FORESTRY STUDY GUIDE

KEY POINTS (summary and general topics that students could be tested on)

Student should be able to:

- Describe plant families and their unique properties
- Describe different types of leaves
- Explain chemical processes that take place with plants
- Describe major forest types found in Virginia
- Identify different structural aspects of a forest ecosystem
- Understand the ecosystem services that a forest provides, such as water quality and wildlife habitat
- Explain influences on plant communities based on location
- Understand the process of succession
- Explain importance of biodiversity
- Describe economic benefits of forests and grasslands
- Identify climate change impacts on forests
- Identify major legislation locally and nationally for forests
- Understand Best Management Practices (BMPs) in forestry
- Explain role of forests in recreation
- Operate forestry tools and take samplings of trees

*FORESTRY LEARNING OBJECTIVES**

These key concepts serve as an overview of the types of knowledge and skills to help teams study for the Virginia Dominion Energy Envirothon program and NCF-Envirothon international level of competition.
Not every learning objective listed will be used for every competition.

**these are worded differently from the official forestry learning objectives set by NCF Envirothon in 2021, but are re-organize here to help you study! There is no change to the official learning objectives.*

Concept 1: Plant Biology

- Explain fundamentals of plant biology
- Describe evolution and function of plant families
- Describe different types of leaves
- Understand characteristics of monocots and dicots
- Understand chemical processes taking place within plants
- Describe how tree rings form

Concept 2: Forest/Grassland Ecology

- Describe major forest types found in Virginia
- Explain different forest stand types and structure
- Describe typical structure of grassland soil
- Understand energy flow in a forest ecosystem and trophic levels
- Define resilience and what it means for a forest ecosystem

Concept 3: Plant Communities

- Understand concept of successional processes in a forest
- Explain why certain plant communities develop in certain areas
- Explain role of plant communities in nutrient cycles
- Describe the importance of biodiversity in plant communities
- Apply concepts of land ecology to plant communities

Concept 4: Forests and Society

- Describe ecosystem services provided by forests and grasslands
- Explain economic benefits of forests and grasslands
- Describe how forests and plants are used for recreational purposes
- Identify major legislation locally and nationally for forests, grasslands, and plant communities
- Explain concept of Best Management Practices (BMPs) in forestry
- Describe different types of forest management
- Describe role of key leaders in forestry and forest conservation

Concept 5: Field Skills

- Identify common Virginia trees and plants without using a key
- Identify uncommon local trees and plant with use of a key
- Be familiar with operation of common forestry tools
- Describe role of GIS in forestry work
- Be able to make management recommendations based on ecological conditions of the forest
- Be able to make common forestry measurements
- Identify common plant pests and disease without use of a key

FORESTRY CONTENT OVERVIEW

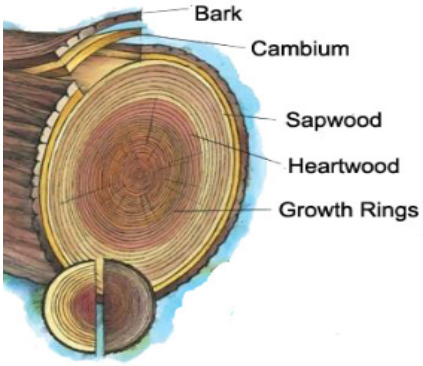
Forests are ecosystems, and the current approach to managing our forests is ecosystem management. Forests provide habitat for wildlife and support a great diversity of plant and animal species. They are watersheds that are important to water quality. An ecosystem management approach considers these roles, as well as soil types, forest protection, wilderness preservation, historical roles, outdoor recreation, silviculture, and timber production.

Our forests are important economic resources, providing lumber and thousands of other products used by man. However, forests also provide many ecological services upon which man and wildlife depend. Some of these services include climate moderation, water and nutrient cycling, prevention of soil erosion and flooding, removal of air pollutants, and social, recreational, and aesthetic values.

The distinguishing vegetation of the forest is its trees, which are second only to grass as the most common and widely distributed plants on earth. Our forests have been an important part of our history and our economic growth from the time of early settlement. Forests are our renewable, ecological, and economic resource that supply habitat for wildlife and products for man.

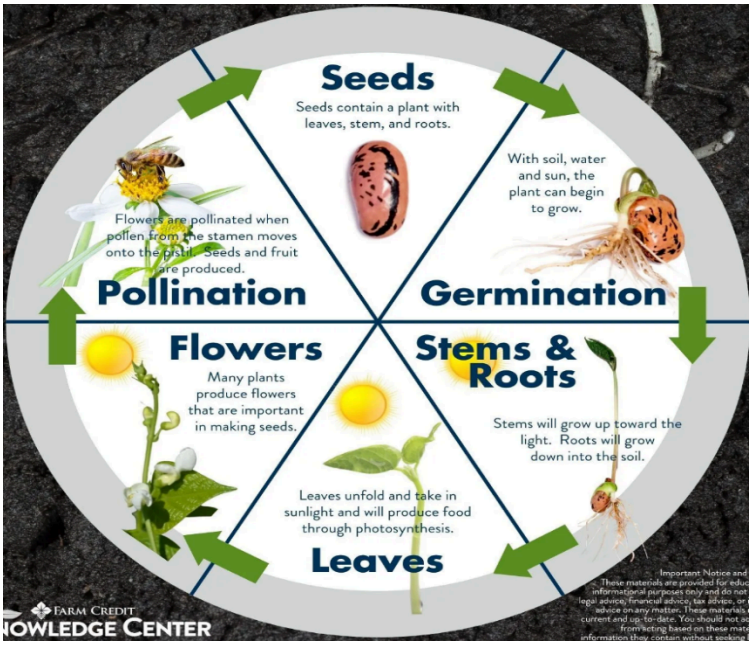
Concept 1: Plant Biology

Fundamentals



- **Outer bark** is the tree's protection from the outside world. Continually renewed from within, it helps keep out moisture in the rain, and prevents the tree from losing moisture when the air is dry.
- **Inner bark**, or "phloem", is pipeline through which food is passed to the rest of the tree. It lives for only a short time, then dies and turns to cork to become part of the protective outer bark.
- **Cambium cell layer** is the growing part of the trunk. It annually produces new bark and new wood in response to hormones that pass down through the phloem with food from the leaves.
- **Sapwood** is the tree's pipeline for water moving up to the leaves. Sapwood is new wood.
- **Heartwood** is the central, supporting pillar of the tree.

Basic Life Cycle

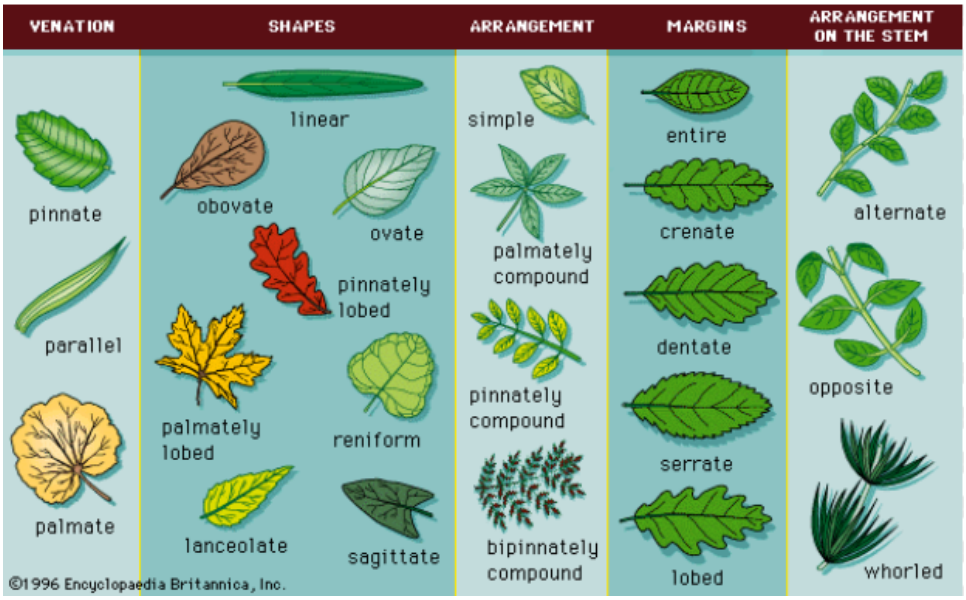


- **Adaptations** - The environmental factors affecting trees are climate, soils, topography, and biota. Each species of tree adapts to these factors in an integrated way—that is, by evolving specific subpopulations adapted to the constraints of their particular environments. As discussed above, the major factor is the decrease in temperature with increasing elevation or extremes in latitude. Each subpopulation adapts to this by modifying the optimum temperature at which the all-important process of **photosynthesis** takes place

Tissues

- **Xylem**: A type of vascular tissue in plants responsible for the transport of water and dissolved minerals from the roots to the rest of the plant. It also provides structural support.
- **Phloem**: Another type of vascular tissue in plants that primarily transports sugars, produced through photosynthesis, and other organic nutrients from the leaves to other parts of the plant.
- **Cambium**: A layer of actively dividing cells between the xylem and phloem in most vascular plants. The cambium facilitates the growth of new xylem and phloem cells, contributing to the increase in plant girth.
- **Cuticle**: A waxy, protective layer found on the outer surface of the leaves and stems of plants. It helps reduce water loss by evaporation and provides some protection against pathogens.
- **Stomata**: Small openings or pores found mainly on the underside of plant leaves. Stomata are surrounded by guard cells that regulate their opening and closing, thus controlling gas exchange and water loss through transpiration.
- **Vascular Bundle**: A part of the transport system in plants, consisting of xylem and phloem tissues. In stems, these bundles are organized in a specific pattern, while in leaves, they form veins.
- **Apical Meristem**: A region of actively dividing cells at the tips of roots and shoots in plants. This meristem is responsible for primary growth, leading to an increase in the length of the plant.
- **Lateral Meristem**: A type of meristem that contributes to secondary growth in plants, leading to an increase in thickness or girth. Examples include the vascular cambium and the cork cambium.

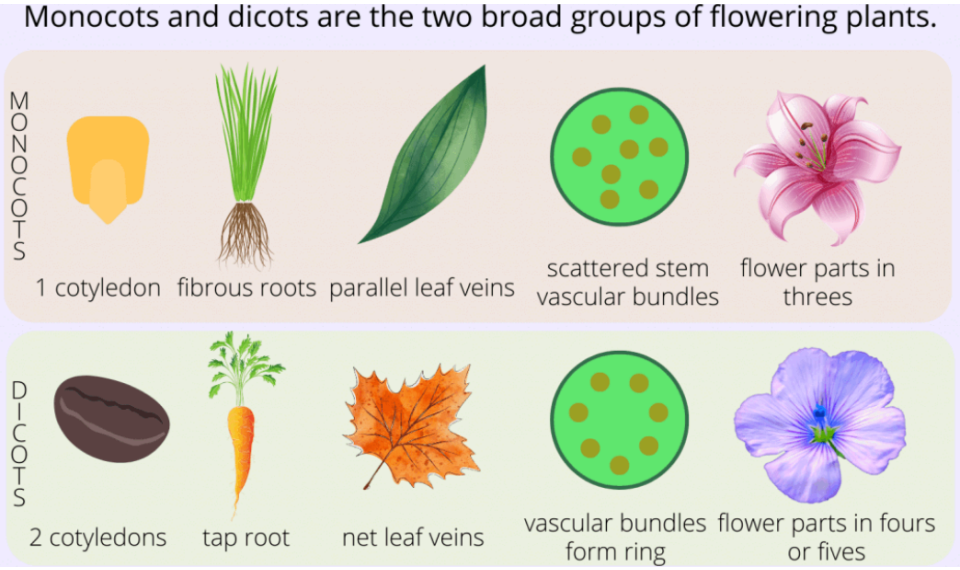
Leaf Basics



Differences

- **Angiosperms**: Also known as flowering plants, angiosperms produce seeds enclosed within a fruit. They are the most diverse group of land plants and include a wide range of plants like grasses, herbs, shrubs, and trees.
- **Gymnosperms**: These are seed-producing plants, but unlike angiosperms, their seeds are not enclosed in fruits. They typically have needle-like or scale-like leaves.
- **Deciduous**: Deciduous plants are those that shed their leaves annually, usually in response to seasonal changes like autumn. This group includes many angiosperms, such as oaks and maples.
- **Coniferous**: Coniferous plants are mostly gymnosperms, and they are characterized by bearing cones and evergreen, needle-like leaves. Examples include pines, spruces, and firs.
- **Evergreen**: Evergreen plants retain their leaves throughout the year, with old leaves being replaced by new ones gradually. This category includes many coniferous trees (like pines and spruces) as well as some angiosperms (like holly and eucalyptus).
- **Hardwood**: Hardwood typically refers to wood from angiosperm trees that have broad leaves, like oak, maple, or walnut. These woods are often denser and more durable than softwoods.
- **Softwood**: This term usually refers to wood from gymnosperm trees, like pine or spruce, which generally have needle-like leaves. Softwoods tend to grow faster and are typically less dense than hardwoods.

Monocot vs. dicot



Chemical Processes

- **Photosynthesis**: This is a process used by plants, algae, and certain bacteria to convert light energy, usually from the sun, into chemical energy. In this process, plants use carbon dioxide (CO_2) and water (H_2O), facilitated by chlorophyll and sunlight, to produce glucose (a sugar) and oxygen (O_2). This glucose is then used as energy for growth and development.
- **Respiration**: In plants, respiration is the process by which glucose (produced during photosynthesis) is broken down to release energy. This energy is used for various metabolic activities essential for growth and maintenance. During respiration, glucose combines with oxygen, resulting in the production of carbon dioxide, water, and energy (ATP).

- **Transpiration**: This refers to the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems, and flowers. Transpiration helps in the transportation of nutrients from the soil to different parts of the plant and also aids in cooling the plant. It creates a negative pressure in the xylem, helping in the upward movement of water and nutrients.
- **Nutrient Use**: In the context of plant growth, nutrient use refers to how plants absorb essential elements from the soil through their roots and utilize these nutrients for various physiological functions. Key nutrients include nitrogen, phosphorus, potassium, and various micronutrients. These nutrients are vital for different aspects of plant growth, such as leaf and stem development, flower and fruit production, and overall health and vigor.

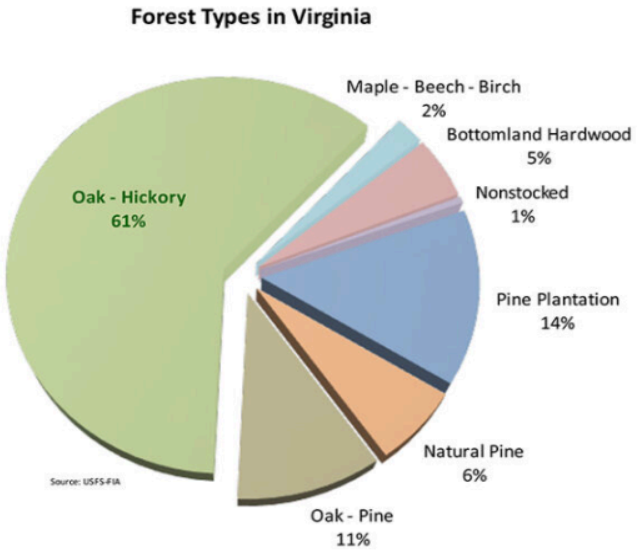
Tree Rings

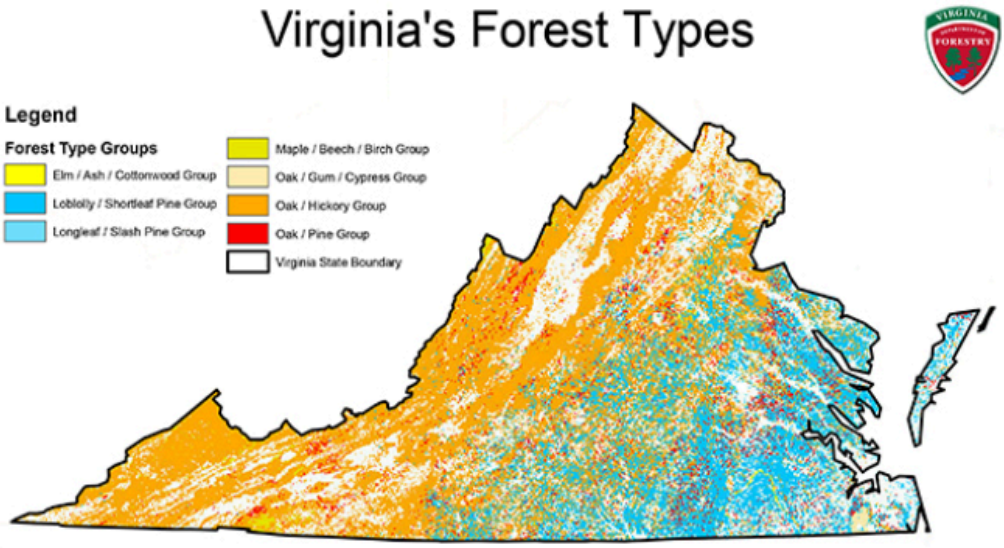
- **Tree rings** form as a result of the growth patterns of trees in different seasons. During the growing season, usually in spring and summer, trees grow faster and produce a layer of new wood that is lighter in color and less dense, known as **earlywood or springwood**. In late summer and fall, growth slows down, and the trees produce a darker, denser wood called **latewood or summerwood**. **The transition between the growing season and the dormant season creates a distinct ring, visible in a cross-section of the tree trunk. Each ring typically represents one year of growth**, with variations in ring width reflecting environmental conditions such as climate, rainfall, and temperature. Consequently, tree rings can provide valuable information about the tree's age and the historical climate conditions during its life.

Concept 2: Forest/Grassland Ecology

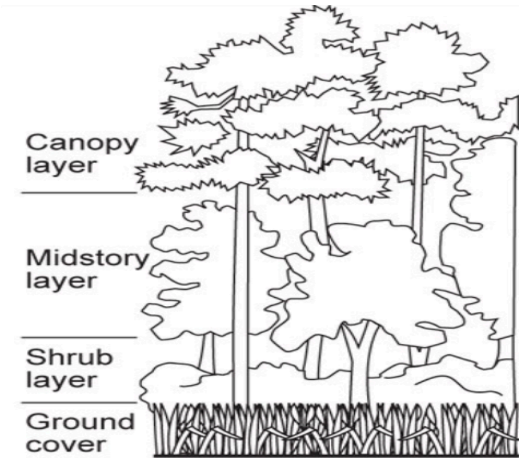
- Forests consist not only of living **(biotic)** components like trees, animals, plants, and other living things but also of nonliving **(abiotic)** components such as soil, water, air, and landforms. All these components together make up a f**orest ecosystem.**

Forests in Virginia





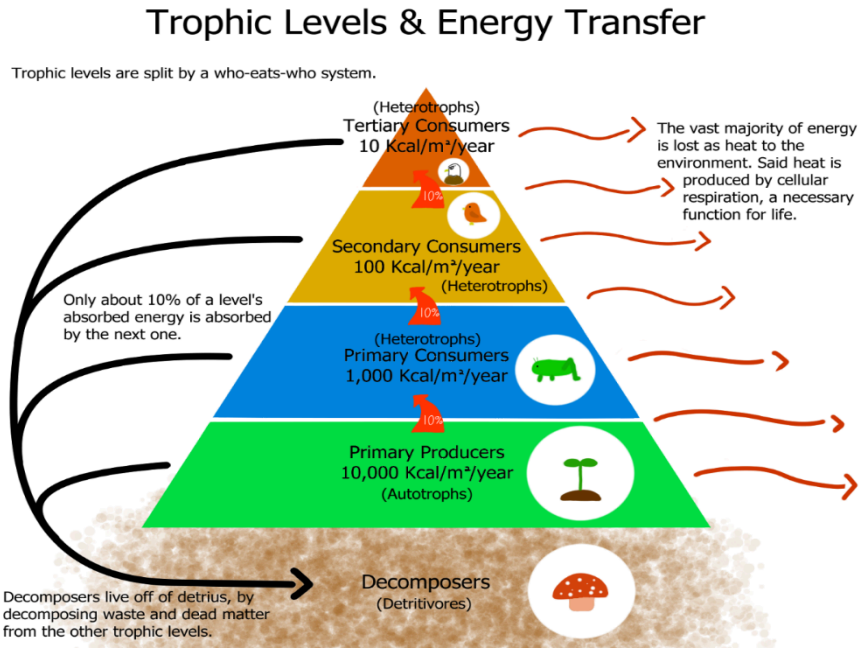
Forest Structure



Soils – Forests and Grasslands

- **Forest soils** - Because our forest tends to be dominated by species that prefer **acidic soils**, such as oaks, beech, and tuliptree, you would start with an acidic soil. Almost just as important is the soil composition. Gardeners will attest to the prevalence of clay in their soil, and the difficulty of digging in this **clay**, but we do also have **sand and silt** in our soil. A good mix of the three, with a focus on the water-retaining clay, gets us a good soil to start with.
- **Grassland soils** - The soil of the temperate grasslands is deep and dark, with fertile upper layers. It is nutrient-rich from the growth and decay of deep, many-branched grass roots. The rotted roots hold the soil together and provide a food source for living plants.

Energy and Trophic levels



Forests and Water

- Forests act as a natural water filter. When it rains, any water that does not soak into the ground becomes **runoff** and travels downslope to the closest stream, river or lake. As runoff travels it picks up nutrients from excess fertilizer and animal waste carrying that nutrient pollution into our waters, which is mainly **nitrogen and phosphorus**. All plants, including trees, use nitrogen and phosphorous for growth. But excess nutrients that get washed into streams, rivers and lakes support the growth of plants like algae. When there are a lot of pollutants in the water and an overgrowth of algae, it causes health concerns not only for the people who fish, swim or drink that water, but also other plants, fish, and insects that live in the water. **Tree roots are an important mechanism for absorbing nutrient pollution before it reaches our waters**

Edge Effects

- **Edge effects** are the changes in biodiversity that occur inside the space surrounding the shared edge of two or more distinct ecosystems. This transitional zone rich in biodiversity is known as the **ecotone**; examples are between woodlands and plains, forests and mountains, and land and water. Informally known as the edge, the ecotone affects the plants and animals living there in a way that is unique from the connecting habitats.
- Edge effects in natural settings can be positive for plants and wildlife, however edge effects brought on by human development or habitat destruction can be negative

Fungi in the forest

- **Mycorrhizal associates** - Mycorrhizal fungi form mutualistic symbioses with host plant roots, increasing plant water and nutrient uptake in exchange for carbon
- **Pathogens** - By killing trees, pathogenic fungi can reduce or eliminate plant species, cause gaps in the forest canopy that may increase plant species diversity, and add to accumulation of dead wood.

- **Decomposers** – Wood and litter decay fungi recycle carbon, minerals, and nutrients for use by other organisms, and contribute to the soil matrix physical properties. Fungal fruiting bodies are a major agent of nitrogen, phosphorus and potassium export from logs, particularly in the early stages of decomposition
- **Wildlife food sources** - Fungi provide an important food source for many species, including microbes, arthropods, nematodes, and mammals
- **Edibles and medicinals** - The harvest of edible and medicinal fungi, including chanterelles, morels, matsutake, boletes, truffles, ganoderma and others is a growing industry

Plant Resilience

- **Resilience** - the ability of an individual to regenerate following **disturbance**, either through replacement of damaged tissues or by the germination of its offspring from seed. Disturbances can be natural (fire, wind, ice, flooding, etc) or human caused (clearcutting, timber harvesting, etc).

Concept 3: Plant Communities

Factors influencing plant communities

- **Climate**: The temperature, precipitation, humidity, and wind patterns of an area significantly influence which plants can survive and thrive there. Different plants have adapted to various climates, from deserts to rainforests.
- **Soil Type**: The composition, pH, and fertility of the soil affect plant growth. Different plants require different soil conditions, such as loamy, sandy, or clay soils, and specific nutrient compositions.
- **Aspect**: The direction a slope faces affects the amount of sunlight and moisture it receives. South-facing slopes in the Northern Hemisphere (and north-facing in the Southern Hemisphere) typically receive more sunlight and are warmer and drier.
- **Topography**: The physical features of the landscape, like hills, valleys, and flat plains, influence drainage, sunlight exposure, and wind patterns, all of which affect plant growth.
- **Elevation**: Higher elevations typically have cooler temperatures and different moisture levels, which can limit which plants are able to grow there.
- **Seed Dispersal**: The ability of a plant to spread its seeds affects where its community can develop. Different plants have various dispersal mechanisms, like wind, water, or animals.
- **Available Light**: Sunlight is essential for photosynthesis. The amount of available light, influenced by factors like canopy cover and aspect, determines which plants can grow in an area.
- **Available Nutrients**: The availability of essential nutrients like nitrogen, phosphorus, and potassium in the soil affects plant growth. Different plants have different nutrient needs.
- **Competition**: Plants compete for resources like light, water, and nutrients. Dominant species can shape a community by outcompeting other plants and creating conditions favorable for certain species over others.

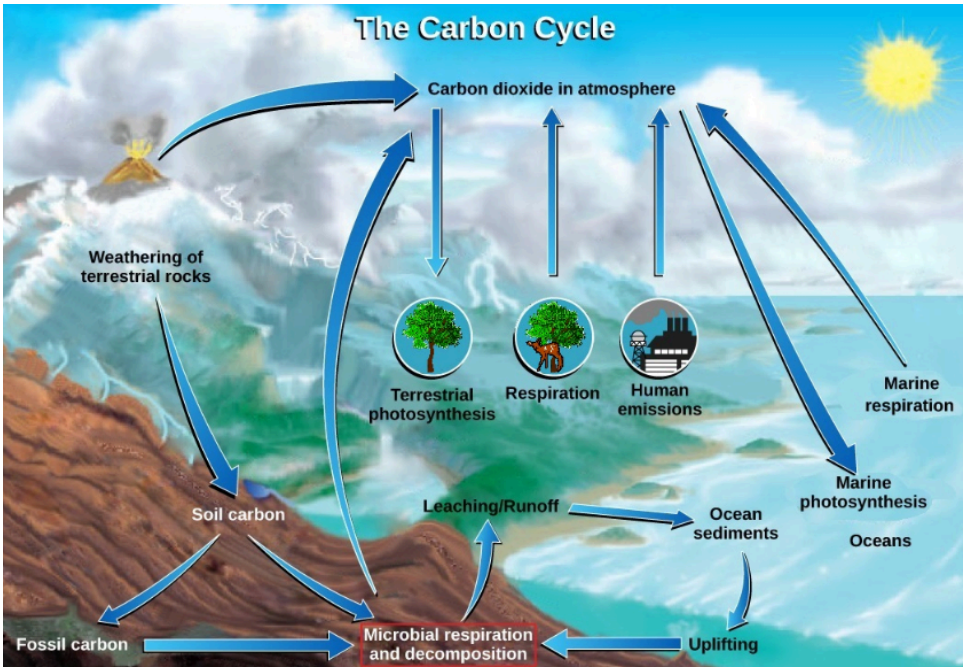
Succession

- Vegetation follows established patterns of regrowth and change after disturbances by farming, timber harvesting, hurricanes or fire. This process of patterned regrowth and change is called plant **succession**. The rate of succession and the species present at various stages depend on the type and degrees of disturbance, the environment of the particular sites, and the species available to occupy the site.
- **Shade-tolerant species** are species that are able to thrive in the shade, and in the presence of natural competition by other plants
- **Shade-intolerant species** are species that need sufficient light resources in order to survive. They will typically grow faster and out compete shade tolerant species where there are gaps in sunlight
- **Primary succession** is the process in which plants first colonize a barren habitat
- **Secondary succession** differs from primary succession in that it begins after a major disturbance

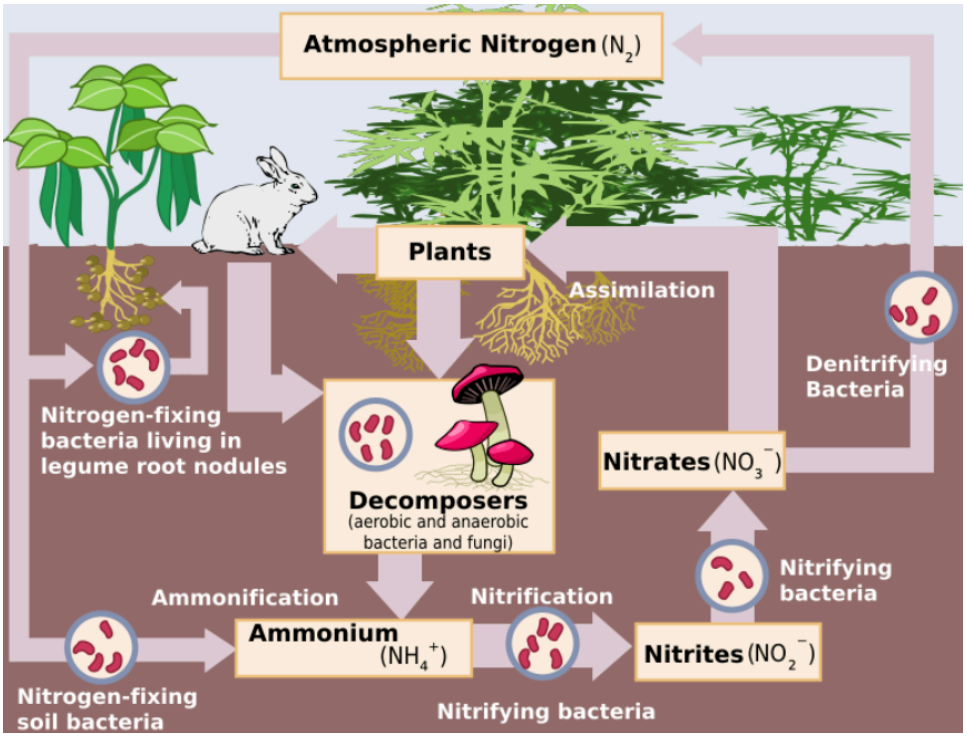
Fire in ecosystems

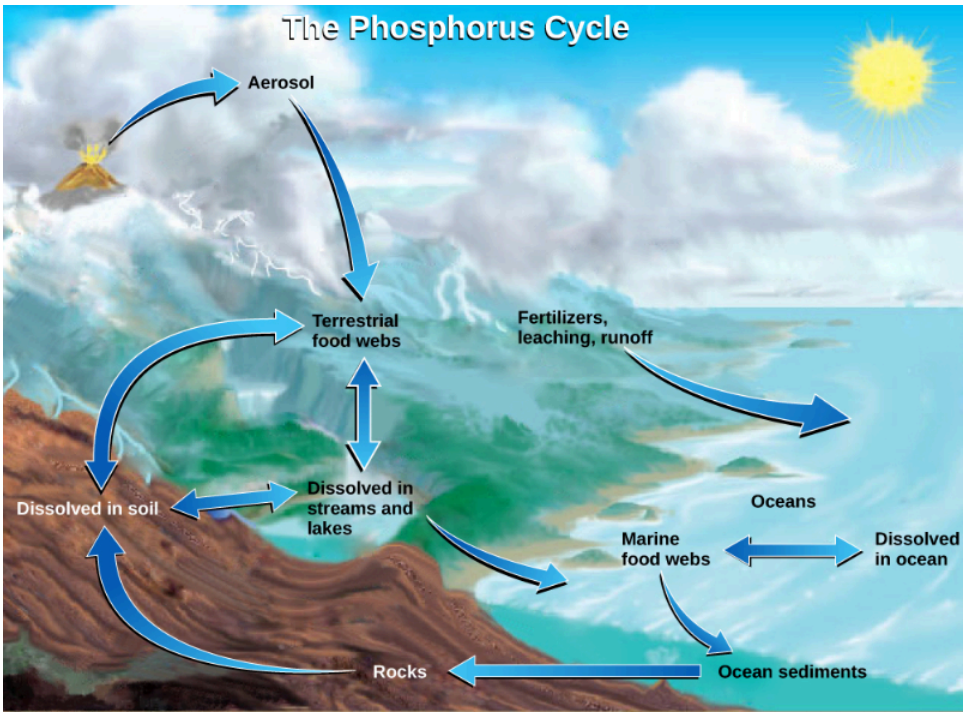
- Fire plays a complex and often essential role in many ecosystems. In **fire-dependent systems**, such as certain types of grasslands, savannas, and some coniferous forests, fire is a natural and necessary disturbance that helps maintain ecosystem health and biodiversity. It does so by clearing out underbrush, recycling nutrients back into the soil, controlling pests and diseases, and promoting the growth of fire-adapted species. **Many plants in these ecosystems have evolved adaptations to survive or even thrive after fires**, such as seeds that germinate in response to heat or smoke. In contrast, in **non-fire-dependent systems**, such as rainforests or deciduous forests, fires can be more destructive and less frequent. Here, fires can cause significant damage to the ecosystem, leading to loss of biodiversity and alteration of habitat. In both types of systems, the role of fire is shaped by factors such as climate, vegetation type, and fire frequency, and human influence through land management and climate change can significantly alter fire regimes and their ecological impacts.

Role of plant communities in nutrient cycles

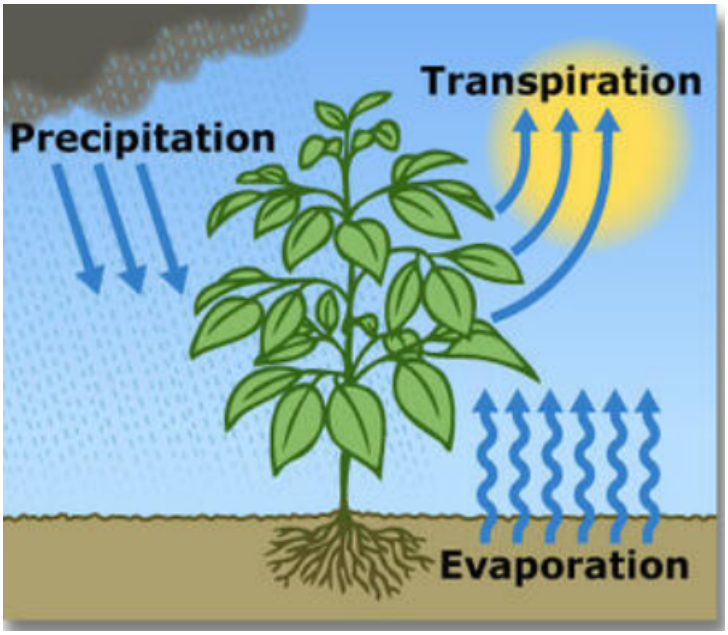


Nitrogen Cycle





Water Cycle



- **Transpiration** has three main steps

1. Roots uptake water from the soil
2. Water moves through plant tissues, serving critical metabolic and physiologic functions in the plant
3. Leaves release water vapor into the air through their stomata

Forests and wildlife habitat

- **Different plant communities create diverse habitats**, each offering unique living conditions and resources for various animal and insect species. For instance, a dense forest with tall trees, thick underbrush, and a multi-layered canopy provides varied habitats at different heights – from the forest floor to the treetops – each with its own microclimate and species. This contrasts with grasslands, where the open, sunny environment favors ground-dwelling animals and those that require wide, open spaces for grazing or hunting. Each plant community, therefore, not only supports a unique set of plant species but also a distinct assemblage of wildlife, adapted to the specific conditions and resources that these plant communities offer.
- **Snags** - Standing dead trees. Provide birds and mammals with shelter to raise young and raptors with unobstructed vantage points
- **Downed logs** - downed logs provide habitat for many living organisms, including fungi, mosses, lichens, invertebrates, birds, mammals, reptiles, and amphibians

Plants and landscape ecology

Landscape ecology provides a comprehensive perspective on how plant communities are influenced by and interact with their environment. It emphasizes the importance of spatial patterns, the distribution of different habitats, and the processes that occur over varying scales in landscapes. Here's how landscape ecology applies to plant communities:

- **Patterns and Spatial Differences**: The arrangement and size of different vegetation types in a landscape (like forests, grasslands, wetlands) create a mosaic pattern. These patterns and spatial differences affect the distribution and interaction of plant communities. Factors like climate, soil type, and topography influence the spatial organization of these communities.
- **Growing Conditions and Vegetation Type**: The physical environment, including soil quality, water availability, and light, shapes the type of vegetation that can thrive in a given area. For example, wetlands support hydrophytic plants, while xerophytic plants are adapted to arid conditions.
- **Distribution of Plant Species**: The distribution of plant species is influenced by the variability in environmental conditions across the landscape. This includes gradients like moisture, elevation, and soil nutrients, which can create distinct niches and lead to a variety of plant communities.
- **Effects of Disturbance**: Disturbances such as fire, floods, windstorms, and human activities can drastically alter plant communities. Some ecosystems rely on periodic disturbances (e.g., fire-dependent forests), while others may suffer long-term impacts. Disturbances can change species composition, promote early successional species, and impact ecosystem functions.
- **Importance of Habitat Connectivity**: Connectivity between habitats is crucial for the spread and adaptation of plant species. Corridors facilitate gene flow, species migration, and recolonization of disturbed areas, contributing to the resilience and genetic diversity of plant populations. This is especially important in fragmented landscapes.
- **Genetic Diversity Across Landscapes**: Genetic diversity within plant species can vary significantly across different landscapes due to isolation, different selective pressures, and varied gene flow. This diversity is crucial for the adaptability and long-term survival of species, as it allows for a greater range of responses to environmental changes and disturbances.
- **Importance of Genetic Diversity**: High genetic diversity within and among plant populations is vital for maintaining healthy species populations. It enhances the ability of species to adapt to changing conditions and resist diseases and pests, thereby contributing to the overall resilience and stability of ecosystems.

Concept 4: Forests and Society

Ecosystem Services

Forests, grasslands, and other plant communities provide a range of vital ecosystem services that support and sustain both natural environments and human societies. Here's a description of the services provided by each:

- **Forests**:
  - **Carbon Sequestration**: Forests absorb and store large amounts of carbon dioxide, playing a crucial role in mitigating climate change.
  - **Biodiversity**: They are home to a majority of Earth's terrestrial species, offering diverse habitats.
  - **Water Regulation**: Forests influence the water cycle, aiding in groundwater recharge and stabilizing runoff, thus reducing erosion and preventing floods.
  - **Air Purification**: Trees and plants filter pollutants from the air, improving air quality.
  - **Climate Regulation**: Forests affect local and global climate patterns through moisture release and shade provision.
  - **Raw Materials**: They provide resources like timber, resins, and other forest products.

- **Grasslands**:
  - **Carbon Storage**: Grassland soils are significant carbon sinks, helping to store carbon and mitigate climate change.
  - **Biodiversity**: They support a wide range of plant and animal species, particularly herbivores and ground-nesting birds.
  - **Soil Erosion Control**: Grassland roots stabilize the soil, reducing erosion.
  - **Water Regulation**: They play a role in water infiltration and groundwater recharge.
  - **Forage Production**: Grasslands are essential for livestock grazing and hay production.
  - **Climate Regulation**: They can influence local climate conditions through their impacts on the water cycle and reflectivity of the land surface.

Economic benefits

- **Timber and Wood Products**: Forests are a primary source of timber used in construction, furniture making, and paper production. Wood products from forests contribute significantly to the global economy.
- **Non-Timber Forest Products**: Forests provide a variety of non-timber products like fruits, nuts, mushrooms, resins, latex, medicinal plants, and honey, which are important sources of income for many communities.
- **Livestock Grazing**: Grasslands offer vast areas for grazing livestock, which is a vital economic activity for many rural communities. They support the production of meat, dairy products, and wool.
- **Agricultural Benefits**: Both forests and grasslands contribute to agricultural productivity. Forests can enhance soil fertility and moisture, while grasslands provide forage for livestock and are often used for hay production.
- **Tourism and Recreation**: Natural landscapes like forests and grasslands attract tourists and provide opportunities for recreational activities such as hiking, bird watching, camping, and nature photography, contributing to the tourism industry.
- **Water Resources**: Forests and grasslands play a crucial role in the water cycle, including the maintenance of watersheds. They ensure the availability of clean water, which is vital for human consumption, agriculture, and industry.
- **Employment**: Forestry and grassland management provide employment opportunities in sectors like logging, conservation, and ecotourism.

Climate change and forests

- Climate change could alter the frequency and intensity of forest disturbances such as **insect outbreaks, invasive species, wildfires, and storms**. These disturbances can reduce forest productivity and change the distribution of tree species. In some cases, forests can recover from a disturbance.

History

- Virginia is a state rich in history and its forests have been affected by the natural environment, climate, and heavily by the influence of humans. Ice ages that affected North America also influenced the trees that grow in Virginia. Trees now commonly found in the far north like spruce and fir can still be found

today in the highest elevations. As the ice age ended and cold temperatures retreated northward, Virginia began to warm eventually leading to the mixed temperate forests we see today.

- **Native Americans used fire extensively to create conditions suitable for wildlife, hunting, and farming. Virginia's forests were more open and had species adapted to fire, like oaks and yellow pines.** Forests were both a resource and impediment to the European settlers. Wood was used to build and support settlement, to export, or was simply burned to make way for farming. **Extensive forest clearing was done for farming and by the mid-1800s**, most lands that were not too steep to plow or graze had been cleared.
- Repeated cropping and erosion depleted the soil to the point where the land was eventually abandoned. **After the land was abandoned, the natural process of plant or forest succession began to occur. This begins with weeds, grasses, and shrubs followed by pioneer trees until these abandoned lands naturally returned to forest.**

Major legislation

- **Multiple Use Sustained Yield Act of 1960**: Addresses the establishment and administration of national forests to provide for multiple use and sustained yield of products and services, including recreation, range, timber, watershed, and wildlife and fish purposes
- **National Environmental Policy Act of 1969:** Signed into law by President Richard Nixon on January 1, 1970, NEPA set forth a bold new vision for America. Acknowledging the decades of environmental neglect that had significantly degraded the nation's landscape and damaged the human environment, the law was established to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans
- **National Forest Management Act of 1976**: This act amends the Forest and Rangeland Resources Planning Act of 1975 and recognizes that the management of the Nation's renewable resources is highly complex and the uses, demand for, and supply of the various resources are subject to change over time
- **Wilderness Act of 1964:** Established the National Wilderness Preservation System composed of federally owned areas designated by Congress. The act also stipulates these lands be administered for the "use and enjoyment of the American people in such manner as will leave them unimpaired for future use as wilderness and preserve their untouched character.

Timber management terms

- **Regeneration**--the replacement of one forest stand by another as a result of natural seeding, sprouting, planting, or other methods; also young trees that will develop into the future forest.
- **Regeneration method**--a timber harvest designed to promote and enhance natural establishment of trees. Even-aged stands are perpetuated by three regeneration methods: seed tree, shelterwood, and clearcutting. Uneven-aged stands are perpetuated by selecting individual or small groups of trees for removal
- **Silviculture**--the art, science, and practice of establishing, tending, and reproducing forest stands.
- **Silvicultural treatment**--altering the existing composition and structure of a stand to achieve a given management objective, such as thinning a timber stand
- **Thinning**--removal of trees to encourage growth of other selected individual trees. May be commercial or pre-commercial.

- **Clearcut**--a regeneration technique that removes all the trees, regardless of size, on an area in one operation. Clear-cutting is most often used with species like aspen or black cherry, which require full sunlight to reproduce and grow well, or to create specific habitat for certain wildlife species. Clearcutting produces an even-aged forest stand.
- **Even-aged stand**--a group of trees that do not differ in age by more than 10 to 20 years or by 20 percent of the rotation age.
- **Uneven-aged stand**--a group of trees of a variety of ages and sizes growing together on a site.

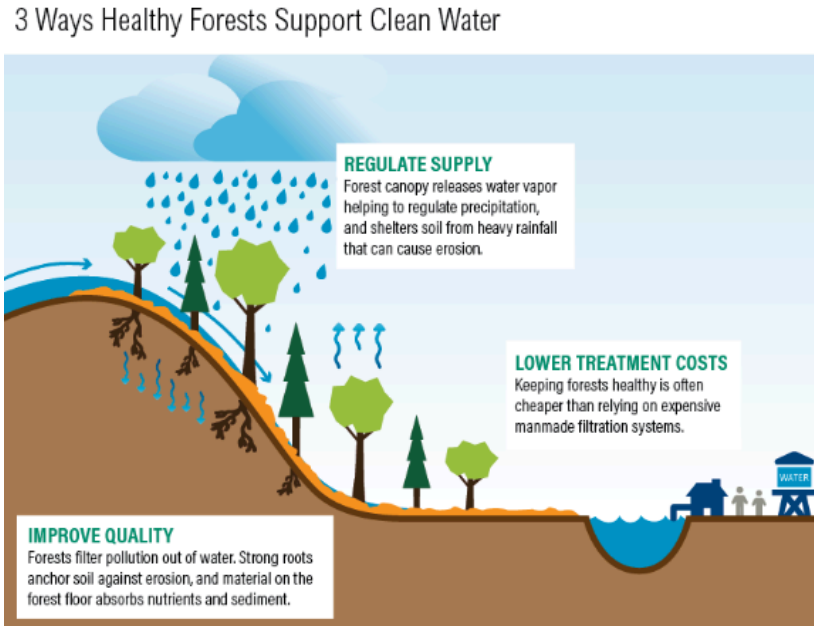
Best Management Practices (BMPs)

- **Best Management Practices** are activities chosen to reduce soil erosion and prevent or control pollution. BMPs have been in existence for many years in the areas of forestry, agriculture and urban development. Forestry BMPs are directed primarily at controlling erosion. Erosion can lead to sedimentation, which is the entry of soil into waterways. BMPs are proven methods to lessen the potential damage from land-disturbing activities.
- Some examples of BMPs include correctly planning and constructing forest roads, log landings, stream buffers, and stream crossings.

Urban Forestry

- Over 141 million acres of America's forests are located right in our cities and towns. Urban forests come in many different shapes and sizes. They include **urban parks, street trees, landscaped boulevards, gardens, river and coastal promenades, greenways, river corridors, wetlands, nature preserves, shelter belts of trees, and working trees at former industrial sites**. Urban forests, through planned connections of green spaces, form the green infrastructure on which communities depend
- They are dynamic ecosystems that provide critical benefits to people and wildlife. **Urban forests help to filter air and water, control storm water, conserve energy, and provide animal habitat and shade.** They add beauty, form, and structure to urban design. By reducing noise and providing places to recreate, urban forests strengthen social cohesion, spur community revitalization, and add economic value to our communities.

Forests and watershed health



Leaders in forestry

- **Gifford Pinchot**:
  - Gifford Pinchot is often celebrated as the father of American forestry. He was the first Chief of the US Forest Service, appointed in 1905, and served under President Theodore Roosevelt. Pinchot's role was instrumental in the establishment of national forests and the promotion of conservation practices. He advocated for the scientific management of forests for sustained use, emphasizing that forests should be managed in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- **Carl Schenck**:
  - Carl Schenck was a German forester who played a crucial role in the development of forestry education in the United States. In 1895, he was hired by George W. Vanderbilt to manage the vast forests of the Biltmore Estate in North Carolina. Schenck founded the Biltmore Forest School in 1898, the first forestry school in the U.S., where he trained many of the nation's first generation of foresters. His work laid the foundation for forestry education and practice in America.
- **Robin Wall Kimmerer**:
  - Robin Wall Kimmerer is a plant ecologist, writer, and professor. She is a member of the Citizen Potawatomi Nation and has been a powerful advocate for combining traditional indigenous knowledge with scientific methods in conservation efforts. Kimmerer's work emphasizes the importance of understanding and respecting natural systems and the reciprocal relationship between humans and the natural world. Her book, "Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants," has been influential in promoting a more integrated and holistic approach to environmentalism and conservation.
- **Wangari Maathai**:
  - Wangari Maathai was a Kenyan environmental activist, scholar, and the 2004 Nobel Peace Prize laureate. She founded the Green Belt Movement in 1977, an environmental non-governmental organization focused on tree planting, conservation, and women's rights. Through her leadership, the Green Belt Movement has planted over 51 million trees, combating deforestation and promoting environmental conservation in Kenya and across Africa. Maathai's work highlighted the interconnectedness of environmental sustainability, democracy, peace, and women's rights.
- **Rue Mapp**:
  - Rue Mapp is the founder of Outdoor Afro, a non-profit organization established in 2009 that encourages African American communities to engage with outdoor activities and nature conservation. Mapp's role has been transformative in redefining the narrative around Black participation in outdoor activities and environmentalism. Through Outdoor Afro, she has worked to create a more inclusive environmental movement, highlighting the importance of diversity in conservation efforts and fostering a deep connection between Black communities and the natural world.

Concept 5: Field Skills

Common trees by leaf shape

Using GIS

- Foresters and plant ecologists increasingly rely on **Geographic Information Systems (GIS)** to enhance their work, utilizing its powerful spatial analysis tools to map and monitor forests, ecosystems, and plant distributions with unprecedented accuracy and efficiency. **GIS enables these professionals to overlay various data layers—such as soil types, topography, and vegetation cover—to assess forest health, identify areas at risk of disease or fire, and plan conservation or restoration efforts effectively**. This technology also facilitates the tracking of changes over time, allowing for the analysis of deforestation, reforestation, and the impacts of climate change on ecosystems. **Moreover, GIS aids in the strategic planning of sustainable forestry practices, including the optimal locations for planting and harvesting, while minimizing environmental impacts**. By leveraging GIS, foresters and plant ecologists can make informed decisions that promote the health and sustainability of forests and their biodiversity, contributing to global conservation goals and the management of natural resources.

Pests and Disease

Spotted Lanternfly

Emerald Ash Borer

Spongy Moth

Thousand Cankers Disease

- **Emerald Ash Borer (Agrilus planipennis)**: This invasive beetle has devastated ash tree populations across North America. It targets all species of ash trees, causing death within 3-5 years of infestation. The loss of ash trees impacts forest ecosystems, reduces biodiversity, and has significant economic impacts on timber, nursery industries, and urban landscaping.
- **Spongy Moth (Lymantria dispar)**: Known for its caterpillar stage's voracious appetite for the leaves of over 500 species of trees and shrubs, the Spongy Moth causes defoliation, leading to reduced tree growth, increased susceptibility to other pests and diseases, and, in severe cases, tree death. Repeated defoliation can lead to significant ecological and economic damage.
- **Laurel Wilt (caused by Raffaelea lauricola)**: This fungal disease, spread by the redbay ambrosia beetle, affects members of the laurel family, including avocado, leading to wilt and rapid death. It has significantly impacted redbay populations and poses a major threat to both natural and agricultural systems, especially the avocado industry.
- **Oak Decline**: This complex condition results from the interaction of several factors, including pests, diseases (such as fungal infections), and environmental stresses, leading to the gradual decline and death of oak trees. Impacts include loss of valuable hardwood timber and habitat, affecting biodiversity and forest health.
- **Southern Pine Beetle (Dendroctonus frontalis)**: This beetle is one of the most destructive pests of pine trees in the southern United States, causing extensive damage to pine forests by boring into and killing healthy trees. Outbreaks can lead to significant timber loss, altered forest composition, and reduced habitat quality for wildlife.
- **Spotted Lanternfly (Lycorma delicatula)**: This invasive planthopper feeds on a wide range of plants, including economically important crops like grapes, apples, and hardwood trees. Its feeding damage stresses plants, reduces crop yields, and can lead to the death of the trees. The sticky honeydew it excretes encourages the growth of sooty mold, further harming plant health and aesthetic value.
- **Thousand Cankers Disease (caused by Geosmithia morbida and spread by the walnut twig beetle)**: This disease primarily affects black walnut trees, causing numerous small cankers under the bark that eventually coalesce, disrupting the tree's ability to transport nutrients and leading to tree death. The disease has led to significant losses in black walnut, a valuable hardwood species for timber and veneer production.

Measurements

- **Diameter at Breast Height (DBH)**: This is a standard method of measuring the diameter of a tree. It is measured at a height of 4.5 feet (1.37 meters) above the ground on the uphill side of the tree. DBH is used for estimating the volume of timber in a tree and for forest management and inventory purposes.
- **Chain**: A chain is a unit of length used in surveying and forestry, equal to 66 feet (20.12 meters). It originates from the heavy metal chain that surveyors used to use for measuring land. One chain is composed of 100 links. Chains are often used to measure distances in forestry and land surveying.
- **Cord**: A cord is a volume measure used for stacked wood (firewood, pulpwood, etc.). A full cord is traditionally a stack of wood that measures 4 feet deep, 4 feet high, and 8 feet long, totaling 128 cubic feet (3.62 cubic meters). Variations like "face cord" or "rick" may refer to smaller, less precisely defined quantities.
- **Total Tree Height**: This is the vertical distance from the base of the tree (ground level) to the top of the highest branch or tip of the tree. It is often measured using tools like clinometers or hypsometers in forestry to assess tree and stand growth and for timber volume estimation.
- **Merchantable Height**: Merchantable height is the usable length of a tree trunk that can be converted into commercial timber products, excluding the top and branches. It is measured from the base to the point on the stem where the diameter decreases to a point that it is no longer commercially viable. This measure is critical for determining the volume of sellable wood in a tree.
- **Board Feet**: Board feet is a volume measure used in the lumber industry to quantify timber. One board foot is defined as a piece of wood that is 12 inches long, 12 inches wide, and 1 inch thick (or its cubic equivalent). It is a crucial measurement for selling and buying lumber, indicating the quantity of usable wood in a tree or log.
- **Log**: In forestry, a log is a length of the tree trunk that has been cut and prepared for transport and processing. Logs are measured in terms of length and diameter to estimate their volume for timber sales and production.
- **Basal Area**: Basal area is a measure of the cross-sectional area (usually in square feet or square meters) of a tree trunk at breast height (4.5 feet or 1.37 meters above the ground) and is used as an indicator of forest density and health. It is calculated for individual trees and can be summed across all trees within a given area to assess the overall stand density. Basal area is a critical parameter in forest management, inventory, and ecological studies, as it helps in determining thinning practices and understanding the competitive dynamics within forest stands.

Tools

- Be familiar with operation of:
  - Biltmore stick/Merritt hypsometer
  - D-tape
  - Wedge prism
  - Tree caliper
  - Clinometer
  - Increment borer
  - GPS