FOREST WORKER CERTIFICATE PROGRAM

Tennessee Forestry Association
www.tnforestry.com

COURSE WORKBOOK

CURRICULUM TABLE OF CONENTS

Module #1 – THE SOUTH'S ABUNDANT FORESTS

Topics covered in this module include:

a) **Topography and Soils**
b) **Physiographic Regions**
c) **Forest Types**
d) **Forestland Ownership**
e) **Forest Certification**

Topography

- Topography – detailed mapping of surface features of land including the mountains, hills, creeks, etc. on a particular area of earth.
- Natural forces shaped the South's topography into mountains, uplands, coastal plains, and floodplains.
- Topography greatly impacts forest types.
- Two topographic features affect site quality and forest productivity: aspect and topographic position (elevation).
- Aspect describes direction that slope faces. Southwesterly facing slopes are typically drier and warmer because of exposure to sunlight. Northeasterly facing slopes tend to be moister and cooler due to limited light exposure, increasing soil moisture and changing species composition.
- Topographic position affects soil productivity and species composition.
- Aspect and topographic position impact microclimate which determines soil temperature, soil moisture, and evapotranspiration rates.
- Forest types are adapted to topographic conditions and create a diversity of habitats across the South.

Soils

- Soil forms from parent rock or organic material that is weathered by climate and native microorganisms. Soil is the medium for plant growth.
- More than 300 soil types occur in different physiographic regions across the South. Soil types differ in fertility and productivity and influence plant distribution.
- Soil is composed of four main components:
    - Mineral particles that provide support for plants and storage of water and nutrients.
    - Organic material that is made up of plant and animal parts that aid in nutrient recycling, influence soil properties, and provide food for microbes.
    - Water that is necessary for plant nutrition.
    - Air that is important for plant roots and functions of soil organisms.

- Plants are adapted to specific soil types and are dependent on the soil's physical and chemical properties.
- Two major physical properties influence soil fertility (water and nutrient holding capacity):
    - Soil texture is the proportion of sand, silt, and clay particles in the soil.
    - Soil structure is the arrangement of each group of soil particles and available pore space.
- Soil aeration is affected by structure and allows movement of water and plant roots through soil.
- Soil chemistry refers to the critical chemical elements available for plant growth.
- Soil fertility is a measure of the essential nutrients (e.g. phosphorus, nitrogen, potassium) available for plant growth.

Climate

- Climate influences the growth of southern forests.
- Temperature, precipitation, and length of growing season interact to determine forest composition and structure.

Physiographic Regions

- Eight physiographic regions encompass the southern United States. Tennessee contains six ecoregions in the state.
- Six basic physiographic regions support varied forest ecosystems. Geology, soils, and landforms make up these different regions and support unique plant and wildlife communities.
    - Mississippi Alluvial Plains is found in west Tennessee as the Mississippi River forms Tennessee's western boundary. It consists of alluvial soils. Much of this area floods and to the east, the flood plains is by the loess soils of the Chickasaw Bluffs, part of the Mississippi Valley loess Plains having bottomland soils that are poorly drained.
    - Southeastern Plains ecoregions is found by Mississippi Plains to the west and The Tennessee River to the east. Sand, silt and clay soils with limestone chert, and shale are also found.
    - Interior Plateau is composed of two primary areas, The Central Basin and the Highland Rim. The Highland Rim encircles the Central Basin and stretches from the Tennessee River in the west to the Cumberland Plateau in the east having limestone, chert, sandstone, siltstone, and shale soils.
    - Southwestern and Central Appalachians (also called the Cumberland Plateau and mountains). is found in the northern portion of the region in Tennessee where the southwestern Appalachians meet sections of the Central Appalachians having mostly sandstone, siltstone, and shale soils.
    - Ridge and Valley is located between the upwards of the Central Appalachians and the Blue Ridge Mountain lies the Ridge and Valley with limestone, dolomite, shale, siltstone, sandstone, chert, mudstone, and marble.

- Blue Ridge Mountains is the most eastern portion of Tennessee characterized by the southern regions of the Appalachian mountain chain that runs in a northeast-southwest direction that is the rugged rocky terrain of these mountains. Soils are predominantly friable loams and fine sandy loams with some limestone and sandstone.

Forest Types of Tennessee

- Six basic physiographic regions and natural disturbances create forest diversity across Tennessee and provide ecological benefits including clean air, clean water, aesthetics, recreation, and timber products.
- Five major forest types include:
  - oak-hickory
  - oak-pine
  - bottomland hardwoods
  - cove hardwoods
  - pine.

Forestland Ownership

- 14 million acres for forestland in Tennessee accounting for 52% of total land area.
- Forest owner ship in Tennessee: 67% family forests; 9.4 million acres of family forest; 2.2 million acres of corporate owned; 2.2 million acres publicly owned.
- Landownership by Forest Products Companies has declined in recent years. Timber Investment Management Organizations (TIMOs), Real Estate and Investment Trusts (REITs), and other corporate landowners have increased their ownership.
- Non-industrial private landowners manage land for variety of uses including investment, recreation, and wildlife management.
- Changes in land ownership have an impact on timber supply, wildlife habitat, recreation, natural resources, and environmental benefits.

Forest Certification

- Certification is system to ensure forests are being managed sustainably. Certification systems include mechanisms for forest monitoring, tracking the origin of timber, and labeling wood and paper products. Forest management quality is judged against set of standards and verified by a third-party audit.
- Sustainable forestry is defined as a set of practices that meet today's needs without compromising needs of future generations.
- Three most common certification systems in Tennessee
  - Sustainable Forestry Initiative was created as a means to improve the way forests were managed in United States and to verify to the public that forest landowners and forest products companies are committed to managing and utilizing forests in a sustainable manner.

- American Tree Farm Program is the oldest voluntary certification system for private lands and is oriented towards family forest owners. The Tree Farm Program's mission is to promote growth of renewable forest resources on private lands, protecting environmental benefits of that land and increasing public awareness of forests benefits.
- Forest Stewardship Council mission is to promote environmentally appropriate, socially beneficial, and economically viable management of world's forests. It originated as environmental organization to protect tropical rainforests from deforestation.

MODULE #2 – MANUFACTURING FOREST PRODUCTS

Topics covered in this module include:

a) **Pulp and Paper Mills**
b) **Sawmills**
c) **Engineered Wood Products**
d) **Wood Energy**
e) **Secondary Wood Products**

The forest products industry includes companies engaged in growing, harvesting and processing wood and wood fiber, manufacturing pulp, paper and paperboard products from both virgin and recycled fiber, and producing engineered and traditional wood products.

Of the employees working in the United States manufacturing industry, more than five percent (approximately one million people) work in the forest products industry.

Pulp and Paper

The pulp and paper industry consists of companies that use wood as a raw material to produce pulp, paper, paperboard, and other cellulose-based products. The pulp and paper industry represents one of the largest industrial sectors in the world. The pulp and paper industry in the southern United States has historically consisted of five segments:

1. Packaging – includes linerboard, medium, and paperboard used to produce containers.
2. Printing – includes writing, copy and magazine paper.
3. Tissue – includes toilet tissue, napkins, and paper towels.
4. Newsprint – includes newspapers, and other publications in advertising materials.
5. Pulp – used in a variety of products including diapers and other sanitary products.

Papermaking was first discovered in China by Ts' ai Lun in 105 AD. He mashed bark, cloth, and hemp in water to create a pulp mixture. When the water was drained, the fibers pressed, and the flattened fibers dried, paper was made. The Chinese art of papermaking was kept a secret for over 600 years!

When papermaking first came to the United States paper was created from rags or cloth. Papermaking continued in this fashion from 1690-1850s. American and European papermaking from wood began in the 1850s. Pulp from trees was created by a mechanical pulping process while chemical pulping methods were invented shortly thereafter. Pulp and paper mills use and recycle water as part of the milling process, so mills are typically located on a river as a water source.

Softwood trees (e.g. pine trees) have long pulp fibers which add strength in the papermaking process. Softwood pulp is used primarily for paper used in packaging. Hardwood tree fibers are shorter and add smoothness to paper. As a result, hardwood pulp is found primarily in paper grades used for printing purposes.

Wood pulp manufactured directly from chips obtained by processing trees is termed "virgin" fiber. Paper can be recycled and the wood pulp reused (recycled) fiber. After fibers have been recycled multiple times, however, they will become too weak for use in the papermaking process.

Sawmills

At a sawmill, trees are processed into lumber by sawing into desired shapes and sizes, dried in heated kilns to achieve dimensional stability, and planed to desired dimensions and surface finish. Much of today's sawmill production is mechanized and computerized for maximum efficiency and safety.

Byproducts of the sawmilling operation can also be used. The portions of a tree that cannot be used to produce lumber are chipped and sold to pulp mills for production of pulp and paper. Sawdust and bark may also be used to heat the kiln for drying or to produce products at another mill. A simple rule of thumb in sawmill is that half of the tree becomes chips, sawdust, or bark.

Lumber may be sawn from both hardwood and softwood trees. In the South, softwood lumber is used primarily in the construction of homes and commercial structures or is pressure treated to retard decay and used in outdoor construction. Hardwood lumber is often used for flooring, cabinets and furniture.

Engineered Wood Products

Plywood and composite panels are manufactured by peeling, slicing, or chipping wood to create a raw material, pressing and gluing these raw materials into panels, engineered lumber, and other wood products, and setting the glue with the application of heat. Particleboard and fiberboard panels can be made from sawdust, planer shavings, and board trim from lumber operations.

Examples of engineered wood products include plywood, oriented strand board (OSB), medium density fiberboard (MDF), particle board, parallel strand lumber (PSL), glued laminated timber (glulam), laminated veneer lumber (LVL), cross-laminated timber (CLT), finger-jointed lumber, I-joists, and I-beams. Engineered lumber products are created as dimensional lumber and may be used in structural design. In many cases, engineered lumber is stronger than solid wood lumber of similar dimension.

Wood Energy

Approximately 40% of the world use of wood is for fuel to heat homes or cook food. Increasing fossil fuel consumption and decreasing supplies had driven the substitution of wood and wood based fuel for some fossil fuel uses. A biofuel is defined as fuel derived from biological source and wood is currently the primary biofuel in use.

In addition to conventional firewood used for heating and cooking, wood pellets have been used as fuel for stoves and heaters. Wood pellets are manufactured by chipping and grinding wood into small fibers, treating them with heat and pressure and extruding them into small pellets for ease in handling and transport. Over the last decade, wood pellets have been increasingly used for production of power in European countries as a means to reduce carbon emissions by replacing coal.

Secondary Wood Products

Secondary forest products are those products that are manufactured by further processing the wood products that are derived directly from the tree (lumber, plywood, etc.). Additional manufacturing adds value to the products and increases the economic contribution of the forest products industry to the local economy. Examples of secondary wood products include cabinets, doors, millwork and furniture.

MODULE #3 – CRUISING TIMBER AND DETERMINING VOLUME

Topics covered in this module include:

a) **Tree identification**
b) **Land measurement**
c) **Boundary marking and maintenance**
d) **Tree measurements**
e) **Volume and weight tables**
f) **Aerial photography and GPS**

Tree Identification

All plants and animals are divided into groups for classification. Binomial nomenclature is the formal system using Latin names that categorize each plant or animal by genus and species (e.g., *Pinus taeda*, loblolly pine). Although plants and animals are often referred to by common names, those names may vary from place to place and some may have multiple common names.

Dendrology is the identification and systematic classification of trees. Differentiation of trees is based on the distinguishing characteristics of each species. Following are the types of the distinguishing characteristics used to distinguish individual species of trees:

- Type –evergreen, deciduous.
- Leaf – form, tip shape, leaf shape, arrangement, composition, margin shape.
- Bark – color, texture.
- Fruit – pome, berry, drupe, nut, capsule, samara, legume, nutlets.
- Twig – slender woody shoots growing from branch or stem of a tree of stub.
- Form – height, shape.

Descriptions provided for most species include typical features commonly observed for that species. Occasionally, however, attributes such as leaves, tree forms and mature size can vary with site and stand conditions, age and position in the tree from which features are observed so it is important to look at multiple characteristics when identifying trees.

Land Measurement

Identification of property boundaries is an important part of forest measurement. There are three methods for legal property description:

- Metes and bounds
    - Oldest method of legal description.
    - Mete refers to the act of assigning by measure.
    - Bounds refers to boundaries limiting extent of property ownership.
    - System relies on natural and artificial landmarks to determine linear measurements and property boundaries.
    - Creates irregular land parcel shapes.

    - Disadvantage is that natural features can change over time and monuments/markers may be moved.
- Rectangular or government survey
    - Logical method for property description.
    - Land is divided according to *Manual of Instructions for the Survey of Public Lands of the United States, 1930*, issued by the General Land Office (GLO) of Department of Interior.
    - Based on a true north-south line known as principal median and true east-west baseline that relates to parallel of latitude.
    - Land is subdivided into tracts of square miles, townships, sections.
- Lot and block
    - Also known as recorded plat.

A unit of horizontal measure common to forestry is the surveyor's or Gunter's chain. One chain equals 66 feet and is divided into 100 links equal to 0.66 feet each. Measurement in chains works very well with the General Land Office system of land division.

Boundary Marking & Maintenance

A legal description defines the property's boundaries. The actual boundaries on the ground must be marked or delineated, however, in order to maintain ownership and guard against trespass or encroachmen.

- Property Corners
    - Usually included in the legal description of the property and may be marked by monuments, steel rods or pins, rock piles, fence corners or other means.
    - Corners may be further marked with witness trees which "point" to the location of the corner.
- Boundary Lines
    - Historically marked by stone or wire fences, especially in areas where livestock were grazed.
    - Today, property lines most often marked by "blazing" trees along the boundary.
    - Blazing entails using a draw knife to scrape bark off trees and painting blazes with a long lasting boundary paint.
- Boundary Line Maintenance
    - Maintenance is necessary in order to ensure it remains visible.
    - Boundary paint is designed to be long lasting, but will fade over time.
    - Where boundaries are delineated by natural features, those features may change over time so lines should be marked.
- Relocating Boundary Lines
    - Where boundary line maintenance has been neglected, it may become necessary to re-establish those boundaries.
    - If the boundary was established along a surveyed line, the boundary may be re-established by a surveyor.
    - If identified by natural features, fences, or painted boundaries, it may be necessary to research original legal descriptions and re-trace the line to find evidence of the line in order to remark it.

- Conflicts With Surveyed Lines
    - Historically, many boundary lines were established and mutually agreed upon by neighboring landowners using natural features, fences, or painted lines were used to delineate those boundaries.
    - Although the legal descriptions may call for straight lines between property corners, these mutually agreed upon lines may meander, resulting in differences between the actual boundary location and the legal description.
    - Corners accepted by mutual agreement may not match the location of the surveyed corner.
    - As long as the current property owners or their heirs retain the property, the historically used lines and corners are most often mutually accepted.
    - Conflicts may arise, however, when one owner sells the property and the new owner has the property surveyed and finds that the lines or corners on the ground do not match the legal description.
    - These conflicts are resolved on a case by case basis, but the surveyed line may not prevail.

Tree Measurements

- Diameter – most important measure observed on a tree; characterizes stand structure and estimation of tree volume or weight; closely related to tree value; most common diameter measure of standing trees is diameter at breast height (DBH) which is 4.5 feet above ground level on uphill side of tree.
    - Diameter tape – most popular instrument for measuring DBH; easy to use; reasonably consistent; convenient to carry; tape is wrapped around tree at 4.5 feet above ground line and diameter is measured directly.
- Basal area – derived from tree diameter and defined as cross-sectional area (usually in square feet) of a tree at breast height; directly related to volume and growth of forest stands; basal area per acre is a measure of the sum of the basal area of each tree growing on that acre; basal area is a measure of crowding or density in a stand and is frequently used to determine how many trees to remove in a thinning operation.
- Height – important information for forest measurements; instruments used to measure tree heights include:
    - Clinometers
    - Hypsometers

  The point of a tree where tree height is measured depends how the measurement will be used. Definitions of tree height include:
    - Total height – distance from groundline to highest point of main stem.
    - Bole height or height to live crown base – distance from groundline to base of live crown.
    - Crown length – total tree height minus bole height.
    - Stump height – distance from groundline to typical point where tree will be cut and felled.
    - Merchantable height – distance from groundline to terminal position of economically usable portion of tree.
    - Merchantable length – distance from top of stump to terminal position of economically usable portion of tree.

- Age – average tree age combined with average total height of dominant and co-dominant trees in a stand can be used to estimate site index (productivity).
    - Increment borer – instrument used to extract small cylindrical core of wood from tree, log, or pole; increment core usually taken at DBH so some adjustment of actual tree age must occur.
    - Age determination – growth rings are used to determine age and past tree growth; trees produce one growth ring per growing season; earlywood growth in spring and latewood growth in summer.
- Site index – Measure of actual or potential forest productivity used as indicator of site quality; can be used to estimate tree volume production; site index is species specific and based on average height of dominant and co-dominant trees at specified index or base age; the higher the site index, the better the trees will grow and thrive.

Volume and Weight of Trees – Volume or weight of trees is critical information as measurement basis when trees are sold.

- Stacked wood volume – Cubic-foot volume is good measure of volume for individual trees and can be summed across all of the trees in a stand to obtain cumulative cubic-foot volume. Because measuring individual pieces of wood is inefficient, measures of stacked wood volume have been developed and have become a standard for some products. The most common stacked wood volume unit is standard cord, which is 128 cubic feet of wood (including bark and air) contained in a stack of bolts. One cord equals a stack of wood that is 4 feet high x 8 feet long made up of 4 ft. long bolts of wood (4'x4'x8' – 128 cubic ft).
- Weight – Weight of trees can be determined by weight scales at a mill. Truck load full of trees can be weighed upon entering mill fully loaded and as it exits mill when empty. Difference in the loads is weight of trees.
- Board foot – common form of measurement for sawtimber; defined as a board or plank that measures 1 inch thick x 1 foot wide x 1 foot long (144 cubic inches); measure is based on nominal dimensions of rough green board when cut in sawmill before shrinkage from drying and planing.
- Log Rules – Log rules are tables or formulas that estimate volumes, usually in board feet, for various log diameters and lengths. Log rules estimate amount of finished product from standing trees or cut logs. Three main log rules used in Southeastern United States are: Doyle, Scribner, and International ¼" log rules. The International ¼" log rule is considered to be the most accurate. Sawtimber is now purchased more often based on weight than log rule.
- Volume and Weight Tables – Volume and weight tables were created for estimation purposes since trees cannot be cut and/or weighed to derive estimates. Tree DBH class and tree height class are two ways that tables may be arranged.
- Form Class – Form class is the classification of trees or logs based on their taper. The shape or form of the tree factors into tree volume determination.
- Crown Class – Crown class is a classification of an individual tree based on how that tree's crown compares to other trees in the same stand. Four crown classes include: dominant, co-dominant, intermediate, and suppressed.

Forest Inventory

A forest inventory provides information with which important decisions are made about forest resource management. Forest inventories are accomplished by cruising (sampling) the property. Sampling a portion of the forested area is more efficient than measuring ALL of the trees within a given area.

When cruising a tract, one must adequately sample the forest stand in a manner that accounts for the variability across the stand. Variability may occur in species, size, value, and density of trees in the stand. Although a 100% sample (measuring all of the trees in the stand) is the most accurate, it is too time consuming and, therefore, too costly. Sampling methods, therefore, attempt to collect a "representative" sample at the least cost possible. Sampling may be done by fixed-area plots or variable-radius inventory.

Aerial Photography and GPS

Aerial photographs provide useful information and details on forested property. Relative size, location, and shape of forest stands, streams, roads, and other features can be seen on aerial photographs. Aerial photographs must be corrected to conform accurately to earth's surface in order to apply the proper across a photograph. Satellite imagery may be used for the same purposes and when working with larger areas.

Global Positioning System (GPS) is a satellite-based navigational device that uses a network of 24 satellites and their ground stations to record geographic coordinates. There are three basic types (grades) of GPS: navigational/recreation, mapping, and survey grades. The GPS receiver calculates it current position by measuring its distance from orbiting satellites. The three-dimensional location is stored by some GPS units as a set of x and y (horizontal) and z (vertical) geographic coordinates. The coordinates can be used to create a point, a line, or a polygon. These features can be exported to a computer to create geographically accurate maps.

A Geographic Information System (GIS) is a method for capturing, manipulating, and displaying forms of geographically or spatially referenced information that can be used on personal computers. GIS is a database that links information to spatially referenced positions. GIS serves as a platform to link management strategies and activities that occur at local levels to a regional or national scale.

Using Unmanned Aircraft Systems (UAS) in Forestry.

Unmanned aircraft systems (UAS), commonly called drone systems, have gained popularity in several industries and sectors in the last decade. UAS have become critical for information gathering, monitoring, and decision-making in emergency response situations, such as wildland firefighting where UAS can detect spot fires occurring outside a contained fire perimeter. UAS can be used to monitor forest stand conditions, to pinpoint sources of water quality issues, and to map the spread of forest health pests, disease, and invasive plants. UAS can also be used with satellite imagery to detect changes in forest type over time and in timber volume and regeneration following an extreme weather event, such as tornadoes and late spring freezes. UAS is highly cost-effective and reproducible, making it an effective choice for monitoring and decision-making in private and public sectors.

MODULE #4 – HARVESTING TIMBER

Topics covered in this module include:

a) **Marketing Timber**
b) **Harvesting Systems**
c) **Best Management Practices (BMPs)**
d) **Forest Roads**
e) **Closing Out the Harvest**
f) **Logging Safety**

Marketing Timber

Timber markets vary across the South based on the number and size of the mills in the area and the types of trees required by that mill. Each mill has its own unique specifications for the type of wood it will purchase. Weather conditions, timber volume per acre and tract accessibility also make a big difference in the marketability of any tract of timber. Landowners who are ready to market timber should consider the following steps:

1. Establish sale objectives
2. Plan and layout sale area
3. Estimate inventory
4. Mark boundaries
5. Consider safety, aesthetics, and the environment
6. Develop sale prospectus and advertise
7. Negotiate contracts
8. Execute the sale

Harvesting Systems

1. Animal logging – Although common a century ago, a few loggers today use horses or mules for logging. In this system, trees are felled (cut down), delimbed (limbs cut off) and topped (tops cut off) with a chainsaw then skidded to the logging deck using mules or horses. With animal logging, skid distances must be relatively short and production is low.
2. Cable logging – Cable logging system is not common in the South but is the method of choice in steep terrain along the West Coast. Trees are felled, delimbed, bucked (cut up in log lengths), then hooked to an overhead cable by way of a choker cable. The cable is then reeled in by a yarder located on the logging deck. From there trees are put onto a truck by a loader for transport to the mill.
3. Conventional or tree-length logging – Majority of harvesting systems in the South are conventional or tree-length operations. Equipment consists of feller buncher (cutter), skidders to move trees from stump to loading deck, and knuckleboom loader to place trees on trailer. Trees may be cut manually (chainsaw) or mechanically (feller buncher), skidded

to deck, then loaded onto a truck. Skidding is typically handled with grapple skidder although cable skidders may be used in steeper terrain. Knuckleboom loaders on the deck are often used to process trees for hauling (delimbing and topping) before loading onto a trailer.

4. Cut-to-length (CTL) – While used occasionally in the South, CTL operations are more common in Lake States and northeastern United States. The harvester is a boom type, rubber-tired machine that fells, delimbs, bucks, and tops each tree at the stump. Trees are piled for pick up by the forwarder, a rubber-tired machine that transports the tree to the loading deck. Unlike a skidder, forwarders pick up the trees and carry them in a bunch off the ground resulting in less site disturbance. Overall operations are low impact with reduced soil disturbance and residual tree damage. Loading deck size is also small since the forwarder loads trees directly onto a trailer at the deck.
5. Helicopter logging – In areas where reduction of environmental impact is critical, helicopters are used to transport trees that have been felled, delimbed and topped from the stump to the loading area. With helicopter logging, fewer roads are built on a harvest area. Although this logging system is costly it can be productive in areas environmental constraints prevent use of other systems. This system is not commonly used in the South due to the high costs.
6. In-woods chipping – This system is a conventional, mechanized harvesting operation with the addition of a chipper to process the trees into chips prior to transport to the mill. Chipping systems produce either clean chips (chips without bark that can be made into pulp) or fuel chips (chips that include bark, limbs, leaves/needles) that are used for energy production at the mill. Chippers are expensive and require high production for profitability.
7. Shovel logging – Ideal harvesting system for low-lying tracts with wet ground conditions. Cutting system includes a shovel to harvest trees which consist of a swing-type feller head mounted on the end of a boom of a tracked machine. Tracked machines are use rather than conventional rubber-tired cutters in order to reduce ground pressure. Skidders used usually have wide tires or dual wheels to skid trees to the loading deck which is located on higher ground. Tracked loaders may be included in this type of harvesting system. In this system, the shovel places trees on the ground to form the surface of a "roadbed" for the skidder to use in skidding other trees from stump to deck. Upon completion of harvesting the skidder will remove the roadbed trees.

Best Management Practices

Little consideration was given to water quality until the 1960s when several water-related issues made national news. In 1972, Congress passed the Clean Water Act (CWA) empowering the Environmental Protection Agency to protect the nation's water quality. In many states, EPA has delegated enforcement to states but each state's regulations are subject to federal mandates under the CWA. Silvicultural activities must be conducted in a manner that does not lead to nonpoint source pollution. Sediment produced by rainfall runoff across harvested sites is considered a "nonpoint" source of pollution and is regulated under the CWA.

Although forestry activities are exempt from the permitting requirements under the CWA, steps must be taken to protect water quality during harvesting operations. In most southern states, a set of voluntary guidelines (Best Management Practices – BMPs) have been adopted to reduce the impact of forest management activity, including harvesting, on water quality. Foresters and loggers receive BMP training and periodic surveys by state forestry agencies indicates that voluntary BMPs are very effective in protecting water quality with compliance rates exceeding 90% across the South.

In addition to regulatory requirements, most forest products companies are required to monitor and promote BMP compliance as a condition of participation in the Sustainable Forestry Initiative program as well as other forest certification programs. BMPs include guidelines for streamside management zones, stream crossings, forest roads, timber harvesting, reforestation, wetlands, and revegetation/stabilization.

Forest Roads

Forest roads are the main point of access into forestland by landowners. Forest roads must be built and maintained in a way that does not lead to erosion and potential sedimentation in waterways. Road location and design are main considerations when building new roads or maintaining existing roads. Maintenance problems on forest roads are almost always due to water so it is best to properly locate the road when building. Design principles for road building include:

1. Minimize stream crossings.
2. Avoid location perpendicular to the contour.
3. Locate roads as far from streams as possible.
4. Reduce soil disturbance.
5. Minimize drainage pattern effect.
6. Select appropriate road standard.
7. Avoid unstable soil types.
8. Select road grades as flat as possible.
9. Design curves to accommodate expected traffic.
10. Select appropriate road width.
11. Maintain appropriate site distance for safety.

Closing Out the Harvest

As a harvest operation draws to a close, it is important for all involved in the operation (landowner or landowner's agent, forester, and logger) to consider harvest closing. BMPs require that all roads and skid trails be stabilized and temporary stream crossing removed prior to leaving the tract. In addition, any trees limbs or tops that were inadvertently place in the streams as a result of harvesting should be removed.

Logging Safety

Logging is considered one of the most dangerous occupations in the United States because of the size of the equipment and the nature of harvesting large trees that can fall and/or roll. The Occupational Safety & Health Administration (OSHA) has developed a set standards specifically for logging operations that must be followed. In addition to the importance of following in-woods standards, safety is of the utmost importance as trucks move equipment or haul wood to the mill.

Every harvesting operation will have specific safety requirements based on the equipment used, type of harvesting operation and site conditions. Following are some of the safety considerations for all logging operations:

- Personal protective equipment (PPE) required – hearing and eye protection, hard hats, steel-toed boots, chaps (when using chainsaws), and gloves.
- First aid kits required on site (approved logging first aid kits).
- Crew training on safety, first aid and cardio-pulmonary resuscitation (CPR).
- Seat belts on all equipment.
- Roll-over protection (ROPS) on all equipment.
- Fire extinguishers on all equipment.
- No riders on equipment other than operator.
- Maintain 2 tree-length distance from cutter.
- Awareness of environmental conditions including electrical lines.
- Engage brakes and releasing all stored energy when parking equipment.
- Maintain safe distance between any flammable or combustible liquid and operating equipment.
- Identify and remove danger trees.
- Clear communication between equipment operator and any person on the ground.
- Secure all logs and equipment with chains, cables, or tie-down straps.

MODULE #5 - GROWING TREES

Topics covered in this module include:

a) **Basic Concepts**
b) **Silvicultural Systems**
c) **Regeneration Techniques**
d) **Site Preparation**
e) **Planting**

Basic Concepts

- Silviculture – is the art and science of controlling the establishment, growth, composition, health, and quality of forests to meet the diverse needs and values of landowners and society on a sustainable basis. Silviculture is based on the science of silvics which is the study of the life history and general characteristics of forest trees and stands.
- Stands – are portions of a forest with similar characteristics delineated by easily identifiable boundaries that are managed as units. A forest is a collection of stands, therefore, forest management involves managing the stands that make up that forest.
- Tolerance – is a term used to indicate a tree's capacity to develop and grow in competition with other trees. Trees compete with other trees and plants for nutrients, light and water. Trees that are growing in open stands with few trees or other vegetation around them have less competition and generally grow faster and are healthier. Trees surrounded closely by other trees or competing vegetation tend to grow more slowly.
- Site quality – refers to the productive capacity of the site and is influenced by soil nutrients and moisture, climate and topography. Site index is a measure of the site quality. Generally, the higher the site quality, the higher the productive capacity.

Silvicultural Systems

- Natural Stands – Forest stands develop naturally as trees grow, reproduce and die. Natural regeneration occurs when seeds or nuts germinate to produce seedlings or when stumps or roots sprout (coppice) following the removal of the tree.
    - Even-Aged Stands – usually occur after some disturbance in the stand that removes most or all of the overstory. An example of this would be a tornado that blows down all of the trees in the stand and creates favorable conditions for seeds on the forest floor to germinate. Even-aged stands usually have one age class as a result of most of the seedlings being established at the same time.
    - Uneven-Aged Stands – have at least three well-defined age classes, differing in height, age and diameter. These uneven-aged stands usually develop as a result of disturbances that create favorable conditions for seeds to sprout but do not affect the entire stand. An example of this would be a fire that kills groups of trees and creates openings in the canopy but doesn't kill all of the trees in a stand.
- Even-Aged Silvicultural Methods
    - Clearcutting – Overstory is removed in one harvest. Regeneration following harvest may be natural or artificial. This system used to replace old stands with new, vigorous stands.

  - Seed Tree – A typical seed tree system depends on natural regeneration. Entire cutting unit is managed as with clearcut method, but for designated time period, a small number of mature trees per acre are left. Based on desirable genetic traits, these "seed trees" are selected to remain in the stand and provide a seed source for the next generation of trees. Seed trees may be harvested once regeneration is established.
  - Shelterwood – This management method generally uses three harvesting steps, each with specific objectives and characteristics. Steps include:
    - Preparatory cut – improves seed trees so they can produce healthy cone crop and be more wind resistant
    - Establishment cut – provide growing space for regeneration and shelter for young growing seedlings
    - Removal cut – seed trees are harvested.
- Uneven-Aged Silvicultural Methods – Rather than cutting all mature trees at once, individual trees or small groups of trees are harvested/removed over relatively short intervals. This method allows open growing space for regeneration. Process depends on establishing reproduction and providing space for it to grow.

Regeneration Techniques

Having a regeneration plan in advance of timber harvesting is critical to proper forest management. Regeneration should consider soil type, site drainage, potential compaction, fertility issues, harvest timing, competition, and weed control treatments.

- Natural regeneration – This system takes advantage of the existing trees growing on a site for use as a seed source for next crop of trees.
- Artificial regeneration
  - Direct seeding – Once a site is ready for planting, seeds are either planted or sown. This method is not commonly used in modern forestry practices.
  - Planting - Young seedlings transplanted from a tree nursery to a site prepared area either by hand or with the use of a machine planter.

Site Preparation

Following harvesting, sites are commonly prepared for planting. Site preparation objectives generally include removal or reduction of logging debris and slash, reducing competing vegetation, improving soil characteristics, and provide better site access for proper planting. Site preparation may involve multiple treatments. Following are site preparation techniques that may be used individually or in combination with others:

- Prescribed fire – exposes mineral seedbed useful for natural regeneration; can help in control competing vegetation; most effective in combination with mechanical or chemical treatments.
- Mechanical site preparation
  - Chopping – rolling a heavy steel drum with cutting blades across a site to kill existing vegetation and compress woody debris; results in better site preparation burn.

  - Shearing – cutting of vegetation and stumps by mechanical means; clears sites of smaller standing trees in preparation for planting; typically followed by piling and/or burning.
  - Piling – also known as root raking; movement of woody biomass into piles to clear the site after harvesting; soil damage and movement often occurs with this technique; fire is used to dispose of piled and windrowed debris.
- Soil manipulation
  - Disking – breaks up soil surface, improves soil aeration and water movement; allows for better root growth.
  - Bedding – forms raised planting beds; most often used in areas with high standing water table or where surface drainage is poor.
  - Ripping – may be used where a hardpan exist in the soil that would impede root growth.
- Chemical site preparation – often used to eradicate wide range of competing plants to reduce competition; goal is to provide ideal growing conditions; herbicides may be applied by foliar treatment (helicopter, ground mechanical treatment, or manual backpack sprayers), soil-active treatment (broadcast, banded, or spot treatments), or single stem treatment; chemical site preparation is often the most cost-effective technique today and is commonly used.

Planting

Tree species, seed source, and genotype s are the most important considerations for planting. Planting with containerized seedlings may begin in the fall and proceed through the winter. Bare root seedlings are planted only during winter months. Seedlings must be properly transported, stored, handled, and planted to ensure overall regeneration success. Follow up monitoring is needed to evaluate success of the operation.

Planting occurs most often for pine regeneration. Hardwood establishment is most often achieved through natural regeneration, although some may occur through planting or direct seeding. Hardwood plantings occur most often for reasons other than economic.

Considerations for pine planting include:

- Contractor – A competent contractor ensures that seedlings are handled and planted properly.
- Stock selection – Selection of proper tree species is based on landowner objectives, climate, soil type, susceptibility to disease/pest problems, site conditions, and market influences. It is important to plant the right tree in the right place for proper survival, growth, and future product yield.
  - Landowner objectives – Objectives may include timber production, recreation, wildlife, restoration, and aesthetics.
  - Disease and pests – Risk factors must be considered and plans taken to reduce risk.

- Container versus bareroot – Species selected for planting may dictate whether bareroot or containerized seedlings are chosen.
- Ordering – Orders for seedlings should be placed well in advance to ensure availability.
- Timing – Best growth and survival occurs when seedlings are planted in moist soils early in the fall. Planting during periods of high temperatures and low humidity can mean lower survival.
- Seedling transportation and handling – Seedlings should be handled with care and protected from direct sun, wind and temperature extremes.
- Planting method
    - Machine – tractor-pulled machine that has a coulter for slicing through the soil, a trencher that opens the soil, and a packing wheel that closes seedling opening. Machine planters production: 7,000-9,000 seedlings/day
    - Hand planting – Individuals or planting crew using hand tools to plant seedlings. Hand planter production: 600 – 1,500 seedlings/day.
- Fertilization – Based on site conditions, fertilization at planting may be done to improve early seedling growth.
- Planting success
    - Planting quality – should be assessed throughout planting operation to make sure seedlings are planted to proper depth, vertical position, and soil packed.
    - Survival and stocking – important factors in evaluating success of planting efforts; survival is % of planted seedlings alive and is usually measured at the end of the first growing season; stocking refers to number and distribution of living seedlings over the plantation.
- Replanting – may be done in areas of low survival or stocking.

MODULE #6 – MANAGING FOREST STANDS

Topics included in this module include:

a) **Vegetation Management**
b) **Prescribed Burning**
c) **Thinning**
d) **Fertilization**
e) **Pruning**

Vegetation Management

Vegetation management is a forest management technique used to control competing, undesirable species growing in a forest. Vegetation management may be used to improve:

- Financial returns.
- Availability of site and soil resources.
- Wildlife habitat
- Aesthetics

Vegetation management may be used at any stage of forest stand development but is most common at site preparation (before planting) or in early stages of stand growth. The amount and type of competition factors determine whether vegetation management is needed.

Vegetation management practices can be used for:

- Site preparation – preparing a site for regeneration; goal is to increase success of regeneration by improving survival of regenerated stand or by improving soil characteristics; mechanical or chemical treatments can be used; most often used in southern United States prior to planting loblolly, slash, or longleaf pines.
- Release – treatment to reduce competition with crop trees after establishment but prior to sapling stage (generally less than 20 feet high).
- Timber stand improvement – reducing undesirable plants in stands past sapling stage at any age until harvest.
- Herbaceous weed control – practice of controlling herbaceous weeds in young stands, usually first year after planting; can be combined with chemical site prep or mechanical site prep.

Herbicides are commonly used for vegetation management. Herbicide application methods include:

- Spot application around crop trees - Application is typically by hand; herbicide cost is low but application costs are high.
- Banded application over tree rows - application typically by tractor mounted sprayers or by backpack sprayers; herbicide cost is relatively low but application cost is higher.
- Broadcast application over entire area - herbicide costs are more expensive than banded or spot applications; can be applied with ground equipment or helicopters.

Prescribed Burning

- Prescribed fire – forest management tool used frequently in southern forests; should be conducted by certified trained professionals; goal is to create specific silvicultural or ecological conditions.
- Wildfire – unplanned fires that spread uncontrollably across landscape; may be result of natural ignition (i.e. lightening), arson, or accident.

Fire management goals and objectives include:

- Hazardous fuel reduction – remove or minimize fuels on the ground to reduce risk of wildfires.
- Silviculture – reduce competition from unwanted vegetation.
- Pest control – prescribed burning may reduce risk of fungus, diseases, or insect infestation of crop trees.
- Ecological restoration – fire-dependent ecosystems frequent use of fire to maintain ecological function.
- Species maintenance – some species of plants require fire for seed germination.
- Aesthetics – fire reduces brush and increases the aesthetic quality of a stand.
- Wildlife habitat improvement – prescribed fire can enhance wildlife habitat by increasing fruits/seeds, stimulating forage production, and creating openings in closed canopy forests.
- Range – fire increases the amount of forage for grazing where cattle are present.
- Access – fire increases access by eliminating brush or logging residual.
- Invasive species control – prescribed fire may be beneficial to the control of certain invasive species.

Prescribed fire planning and preparation –planning is key to success. A prescribed burn plan should include:

- Burn unit description
- Vegetation and fuel descriptions
- Maps and fuel descriptions
- Weather prescription

- Smoke management plan
- Equipment and personnel
- Pre-burn considerations
- Burn prescription
- Contingency plan
- Fire evaluation plan
- Neighbor notification
- Emergency escape wildfire plan
- Medical emergency and injury plan
- Goals and objectives

Thinning

Thinning reduces the number of trees in a stand effectively concentrating available site resources on remaining trees and increasing economic returns to the owner. Landowner's objectives and constraints determine parameters for thinning. Thinning decisions may be based on:

- Overall stand health.
- Wildlife management considerations.
- Risk of wind/storm damage.
- Need for revenue.

Types of thinning methods:

- Precommercial – Precommercial thinning entails removing trees that cannot be sold and is most often used for naturally regenerated pine stands to reduce tree density. Methods include:
    - Prescribed fire – effective in killing smaller trees.
    - Hand tools – removal of trees by circular brush saw, brush hook, machete, or other hand tools. This method is labor intensive and, therefore, costly.
    - Mechanical – drum chopping, rotary mowing, or bush-hogging are options on smaller trees.
    - Chemical – herbicide application.
- Commercial – Commercial thinning entails removing trees that are large enough to be sold. Methods include:
    - Low thinning – Stand is thinned from below by removing mostly suppressed and intermediate trees with the goal of leaving a fairly even distribution of trees. This is the standard approach to pine thinning in the South.
    - Row thinning – Third row thinning (removing every third row) is a common method for thinning young pine plantation. A variation of this is fifth row thinning that involves removing the trees in every fifth row and then selecting suppressed and intermediate trees (low thinning) for removal in the adjoin two rows.

- Crown thinning – Stand is thinned from above with trees from main canopy removed to achieve desired density and spacing so best individuals are developed. This method is not common in southern pine management.
- Selection thinning – Removes selected dominant individuals to achieve desired density and promotes growth of smaller trees in lower crown classes. This method is rarely used in commercial pine operations/
- Free thinning – Releases crop trees without regard to overall stand density or canopy position. This method is often used in previously unmanaged natural stands with age, species, and size class variety.

Fertilization

Fertilization is used to increase profitability of timber production by increasing the growth rate of trees and reducing the time to maturity. When considering fertilization in forest management:

- Evaluate stand conditions – review acreage, stand density, stage of stand development.
- Assess nutrient needs – review visual symptoms for low nutrition in trees, perform foliar nutrient test, or perform soil test.
- Interpret test results – review critical nutrient values for crop trees based on test results.
- Select proper fertilizer – select fertilizer based on needed nutrients.
- Apply fertilizer – typically applied aerially by contractors. Fertilizer may be applied by skidder or tractor-mounted sprayers if stand is accessible.

Pruning

Trees may be pruned for:

- Aesthetics – Appreciation of the beauty of nature.
- Risk reduction – removal of trees along power lines, near roads, homes, or shooting houses for safety or visibility.
- Profit – to create a higher class of sawtimber by the removal of limbs to reduce knots.

While pruning increases the amount of clear wood for sawtimber r purposes, pruning is not considered a profitable option for private landowners. Several forest products companies experimented with pruning in recent years but most have rejected it due to high cost and limited returns.

MODULE #7 – PROTECTING FORESTS

Topics included in this module include:

a) **Risks to Forests**
b) **Wildfire**
c) **Insects and Disease**
d) **Nonnative Invasive Plants**

Risks to Forests

Forests are susceptible to a number of risks including wildfire, wind, insects, diseases, and nonnative invasive plants. While many of the risks associated with forests are related to natural occurrences, others result from actions taken by humans. Forest management techniques can be used to reduce the amount of risk associated with managing a forest.

Wildfire

A wildfire is an unplanned fire that spreads uncontrollably across the landscape. Wildfires may result from natural occurrences or as a result of human action. Lightning ignites wildfires every year and is the most common ignition source in the western United States. Most wildfires in the South, however, are a result of human action, either intentional (arson) or accidental. Accidental ignition of wildfires result from not properly extinguishing a campfire, a carelessly discarded cigarette, or improperly maintained equipment along a roadside or railroad.

In times of drought, wildfires are particularly challenging. How rapidly a fire spreads through a forest is influenced by how much fuel (accumulated leaves, needles and woody material) is on the ground as well as weather conditions (temperature, humidity, soil moisture and wind). Steep terrain may increase the intensity and rate of spread of a wildlife and poor access complicates control efforts.

Forest management techniques like thinning can help reduce the fuel load in a forest stand and reduce the intensity of a wildfire. Firebreaks constructed and maintained along roadways and throughout the stand will reduce the likelihood of a wildfire in the stand or slow the rate of spread.

Insects and Diseases

Insects and diseases can wreak havoc on a forest. While both insects and pathogens (fungi, bacteria, and other disease-causing agents) naturally occur even in a healthy forest, active management can mitigate the impact of forest pests. Across the United States, forest pests cost landowners millions of dollars in damage annually. Healthy forests are more resistant to naturally occurring forest pests. Conversely, a stressed forest stand becomes more susceptible to insects and diseases.

Problems caused by insects and/or diseases:

- Growth loss – growth that would have occurred if a pest were not present.
- Mortality – trees that die because of insects and diseases.
- Cull – wood made unusable for certain products by forest pests.
- Degradation of the aesthetic value of a forest.
- Hazardous conditions caused from dead and dying trees.
- Disruption of short-term and long-term forest management plans

Integrated pest management is a planned approach to preventing and avoiding forest pests. It is easier and more economical if landowners can avoid pest problems prior to their occurrence. An integrated pest management program includes:

- Establish and maintain a healthy, vigorous forest.
- Stay informed of forest diseases and insects.
- Understand forest stand damage.
- Be aware of potential pest management strategies.
- Know economic viability of pest management options.
- Apply pest treatment and evaluate results regularly.

Conifer diseases include:

- Stem diseases
    - Fusiform rust – caused by a fungus; creates spindle-shaped galls on branches or main stems of trees; creates potentially lethal cankers on trees on millions of acres of forestland in South; pine and oak trees are both required for host cycle to complete.
    - Pitch canker – fungus enters pine trees through damaged areas of the bark; symptoms of infection include canker, drooping/color-changing needles, oozing resin from infection site; can occur in young trees like in nurseries or in stands greater than 10 years old.
- Root diseases
    - Fomes or Annosum Root Rot – can attack, infect, and decay large root systems; fungus becomes established during thinning of pine plantations; can occur in hardwoods but most severe and common in conifers; prevention is key since managing the disease after infection is nearly impossible; most severe on sandy, well-drained soils; problem best avoided by thinning trees in summer months on highly susceptible stands.
    - Littleleaf Disease – caused by a root pathogen that is complex interaction of stand of trees, the fungus, and the host; infects and kills tree's fine feeder roots; severe in poorly drained, wet soils with high subsoil of clay, limited aeration, and low fertility.
    - Loblolly Pine Decline – caused by number of stresses that combine and result in decline and mortality of loblolly pine by age 50; symptoms include thinning crowns, annual growth reduction, loss of fine root systems; scattered mortality throughout stand; stand history seems to also factor into whether or not loblolly pine decline infects stand.
- Needle diseases – fungi that affect pine tree foliage; detrimental to tree and stand's health; fungus type determines needle rust, needle cast, or needle blight

Hardwood diseases include:

- Stem cankers – diseases of bark result in cankers or lesions on twigs, branches, or tree's main bole and can disrupt flow of nutrients and therefore tree growth.
- Foliage diseases – number of foliage diseases among hardwood species; reduce stand health, reduce plant photosynthesis and growth, and make trees more susceptible to attack; occurs often on landscape species of hardwood trees.
- Decay – important component in carbon cycle; most fungi that are associated with decay feed only on dead woody material but some decay fungi are pathogens and could interfere with management objectives.

Conifer insects include:

- Southern Pine Beetle – small insect (smaller than a grain of rice!); known as most destructive forest pest in Southern United States; attacks and kills pine species; groups of trees infested and under attack are considered a beetle spot; favors overstocked, slow-growing, or stressed stands of trees.
- Ips Engraver and Black Turpentine Beetles – attracted to overstocked, slow-growing, and stressed stands; black turpentine beetle prefers fire-scarred or injured trees and tends to be in lower 6-8 feet of tree; Ips engraver beetles located in upper portion of tree; symptoms include pitch tubes, boring dust, and foliage discoloration.
- Pine Tip Moths – larval stage of tip moths feeds on pine needles and bud or shoot of the tree, killing the tip; problematic only in young stands of pines, ages 1 to 4; trees respond by producing new bud but successive generations continue to infest the tree; insect greatly reduces growth potential of the tree.
- Reproduction Weevils – pales weevil and pitch-eating weevil; most pronounced on newly planted pine seedlings established in recently cut-over pine forest; best prevented by adjusting planting time based on harvest completion date.
- Conifer Sawflies – larval stages of insect can defoliate Southern yellow pines; heavy defoliation may predispose trees to other forest pests.

Hardwood insects include:

- Defoliators – insects that defoliate hardwood trees, reducing leaf area for plant photosynthesis and growth.
- Insect Borers – insects that bore into branches, stems, or main bole of hardwood trees; indicator of stressed or unhealthy trees.
- Abiotic Disorders – problems caused to a tree by great variation of temperature, moisture, and nutritional requirements of trees.

Certain nonnative invasive insects and diseases are also increasingly a threat to forest health. Many of these insects and diseases can kill trees and impact the economic and ecological productivity of forests.

- Gypsy moth: caterpillars feed on leaves from a wide variety of tree species, and can cause heavy defoliation of trees; over successive years, defoliation reduces the health of trees, leaving them susceptible to other health threats and mortality; gypsy moth is an issue throughout much of the eastern United States, but decades of monitoring and managing this insect have helped slow its spread into new areas.

- Hemlock woolly adelgid: these tiny insects feed on hemlock needles and suck nutrients from those needles, causing tip dieback on branches and over successive years can kill hemlock trees; hemlock woolly adelgids are most noticeable as fuzzy white spots on the underside of needles; some management options have shown success at temporarily protecting hemlock trees, but these insects have spread throughout much of the range of eastern hemlock.
- Laurel wilt disease: this disease is caused by a fungus that is carried by a nonnative insect, the redbay ambrosia beetle, and affects sassafras trees in Tennessee; when trees become infected, leaves quickly wilt and may fall from the trees, and the disease kills the sassafras within one to two years; this disease is relatively new to Tennessee and seems to have spread largely by human transport of infected firewood or other materials.
- Emerald ash borer: these beetles tunnel beneath the bark of ash trees as larvae and can cause ash to die within just a few years; emerald ash borer has caused widespread loss of ash trees throughout the eastern United States.
- The spread of other nonnative invasive insects and pathogens into Tennessee is also of concern, so watching for potential new health threats can help protect forests.

Nonnative Invasive Plants

Nonnative invasive plants impact Tennessee's forests in a number of ways:

- Displace native plants.
- Increase susceptibility of native plants to become threatened or endangered.
- Change native animal populations.
- Alters water flow and nutrient cycling.
- Inhibits natural and artificial regeneration.
- Reduces tree volume growth.
- Increases intermediate stand treatment costs.
- Changes prescribed burning objectives.

Nonnative invasive plant traits include:

- Adaptation to wide variety of sites.
- Rapid juvenile growth and early reproductive maturity.
- Aggressive reproduction.
- Long-lived seeds in soil.
- Release of toxic chemicals from foliage/roots that inhibit growth of surrounding plants.
- Development of structures (like thorns) that minimize browsing.

A plan for containing and controlling nonnative species infestations should be established as part of forest management plans. Eradication may occur through mechanical control, prescribed fire, biological control, or chemical treatments. Restoration of native species will best occur after eradication.

MODULE #8 – NON-TIMBER FOREST RESOURCES

Topics covered in this module include:

a) **Forest Management for Wildlife**
b) **Oil/Gas/Minerals**

Although timber production represents the largest source of potential revenue, forest landowner have a number of other opportunities to generate income from their forestland. Revenue may be generated from leasing land for hunting or other recreational purposes and marketing non-timber forest resources (e.g. pine straw). In addition, where oil, gas, and mineral deposits exist, landowners may lease their land for extraction of these valuable resources. These activities may require changes to forest management plans in order to meet the landowner's objectives.

Forest Management for Wildlife

Wildlife is considered a natural resource. Although ownership of wildlife is held by the state as a public resource, landowners own the forests that provide habitat for these species and control access to the land for hunting or other recreational purposes.

Although wildlife management for game species (wildlife that are hunted) involves manipulating populations through setting seasons and bag limits, managing the habitat for these species has the largest impact on the number of individuals present and the health of those individuals. In other words, wildlife biologists working for state agencies influence population levels through regulations set but forest landowners are the true wildlife managers since the decisions they make have the biggest impact on wildlife populations.

Although some landowners may have a singular objective to manage timber or wildlife, most incorporate both into their management strategy. This approach allows them to generate revenue from both timber production and hunting-related activities. Generally, good forest management is good wildlife management. However, in order to manage for wildlife and optimize hunting/recreation-related income, landowners may be required to alter forest management strategies.

In order to incorporate wildlife objectives into forest management planning, landowners must first have a clear understanding of the basic requirement of any wildlife species. Those requirements include:

- Food – adequate food throughout all seasons of the year.
- Cover – adequate cover for reproduction / nesting, brood rearing, loafing and escape.
- Water – open water sources (streams, creeks, ponds) are required by some species but others may obtain needed water from vegetation or dew.
- Living space – all species have certain space requirements (referred to as home range). Some species require larger home ranges (e.g. white-tailed deer: 300 – 700 acres) while other species are smaller (cottontail rabbits: 10 acres).

When developing a forest management plan with wildlife included as a landowner objective, habitat requirements for target species should be considered and provided across the landscape. Most game species benefit from a variety of different habitat types in close proximity. This variety can be created by planning the timing and location of harvesting and other forest management practices to create a mosaic of habitat conditions. Especially valuable is the transition zone (edge) between two distinct habitat conditions.

Although wildlife management is perfectly compatible with timber management, trade-offs may be required. These trade-offs are driven by landowner objectives and are often designed to optimize revenue generated from management of both the wildlife and timber resources rather than maximize revenue from either one of those objectives.

Oil/Gas/Minerals

In certain parts of the South, oil and natural gas deposits may be found. Other areas may contain coal, lignite or methane. In addition to these carbon-based fuels, a variety of minerals, including sand and gravel, may be found.

Discovery of any of these can result in a financial windfall to the landowner if the current landowner owns the mineral rights. In some cases, however, the mineral rights may have been retained by previous owners.

Irrespective of who owns the mineral rights, changes in forest management plans may be required in order to extract those minerals. Where sand and gravel is found, this material may prove beneficial to the landowner for use on road construction and maintenance.

MODULE #9 – LEGAL ISSUES IN FORESTRY

Topics covered in this module include:

a) **Property Rights**
b) **Boundary Disputes**
c) **Easements and Rights-of-Ways**
d) **Trespass and Encroachment**
e) **Liability**
f) **Timber Theft**

Property Rights

Property rights are based on laws created by local, state and federal governments which dictate how individuals can control, benefit from and transfer property. Strong property rights provide an incentive for individuals to protect and manage their property over the long term because they are assured that their ownership rights will be protected against unjust and/or unlawful actions by other parties.

Property rights are defined as:

- Exclusive right to determine how a resource is used.
- Exclusive right to the services of a resource.
- Right to exchange resource at mutually agreeable price.

The United States was established on the principle of an individual's right to own property. These strong property rights have been foundational to the success of the American economy over the years. Well-defined property rights encourage:

- Increased productivity
- Reduced conflict
- Security
- Surplus

In some countries individuals cannot own land. Instead, the government or some other entity owns the land and individuals may be granted the right to use the land. In other cases, individuals may own land but their rights are ill-defined. Where property rights are ill-defined or unprotected, results can include:

- Scarcity
- Disputes
- Violence

In the United States, individual states are vested with the authority to set laws regarding private property. However, the US Constitution provides protection from unreasonable seizure of property (4th Amendment) and provides that a person may not be deprived of personal property without due process and just compensation (5th Amendment).

In the United States, the greatest threats to private property rights for forest landowners comes from federal, state or local government regulatory actions that may result in seizure of the property (with compensation) for a public purpose or restriction of certain activities, such as timber harvesting, that might diminish the value of the property. In the case of the latter, these "regulatory takings" are becoming more commonplace as enforcement of many federal laws (e.g. Endangered Species Act, Clean Water Act) increase.

Boundary Disputes

Forestland descriptions refer to legal property descriptions which may or may not always be easily be located on the ground. Having a survey performed on property lines is the best way to locate boundaries on the ground, however, surveyed lines may not always prevail in court. When disputes about property lines cannot be resolved by mutual agreement, they are typically handled with legal intervention.

Easements and Right-of-Way

An easement is defined as the non-exclusive privilege to use the land of another. Right-of-way (ROW) easements are corridors (of a specified width) acquired and used by another party. One example of this is where utility companies acquire ROW easements to construct, operate, and maintain utility lines (e.g. electric lines and gas pipelines). These easements grant the utility company the right to remove trees, brush, etc. from the right-of-way.

Trespass and Encroachment

- Trespass - involves intentionally entering upon land belonging to another individual or causing a substance or thing to enter upon that land.
- Encroachment - refers to a dispute on boundary line locations as well as to buildings that may be partially located across the property line.
- Timber trespass - occurs when a logging crew harvesting on one parcel of land crosses (intentionally or unintentionally) the boundary and cuts trees on the neighbor's property without permission. Most states have laws that govern the payments required to the neighboring landowner for trees cut without permission.

Liability

Liability is the state of being legally responsible for something. There are several areas of liability common to owning and managing forests.

1. General liability of ownership - The duty owed by forest landowners to individuals who enter their land varies by the legal status of the party. The three categories of individuals who enter a landowners property include:
    a. Trespassers - present without permission.
    b. Licensees - present with owner's permission but without any benefit to the landowner.
    c. Invitees - present with owner's permission for a purpose that benefits the landowner, e.g. individuals leasing hunting rights.
2. Control burn liability – Although prescribed burning is a legal forest management tool, landowners and their agents are responsible protecting the public from any hazardous conditions that might be created as a direct result of the fire. Liability usually occurs in two areas:
    a. Escaped fire – Landowners are responsible to contain the fire on their property and are responsible for the damages if that fire crosses onto a neighbor's property.
    b. Smoke – Smoke represents the greatest liability from prescribed burning. When smoke drifts onto roadways and reduces visibility for the driving public, accidents and injuries may occur. As a result, landowners must exercise great caution when burning to ensure conditions are appropriate to minimize the risk of smoke drifting onto roadways.

Timber Theft

The act of removing or damaging timber belonging to another can arise in a variety of ways including:

- Cutting across property line by mistake.
- Outright theft of standing timber.
- Misclassification of raw materials.
- Rerouting materials from intended destination.

Absentee landowners (landowners who do not live on the property) have a greater risk of timber theft since their visits to the property are often infrequent.

Landowners may reduce the risk of timber theft by one or more of the following:

- Establish and maintain clearly visible boundary lines.
- Enlist neighbors or hunting club members to help monitor the property for any unpermitted activity.
- Inspect the property periodically.

When selling timber landowners should take the following steps to reduce the risk of timber theft:

- Educate themselves about timber products and markets.
- Contract with a reputable timber buyer or logger.
- Require documentation on loads produced.
- Personally inspect and monitor harvesting operations.
- Engage a professional forester to inspect and monitor harvesting operations.

MODULE #10 – WORKING IN FORESTRY

a) **Logging**
b) **Forestry**
c) **Forest Product Manufacturing**

In many parts of the southern United States, the forest products industry is the largest employer and is the engine that drives the rural economy. In addition to the job opportunities found working directly for forest products companies, there are a number of indirect jobs available with companies that supply goods and services necessary to support the industry.

Logging

Companies that manufacture forest products all have one thing in common…they require timber as a raw material to produce their finished products. That timber is harvested and delivered by thousands of independent loggers across the South. Logging crews across the southern United States can range in size from a single 2-man crew to multiple crews consisting of 8 or more workers per crew. There are no education requirements for logging workers but experience working on a logging crew and operating equipment is highly valued.

Following are some of the job opportunities in logging:

1. Equipment Operator – Equipment found on most logging jobs today is climate controlled with an ever-increasing amount of technology on board. Many of the latest models incorporate on board diagnostic systems and GPS technology that provides real-time information on location and programs that assist with harvesting efficiency. Although no formal education is needed, all crew members must be trained in safety, first aid and CPR. Also, crew members must have a Commercial Drivers License (CDL) when transporting fuel to the job. Logging crews in the South typically operate 3 types of equipment:
    a. Cutter (feller buncher) – harvests trees and accumulates those trees in piles.
    b. Skidder – usually equipped with a grapple that is used to pick up the piles of wood left by the cutter and skid them to the logging deck.
    c. Loader – a knuckledboom loader that picks up individuals stems, feeds them through a delimbing device to cut off limbs and the top, and then loads them onto a waiting log trailer.
2. Mechanic – Larger crews or companies with multiple crews may have a mechanic on site to maintain and repair logging equipment and trucks. Experience in working on diesel engines and heavy equipment is required.
3. Log Truck Driver – Many logging crews include one or more trucks to transport the wood from the logging job to the mill. In addition, some drivers own and operate their own trucks and contract with a logger to deliver the wood. Truck drivers typically make 2-4 trips daily from the woods to the mill and are required to maintain a CDL.

Forestry

The forest products industry is such a large part of the rural South's economy because of the abundance of forest. These abundant forest resources exist as a direct result of the active management by forestry professionals. Whether they are working with landowners to grow trees to generate revenue or manage their forests for wildlife and other recreational purposes, these forestry professionals apply their knowledge and experience to ensure landowners' objectives are met and forests are managed sustainably.

Job opportunities in forestry include:

1. Professional Forester – There are a variety of job opportunities for forestry professionals working with a broad range of companies. Education requirements include a 4-year degree in forestry from a university with a program accredited by the Society of American Foresters. In addition, many states require foresters to be "registered" by a state board or agency in order to practice forestry in that state. Following are examples of jobs for professional foresters:

    a) Land management forester – manages forest owned by large corporate or institutional landowners.
    b) Procurement forester – purchases timber from landowners or works with wood suppliers to deliver timber to wood-using mills.
    c) Wood supplier forester – purchases timber for a wood supplier and delivers to local mills.
    d) Consulting forester – provides consultation to individual forest landowners and represents those landowners in timber sale transactions.
    e) Government forester – work with local, state or federal agency in a variety of forestry-related jobs including land management, fire control, and regulatory enforcement.
    f) GIS forester – manages geographic information systems in support of land management and other forestry activities.

2. Forestry Technician – Forestry technicians perform many of the same functions as professional foresters but tend to be involved more in on-the-ground activities including timber marking, boundary line maintenance, cruising, and prescribed burning. Education requirements include a 2-year degree from a junior or community college. In many states, forestry technicians must work under the direct supervision of a professional forester.

3. Forestry Worker – Forestry workers may perform some of the same functions as a forestry technician, including boundary line maintenance and prescribed burning, and may also function as equipment operators plowing / disking firelines, planting foodplots, and planting trees. There is no educational requirement for forestry workers but a knowledge of forestry and experience in forest management is needed.

4. Timber Buyer – Most timber buyers work for a wood supplier. Although many timber buyers are professional foresters, there is no education requirement. Timber buyers typically work with individual forest landowners to purchase timber and then contract with independent logging crews to harvest and deliver the timber to local mills.

Forest Products Manufacturing

Forest products manufacturing companies in the southern United States include sawmills, plywood mills, oriented strand board mills, wood pellet mills, and pulp and paper mills. In addition, there are a variety of jobs available in secondary manufacturing companies including those that produce cabinets, furniture, doors, and millwork. Job opportunities in these mills are quite varied depending on the type of operation. Many of these mills operate multiple shifts and some run 24 hours a day, 7 days a week, 365 days a year. Education, training and experience requirements vary by job. Following are some examples of jobs available:

1. Mill worker – examples includes lumber graders and off-bearers. Experience is needed for some positions and On-The-Job Training (OJT) may be required.
2. Machine operator – most mills have a variety of machines used to process the timber into finished products. Automation of many manufacturing processes today requires increased training to operate the processing equipment. In some cases, training at two-year colleges is required.
3. Saw Filer – a Saw Filer is responsible for safely maintaining saw equipment, performing machine alignment and providing preventive maintenance to saw filing machines. An apprenticeship may be required.
4. Maintenance Technicians – almost all forest product manufacturing facilities employ technicians to maintain and repair equipment. Training at two-year colleges may be required via an associate's degree or short certificate may be required.
5. Welders – all larger mills employ welders for fabrication, equipment installation and repair. Training in welding is required and is available at many two-year colleges.
6. Electricians – all larger mills employ electricians. Training at a two-year college may be required. In addition, most companies have an apprenticeship system established.
7. Equipment operator – A variety of equipment is needed in handling raw material that is fed into a mill and moving and loading finished product. Cranes, knuckled boom loaders, and forklifts are a few examples of equipment used. There are no specific education requirements but experience is valued.
8. Scalehouse operator – Scalehouse operators are responsible for inspecting and weighing trucks delivering timber to a mill and monitoring outbound trucks.
9. Truck driver – Although some mills maintain their own trucking fleet with a large number of drivers, almost all employ at least a few truck drivers that move finished product around prior to shipment. A commercial driver's license is required.
10. Professional Engineer – Mills may employee a variety of engineers depending on the type of operation. Education required includes 4-year degrees in electrical, chemical, mechanical or pulp and paper engineering.
11. Information Technology (IT) – Many larger companies employ a staff of IT professionals to manage and maintain the company's information systems. Education requirements vary from company to company but often include a 4-year degree in information technology or related fields.
12. Accountant – Larger mills employee a number of accountants to process and track purchases and billing of finished product as well as manage financial systems. Many of these positions require a 4-year degree in accounting. Some smaller operations may employ bookkeepers who perform much the same function. Education requirements for bookkeepers will vary by company.

13. Sales – Most every mill has employees responsible for the sale of finished products. For larger companies, this sales force may be extensive. Education and experience requirements will vary from company to company.

There are also job opportunities for individuals in supervisory or management roles with a varying amount of experience required. Many of these jobs are filled by individuals who have worked in other functions within the company for a period of time.

Salary and wages for jobs in forestry and forestry-related companies vary widely based on a variety of factors. In most cases, however, they represent some of the most stable and best-paying jobs available in the rural areas where these companies are located.