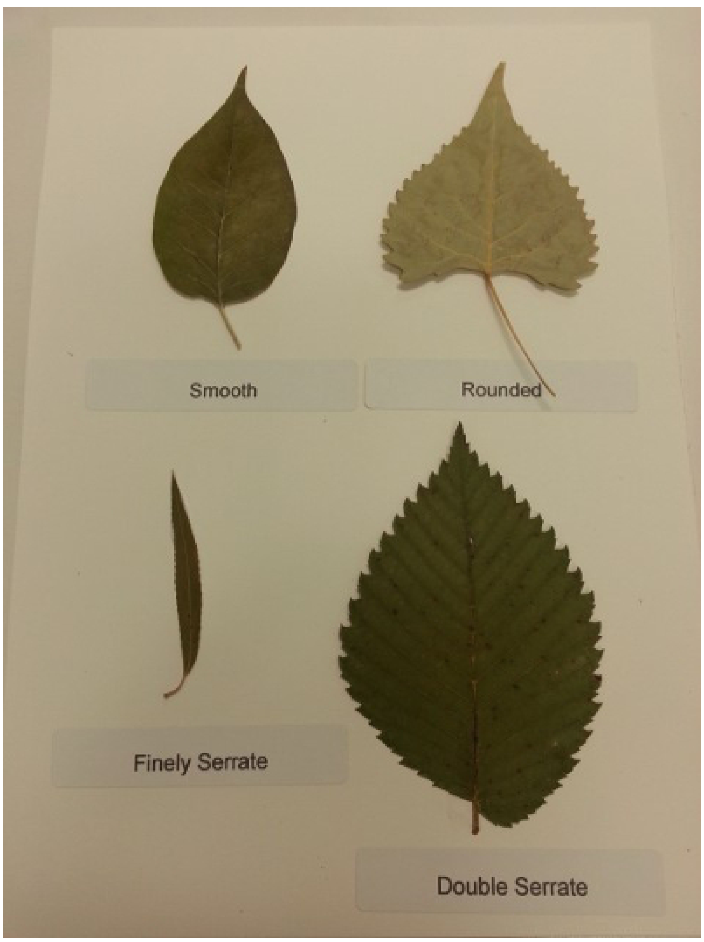


Figure 4. Examples of various leaf margin, including smooth, rounded, finely serrate, and double serrate.

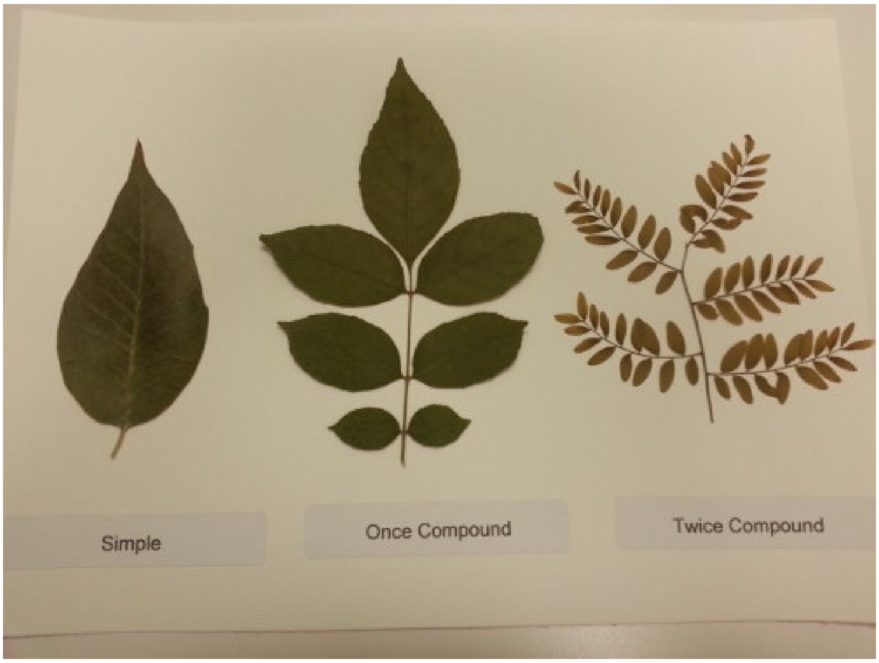


Figure 5. Examples of leaf type, including simple, once compound, and twice compound leaves.

Procedure

1. Identification of a Set of 10 Unknown Samples

Use the dichotomous key (**Table 1**) to identify the 10 unknown leaf samples (**Figures 6-15**).

1. Pick a leaf, and starting at number 1 on the key, answer each of the questions.
2. Choose the statement that best describes the leaf in question.
3. The column on the right lists either the tree species or a number that lists the next set of statements to consider.
4. Continue until the key lists the name of the tree from which the leaf sample came, and fill in the blank table supplied (**Table 2**).

2. Field Investigation

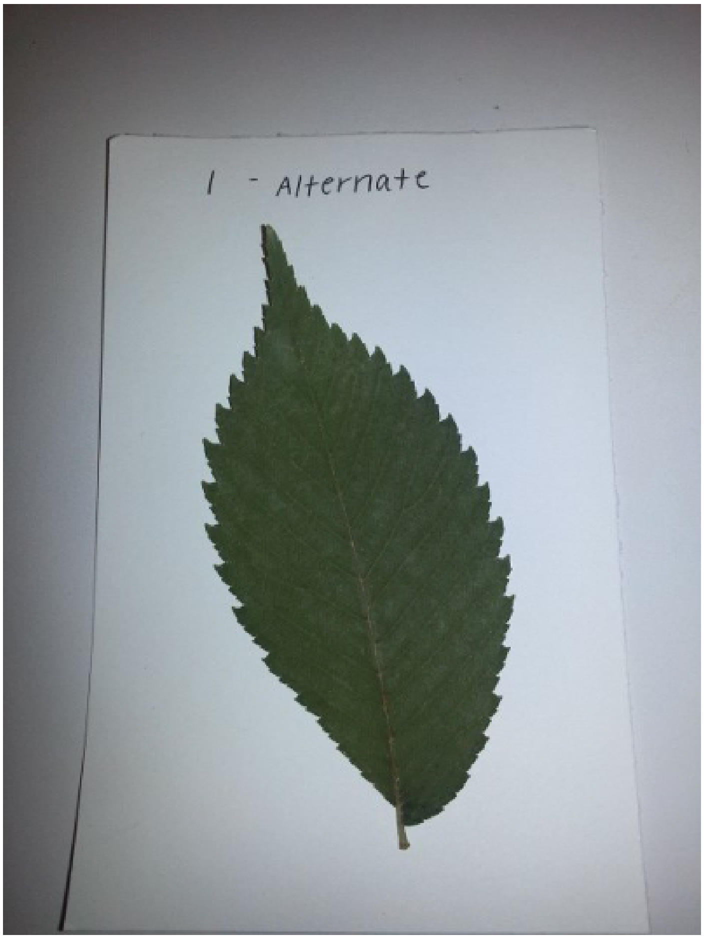
Collect leaf samples from 5 trees, properly identify the trees using a field guide to trees, and record on a data sheet (**Table 3**).

1. Select a tree to be identified.
2. Collect one representative leaf sample from the tree.
3. Glue it to a herbarium sheet with regular glue.
4. Note whether the leaves have an alternate or opposite arrangement on the stems.
5. Record this on the herbarium sheet and the data sheet.
6. Measure the diameter at breast height (dbh) of the tree in inches.
    1. This is done by measuring the circumference of the tree at 4½ feet above the existing grade. The diameter of the tree is calculated from the circumference using the formula $d = C/\Pi$. Record the circumference and the diameter on the data sheet.
7. Note on the data sheet what type of land use is nearest to the tree: single family residential, multi-family residential, small commercial business, industrial/large commercial business, or park/other vacant land.
8. Repeat steps 2.1 – 2.7 for 4 additional trees. 5 total leaf samples should be collected.
9. Using a field guide to trees of choice, identify the leaf samples. Record the species on the data sheet.

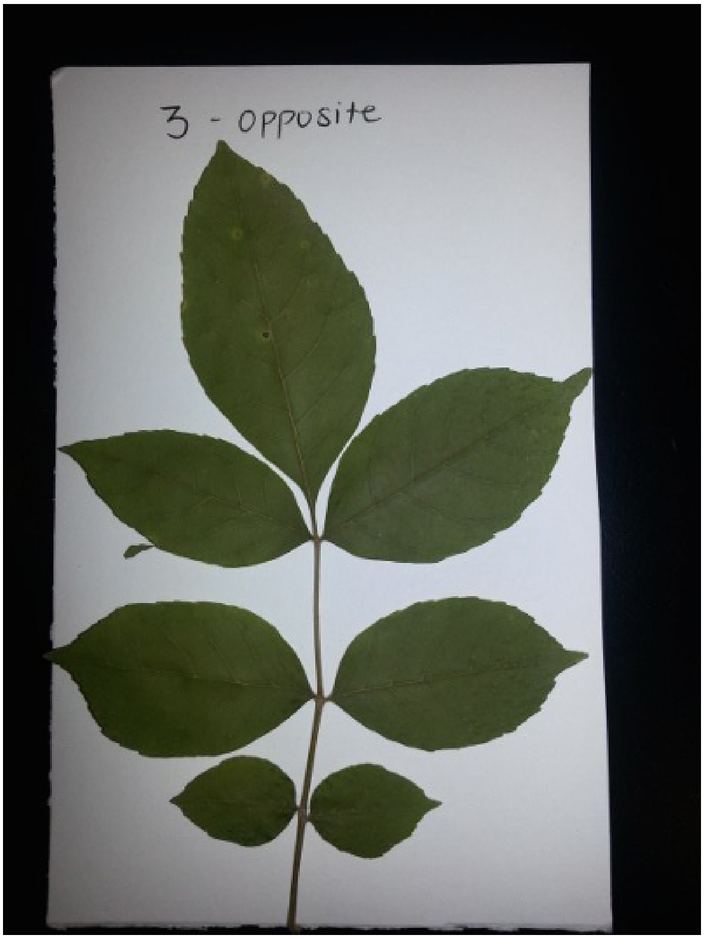
3. National Tree Benefits Calculator

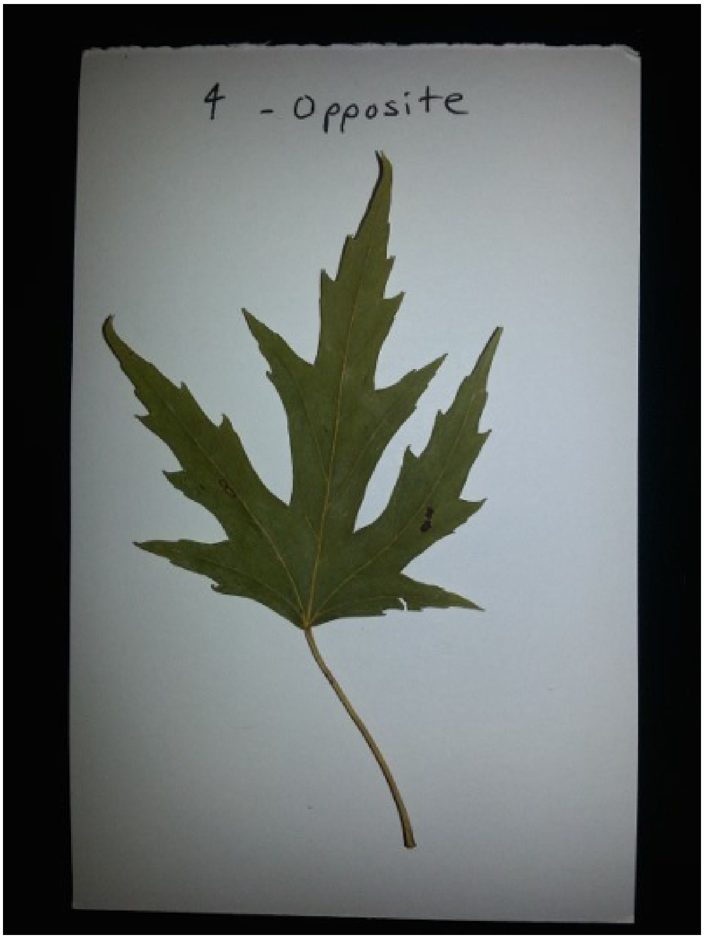
Using this software, the benefits of street-side trees can be calculated. This includes a tree's annual benefits for storm water management, property value, energy efficiency, and carbon sequestration.

1. Open up the iTree for education software tool found at http://www.treebenefits.com/calculator/ created by the USDA Forest Service, which means iTree tools are in the public domain.
2. Using the National Tree Benefits Calculator (**Figure 16**) and the data collected on the trees, calculate the environmental benefit of each tree.
3. Record the results.


1 - Alternate

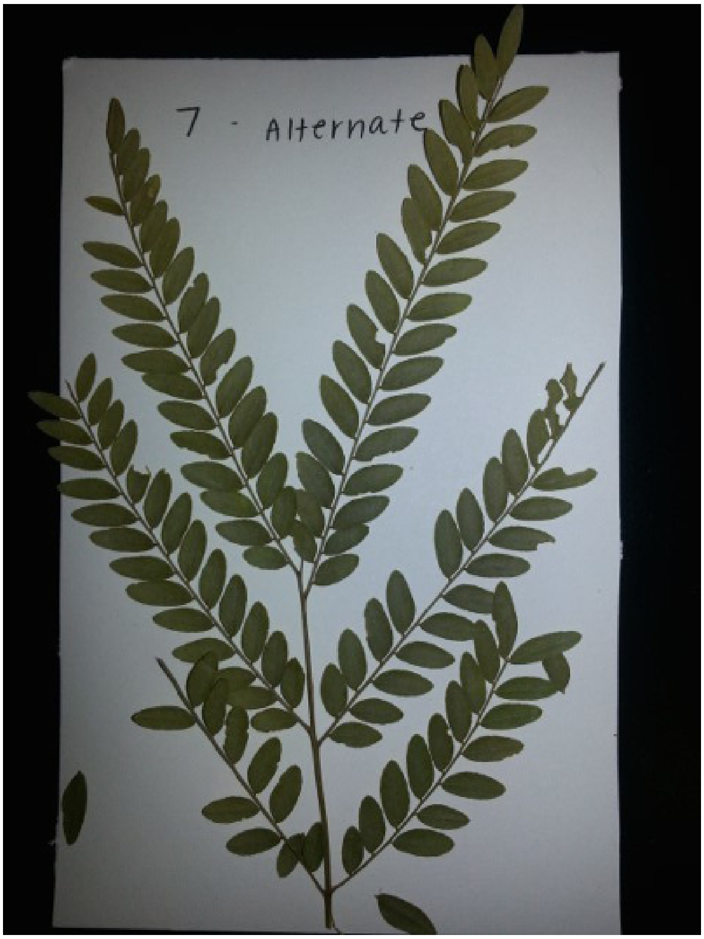

2 - Alternate


3 - opposite


4 - Opposite

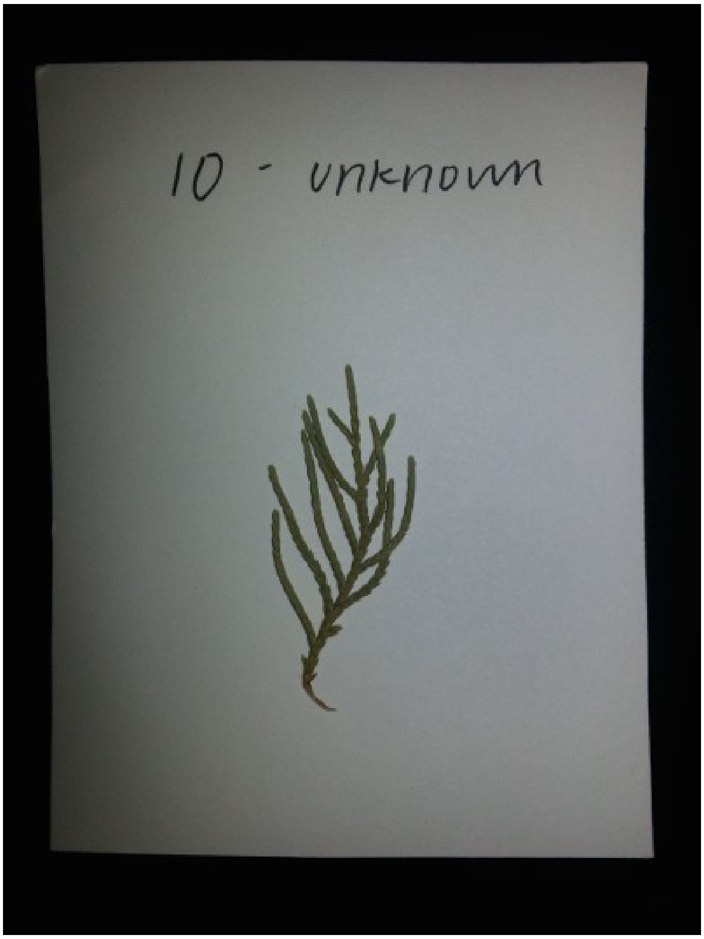

5 - Alternate


6 - Alternate


7 - Alternate


8 - unknown


9 - Alternate



Figures 6-15. Unknown leaf samples.

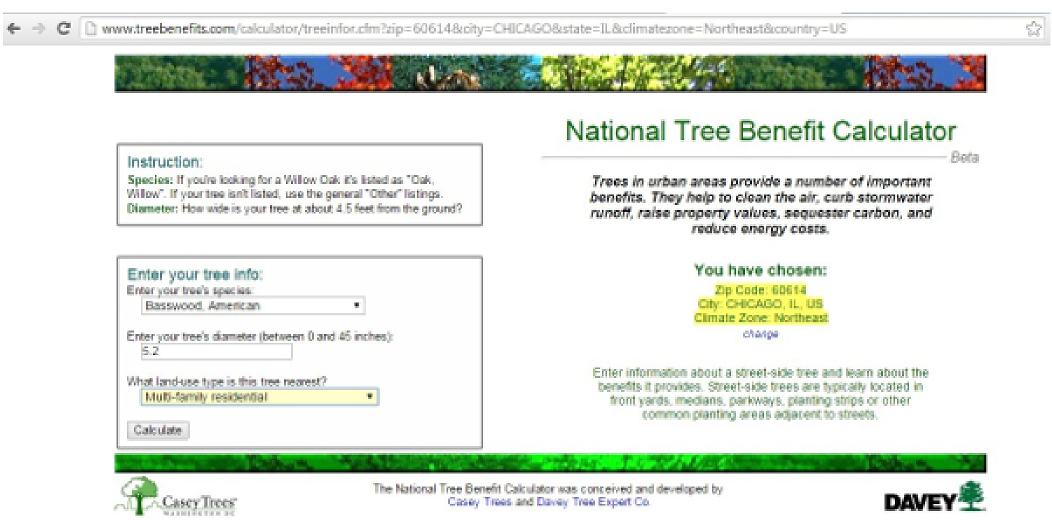


Figure 16. National Tree Benefit Calculator.

1	Is the leaf needlelike or scalelike? Is the leaf a broadleaf?	Row 2 Row 3
2	Is the leaf scalelike? Is the leaf needlelike?	Red Cedar Scotch Pine
3	Is the leaf simple? Is the leaf compound?	Row 4 Row 5
4	Is the leaf lobed? Is the leaf unlobed?	Row 6 Row 7
5	Is the leaf once compound? Is the leaf twice compound?	Green Ash Honeylocust
6	Is the leaf pinnately lobed? Is the leaf palmately lobed?	Bur Oak Row 8
7	Does the leaf have teeth on the margin? Does the leaf NOT have teeth on the margin?	Row 9 Redbud
8	Does the leaf have 3 – 5 deep lobes with opposite leaf arrangement? Does the leaf have 3 – 5 shallow lobes with alternate leaf arrangement?	Silver Maple Sycamore
9	Does the leaf margin have double teeth, elliptical shape and asymmetrical at the base? Does the leaf have a single teeth margin?	American Elm Cottonwood

Table 1. Tree Identification Dichotomous Key.

Unknown Sample	**Species**
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Table 2. A blank table to fill out tree species for each unknown leaf sample.

Tree Sample Number	Leaf Arrangement (opposite, alternate, or whorled)	Circumference at 4½ feet above grade (inches)	Diameter at 4½ feet above grade (inches) *calculated	Land Use	Species	Notes
1						
2						
3						
4						
5						

Table 3. A blank data sheet to fill out leaf arrangement, circumference, dbh, land use, species, and notes.

Results

Table 4 contains the correctly identified leaves for the identification of a set of 10 unknown species.

Results for the field investigation will vary depending on the samples collected. Representative results for trees found in the Chicagoland area (zip code 60031) can be found in **Table 5.**

The results for using the Tree Benefit Calculator can be found in **Table 6**. This calculator provides an estimation of the benefits individual street-side trees provide. When the data from the Field Investigation is input, including zip code, species, diameter, and land-use, the environmental and economic benefit provided by each tree can be seen.

Unknown Sample	Species
1	American Elm
2	Sycamore
3	Green Ash
4	Silver Maple
5	Red Bud
6	Cottonwood
7	Honeylocust
8	Scotch Pine
9	Bur Oak
10	Red Cedar

Table 4. The unknown leaf samples and their correctly identified tree species.

Tree Sample Number	Diameter at 4½ feet above grade (inches) *calculated	Land Use	Species
1	5.2	Multifamily Residential	American Basswood
2	6.1	Multifamily Residential	American Elm
3	4.3	Multifamily Residential	American Sycamore
4	4.5	Single Family Residential	Dogwood
5	5.3	Single Family Residential	Boxelder

Table 5. Representative results for trees found in the Chicagoland area.

Tree Sample Number	Overall Benefit	Storm Water Management (gallons)	Property Value	Energy Efficiency (kW/h)	Carbon Sequestration (lbs)
1	$20	173	$4	38	109
2	$24	217	$8	41	133
3	$22	161	$11	27	113
4	$11	69	$2	22	74
5	$46	356	$22	56	169

Table 6. Tree Benefit Calculator results.

Applications and Summary

Understanding the benefits trees provide for a community is important. Converting this benefit to a monetary value or ecosystem services value allows for a concrete understanding of exactly the role trees play in an ecosystem. Trees are important for health, the economy, and the environment, and once this is realized, a discussion about ways to protect the trees and increase their benefits can begin. As trees age and grow, their benefits increase. This provides a reason to protect mature trees (**Figure 17**).

This information can be used to determine which trees would be more beneficial to plant in a community. It also can be used by city officials to inform decisions about building infrastructure (*e.g.* policy about number/types of trees required to be planted on new building construction). Stakeholders can also decide how many/type of trees to plant on their property to help decrease energy bills (*e.g.* schools, businesses, government offices).

Figure 17. An example of an old, mature tree.