Forestry Resource Manual

Adapted from North Carolina Envirothon Forestry Resource Manual
Revised July 2018

Delaware Envirothon
Forestry Learning Objectives

Students must be able to…

A. Understand the historical roles of forests in society
1. Know the historical role and importance of forests
2. Explain the various benefits of trees and ecological roles of forests
3. Explain the importance of trees in urban areas and aspects of urban forestry
4. Understand forest land use and ownership in Delaware
5. Know the economic value of forests and the many products they provide

B. Understand and describe the physiology of trees and methods for their identification
1. Know the different parts of a tree and their functions
2. Explain the reproduction of the two main types of trees.
3. Describe the lifecycle of a tree and explain how trees grow
4. Understand the method and terminology required to use a dichotomous tree key
5. Know and identify major tree and shrub species native to Delaware's forests

C. Understand and describe the various characteristics and processes of forest ecology
1. Understand the concept and processes of forest ecology.
2. Identify the abiotic and biotics components of a forest ecosystem
3. Explain the process of photosynthesis and nutrient cycling
4. Understand and illustrate the process and stages of succession
5. Understand the developmental stages, structuring, and types of forests

D. Understand and describe the methods and practices of sustainable forest management
1. Identify and describe the various silvicultural principles and treatments
2. Understand tree harvesting and regeneration methods
3. Describe the various forest management objectives
4. Explain forestry best management practices
5. Explain the forest management cycle and each of its component parts

E. Understand and describe the methods and tools used in a forest inventory
1. Understand the importance of forestry measurements and identify the tools used for each
2. Demonstrate proficiency using various forestry tools and interpreting the collected data
3. Explain plot measurement procedures used in a forest inventory
4. Understand and explain the various objectives for completing a forest inventory
5. Explain what site index means and know to read a site index graph

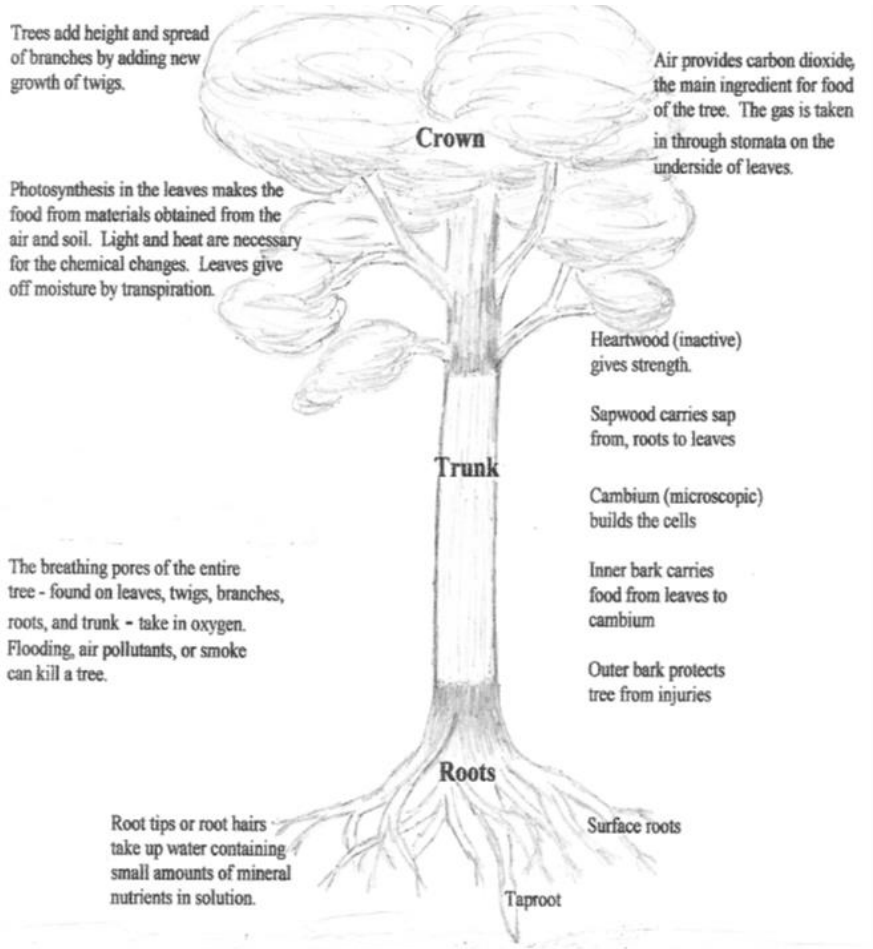
F. Understand and describe practices involved in the conservation of forest resources
1. Explain the importance of forest health
2. Understand the major issues affecting Delaware's forests
3. Identify Delaware's main forest pests and diseases
4. Understand the programs available aimed at conserving forest resources
5. Explain the various laws and regulations aimed at conserving forest resources

Key Concept 2: Tree Physiology

Trees

Trees are amazing organisms that have existed on Earth for more than 200 million years. Trees are also industrious organisms. Every year a tree produces 99% of its living parts. In part due to the capillary motion of water, trees can lift water up through their trunks at the amazing rate of one hundred fifty feet an hour. During the summer a tree can lift more than a ton of water each day. Gravity is the limiting factor that determines how high a tree can grow.

Parts of a Tree
All trees are made up of three major parts: the roots, trunk, and crown or leaves. Each of these parts plays a vital role in the life and survival of the tree.



The buds, root tips, and cambium are the growing parts of the tree. Water containing mineral nutrients in solution is absorbed by the roots then carried up through the sapwood to the leaves. There, it combines with carbon dioxide from the air to make food. The food is carried by the inner bark to all growing parts of the tree, including the root tips.

Tree Parts and How a Tree Grows

Roots
The majority of the roots cannot be seen from our perspective, but this does not diminish their importance. The five primary functions of roots are to anchor the tree in the ground to provide support, to store food for future growth, to take in nutrients and water from the soil, to transport the water, nutrients, hormones and sugars, and they produce some hormones. Roots tend to grow in two patterns: surface-rooted and deep-rooted.

Surface-rooted trees extend roots laterally in a wide area below the tree. In some species, the roots are shallow in the soil. Some surface-rooted species include birch, elm, hemlock, and spruce.

Deep-rooted trees have **taproots** that extend down into the soil strata. Pines have taproots. The longleaf pine is less susceptible to being blown down by winds, than most southern pines, due to a taproot that extends deep into the soil. Most hardwood trees have a combination of taproots and lateral or surface roots which anchor them firmly to the soil. Hardwood species with deep taproots include hickory, oak, and walnut.

Roots grow continually to form a large network that works together to support the tree both physically and with nutrients and water. Larger roots grow smaller roots called rootlets, which act as an extension of themselves. In many species, the rootlets grow even smaller, fine, hair-like roots called *root hairs*. It is the root hairs that take in nutrients and water from the soil. Pine trees are the only type of tree that does not have root hairs. They however, have a special fungi living on their roots that aids them in taking in nutrients and water. The fungi are known as mycorrhizae. Mycorrhizae are found naturally in most soils and help to increase the mobility of nutrients in the soil and protect the tree from disease and infections.

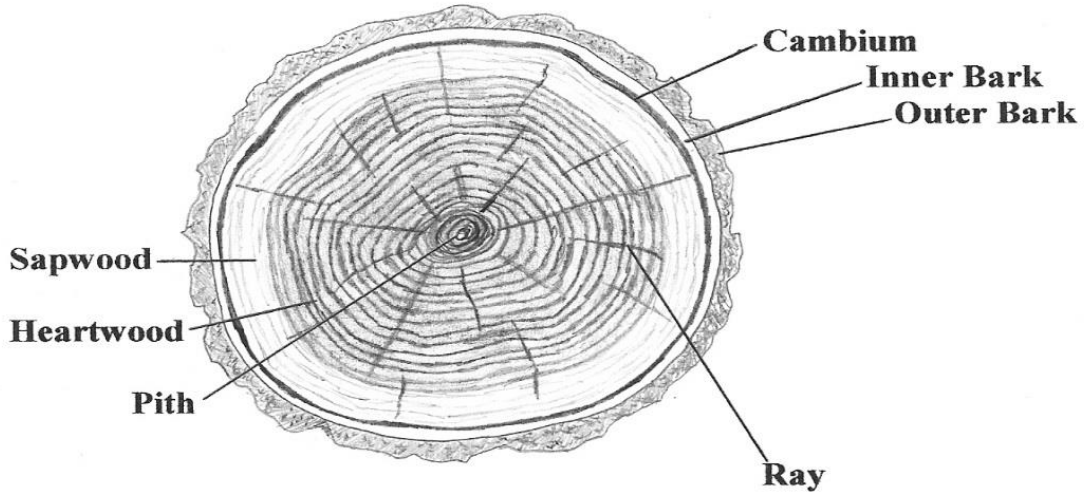
Trunk
The trunk of the tree is readily visible to us. Its major purpose is to support the tree and to move materials. The water and nutrients absorbed by the roots are moved up the tree to the leaves where they are used to make food through photosynthesis. The food produced in the leaves is moved downward to nourish other parts of the tree. The trunk and limbs of the tree are covered by a dead layer of cells known as bark.

Bark can be divided into two layers: the outer bark and the inner bark. The outer bark protects the tree from extreme temperatures, bad weather, insects, fungi, other pests, disease, fire, and humans. The outer bark varies in thickness depending on the tree species. For example the outer bark of birch trees is very thin but the outer bark of the Douglas fir can be up to one foot thick. Under the outer bark is the inner bark, or ***phloem*****.** The inner bark is soft and moist. Its major purpose is to move the food produced by the leaves down to the different parts of the tree, where it is used for growth or stored for later use. The bark of trees is useful to humans. It produces medicines, oils, and dyes.

Under the inner bark, is the ***cambium***. The main purpose of the cambium is the actual growth of the tree. The cambium is a relatively thin layer of cells. The outer side of the cambium produces inner bark, or phloem, and the inner side of the cambium produces sapwood, or

xylem. It is the cambium that each year forms new annual rings visible in a cross section of a tree's trunk.
Sapwood, or ***xylem***, is the living wood of the tree. Its major purpose is to carry nutrients and water to the crown of the tree from the roots. Extra food is stored in the xylem. This food is used by deciduous trees in the winter when they are dormant. Coniferous trees use this stored food on days when there is little or no sunlight.

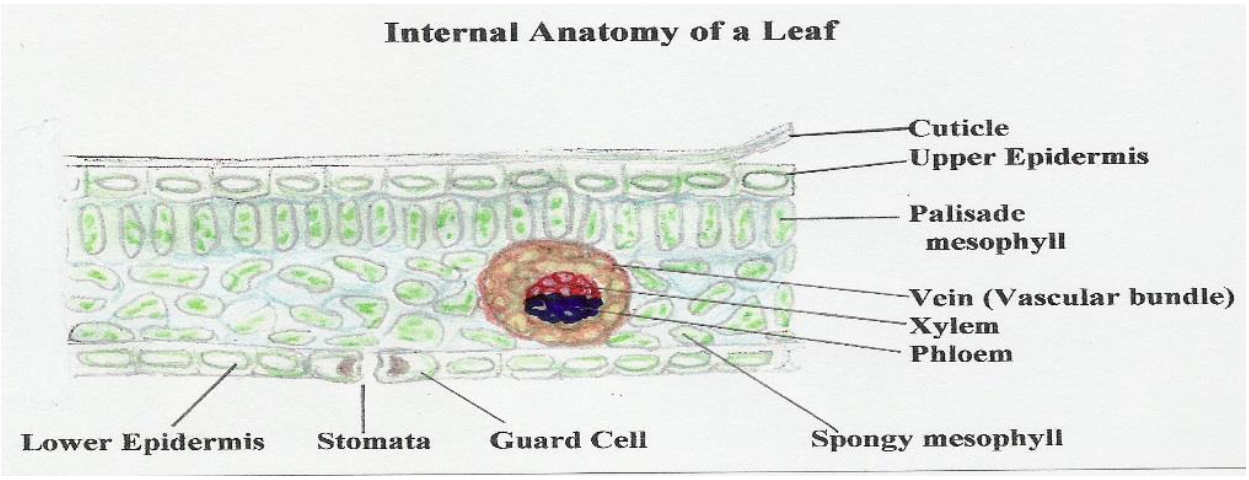
The next layer in is the **heartwood** of the tree. The heartwood is made up of old cells that are actually dead. It is usually darker in color than the other parts of the tree's trunk. The major purpose of the heartwood is to provide support and to strengthen the tree. In most trees, the heartwood is the largest part in the cross section of the tree and contains structures called **rays**. These medullary or pith **ray**s are essential for the radial conduction of the water, minerals and other organic substances. They transport the substances from center to periphery. Finally, the very center of a tree's trunk is called the pith.

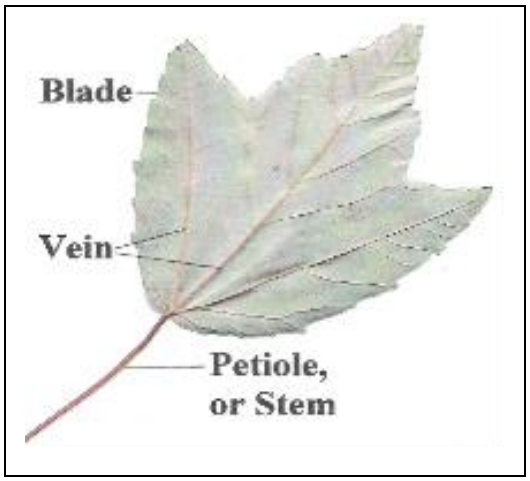


Cross section of a Tree

Crown
The branches, twigs, and leaves collectively make up what is known as the crown. The crown of a tree is important, because it is where photosynthesis, or food production, actually takes place. Once the food is produced, it is moved down through the branches, trunk, and roots to the growing parts of the tree.

Two other processes that take place within the crown are transpiration and respiration. Respiration is the process by which trees convert food to energy used for growth. Oxygen is required for the tree's respiration, but much more oxygen is released as a by-product of photosynthesis. This is one reason trees are so important in our daily lives. They help produce the oxygen we need to breath. According to NC State University one large tree can produce a day's supply of oxygen for up to four people. Transpiration is the process by which water is released from the leaves to the atmosphere. This happens through small pores, or openings, on the leaves called *stomata*. Stomata are generally more numerous on the underside of leaves. A large oak tree can transpire over 40,000 gallons of water per year according to the US Geological Survey.





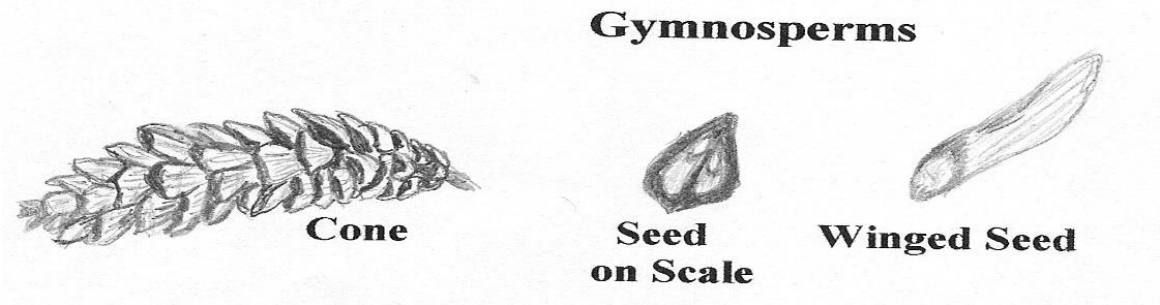
The Leaf

The mesophyll, or interior portion of the leaf, contains the chloroplasts, where photosynthesis takes place. Most photosynthesis occurs in the palisade layer. Within the spongy mesophyll are vascular bundles, the vein of the leaf. These bundles contain xylem and phloem, which transport materials to and from the leaf. The upper epidermis is covered by a waxy cuticle to prevent water loss. The lower epidermis contains many stomata or pores with guard cells to control their opening and closing. During the day, carbon dioxide enters the stomata for use in photosynthesis. Oxygen also enters the stomata for use in respiration. Water vapor transpires and oxygen exits from leaves through the stomata.

Life Cycle of Trees

How Trees Reproduce

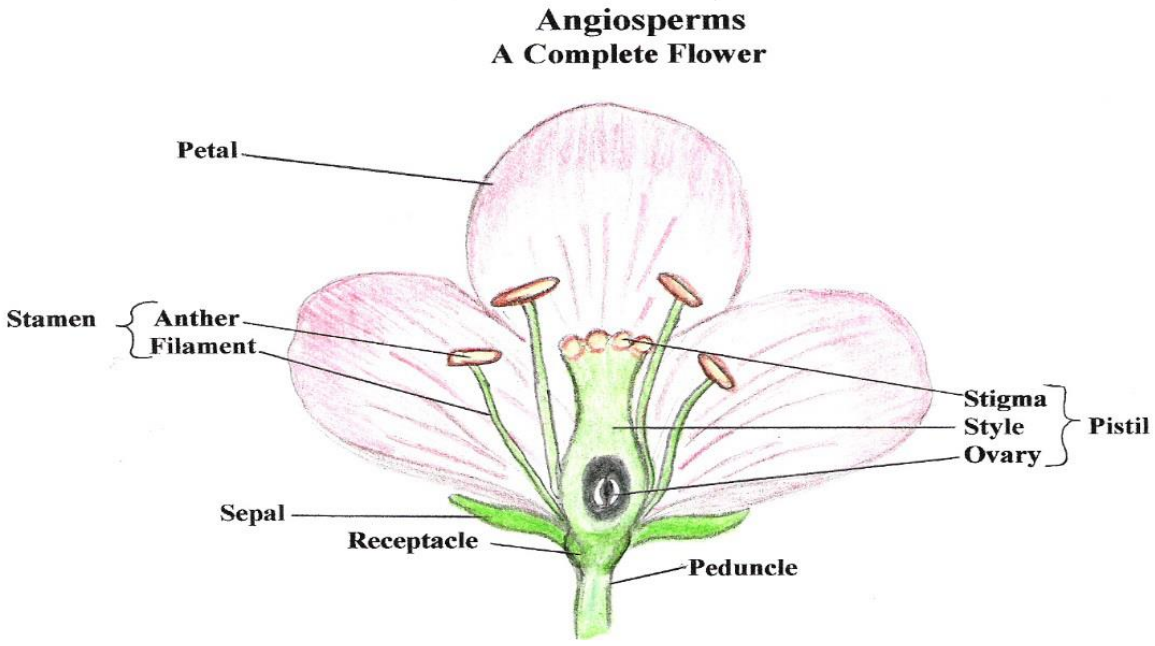
Like most plants, trees can begin life as a seed. Coniferous trees, or gymnosperms, grow exclusively from seeds found within their seed cones. Hardwood trees, angiosperms, can grow from seeds, suckers or sprouts. Sprouts grow from stumps while suckers grow from underground roots of an existing tree, called the parent tree.



Seed Production
In conifers (gymnosperms) the adult tree produces male and female cones on separate branches. Female cones develop two ovules on each cone scale. These develop into eggs. Male cones are small and easily overlooked. They produce pollen grains. The wind-blown pollen travels to the female cone. This is known as **pollination**. A pollen tube grows and a sperm cell, from the pollen, unites with the egg, in the process of **fertilization**. The fertilized egg, known as a zygote, develops into an embryo, and a mature seed is produced. The female cone opens when mature, releasing the seeds. One exception is the pond pine, which retains cones for years until a fire forces the cones to open spewing out the seed on mineral soils after the fire burns through the forest. This gives the pond pine a better chance of the seeds developing into seedlings.

Within each seed are the tiny plant embryo and a food supply of starch for its development and growth. All of this is enclosed in a seed cover or seed coat. When a seed is placed in a favorable environment, with enough moisture and adequate temperature, **germination** occurs. The seed cover opens, and a tiny root extends down into the soil. This root holds the new plant in place and starts to absorb water and nutrients to aid the growth of the plant. At the same time, the tiny plant leaves are released from the seed cover and begin to grow upward toward the sun. In conifers, a new, young sporophyte – a pine tree seedling emerges.

Deciduous trees are angiosperms or flowering plants, and most produce both male and female flowers or complete flowers, which contain both male and female parts. Some, known as **dioecious** species, produce male and female flowers on separate plants. Persimmon and holly are two examples of dioecious trees. Seeds are formed when ovules within the ovary of the female portion of the flower, the pistil, is fertilized by sperm from pollen grains produced in the anther of the male part of the flower, the stamen. Angiosperms enclose their mature seed inside protective fruits. Pollination, the transfer of pollen from the stamen to the pistil, is the first step in this process. Many animals, especially insects such as bees, are important in pollination, but wind is also a major vehicle for pollination for many trees.

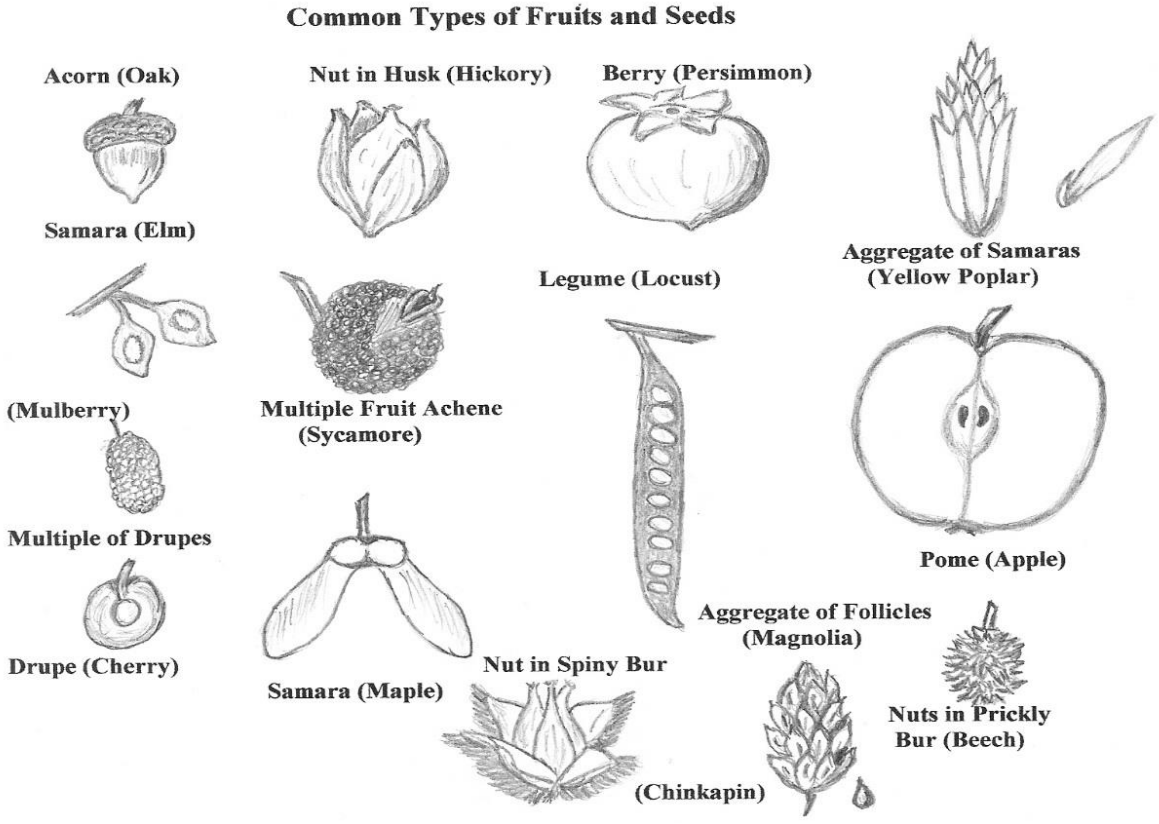


How seeds Travel

1. Animals
2. Wind
3. Water
4. Gravity (especially in mountains where nuts roll downhill)
5. Special adaptations which shoot seeds from enclosed pods (usually in plants other than trees.)

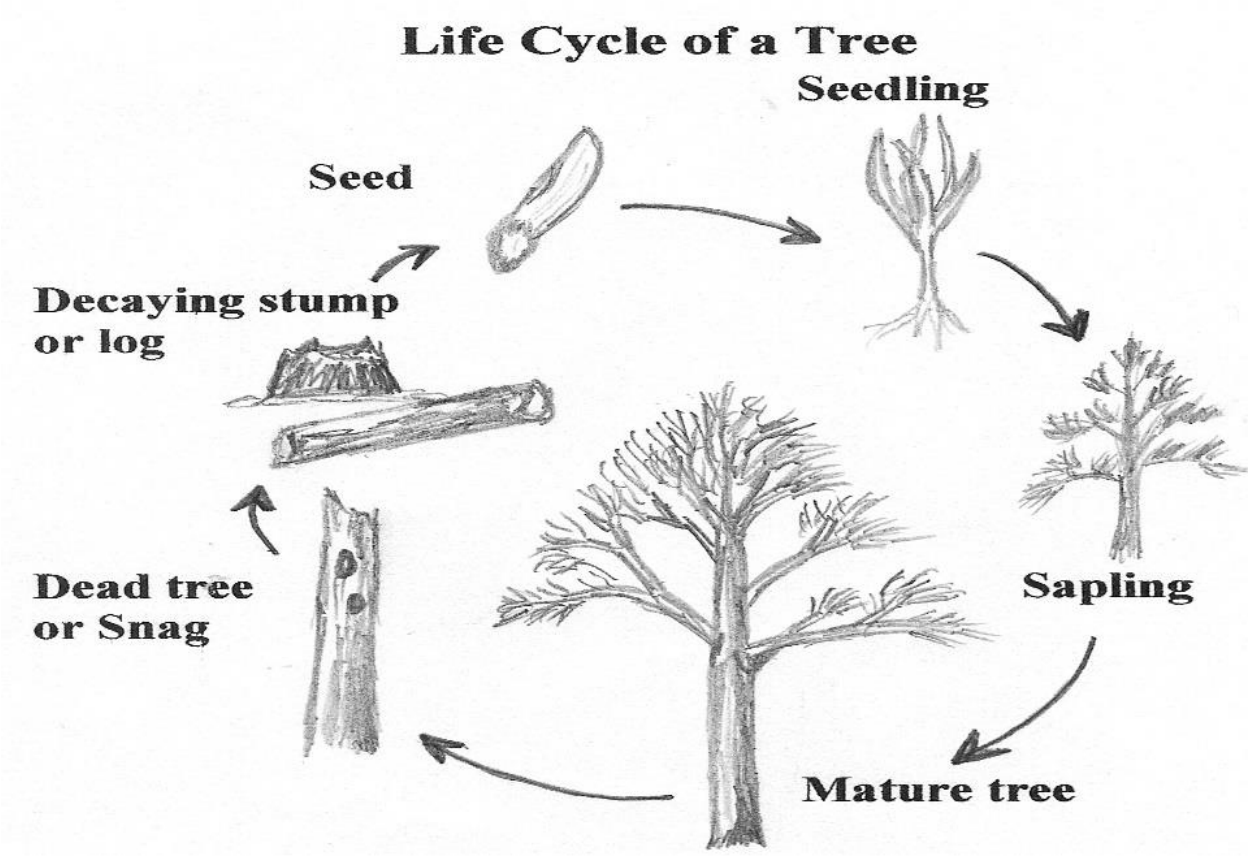
Trees that grow from suckers must grow close to the parent tree, but trees that grow from seeds may grow as far from the parent tree as the seed can travel. Seeds can travel from place to place in a wide variety of ways. Some animals such as birds, deer, raccoons, foxes, dogs, opossums, and coyotes eat the fruit of trees and then deposit the seeds in their waste. Other animals bury the nuts or acorns for winter food. If these nuts are not found, they will generally germinate and form a new seedling far from the parent tree. Seeds can be blown to distant places by the wind or fall into streams and be carried by the water. Flood waters can also pick up seeds close to stream banks and carry them downstream and deposit them at other locations. They can also attach themselves to the fur or feet of animals and be carried from place to place. In the mountains, the nuts can roll downhill by gravity and be deposited.

Most trees reproduce by seed. Broadleaf trees or hardwoods sprout profusely from the stump after they are cut, but needle leaf trees (conifers) usually do not sprout. Suckering is when the tree sends up shoots from the root system under the soil of a standing living tree. Black locust can reproduce in this way.



Tree Development
If seeds are carried far away from their parent tree, there is no competition between the parent tree and the young tree. Trees produce thousands of seeds each year. Not all of these seeds grow into trees. Excess seeds are produced to ensure that there are enough for wildlife consumption and to ensure the survival of the tree species. If seeds do find a suitable place to grow, their battle is not over. Once a seed enters the next stage of its life and becomes a small plant, called a **seedling**, it finds itself in competition with other plants for sunlight, food, water, and nutrients. It must also fight off disease, insects, and plant eating animals for survival. Only a small percentage of seedlings actually survive to mature into a full-grown tree.

A seedling grows into a **sapling**. Its chances for survival are much greater once it reaches this stage in life. A sapling can grow into a mature tree. A mature tree can live for decades or up to hundreds of years. When the mature tree dies, it becomes a dead tree (snag) and then a decaying stump or log. The dead trees and decaying trees provide habitat for a wide variety of wildlife.



Tree Identification

Access the powerpoint for the full species list.

There are many things that should be considered when identifying trees. Usually a combination of characteristics is used to correctly identify a tree species. Some of these characteristics include leaf shape, position of leaves, type of leaf margins, branching patterns, type of fruit, twigs, simple or compound leaves, the silhouette of the tree, and the appearance of the bark. When identifying coniferous trees it is helpful to look at the length of the needles, the number of needles in each bundle, the silhouette, and the bark of the tree.

Other things can be used to identify trees. The location of the tree in the landscape, its position in the canopy, and the size of the tree can often be useful. The geographic distribution of a tree species should also be considered. If the tree grows on the coast, you would not expect to find it in the mountains or vice versa. Is it a hardwood or conifer species? All of these things can be used to correctly identify trees. A good tree id book is also recommended.

Conifers can be identified by their needles. The size and shape are good clues. The length and number of needles per bundle is most helpful in identifying pines. Conifers may also be identified by their cone size and shape, tree silhouette, bark, location where found, and arrangement of limbs.

Deciduous trees can be identified using many characteristics. The following assist in identification: leaf size, shape, arrangement, and margins; buds, twigs, limbs, growth pattern, seeds, fruits, and bark.

Leaves
Trees can be identified by type, size, shape, texture, color, margins, venation, and arrangement of leaves. Leaves may be arranged in an alternate, opposite, or whorled pattern. They may be simple with one blade, or compound with several leaflets per leaf. Leaf colors may also be helpful in autumn. Any good tree guide will show the various leaf shapes, margins, arrangement, types, tips, venation, and bases.

Fruits
There are two major groups of fruits, simple (individual fruit) and compound (a cluster of fruits in one receptacle). Simple fruits are classified as *fleshy* or *dry.* Fleshy fruits include the berry, drupe, and pome. Dry fruits may be *dehiscent* (pop open when ripe), including capsules and legumes; or *indehiscent* (not open when ripe), such as the achene, nut, and samara (winged fruit). Compound fruits may be aggregate, a cluster of fruit from one flower, or multiple, a cluster of fruits from separate flowers crowded together. See the picture of fruits on page 37.

Twigs
Twigs are particularly helpful in identifying trees in the winter. They have textures, arrangements, leaf scars, pith, buds, and bark that assist in identification. Some have distinctive tastes, colors, or smells.

Buds
Buds aid in winter tree identification. Trees produce buds with different sizes, shapes, colors, arrangement, and scaling.

Bark
Bark is perhaps the most important identifying characteristic of large trees in winter. The bark fissures or cracks into ridges, plates, or scales characteristic to each species. Bark also differs in thickness, color, texture, and odor.

Flowers
Some trees have distinctive flowers, such as the poplar and magnolia; but many flowers are very small and short-lived making them of little use for identification.

Growth Pattern
The crown shape, density, color, and branching pattern, as well as the tree silhouette can assist identification. Some species have rounded or umbrella shapes, others have drooping limbs, and some have pointed tops. Some tree species can tolerate wetland areas, while others prefer well-drained or even dry sandy areas. A good tree guidebook will show the characteristic silhouette of each species.

The following tables provide information on some of North Carolina’s more common trees.