2025 National 4-H Forestry Invitational Handbook

http://www.4hforestryinvitational.org/

NATIONAL 4-H FORESTRY INVITATIONAL HANDBOOK

ORDER OF TOPICS

CONTEST EVENTS

National 4-H Forestry Quiz Bowl and Exam Study Guide

This handbook was originally prepared by the National 4-H Forestry Invitational Committee for an experimental event first conducted at the State 4-H Camp, Jackson's Mill, West Virginia, July 1980.

Original Editor, Dr. Frank Roth, Forester, Arkansas Forestry Commission

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SIGNIFICANT REVISIONS INCORPORATED FOR 2025

Throughout the Handbook style, font, and minor wording changes have been made for uniformity and clarity. Also, some definitions and descriptions have been slightly modified to reflect current usage.

ELIMINATION OF POINT DEDUCTION FOR SPELLING

Applies to Tree Identification, Forest Health – Insects, Forest Health – Diseases and Health Indicators and Topographic Map.

FOREST HEALTH – DISEASES AND HEALTH INDICATORS

The following have been added to the official list:

armillaria root rot
beech leaf disease
cytospora canker of spruce
diplodia canker of oak
fire blight of apple
sycamore anthracnose
tar spot of maple
thousand cankers of black walnut
verticillium wilt of maple

TOPOGRAPHIC MAP CONTEST

Revised contest and study guide to increase allowable error of calculations.

FOREST EVALUATION

Added point values for sections and subsections of the score sheet.
Revised the points distributions in Section IV, Practices Recommended.

FORESTRY BOWL

PROCEDURE OF PLAY, Part 2 – Toss Up Questions #10.

The option for the question to be repeated has been deleted. Page 36

PROCEDURE OF PLAY, Completing the Contest #2.

Two score keepers will only be used in the final round. Page 37

PROCEDURE FOR PROTEST - #1.

Clarification: two protests total; one per team per round. Page 38.

STUDY GUIDE

The entire GLOSSARY from the website has been included in the Handbook. This is to place all information related to the contest in one place. Note: all of the short list Glossary items in the 2024 Handbook were already included in this transferred list.

INTRODUCTION

The National 4-H Forestry Invitational is the National Championship of 4-H Forestry. Each year, since 1980, teams of 4-H Foresters from many different states come to Jackson's Mill State 4-H Camp near Weston, West Virginia, to meet, compete and have fun. During two days of competition 4-H Foresters participate in forestry skills and knowledge events including: tree identification, tree measurement, compass and pacing, topographic map reading, forest evaluation, insect identification, disease identification, forestry written examination, and forestry bowl.

In addition, the Invitational includes recreational activities such as local tours, campfires and lumberjack skills events. Although competitive in nature, the Invitational is managed as a wide-ranging forestry educational experience. It provides an opportunity for exploration of the broad aspects of forestry. The setting, contests, leadership, and supplementary events are all directed to this end.

The event is organized and managed by a national steering committee consisting of Extension Service forestry professionals, county Extension educators, forestry industry representatives, state forestry agency professionals and other university faculty.

Team Development

There is no standardized national system for team development or the selection of teams to attend the National 4-H Forestry Invitational. Individual state 4-H forestry programs are too diverse for such standardization. Ideally, there should be county, regional, and state competitions with the winners competing on the national level. Realistically, however, team development must be according to in-state structures and resources. We recommend that a system be established in each state for potential team members to become thoroughly familiar with the Invitational events. This might be at regional or state 4-H forestry camps, or as a special addition to more general natural resources camps. This Handbook is intended as a rule book for the National 4-H Forestry Invitational and as a guide for team development. Please ask forestry professionals to assist with team training, and use other educational materials to broaden the 4-H member's understanding of forestry. Such an understanding is essential to success in the Invitational, and to the successful management of our nation's forest resources in the future.

OBJECTIVES

The objectives of the National 4-H Forestry Invitational are to provide the opportunity and atmosphere for 4-H members from all states to:

- develop leadership talents and to work toward achieving character development and effective citizenship;

- develop an appreciation of the importance of conserving forests as a source of income, raw material, and enjoyment necessary for quality living;

- acquire information and understanding of practical forestry skills in forest management and the use of forest and wood products.

In addition to meeting these objectives, the event encourages and promotes increased knowledge of forests and forestry by 4-H members, volunteer leaders, and Extension agents at local, county, district, state, and national levels. Although they may never be forest landowners, as future adults, 4-H members will learn to weigh and understand renewable resource management needs. Preparation of youth in this event: (1) presents, identifies, and locates the renewable resources of the forest environment such as forest products, water, outdoor recreation, wildlife, and selected grazing; (2) establishes a natural resource value system for participating 4-H members; (3) helps 4-H landowners understand the techniques of managing their land and improving the understanding of 4-H'ers as potential landowners; and (4) furnishes facts and scientific procedures for future landowners, administrators, and planners who are not professional land managers.

The Competitive Team Approach, which is used in the National 4-H Forestry Invitational, develops at all levels the following benefits: (1) intensified learning opportunities using scientifically derived management information and factors concerning forest resources; (2) standardizes, or presents, similar references, materials, guides, and understanding on tree identification, forest measurements, and use of silvicultural problems of management, insects, diseases, etc.; (3) encourages rural, suburban, and urban teens to share ideas and visit potential management areas with a new perspective of 4-H forestry; (4) provides new insight to senior members who serve as teen leaders with younger 4-H members in beginning forestry projects; (5) allows teen members to formulate goals and discuss management procedures with other 4-H'ers and with professional land managers; and (6) provides a new dimension for older 4-H member activities and incentives for younger members beyond the present project-oriented program.

GENERAL RULES AND REGULATIONS

This event will comply with all "Policies and Guidelines for National 4-H Competitive Events" as approved by USDA Extension in the 2016 revision and May 2021 update.

4-H Guidelines for Competitive Events 2021

Contestants and Eligibility

1. Each state is allowed to enter only one team or up to two individual contestants. A team will consist of no less than three and no more than four official entrants who are 4-H members in their state during the current year. If a state is unable to muster a team, it may send up to two contestants to compete in the individual events only.

2. All contestants must have passed their 14th birthday on or before December 31 of the preceding year, and must not have passed their 19th birthday on January 1 of the contest year.

3. An individual may enter the National 4-H Forestry Invitational event only once.

4. The team of contestants must be certified as the official state entry by the State Extension Director or by a person designated by the Director. The individuals or team may be selected by any procedure which a state considers appropriate.

5. Contestants in the National 4-H Forestry Invitational must not have participated in official post-secondary (university, college, junior college, or technical school) competitive events of a similar nature in the same subject matter area. Neither can he/she be a member of a post-secondary team undergoing training in preparation for an event. (For example, a contestant who has competed in an official collegiate forestry contest, either on or off campus, is ineligible to compete.) The State 4-H Program Leaders are responsible for determining the eligibility for participants in National 4-H Competitive Events from their respective States.
6. All states participating in the Invitational must provide a signed statement from the State 4-H Office verifying that the team has insurance coverage while traveling to and from and attending the Invitational.

General Contest Rules

1. State team entries must be submitted on an official entry blank, by the specified due date.

2. Each team shall have no more than one head coach and two assistant coaches. Current 4-H members may serve as coaches for the team, but those individuals will be ineligible as future contestants.

3. Adult representatives from states not competing in the current Invitational are welcome to observe. They may be asked to assist in the Invitational administration.

4. Only contestants and designated officials shall be within the perimeter of an event other than certain parts of the Forestry Bowl. Once a contestant has started an event, he/she will not be allowed to talk with anyone other than an event official until completion of that particular event, except in certain team events.

5. A team may be composed of either three or four members. A team captain will be selected by each state for the Invitational contest. Team scores will be based on the **three highest scoring team members in each individual contest area**. Individual contestants will compete for high-scoring individual honors.

6. There are certain activities, as noted in the schedule at the Invitational for which attendance is required. If a team or team member (including the coach) is absent from a required activity, all points earned during that day's competition will be forfeited. If the attendance policy is abused prior to the start of competition, all points for the first day of competition will be forfeited.

7. Each contestant will bring a clip board or writing board, pencil, and calculator. Binoculars and hand lenses are permitted for use during contest events. Contestants are encouraged to wear field clothing and closed toed shoes. Raingear is highly recommended.

8. No image or audio recording device such as cell phones, tablets, still cameras, video cameras, movie cameras, or tape recorders will be permitted during competitive events listed in the

INTRODUCTION's first paragraph. No Invitational participant (4-H team member, coach or adult chaperone) is allowed to write down or record any questions asked during Forestry Bowl competitions or from written exam.

9. The use of alcoholic, tobacco or other controlled substances will NOT be allowed. Rules of the 4-H camp will be enforced.

10. After the Invitational, individual and team scores will be distributed to the team coach. Contest score sheets will not be distributed.

11. A hard hat will be provided for all 4-H team members, coaches and adult chaperones. Each state delegation will provide its own safety glasses or glasses. Hard hats and safety glasses **must** be worn when a team member, coach or adult chaperone enters a woodland area. Failure to comply with this policy will eliminate the team from competition.

12. Any Invitational participant (4-H team member, coach or adult chaperone) who participates in any of the forestry skills events will be required to wear the personal protection equipment supplied by the Invitational for that event. Closed-toed shoes will be worn by all participants in the forestry skills events. Sandals or other open-toed shoes will not be worn during participation in any of the forestry skills events.

Appeals Procedure

1. The National 4-H Forestry Invitational contest is, primarily, an educational program and few problems are not expected to be associated with the competition. However, realizing that the pressure to win is human nature, the Appeals Procedure, as stated in the USDA Extension Policies and Guidelines for National 4-H Competitive Events will be used.

2. The Invitational Management Committee will serve as the Appeals Committee and review recommendations for operational and procedural changes. Appeals must be filed by the Invitational team captain with the Invitational Chairman within 30 minutes of the end of the day's scheduled contest events and before supper of that day. Forestry Bowl appeals will be handled according to Bowl rules as stated in "Procedures for Protest".

SCORING METHOD FOR INDIVIDUAL AND TEAM COMPETITION

Individual and team scores for the National 4-H Forestry Invitational are determined by the method illustrated in the table below. Remember, a team may be made up of three or four members; but only the top three in each individual category and the two team events count toward the total team score.

	----------Total Possible Points----------				
	Individual Member Scores				Team
Event Categories	A	B	C	D	Scores
Tree Identification	100	100	100	100	300
Tree Measurement	100	100	100	100	300
Compass and Pacing	100	100	100	100	300
Topographic Map Contest	50	50	50	50	150
Forest Health -- Insects	50	50	50	50	150
Forest Health -- Diseases and Health Indicators	50	50	50	50	150
Forestry Written Examination	50	50	50	50	150
Forestry Bowl	----	----	----	----	100
Forest Evaluation	----	----	----	----	300
TOTALS	500	500	500	500	1900

The maximum score an individual contestant may achieve is 500 points, and the maximum team score is 1900 points.

TREE IDENTIFICATION

Objective

Contestants will learn to recognize and identify different tree species. This skill is valuable because tree species have varying requirements for growth, and differ in use and value.

Contest Rules

1. Each contestant will have the opportunity to identify 20 trees as found in a natural outdoor condition or from branches or other parts displayed, and 20 herbarium specimens of trees found in sections of the United States other than the Invitational site. All trees to be identified will be taken from the "official tree list" below.

2. Contestants will be judged on the accuracy of identification of common names. Scientific names will not be required. Incomplete names, such as maple instead of red maple or shortleaf instead of shortleaf pine, will be considered incorrect.

3. Contestants will be given a specific time to identify the tree specimens and record the information on the score sheet.

4. Two and a half points will be given for the correct common name. Common names must be those used in the "official tree list." Maximum score for this event is 100 points.

OFFICIAL TREE LIST

Common Name	Scientific Name
Gymnosperms (Softwoods)	
balsam fir	*Abies balsamea* (L.) Mill.
white fir	*Abies concolor* (Gord. & Glend.) Lindl.
noble fir	*Abies procera* Rehder
incense-cedar	*Calocedrus decurrens* (Torr.) Florin
Rocky Mountain juniper	*Juniperus scopulorum* Sarg.
eastern redcedar	*Juniperus virginiana* L.
tamarack	*Larix laricina* (du Roi) K. Kock
white spruce	*Picea glauca* (Moench) Voss
blue spruce	*Picea pungens* Engelm.
red spruce	*Picea rubens* Sarg.
Sitka spruce	*Picea sitchensis* (Bong.) Carriere
lodgepole pine	*Pinus contorta* Douglas
shortleaf pine	*Pinus echinata* Mill.
two-needle pinyon pine	*Pinus edulis* Engelm.
sugar pine	*Pinus lambertiana* Douglas
longleaf pine	*Pinus palustris* Mill.

ponderosa pine	*Pinus ponderosa* Lawson & C. Lawson
red pine	*Pinus resinosa* Aiton
pitch pine	*Pinus rigida* Mill.
eastern white pine	*Pinus strobus* L.
loblolly pine	*Pinus taeda* L.
Virginia pine	*Pinus virginiana* Mill.
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
giant sequoia	*Sequoiadendron giganteum* (Lindl.) Buchholz
redwood	*Sequoia sempervirens* (Lamb. ex D. Don) Endl.
bald cypress	*Taxodium distichum* (L.) Rich.
Pacific yew	*Taxus brevifolia* Nutt.
arborvitae or northern white cedar	*Thuja occidentalis* L.
western redcedar	*Thuja plicata* Donn ex D. Don
eastern hemlock	*Tsuga canadensis* (L.) Carriere
western hemlock	*Tsuga heterophylla* (Raf.) Sarg.

Angiosperms (Broadleaf Trees or Hardwoods)

Dicotyledons

boxelder	*Acer negundo* L.
Norway maple (exotic invasive)	A*cer platanoides* L.
red maple	*Acer rubrum* L.
silver maple	*Acer saccharinum* L.
sugar maple	*Acer saccharum* Marshall
yellow buckeye	*Aesculus flava* Alton
tree of heaven (exotic invasive)	*Ailanthus altissima (Mill.)*Swingle
red alder	*Alnus rubra* Bong.
yellow birch	*Betula alleghaniensis* Britton
sweet birch or black birch	*Betula lenta* L.
paper birch	*Betula papyrifera* Marshall
river birch	*Betula nigra* L.
pignut hickory	*Carya glabra* (Mill.) Sweet
pecan	*Carya illinoinensis* (Wangenh.) K. Koch
shagbark hickory	*Carya ovata* (Mill.) K. Koch
mockernut hickory	*Carya tomentosa* (Lam.) Nutt.
common hackberry	*Celtis occidentalis* L.
flowering dogwood	*Cornus florida* L.
common persimmon	*Diospyros virginiana* L.
American beech	*Fagus grandifolia* Ehrh.
white ash	*Fraxinus americana* L.
honeylocust	*Gleditsia triacanthos* L.
American holly	*Ilex opaca* Aiton
butternut	*Juglans cinerea* L.
black walnut	*Juglans nigra* L.
sweetgum	*Liquidambar styraciflua* L.

tuliptree or yellow-poplar or tulip poplar	*Liriodendron tulipifera* L.
cucumber tree	*Magnolia acuminata* (L.) L.
southern magnolia	*Magnolia grandiflora* L.
red mulberry	*Morus rubra* L.
blackgum	*Nyssa sylvatica* Marshall
princesstree or royal paulownia (exotic)	*Paulownia tomentosa* (Thunb.) Siebold & Zucc.
American sycamore	*Platanus occidentalis* L.
eastern cottonwood	*Populus deltoides* W. Bartram
quaking aspen	*Populus tremuloides* Michx.
black cherry	*Prunus serotina* Ehrh.
white oak	*Quercus alba* L.
scarlet oak	*Quercus coccinea* Munchh.
southern red oak	*Quercus falcata* Michx.
water oak	*Quercus nigra* L.
bur oak	*Quercus macrocarpa* Michx.
northern red oak	*Quercus rubra* L.
black oak	*Quercus velutina* Lam.
live oak	*Quercus virginiana* Mill.
black locust	*Robinia pseudoacacia* L.
black willow	*Salix nigra* Marshall
sassafras	*Sassafras albidum* (Nutt.) Nees
American basswood	*Tilia americana* L.
American elm	*Ulmus americana* L.

Monocotyledons

cabbage palmetto	*Sabal palmetto* (Walter) Lodd.

The following reference was used as the official source for common names, scientific names and spelling:

USDA Plant Database 2021 2022 plants.usda.gov

TREE IDENTIFICATION WEB SITE

The Virginia Tech Dendrology web site is a suggested reference for training teams for the Tree Identification Contest. This web site can be accessed from the "Training References" section of the Invitational web site. Individual species listed on the Invitational's Tree Identification web pages are linked to the Virginia Tech Dendrology web site. Other tree identification web sites are listed for additional help in training.

Tree Identification Score Sheet			
State:	Group #:	Contestant:	Score

ID #	Common name	2.5 pts each
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
	TOTAL SCORE	

FOREST HEALTH – INSECTS

Objective

Contestants will learn to identify signs of forest insects. Sign is the insect itself or the visual presence of some structure formed by the insect on the host plant. For example, exit holes, galleries, frass, honeydew, skeletonization, and web. Symptom is the visual response of the plant due to an attack by a pest or abiotic factor such as defoliation, dieback, chlorosis, and wilt. This is a valuable skill because the first step in managing a plant problem is to know what is causing the symptoms observed. High insect infestations can cause high dollar value damage in the forests.

Contest Rules

1. Contestants will be required to identify 10 insects or examples of their damage. Specimens will be selected from those on the "Official List of Insects".

2. Contestants will be judged on the accuracy of identification by common names. Scientific names will not be required. Incomplete names such as caterpillar instead of eastern tent caterpillar will be considered incorrect.

3. Contestants will be given a specific time to identify the insect or insect damage specimens.

4. Five points will be given for each correct common name. The common name must be the one used in the "Official List of Insects."

Official Reference for Insects and Diseases

The official reference for the Insect and Disease Identification Contests is the web site link for each insect or disease species listed on the Insect and Disease Identification web pages under the "Training References" section of the Invitational web site.

Insect and Disease Web Sites

The Invitational web site provides links to other insect and disease identification web sites as additional training reference aids. These other web sites are not "Official References" for the contest.

OFFICIAL LIST OF INSECTS

Common Name	Scientific Name
Asian longhorned beetle	*Anoplophora glabripennis* (Motschulsky)
balsam woolly adelgid	*Adelges piciae* (Ratzeburg)
beech scale	*Cryptococcus fagisuga* (Lindinger)
bronze birch borer	*Agrilus anxius* Gory
forest caterpillar hunter	*Calosoma sycophanta* (Linnaeus)
dubious checkered beetle	*Thanasimus dubius* (Fabricius)
Douglas-fir tussock moth	*Orgyia pseudotsugata* (McDunnough)
eastern tent caterpillar	*Malacosoma americanum* (Fabricius)
emerald ash borer	*Agrilus planipennis* Fairmaire
European pine sawfly	*Neodiprion sertifer* (Geoffroy)
fall webworm	*Hyphantria cunea* (Drury)
forest tent caterpillar	*Malacosoma disstria* Hubner
hemlock woolly adelgid	*Adelges tsugae* Annand
Ips engraver beetles	*Ips* spp.
Japanese beetle	*Popillia japonica* Newman
locust borer	*Megacyllene robiniae* (Forster)
locust leafminer	*Odontota dorsalis* (Thunberg)
mountain pine beetle	*Dendroctonus ponderosae* (Hopkins
Nantucket pine tip moth	*Rhyacionia frustrana* (Comstock)
pales weevil	*Hylobius pales* (Herbst)
periodical cicada	*Magicicada septendecim* (Linnaeus)
pine needle scale	*Chionaspis pinifoliae* (Fitch)
red oak borer	*Enaphalodes rufulus* (Halderman)
redheaded pine sawfly	*Neodiprion lecontei* (Fitch)
smaller European elm bark beetle	*Scolytus multistriatus* (Marsham)
southern pine beetle	*Dendroctonus frontalis* Zimmermann
spongy moth	*Lymantria dispar* (L.)
spotted lanternfly	*Lycorma delicatula*
twolined chestnut borer	*Agrilus bilineatus* (Weber)
white pine weevil	*Pissodes strobi* (Peck)
whitemarked tussock moth	*Orgyia leucostigma* (J.E.Smith)

The following reference was used as the official source for common names, scientific names and spelling:

Entomological Society of America

FOREST HEALTH – INSECT SCORE SHEET			
State:	Group Number:	Contestant:	Score
Number	Common Name		5 pts each
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
		TOTAL SCORE	

FOREST HEALTH -- DISEASES AND HEALTH INDICATORS

Objective

Contestants will learn to identify forest diseases and other forest health indicators. This is a valuable skill because most diseases that damage trees affect only certain tree species or groups of related species. Diseases can cause high dollar value damage in the forests. Not all indicators of forest health are diseases. Specimens will be selected and displayed which are representative of diseases and damage.

Contest Rules

1. Contestants will be required to identify 10 diseases, specimens of disease damage or other forest health indicators. Specimens will be selected from those on the "Official List of Diseases and Forest Health Indicators."

2. Contestants will be judged on the accuracy of identification by common names. Scientific names will not be required. Incomplete names will be considered incorrect.

3. Contestants will be given a specific time to identify the disease or damage specimens.

4. Five points will be given for each correct common name. The common name must be the one used in the "Official List of Diseases."

Descriptions of these diseases appear in the references.

OFFICIAL LIST OF DISEASES AND HEALTH INDICATORS

Common Name	Scientific Name
annosum root disease	*Heterobasidion annosum*
armillaria root rot	*Armillaria* sp.
artist's conk	*Ganoderma applanatum*
beech bark disease	*Neonectria ditissima*
beech leaf disease	Nematode *Litylenchus crenatae mccannii*
black knot	*Apiosporina morbosa*
brown spot needle blight	*Mycosphaerella dearnessii*
cedar-apple rust	*Gymnosporangium juniperi-virginianae*
chestnut blight	*Cryphonectria parasitica*
clinker polypore	*Inonotus obliquus*
cytospora canker of spruce	*Cytospora kunzei*
diplodia canker of oaks	*Diplodia corticola*
dogwood anthracnose	*Discula destructiva*
Dutch elm disease	*Ophiostoma ulmi*
dwarf mistletoes	*Arceuthobium sp.*
fire blight of apple	*Erwinia amylovora*
fusiform rust	*Cronartium quercuum* f.sp. *fusiforme*
hypoxylon canker	*Biscogniauxia atropunctata atropunctata*
lichens	numerous species
nectria canker	*Neonectria galligena*
needle cast fungi	numerous species
oak wilt	*Bretziella fagacearum*
red heart of pine	*Phellinus pini*
sycamore anthracnose	*Apiognomonia errabunda & veneta*
tar spot of maple	*Rhytisma acerinum*
thousand cankers of black walnut	*Geosmithia morbida*
verticillium wilt of maple	*Verticillium sp.*
white pine blister rust	*Cronartium ribicola*

FOREST HEALTH -- DISEASES AND HEALTH INDICATORS SCORE SHEET			
State:	Group Number:	Contestant:	Score
Number	Common Name		5 pts each
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
		TOTAL SCORE	

TREE MEASUREMENT

Objective

Contestants will learn to measure standing trees in order to estimate the volume of forest products that may be obtained from the trees. Since most timber is bought and sold on a volume basis (usually by board foot volume), it is a good idea to have some estimate of total tree volume, volume per acre and volume by product before selling timber.

Contest Rules

1. Any standard tree scale stick may be used. Scale sticks may be purchased from companies such as Forestry Suppliers, Inc., POB 8397, Jackson MS 39284-8397, Forestry Suppliers.

2. The equivalent plot size represented by the marked trees will be provided to the contestants. Contestants will be required to calculate the total volume of sawtimber per acre based on a sample plot size of 1/10, 1/5 or 1/4 acre

3. Contestants will identify 15 trees and estimate their diameters, merchantable heights, and volumes. All values will be recorded. **Please note** - For purposes of this contest tree diameters will be measured and recorded in even 2-inch diameter classes. Tree heights will be measured in 16-foot logs to the nearest full half-log. The smallest tree will be 10 inches DBH (diameter at breast height) and one log merchantable height. Merchantable height will be measured from stump height to an 8-inch diameter inside bark (dib) top which matches the thickness of Biltmore stick held 25-inches from the eye at 66-feet from tree, a major fork or serious defect (hollow or point of decay) which affects greater than half the tree's diameter at that point.

4. Tree volumes will be found in the International 1/4-inch volume table furnished at the contest site (see page 18). **Do not use the volume table on the tree scale stick.**

5. One point will be awarded for each correct tree identification, two points for each correct DBH, and two points for each correct tree height, for a possible total of 75 points. No points will be awarded for individual tree volumes.

6. After all 15 trees have been measured, contestants will determine the total volume in the plot and the volume per acre. Twenty-five points will be allowed for the correct **volume per acre**. Remember, the total volume in the plot must be multiplied by a factor (10 for a 1/10-acre plot, 5 for a 1/5-acre plot and 4 for a 1/4-acre plot) to determine the volume per acre. Point allocation will be 25 for ±5% of the official volume, 20 points for ±10%, 15 points for ±15%, and no points over ±15%.

Example: If 4,000 bd. ft. is the official volume per acre, then an answer between 3800 bd. ft. and 4200 receives 25 points; 3600 to 3799 and 4201 to 4400 receives 20 points; 3400 to 3599 and 4401 to 4600 receives 15 points; and under 3400 and over 4600 receives no points.

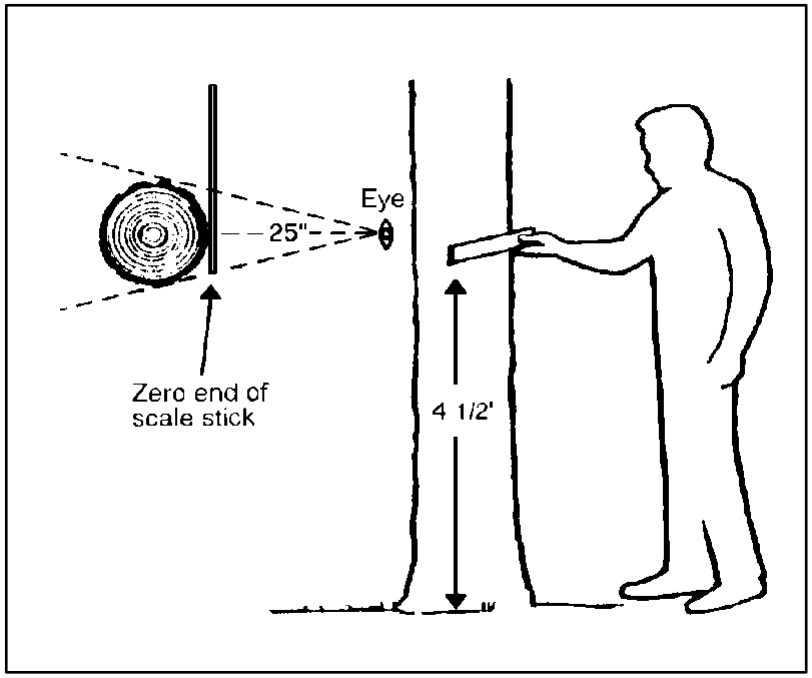
7. Maximum score for this event is 100 points.

MEASUREMENT OF STANDING TREES STUDY GUIDE

When trees are sold as harvested products (sawlogs, veneer logs, or pulpwood), the sale is generally based upon a measured volume. The two measurements used to estimate the volume of a tree are diameter and height. Diameter of standing trees is measured by a time-honored custom, at 4-1/2 feet above ground on the uphill side of the tree (if the tree is on a slope). This is abbreviated as **DBH** (diameter breast height). **Height** of a standing tree might be measured as **total** (the entire height from ground line to the top) or **merchantable**. Merchantable height implies the ability to cut lumber, veneer, or other products from the logs. It is the distance from the stump height to the top of the merchantable material in the tree and varies depending on the products to be made from the tree. The basic unit of height measurement for sawtimber is the log, which is 16 feet in length.

To measure diameter, foresters may use a caliper, diameter tape, or tree scale stick. Since the tree scale stick is to be used in the contest, the method of using it will be explained.

The drawing below shows how the tree scale stick is used to find tree diameter. Use the flat side of the stick, which reads, "Diameter of Tree (in inches)." The instrument on this side of the tree scale stick is called a **Biltmore Stick**. Hold the stick against the tree, perpendicular to the trunk, 25 inches from your eye at a height of 4 ½ feet above ground on the uphill side of the tree. Once the stick is placed against the tree, close one eye and line up the left end with the edge of the tree's bark. Now, **WITHOUT MOVING YOUR HEAD**, look across the stick to the right-hand edge of the tree and read the diameter measurement at the point of intersection. Record the measurement by its proper 2-inch diameter class. For example; if the tree measures between 15.0 and 16.9 inches it should be recorded as a 16-inch diameter tree.



2-inch Diameter Classes

if DBH Measures	**Record As**
9.0 - 10.9	10
11.0 - 12.9	12
13.0 - 14.9	14
15.0 - 16.9	16
17.0 - 18.9	18
19.0 - 20.9	20
21.0 – 22.9	22
23.0 – 24.9	24
25.0 – 26.9	26
27.0 – 28.9	28
29.0 – 30.9	30
31.0 – 32.9	32
33.0 – 34.9	34
35.0 – 36.9	36
37.0 – 38.9	38
39.0 – 40.9	40

Figure 1. Use of tree scale stick to estimate tree diameter 4 1/2 feet above ground

To measure the merchantable height of a tree, pace out 66 feet from the base of the tree, to a point where the entire tree can be seen. It is a good idea to stay on the same contour as the tree or slightly up hill from it. Hold the tree scale stick so that the edge of the stick that reads "Number of 16-foot logs" faces you. The instrument on this edge of the tree scale stick is called a **Merritt Hypsometer**. The zero end should point toward the ground. Plumb the stick, at 25 inches from the eye. Sight the zero end to appear to rest at stump height. Stump height, for purposes of this contest, will be measured one foot above the ground. **DO NOT MOVE YOUR HEAD OR THE STICK.** Look up the stick to a point where the top of the last merchantable cut would be made in the tree (8-inch top diameter inside bark, a major fork, or serious defect which affects greater than half the tree's diameter at that point). Read the merchantable height to the nearest **full** half-log. For example, if the merchantable height is slightly more than 2 ½ logs you can record it as 2 ½ logs. On the other hand, if the merchantable height is slightly less than 2 ½ logs you must record it as 2 logs.

Practice on pacing is needed to find the 66-foot distance from the tree. The 25-inch distance from your eye to the stick is still the same as in measuring tree diameter.

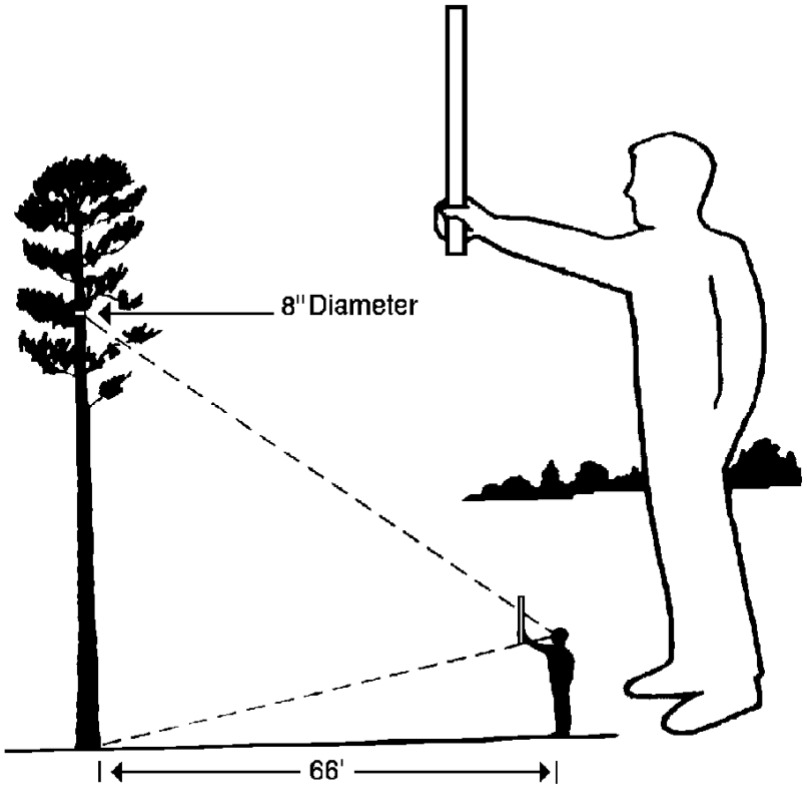


Figure 2. Use of tree scale stick to estimate merchantable height.

VOLUME TABLE

To use this table, first measure the diameter at breast height (DBH) of a tree and place it into the proper 2-inch diameter class. Next measure the merchantable height of the tree in 16-foot logs to the nearest full half log. Read down the left-hand column until you come to the row containing the DBH. Then move across from left to right until you come to the column containing the tree merchantable height at the top. At the intersection of that row and column you will find the merchantable volume of the tree. Read and record each tree volume directly and separately. **FOR CONTEST PURPOSES, DO NOT USE THE VOLUME TABLE ON THE TREE SCALE STICK**.

International ¼ inch Log Rule -- Form Class 78

VOLUME (board feet) BY NUMBER OF 16-FOOT LOGS

DBH	1	1½	2	2½	3	3½	4	4½	5
10	**36**	**48**	**59**	**66**	**73**	**-----**	**-----**	**-----**	**-----**
12	56	74	92	106	120	128	137	-----	-----
14	**78**	**105**	**132**	**153**	**174**	**187**	**200**	**-----**	**-----**
16	106	143	180	210	241	263	285	-----	-----
18	**136**	**184**	**233**	**274**	**314**	**344**	**374**	**-----**	**-----**
20	171	234	296	348	401	440	480	511	542
22	**211**	**290**	**368**	**434**	**500**	**552**	**603**	**647**	**691**
24	251	346	441	523	605	664	723	782	840
26	**299**	**414**	**528**	**626**	**725**	**801**	**877**	**949**	**1,021**
28	347	482	616	733	850	938	1,027	1,114	1,201
30	**403**	**560**	**718**	**854**	**991**	**1,094**	**1,198**	**1,306**	**1,415**
32	462	644	826	988	1,149	1,274	1,400	1,518	1,637
34	**521**	**728**	**934**	**1,119**	**1,304**	**1,447**	**1,590**	**1,727**	**1,864**
36	589	826	1,063	1,274	1,485	1,650	1,814	1,974	2,135
38	**656**	**921**	**1,186**	**1,428**	**1,670**	**1,854**	**2,038**	**2,224**	**2,410**
40	731	1,030	1,329	1,598	1,868	2,081	2,294	2,494	2,693

TREE MEASUREMENT SCORE SHEET						
State		Group No.	Contestant's Name			
No.	Species (1 pt ea)		DBH (2 pts ea)	# 16 ft logs 4 max (2 pts ea)	Volume Board Feet	Score
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
Total board foot volume in plot						----------
Total board foot volume per acre						----------
(a) Subtotal of Tree Scores (75 points possible)						
(b) Score for Volume Per Acre (25 points possible)						
Contestant Score (a + b)						

Plot Size_____

COMPASS AND PACING

Objective

Contestants will learn to estimate ground distances by using the pacing method and to determine direction of travel using a compass. This will be accomplished by measuring a course of five lines. The lines may be level, or slope up or down hill. Successive lines may or may not be continuous.

Contest Rules

1. Each contestant should determine the number of paces he or she takes per 100 feet on a practice course prior to the contest. Pacing distances **must** be estimated using a normal walking stride. **No heel to toe or other measurement is allowed**.

2. A Silva Ranger mirror-sighting type azimuth or quadrant compass will be used during the contest. A contestant may use his or her own hand-held compass, provided that it is of a type that is neither more accurate nor more sophisticated than a Silva Ranger compass. The contest committee will provide mirror-sighting type compasses for this event upon request. Compass declination must be set at zero.

3. Contestants using a quadrant compass are required to use the correct two-letter designation with each bearing recorded on the score sheet, for example N 27º W.

4. The course layout will consist of five (5) lines with staked corners. Every effort will be made to avoid slopes over 15 percent, steep ravines, heavy brush, large rocks and wetlands on the contest course.

5. Instructions will be given to the contestants before beginning the course. The exercise will be completed on an individual basis. Each contestant will measure the azimuth or bearing and the distance for each line, record the measurements on a score sheet, and return the score sheet to the official in charge.

6. Contestants may receive a maximum total score of 100 points. A maximum of 20 points is possible for each of the five lines, 10 points for the correct azimuth or bearing and 10 points for the correct distance. One-half point will be deducted for each degree of error in the azimuth or bearing up to a maximum of 10 points per line. One-half point will be deducted for each foot of error in distance up to a maximum of 10 points per line.

COMPASS AND PACING STUDY GUIDE

Foresters are often required to estimate horizontal distances by the pacing method, and to determine direction of travel by using a compass. These methods are very useful in cruising timber and finding property boundaries.

All maps and land surveys express the distance between two points as the horizontal distance, that is the distance measured on the level. Thus, it becomes necessary to correct for slope when estimating horizontal distance on the ground. Pacing is an expedient, but crude, method of determining ground distances. A pace is two steps (Figure 3). On level, open ground, pacing can become fairly accurate with practice. But, on slopes, and in brushy or rocky areas, its accuracy diminishes (Figure 4). To correct for slope the following suggestions from the *Forestry Handbook* are provided:

> In difficult terrain no attempt should be made to maintain a standard pace. Instead, allow for an inevitable shortening (downhill as well as uphill) by repeating the count at intervals. For example, on moderate slopes count every tenth pace twice: 1, 2,3 ,4, 5, 6, 7, 8, 9, 10, 10, 11, 12 and so forth. On steeper slopes it may be found necessary to repeat every fifth count: 1, 2, 3, 4, 5, 5, 6, 7, 8, 9, 10, 10, 11, 12, and so forth. Consistent accuracy in pacing is maintained only by constant checking. Errors of 1 to 2 chains per mile are expected under average conditions, and errors of less than 1 chain in 100 chains are common On the steepest slopes in very heavy brush, in swamps, or among boulders, every count may have to be repeated. Consistent accuracy in pacing under such conditions is attained only by practice and is maintained only by constant checking. (*Forestry Handbook*, Second Edition 1984, Section 19, page 1090.)

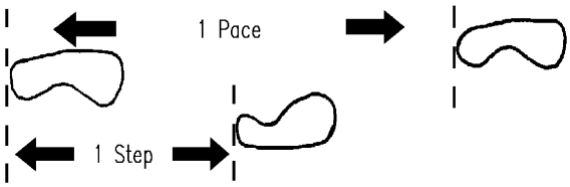


Figure 3. Illustration showing the difference between a step and a pace.

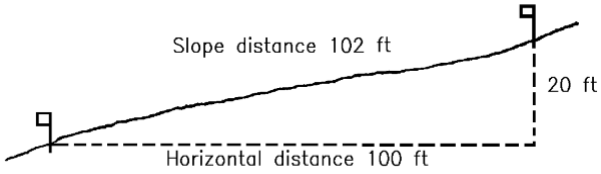


Figure 4. Estimating horizontal distance on a 20 percent slope.

A compass is used to tell the direction of travel by estimating the angle of deflection from magnetic north. Magnetic north is the direction toward which the compass needle always points Most compasses are designed to measure direction in either azimuths or bearings. Azimuths range from 0º to 360º (Figure 5). Bearings range from 0º to 90º in each of four quadrants (Figure 6).

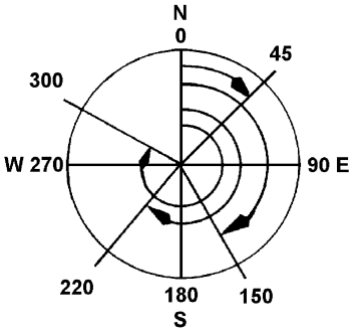


Figure 5. Azimuths are read from an azimuth compass

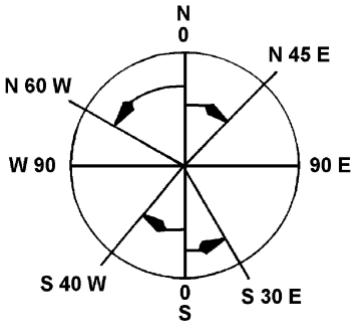


Figure 6. Bearings are read from a quadrant compass

COMPASS AND PACING SCORE SHEET					
State		**Group No.**	**Contestant's Name**		
Line	Azimuth or Bearing	Points	Distance	Points	Score
A-B					
B-C					
C-D					
D-E					
E-F					
Contestant Score					

Contestants should fill in the azimuth or bearing and distance for each line.

TOPOGRAPHIC MAP CONTEST
USGS US TOPO

Objective

Contestants will learn the following skills relating to the recreational use of topo maps:

1. Identifying topographic and/or man-made features.
2. Locating features based on UTM grid designation.
3. Measuring the straight-line distance between two locations.
4. Determining the map azimuth between two locations based on grid north (GN).
5. Converting the gird north (GN) map azimuth to magnetic north (MN) for field use.
6. Calculating the elevation difference between two locations.
7. Calculate the % slope – combination of skills contained in #3 and #6 above.

The contest is based on US TOPO Quadrangle 7.5 Minute Series maps, 2010 or newer. Contest maps will be selected from US Forest Service (USFS), National Park (NPS), or State Park recreational areas providing information showing trails, campsites, parking, etc. and land topographic configuration at a scale of 1:24,000. These maps have a UTM 1,000-meter square (yellow) grid superimposed on the map for locating features and determining azimuths based on grid north (GN).

Contest Information and Rules

1. Materials provided for contestants:
   a. 1:24,000 UTM grid reader with 360-degree protractor. Test questions will be referenced to UTM grid locations. No supplemental arrows, marks or lines will be added to the map for testing purposes.
   b. An engineer's scale ruler.
   c. US TOPO Quadrangle 7.5 Minute Series Map.

2. Materials contestants need to bring: pen or pencil and a calculator.

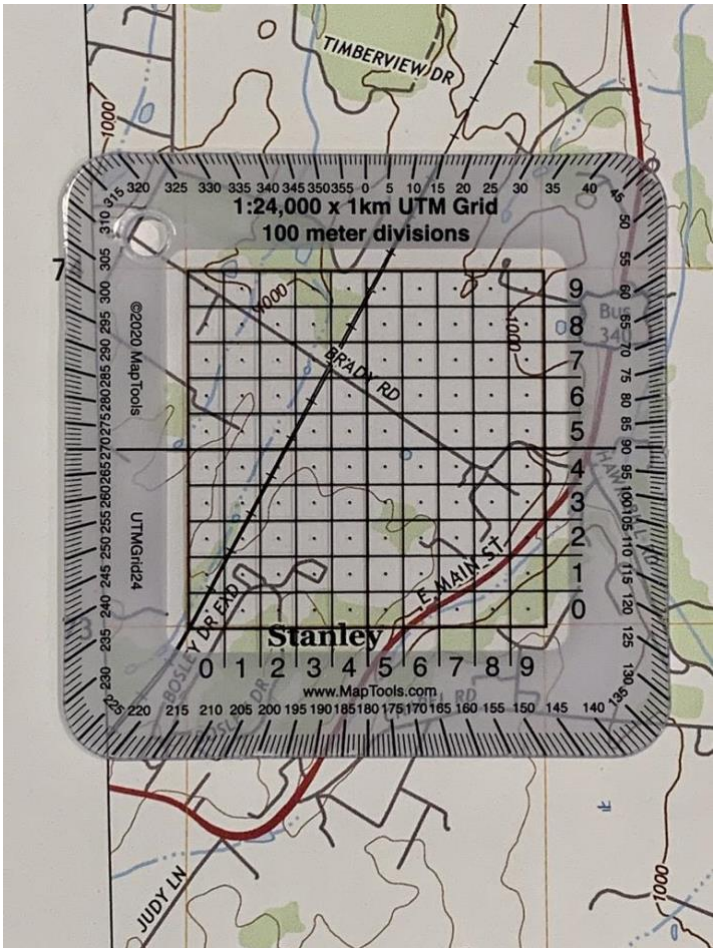
3. Identification of map symbols and/or features based on UTM grid coordinates from the listing of map symbols: us-topo-map-symbol-file

4. There will be five (5) of the map features listed above, designated by UTM coordinates, for identification worth two (2) points each for a total of 10 points for this section of the contest.

5. Determine the distance between the two locations to nearest 100 feet using an engineer's scale ruler or the map scale (feet) at the bottom center of quad sheet. Locations will be designated by UTM coordinates. A correct measurement, based on the value determined by the judge(s) is worth 8 points. Hint: UTM 1,000-meter squares are designate by the junction of the "easting" vertical lines and the "northing" horizontal lines in the southwest corner of the square, i.e., the "address" for everything within the 1,000-meter square. Locations can be refined to 100-meter squares with the grid reader by adding another digit to the 1,000-meter square identification "address". Read right then up for the 6-diget UTM locations used in this contest.

Example: What is the distance from the railroad junction with Brady Rd north to the end of the double railroad track?

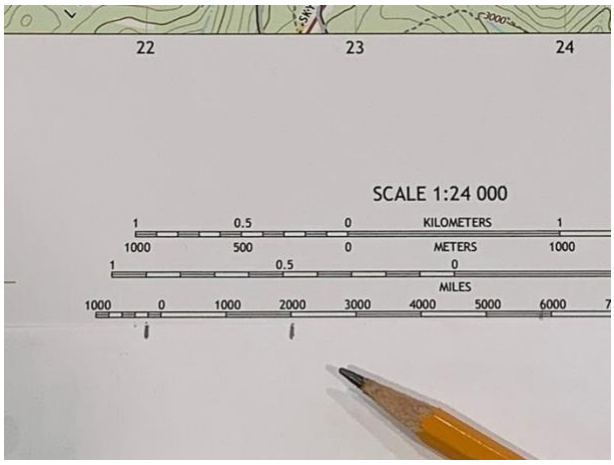
Locate the junction of the double railroad track and Brady Rd UTM 183737



Measure the map distance with an engineer's scale ruler using the 20-factor side of the ruler and multiply by 1000 to obtain field distance to the nearest 100-feet.

As an alternative method use the edge of a piece of paper (test score sheet for example) and mark the two points. Use map scale bar for feet located in the bottom center of the map to determine distance between marks to nearest 100-feet.

On the edge of a piece of paper place a tic mark at the road junction an at the end of the double track. Using the feet scale at the bottom center of the map place the right-hand tic mark on appropriate 1000-foot mark and read the distance to the nearest 100-feet at the left-hand tic mark.



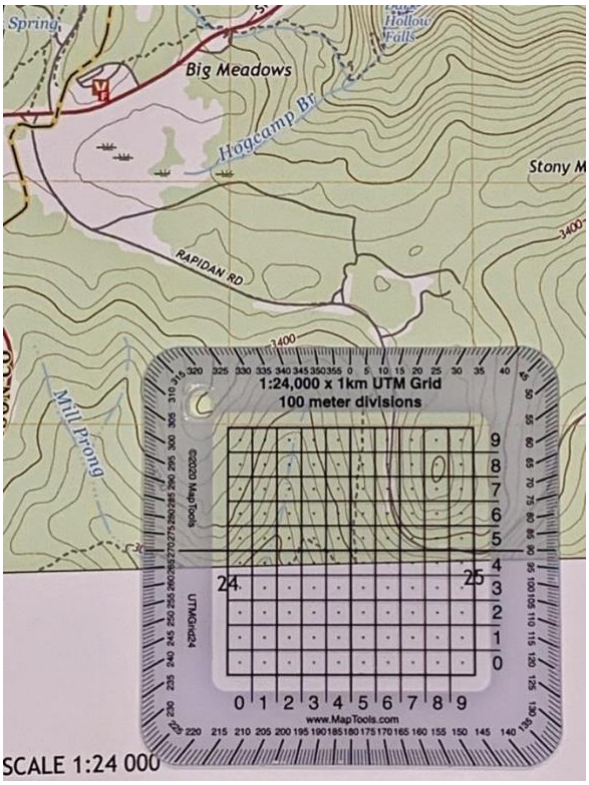
Both methods produce a value of 2,200 feet.

6. Determine the azimuth based on grid north (GN) between two points identified by UTM grid coordinates using the supplied grid reader. This azimuth calculation is worth 8 points if within $\pm$ 2 degree or 4 points if within $\pm$ 3 degrees based on the value calculated by the judge(s).

Center the UTM grid reader on the observation point and orient with the UTM grid (yellow) north/south (vertical) and east/west (horizontal) lines. Then place a ruler or straight edge such that it intersects with grid reader center and distant location. Read the grid north (GN) azimuth to the nearest whole degree along the edge of the reader.

Example: What is the azimuth from the top center of the peak at UTM 248648 to the Big Meadows Visitor Center? Hint: The northing grid line 64 is below the lower edge of the map. Measure down from the 65 northing gird line.

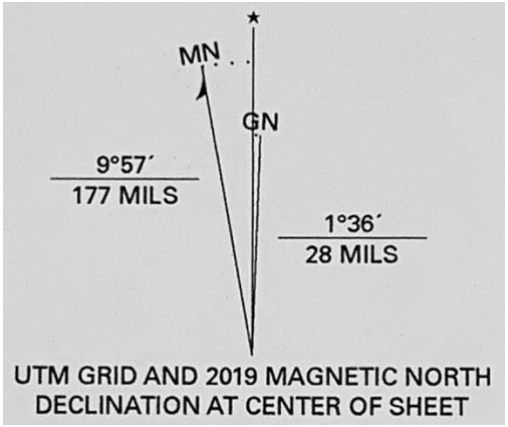
Center the gird reader on the top of the peak. Orient grid reader to align with the N-S and E-W yellow grid lines. Use the edge of a piece of paper or a ruler so that is passes through the center of grid reader and the Visitor Center. Read the azimuth to the nearest degree along the edge of the grid reader.



Answer: 320 degrees GN.

7. Convert the map grid north (GN) azimuth from #6 above to a magnetic north (MN) azimuth, to the nearest whole degree, for field use. This calculation is worth 8 points and is independent of the answer for #6 above, i.e. if GN from #6 was incorrect but the conversion value from that GN to MN is correct then 8 points are awarded.

Both grid north (GN) and magnetic north (MN) are shown in relation to true north (TN) in a diagram located to the left of the scale bars at the bottom of US Topo maps.

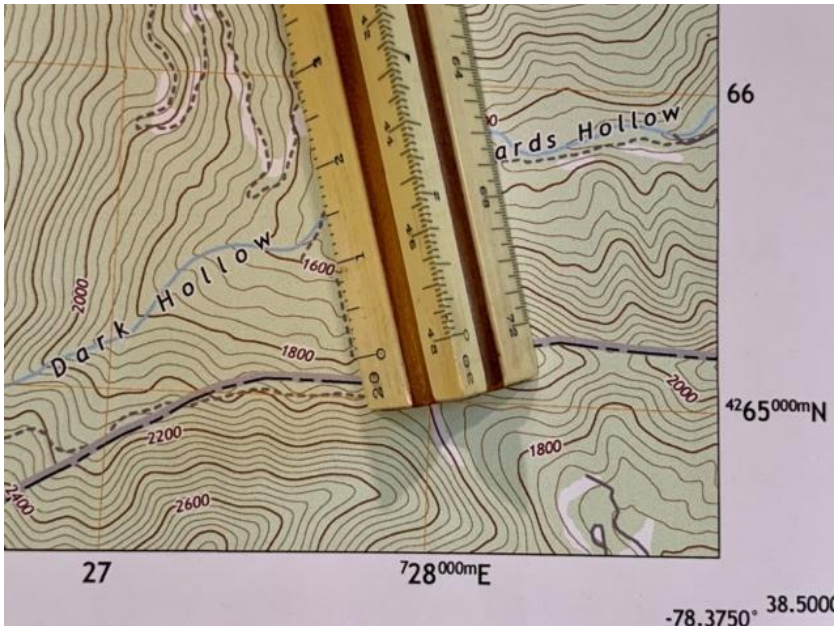


Adjusting values in a clockwise direction require addition of departure values. Adjustments in a counter-clockwise direction subtraction. For the Big Meadows VA quad MN is separated from GN by 9° 57′ to convert to TN plus 1° 36′ to convert TN to GN for a total positive difference of 11° 33′, round off to 12°. Therefore, 320° + 12° = 332°

8. Determine the difference in elevation between two locations identified by UTM grid coordinates. A site description of the map locations will also be included for conformation of location point. If a location is between contour lines, use one-half (1/2) the contour interval for the elevation value of that point, i.e., if a peak does not have a spot elevation marked then the elevation is the top most contour line plus one-half (1/2) the contour interval. Correct answers are worth 8 points based on calculations by the judge(s).

9. Calculate the % slope between two locations identified by UTM grid coordinates. Correct answer worth 8 points if within ±2%.

   % slope is the difference in elevation divided by the distance times 100.



   For the trail section in UTM 2765 located between index contour lines 1800 and 1600. The difference in elevation is 200-ft and the distance between the index contours is 900⁺-ft. % slope = (200 / 950) ∗ 100 = 21%. Calculations using 900-ft yield 22% and 1000-ft yield 20% which all fall within the ±2% range for a maximum score of 8 points.

10. Any applicable special instructions will be given by the judge(s) prior to commencement of the contest. Contest will be conducted on an individual bases.

11. A maximum of 50 points is possible for this event. A typical recreation topo map for use in this contest, and the one shown in the examples above, is exemplified at Big Meadows, VA

TOPOGRAPHIC MAP SCORE SHEET			
STATE:	GROUP:	CONTESTANT:	
QUESTION	MAP SYMBOL OR FEATURE		SCORE 2 pts ea
1			
2			
3			
4			
5			
CALCULATIONS			SCORE 8 pts max each
DISTANCE			
GRID AZIMUTH			
MAGNETIC AZIMUTH			
ELEVATION DIFFERENCE			
% SLOPE			
		TOTAL SCORE	

FORESTRY BOWL

OBJECTIVES

The Forestry Bowl will provide an opportunity for teams of three or four contestants to demonstrate their knowledge of forestry and related subject matter in a competitive setting where attitudes of friendliness, fairness, and excitement prevail. States **must** have at least three contestants to participate in the Forestry Bowl.

Teams will be placed in a bracket for the Forestry Bowl based on team scores in the written exam. Any byes necessary will be used during the first round of the Forestry Bowl. This will produce a full bracket in the second round.

EQUIPMENT

Panels -- Two interconnecting panels, each to accommodate four contestants plus a moderator panel with suitable controls are to be used. The equipment will be checked prior to the start of each round of competition.

Time keeping device -- A stop watch or another appropriate device is to be used.

Score keeping device -- This may be a blackboard or flip chart.

Questions -- A packet of questions for each round shall be prepared in advance. Each packet shall contain at least 30 questions but not more than 50. If there are several acceptable answers to a question, all answers shall be listed. For the semifinal and final rounds questions may include a visual aid such as a slide.

Setup -- See diagram for a sample bowl contest setup.

OFFICIALS

Moderator (Quiz Master) -- The moderator assumes complete direction of all rounds, asks all questions, designates contestants to answer questions, accepts or rejects all answers, but may seek interpretation of questions from the Referee Judge.

Referee Judges -- One judge may be used. The referee judge and the moderator must agree on the acceptability or rejection of a question and/or answer if either is challenged by team captains (See Procedure for Protest 1., page 29).

Time-keeper -- A time-keeper will be used to indicate to the moderator the expiration of the time allowed in which to answer questions. The time-keeper may be one of the referee judges but, only when so designated.

Score-keepers -- One or two individuals will keep score on each round. Score-keepers will keep score in such a manner that all points awarded or taken away in penalties may be checked. A judge may serve as score-keeper.

PROCEDURE OF PLAY

Starting the Contest

1. Teams are assembled and seated at their respective panels.

2. The team captains shall be seated nearest the moderator.

3. The question packet is opened by the moderator.

4. The moderator will **not** give the correct answers, except in the final round. No discussion is permitted.

Part I – Directed Questions

5. A coin is tossed to determine which team captain will answer the first question.

6. The second question will be answered by the captain of the opposing team. Succeeding questions will be asked alternately of each team, and rotated among team members, until a total of 24 questions has been asked.

7. Only the designated team member may answer the question. The team member has ten (10) seconds to **begin** the answer, and ten (10) seconds in which to **complete** the answer. A request to repeat the question **must** be made within five (5) seconds, and the question will be repeated only once.

8. If the answer is correct, 10 points will be awarded the team. No points will be given for partial or incorrect answers.

Part 2 – Toss Up Questions

9. Part 2 begins with the moderator reading a toss-up question (as with all succeeding questions) until a contestant activates a buzzer.

> a. If a buzzer is activated during the reading of any question, the moderator immediately will cease reading the question and the contestant activating the buzzer shall begin the answer based on that portion of the question read.
>
> b. If the answer given is incorrect, or no answer is given, **five (5) points are taken from that team's score** and the moderator repeats the question. The opposing team then has ten (10) seconds for any member to activate the buzzer and answer the question. If the answer is incorrect, 5 points will be taken from that team's score. No team consultation is permitted.
>
> c. If a bonus question is attached to an incorrectly answered toss-up or a toss-up question is unanswered following an activated buzzer, that bonus question is transferred to the next possible toss-up question to which no bonus question is attached.

10. At the completion of the reading of a question or when a buzzer is activated, ten (10) seconds are allowed in which to begin an answer, and another ten (10) seconds are allowed in which to complete the answer.

11. The answer **must** be given by the contestant activating the buzzer. No consultation on toss-up questions is permitted. It shall be the responsibility of the moderator to determine if an actual answer is started and completed within the time period.

12. If the time elapses in which to answer a question without a contestant activating the buzzer, the question is discarded. If a bonus question was attached to an unanswered toss-up question, the bonus question is then transferred to the next toss-up question to which no bonus is attached.

13. If the toss-up question is correctly answered within the 10-second time limit, that team scores 5 points.

a. If a bonus question is attached to the correctly answered toss-up question, the moderator then reads the bonus question and a 10-second discussion period is permitted for the team consultation to determine the answer. The end of the 10-second period is signaled by the timer. begin the answer.

b. Successful completion of the answer will result in that team being awarded 10 points for that bonus question.

c. All parts of the bonus questions must be answered correctly with no partial points permitted regardless of the number of parts of the question answered correctly.

d. Failure to answer a bonus question or failure to answer correctly, results in no penalty (loss of points) to the team.

14. When slides are used in the semifinal and final rounds for toss-ups, no questions will be written on the slides.

Completing the Contest

1. The moderator will continue reading toss-up and bonus questions until all toss-up questions and their accompanying bonus questions have been asked or 30 minutes have elapsed, whichever comes first, except the last round which may last 45 minutes or less.

2. Following the final question, the score will be announced. In the final round, scores from the two score keepers shall be compared. If there is disagreement as to the score of the game, the score that is tabulated on the written score card will be used and any discrepancies resolved by the Judges.

PROCEDURE FOR PROTEST

1. A total of two protests are allowed as follows: one protest can be made per team per round. Each Bowl game will consist of two (2) rounds: Directed Questions and Toss Up Questions

2. Any protest of a question or procedure **must** be made by the team captain at the time a particular question is presented or is being administered. Once a new question has been read it is too late to protest a previous question.

3. The captain can declare a protest immediately after:
    a. The question has been read
    b. The answer has been determined correct or incorrect by the moderator or judge
    c. Points are awarded
    d. The moderator gives the correct answer.

4. Upon declaring a protest, the team captain must state on what grounds the question is being protested. The moderator will then rule upon the protest, or consult with the judge and then give their ruling. Options regarding the ruling include:
    a. The question is discarded and another question is substituted
    b. The moderator (or judge) agrees or disagrees with the basis of the protest and awards points or not accordingly
    c. The question may be forwarded to the opposing team in accordance with the contest rules.

    It will be the moderator's prerogative to give the correct answer and reason for the ruling before moving on to the next question.

5. Spectators, coaches, parents and visitors may not protest any question, answer, or procedure during the course of play. However, coaches may submit in writing to the contest officials any suggestions, complaints, or protests at the conclusion of the contest. Questions and procedures will then be modified or not as appropriate for future rounds.

6. Inappropriate behavior, unsportsmanlike conduct, or any actions which are generally deemed as detrimental to the contest, may result in dismissal of individual(s) responsible for such actions from the immediate area of the contest. Such action could result in that team's disqualification.

RECORDERS AND CAMERAS

Absolutely no recording of quiz bowl questions or visual aids is permitted; this includes writing down questions while the contest is in progress. Voice recording devices such as video tape cameras, movie cameras, cell phone cameras, or any other type of camera may **not** be used during the conducting of the match. Photographs will be permitted only before or after a match and then only in such a manner as not to be disruptive of the contest.

EQUIPMENT FAILURE

1. If the device being used ceases to function during a match or is believed to be malfunctioning, a "time-out" may be called by any contestant or moderator.

2. If, after checking, it is determined that there is an equipment malfunction, the faulty part or parts will be replaced and play will be resumed.

3. Scores accumulated up to the point of the "time-out" shall stand, and all further points given or taken during the remainder of the match will be added to or subtracted from this total.

4. If both referee judges or one referee judge and the moderator deem it advisable, points awarded for the two (2) questions asked immediately prior to determination of equipment failure may be recalled and two (2) additional questions used.

5. Under no conditions shall there be a replay of a match in which there was equipment failure.

METHOD OF SELECTING FORESTRY BOWL QUESTIONS

Questions will be selected by the National 4-H Forestry Invitational Committee, and all questions used during a particular round will be eliminated for all remaining rounds.

SAMPLE QUESTIONS FOR BOWL

1. A board foot is equivalent to a board that measures: **Answer** - 12" wide, 1" thick, 12" long, or 144 cubic inches.

2. The board foot formula is: **Answer** - Length in feet x width in inches x thickness in inches divided by 12.

3. Diameter at breast height (DBH) is measured on the tree trunk at what distance above the average ground level? **Answer** - 4.5 feet

4. A standard cord of wood is measured: **Answer** - 4' x 4' x 8' (128 cubic feet)

5. Habitat is: **Answer** - The area where a plant or animal lives.

REFERENCES FOR FORESTRY BOWL AND WRITTEN EXAM

1. National 4-H Forestry Manuals - Units A, B, and C; available from the “Training References” section of the Invitational web site.

2. *National 4-H Forestry Invitational Handbook*. http://www.4hforestryinvitational.org/

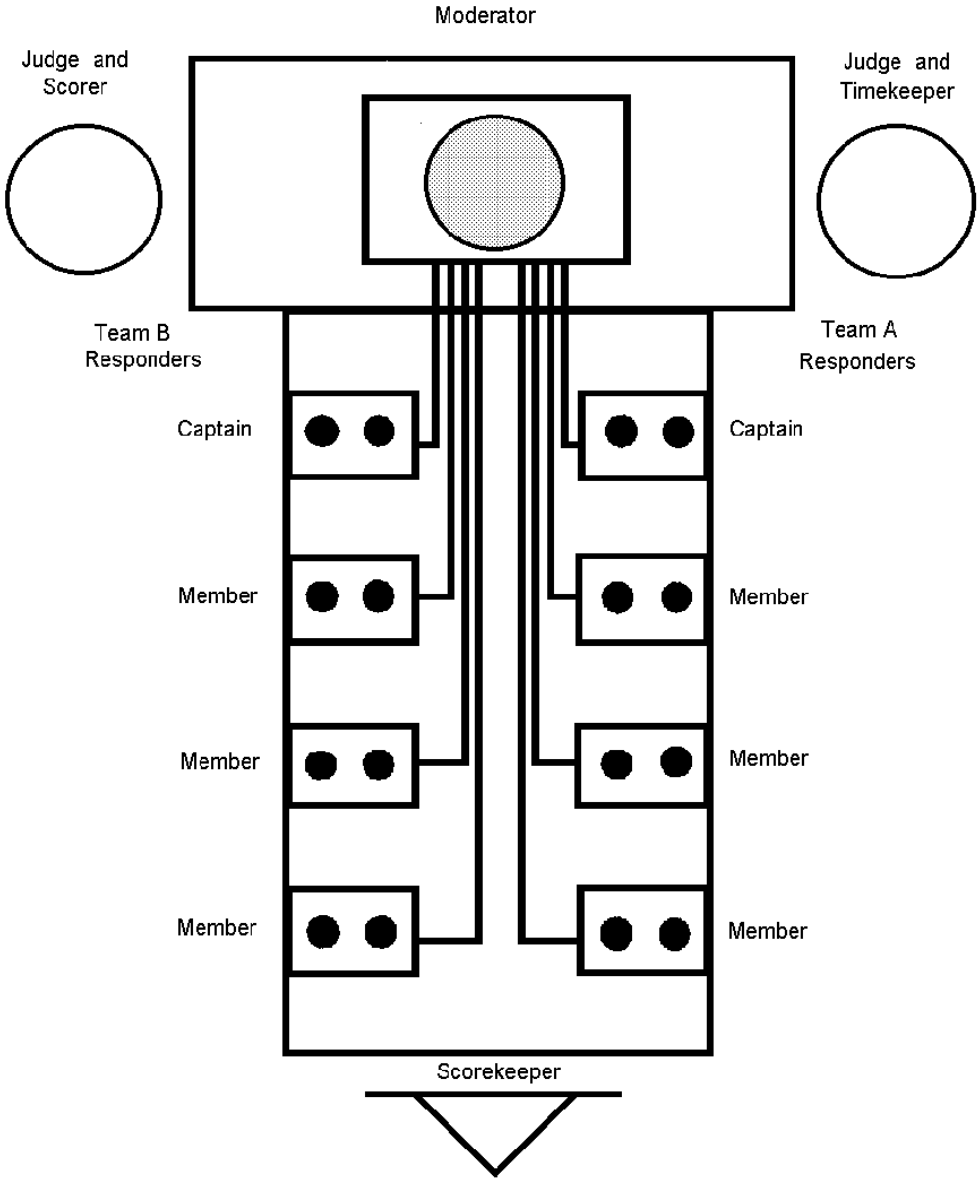
3. Only those species of trees, insects, and diseases listed in Tree Identification, Forest Health - Insects and Forest Health - Diseases and Health Indicators will be addressed in bowl questions.

SCORING

The winning team will receive 100 points. The second-place team will receive 90 points. Teams that reach the semifinal round will receive 80 points, the round before that 70 points, etc. All teams will receive the points due for competing in the first round, whether or not they advance.

Spectators will be allowed only for the final round of competition, except when authorized by the Management Committee member supervising the Forestry Bowl.

SUGGESTED BOWL SETUP



FOREST EVALUATION

Objectives

Teams of four contestants will evaluate site factors and stand factors which effect the growth of forest crops. In addition, they will plan the future management of a forest stand. In order to successfully compete in this event, it is necessary for the participants to carefully study the material in the Forest Evaluation Study Guide. Each part of the event is closely related to the others so it is very important to gain an understanding of these relationships.

Contest Rules

1. Forestry teams will complete the forest evaluation contest as a group. This is not an individual event.

2. Forest Evaluation is divided into four parts; I Site Evaluation, II Forest Stand Evaluation, III Forest Inventory and IV Recommended Practices.

3. Competing teams will be given a situation description for the plot designated for the event. This situation description may include information about the landowner, his or her management objectives, local markets for forest products, etc. Teams will be responsible for completing all four parts of Forest Evaluation.

4. Devices and conditions to aid participants in making their decisions may include compass, clinometer, Abney level, tree scale stick, marked plot boundaries, designated trees for Section III INVENTORY, and a soil pit for Section I SITE EVALUATION.

5. Seventy-five (75) points are possible for each of parts I, II, III and IV, and a total of 300 points are possible for the entire contest.

   For part I categories A, B, C, D and E have a possible value of 15 points each.

   For part II categories A, B, C, D, E are each worth 10 points. Part F is worth 25 points.

   For part III each correct answer of tree species, crown class, DBH, and height in 16-foot logs are worth 3 points. Board-foot volume per acre and tree value per acre are worth 7.5 points each, provided that they are within ± 10% of the correct value.

   For part IV each management practice is worth 7.5 points each.

FOREST EVALUATION STUDY GUIDE

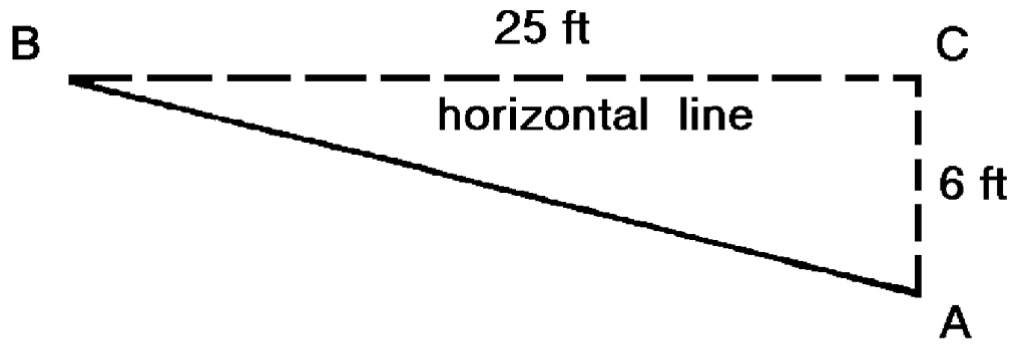
Every acre of land should be devoted to its best use. This is an idea that landowners have had about agricultural land for many years. Level and slightly rolling land was used for row crops and grain, and rolling and better upland slopes for pasture and meadow. The general ideas about forest land are that forests will grow well on all lands not suited for other crops. This is not correct. There are excellent, good, fair, and poor sites for timber production just as there are different kinds of farm crop land. There are forest lands that will economically support cultural practices and permanent physical improvements, and other stands in the same area might barely pay land taxes. There are acres that can be harvested every 10 years, and there are other acres that may never produce commercial timber. Forest Evaluation is based on the premise that trees will be harvested, now or in the future, to maximize the goals of a specified landowner.

SITE EVALUATION

The site is the habitat or environment in which a plant or plant community lives. There are a number of site factors that determine the desirability of a particular location for tree species. Some of the factors are soil depth, slope percent, aspect and slope position. These factors can be used to determine the forest land capability class of a particular tract of land.

Soil depth is the distance from the soil surface down to un-weathered rock or an impermeable layer which restricts water movement and root penetration. For contest purposes shallow soils are less than 24 inches deep, and deep soils are greater than 24 inches deep.

Slope percent is the number of feet of rise or fall in 100 feet of horizontal distance. For contest purposes slope percent is broken into the following categories: 0-20 percent, 21-40 percent and 41 percent plus. Slope percent can be measured with an Abney level or a clinometer. Figure 7 below illustrates a 24 percent slope. Measure the slope within the boundary of the plot for the contest.



AC / BC X 100 = slope percent of AB
6 / 25 X 100 = 24 percent

Figure 7. Method of determining slope percent.

Aspect is determined by taking a compass reading while facing down a slope. The direction water would run gives the compass direction. Any slope facing north and east of a line extending from N315°W to S135°E is considered to have a desirable northeast aspect. Any slope facing south and west of that same line is considered to have a less desirable southwest aspect. See Figure 8, below.

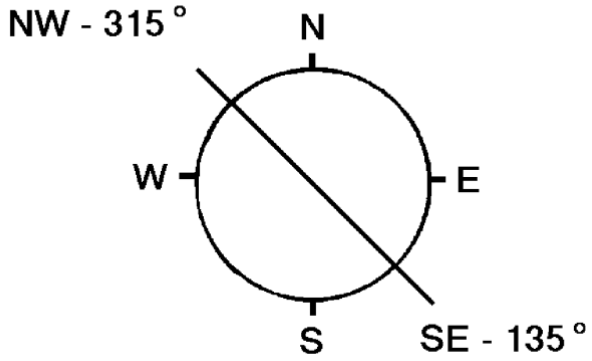


Figure 8. Method of determining aspect.

Slope positions are classified as upper 1/3, middle 1/3 and lower 1/3.

Forest land capability classes are described below for the purpose of this contest:

> **Class I. Excellent** has few limitations for tree growth. Most sites have little slope and no erosion problems. The soil is fertile and holds water well. It is well drained, but not droughty. These sites will produce high quality timber.
>
> **Class II. Good** is usually gently sloping. In some cases, there are drainage problems that affect tree growth.
>
> **Class III. Fair** may be fairly steep. Soils may have low fertility and tend to be droughty.
>
> **Class IV. Poor** may be very steep with shallow soil. Sites may be rocky, shaly, have low fertility and be very dry.

FOREST STAND EVALUATION

Grazing damage is defined by the following categories for the purpose of this contest:

Grazed - tree seedlings eaten or trampled, soil compacted, and bark rubbed off.

Un-grazed - no evidence of grazing damage.

Fire may be present as a destructive agent or a management tool. **Wildfire** can be very destructive particularly in hardwood forests. Destruction of the litter layer on the forest floor, crown scorch or burning of the foliage, and scalds or scars on the tree trunks are all evidence of wildfire damage. **Prescribed burn** or controlled burn is a management tool which can be used to manage competing vegetation, prevent fuel accumulation, and improve wildlife habitat without damaging crop trees.

Size distribution is classified into 4 categories for the purposes of this contest. In some stands more than one size class may be represented, particularly in uneven-aged stands. To determine the size class of the stand, evaluate the trees that make up the overstory or main forest canopy of the plot. Specific size classes are defined as follows: trees less than 1 inch in diameter –seedlings; trees from 1 to 3 inches in diameter – saplings; trees 4 to 10 inches in diameter – pole timber; and trees more than 10 inches – sawtimber (each measured at DBH).

Forest types are different from each other in species composition and management requirements. The following forest types, defined by the Society of American Foresters in *Forest Cover Types in the United States and Canada 1980*, are used in this contest:

Mixed Oaks (Type 53, White Oak; and Type 55, Northern Red Oak)

Dominant species – white oak and northern red oak

Associated species – black oak, scarlet oak, chestnut oak, white ash and yellow-poplar

White Pine (Type 21 – White Pine)

Dominant species – eastern white pine

Associated species – yellow-poplar, eastern hemlock, oaks, birches, black cherry, white ash, sugar maple, American basswood, shortleaf pine and pitch pine

Cove Hardwoods (Type 57, Yellow-poplar; Type 58, Yellow-poplar – Hemlock)

Dominant species – yellow-poplar

Associated species – eastern hemlock, black locust, red maple, sugar maple, sweet birch, oaks, cucumbertree, American basswood, blackgum and white ash

Red Oak, White Oak, Hickory (Type 52, White Oak, Red Oak, Hickory)

Dominant species – northern red oak, white oak, black oak and hickories

Associated species – a wide variety of hardwood species

Northern Hardwoods (Type 25, Sugar Maple-Beech-Yellow Birch; Type 60, Beech-Sugar Maple)

Dominant species – American beech, sugar maple, (yellow birch - absent at Jackson's Mill)

Associated species – American basswood, red maple, eastern hemlock, white oak, northern red oak, white ash, black cherry, mockernut hickory, sweet birch, yellow-poplar, cucumbertree, and black walnut.

Stand origin can vary from one stand to another, even though the stands are of the same forest type and size distribution. Timber stands may originate by several different means. Natural stands may arise from **seedlings, sprouts** or a **mixture** of both. Sprouts, also known as coppice, can be from either cut

stumps or root suckers. Sprouts are important sources of new trees in the regeneration of most hardwood forests. Stands which originate from planted seedlings are called **plantations**. These stands may be of higher quality than their predecessors if genetically improved seeds or seedlings are used.

Stocking is a term used to describe how well the trees in a stand utilize the available space. Stocking, for the purposes of this contest, is measured using the average diameter of all trees 10 inches DBH and larger, and the number of trees per acre 10 inches DBH and larger. Figure 9 is used to determine stocking. A **well-stocked** stand is one in which the trees are well distributed, and all the space is utilized, but the trees still have room to grow. An **understocked stand** is one in which there are open spaces between the trees so that the stand will not produce its full potential. An **overstocked stand** is one which is so crowded that trees are growing very slowly, and some may be dying because of too much competition.

For example: If the plot size is 1/10-acre, average DBH of trees 10 inches DBH and larger is 16 inches and the number of trees in the plot 10 inches DBH and larger is 12, is the stand understocked, well-stocked or overstocked? If there are 12 trees in a 1/10-acre plot there are 120 trees per acre. Look at the Stocking Guide (Figure 9) and find 120 trees per acre on the Y-axis. Now find 16 inches dbh on the X-axis. Extend the trees per acre horizontally toward the right and the DBH vertically toward the top until they intersect. The point of intersection falls in the part of the Stocking Guide labeled "overstocked." This means the plot is overstock

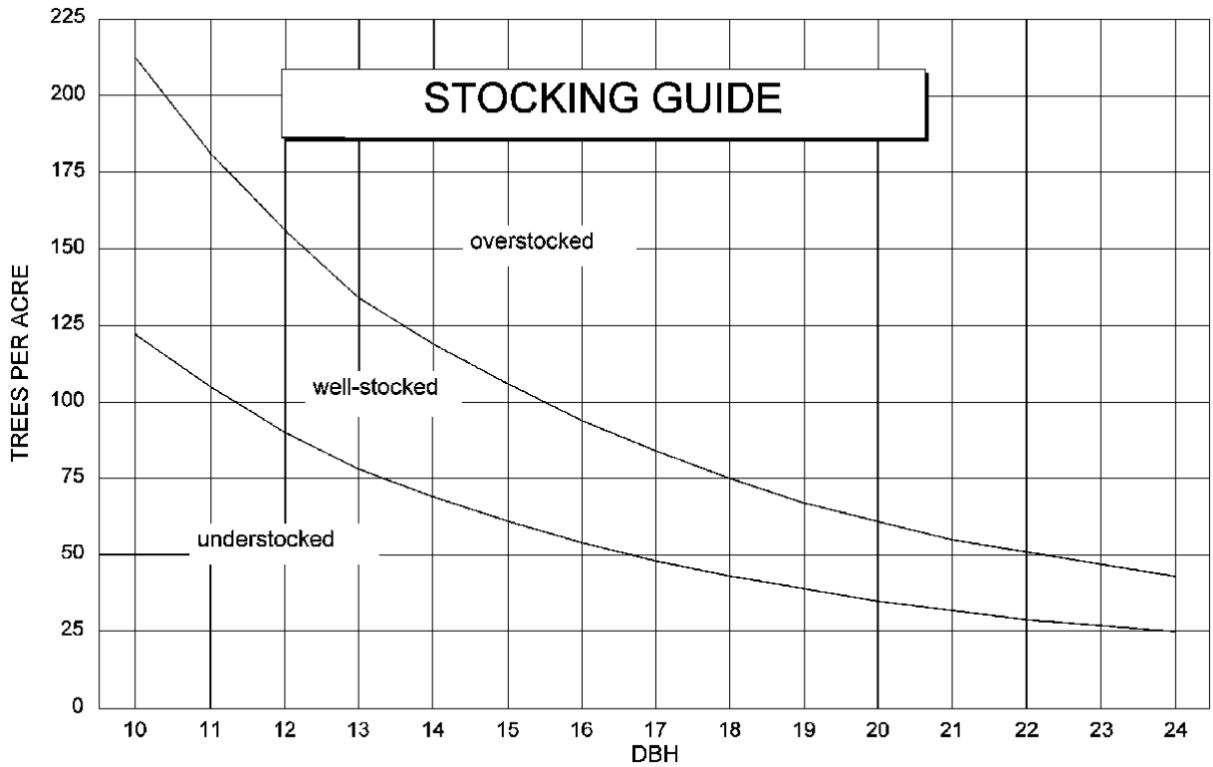


Figure 9. Method of determining stocking.

FOREST INVENTORY

Species of each numbered tree should be listed using the common names from the Official Tree List on pages 6-8.

Crown class of each tree should be determined and recorded as either dominant, co-dominant, intermediate, or suppressed. These crown classes are defined in the Glossary on page 42.

DBH(diameter at breast height) of each tree should be measured and recorded to the nearest even 2-inch diameter class (see page 16).

Height (in 16-foot logs) of each tree should be measured and recorded to the nearest full half-log.

Board-foot volume per acre – The board-foot volume of each tree should be determined and recorded using the table on page 18. Then, after taking into account the plot size, the board-foot volume per acre should be calculated.

Tree value per acre – The dollar value of each tree should be determined by multiplying the volume of each tree, expressed in thousand board feet, by the value of that species per thousand board feet. Values for each species will be given in the written situation description. For example: if a 20-inch, 2½ log white oak contains 348 board feet, and white oak sells for $300 per thousand board feet, then the value of the tree equals $300 X 0.348 = $104.40. Then, after taking into account the plot size, the tree value per acre should be calculated.

RECOMMENDED PRACTICES

A list of forest management practices appears on the Forest Evaluation Score Sheet. Each team will be given **a written scenario** with information about the landowner and his or her objectives for management. Based on the data you collected about the site and forest stand, and on the landowner's management objectives, consider each practice listed on the score sheet. Mark the practices you recommend which will improve the stand and help accomplish the landowner's objectives. Those practices that do not support the landowner’s objectives should be left blank.

Sample Scenario – Henrik and Dolores Svensen are a couple in their late forties. Their twins will be starting college next fall and they are looking to the 40-acre woodlot to supply them with some cash to help pay for some of the college expenses. Henrik enjoys hunting deer and turkey on his property and often invites one or two friends to hunt with him. They would not want any activity in their woods to damage the wildlife habitat. They have owned the woodlot for about 20 years and have managed it diligently over that time. They have a Stewardship plan that was drawn up right after they purchased the property and it has been updated once since then. Local markets are good with red oak worth $300, white oak worth $250, and mixed hardwoods worth $200 per thousand board feet on the stump. After your inventory and observation of their woodlot what recommendations would you make that would help them meet their objectives at this time?

Thinnings - are partial cuttings in even-aged timber stands. They are designed to improve future growth by regulating stand density. Thinnings can be commercial, where some or all of the wood harvested is put to use, or precommercial, where no wood is utilized.

Salvage or Sanitation Harvests - are cuttings by which the dead, dying, damaged, or deteriorating trees are removed to prevent the spread of pests as well as putting this "at risk" wood to use.

Selection Harvest - is a regeneration method used in uneven-aged stands, or to create uneven-aged stands, in which individual trees or groups of trees are removed. Some trees in each age class are removed including mature trees, poorly-formed trees, and trees of undesirable species.

Shelterwood or Seed Tree Harvests - are regeneration methods designed to create an even-aged timber stand. These harvests remove the mature stand leaving only a few trees for seed or to shelter the new stand.

Clearcutting - a regeneration method that involves the removal of the entire stand in one cutting to create an even-aged stand. Regeneration is provided for naturally, where desirable tree species seedlings or seed exists, or artificially through planting, where conversion to a more desirable species is recommended.

Prescribed Burning - is generally used as a means of controlling hardwood vegetation in softwood stands. Prescribed burning also improves wildlife habitat, stimulates sprouting seed germination, and encourages the growth of herbaceous plants.

Wildlife Habitat Improvement - Wildlife will generally coexist with any forest management scenario but the type of wildlife will vary depending on the management system a forester employs. Most wildlife species prefer a varied landscape with many edge and riparian zones. The type of wildlife a forester manages for is largely dependent on landowner objectives but also the type of forest a particular site will support

Recreational Opportunities - Recreation often goes hand-in-hand with forest management. Hiking, hunting, fishing, cross-country skiing, ATV riding, mountain biking, and bird watching are only a few of the types of recreation for which a forester might manage a forest. The ultimate decision should be largely based on the objectives of the landowner.

Non-Timber Forest Products - This area of forest management can work simultaneously with other forest management practices and is more developed in some regions of the United States such as the Pacific Northwest. It may be a hobby for some landowners yet can also generate a significant cash income for other landowners. Such things as Ginseng, St. John's Wort, and a whole host of mushroom species are items that a forester should be aware of and could be managing for given proper site conditions.

FOREST EVALUATION SCORE SHEET

State _____ Total Score_____

I. SITE EVALUATION (75 points total)**: Circle one** for each section as applicable (A) Soil Depth (15 pts), (B) Slope Percent (15 pts), (C) Aspect (15 pts), and (D) Slope Position (15 pts).

A. Depth of Soil	Deep - 24" or more						Shallow - less than 24"					
B. Slope Percent.	Rolling 0-20%		Steep 21-40%		Very Steep 41%+		Rolling 0-20%		Steep 21-40%		Very Steep 41%+	
C. Aspect	NE	SW	NE	SW	NE	SW	NE	SW	NE	SW	NE	SW
D. Slope Position												
Lower 1/3	I	II	I	II	I	III	I	III	II	III	III	IV
Middle 1/3	I	II	II	III	II	III	II	III	III	IV	IV	IV
Upper 1/3	II	III	III	III	IV	IV	III	IV	III	IV	IV	IV

E. Forest Land Capability Class (15 pts)**:** Determine the proper class by drawing a line down from the **Aspect** circled and across from the **Slope Position** circled. The Roman numeral where these lines intersect indicates the class. **Circle the class below**.

I. Excellent II. Good III. Fair IV. Poor

Part I Score_____

▪

II. FOREST STAND EVALUATION (75 pts total)**:** (Circle the correct answer in each section).

Grazing Damage (10 pts)
1. Grazed
2. Un-grazed

Fire (10 pts)
1.Un-burned
2. Wildfire
3. Prescribed Fire

Stocking (25 points)
1. Under stocked
2. Over stocked
3. Well stocked

Forest Type (10 pts)
1. Mixed Oaks
2. White Pine
3. Cove Hardwoods
4. Red Oak, White Oak, Hickory
5. Northern Hardwoods

Stand Origin (10 pts)
1. Natural regeneration
2. Plantation planting

Size Distribution (10 pts)
(May be more than one answer)
1. Seedlings
2. Saplings
3. Poles
4. Sawtimber

Part II Score_____

III. FOREST INVENTORY **Plot Size_____**

Tree #	Tree Species (3 pts ea)	Crown Class (3 pts ea)	DBH (3 pts ea)	# 16 ft Logs 4 max (3 pts ea)	Board-foot Volume	Tree Value
1						
2						
3						
4						
5						
Total Board Foot Volume and Tree Value in Plot						
Per acre values (7.5 points each)						

Crown Class: D = dominant, C = co-dominant,
I = intermediate, and S = suppressed **Part III Score**_____

IV. PRACTICES RECOMMENDED (75 pts total)**:** Check your recommend practices. (7.5 pts ea)

10. Which specie(s) would you favor on this site?_____
11. Protect the area from wildfire. Report any fire by calling 911 . . . . . _____
12. Stand is not yet merchantable, leave alone to grow . . . . . _____
13. Conduct a harvesting operation (If checked, select appropriate type below for pts). . . . . _____
    a. Conduct a thinning . . . . . _____
    b. Clearcut the stand and plant with a desirable species . . . . . _____
    c. Clearcut the stand and allow for natural regeneration . . . . _____
    d. Conduct a shelterwood or seed-tree harvest . . . . . _____
    e. Conduct a selection harvest . . . . . _____
    f. Conduct a salvage or sanitation cutting . . . . . _____
14. Use Best Management Practices and Sustainable Forestry guidelines . . . . . _____
15. Manage stand for non-timber forest products . . . . . _____
16. Manage stand for wildlife habitat improvement . . . . . _____
17. Manage stand for recreational opportunities . . . . . _____
18. Conduct a prescribed burn . . . . . _____
19. Fence the area from livestock . . . . . _____

Part IV Score_____

FORESTRY WRITTEN EXAMINATION

Objective

Contestants will be given an opportunity to demonstrate their knowledge and understanding of forestry information by completing a written examination. The examination will cover a broad spectrum of subject matter similar to the Forestry Bowl but will allow for more detailed questions since contestants will get to read them.

Contest Rules

1. The examination will be an individual event with the score contributing to each individual participant's score and the team score. A maximum of 50 points is possible.

2. The examination may include multiple choice, fill-in-the-blank, matching and discussion questions. One hour will be allowed for completion.

3. Discussion questions will be drawn from the following subject areas: forest management practices, forest health, forest regeneration, forest harvesting, and forests and society.

4. Study references are the same as for the Forestry Bowl.

STUDY GUIDE
NATIONAL 4-H FORESTRY INVITATIONAL QUIZ BOWL & WRITTEN EXAM

GLOSSARY
Rev.05.02.2019

TREES

Angiosperms - tree species are split into two broad categories, Angiosperms and Gymnosperms. Angiosperms are a taxonomic class of plants in which the ovule (which upon fertilization becomes the mature seed) is contained inside an ovary. The term hardwood is commonly used in reference to angiosperms, even though the wood is often softer than softwoods. Some major hardwood genera include oak, maple, hickory, birch, poplar, sweetgum and eucalyptus. "Angiosperm" translates as "hidden seed". Trees in this group are also often referred to as deciduous. Deciduous trees shed all their leaves during or before the onset of winter. However, some angiosperms (e.g. rhododendron, southern magnolia) hold green leaves all winter and recall some "evergreens" lose their leaves.
Annual ring growth - layer of wood-including springwood and summerwood - grown in a single year.
Artificial reproduction - means of reproducing trees asexually through the use of cuttings or budding and grafting.
Axis - main line of growth.
Bark - the tough outer covering of the woody stems and roots of trees, shrubs, and other woody plants. It includes all tissues outside the vascular cambium. Tree bark can vary greatly throughout the life of a tree, often becoming rougher as a tree grows. Examples:

- Beech bark stays smooth its entire life.
- Shagbark hickory shreds its bark in long strips as it gets older.
- Pitch pine has large plates. Epicormic sprouting is also common.
- Tulip-poplar bark displays a pattern of interlacing ridges and furrows that form a diamond shaped pattern.
- Persimmon has small blocky plates and often looks like charcoal briquettes.
- Yellow birch has a very fine shreddy bark that peels into small strips.

Bole - trunk of a tree.
Bracts - a modified leaf from the axis of which a flower or floral axis arises; portion of Douglas-fir cone also.
Broadleaf - trees having broad leaves instead of needles, often called hardwoods.
Bud scale scars - scar left where terminal bud scale formed, often visible for several years. Can be used to determine growth of a twig in a given year.
Buttressed roots - area swellings at the base of some shallow-rooted species that increase the tree's ability to withstand high winds and aid in the aeration of submerged root systems. Excellent examples include water tupelo and baldcypress.
Cambium layer - one cell thickness of tissue between the bark and wood that repeatedly divides to form new wood and bark cells.
Conifer - tree that is a gymnosperm, usually evergreen, with cones and needle-shaped or scale-like leaves, producing wood known commercially as softwood.
Crown - the head of foliage of a tree or shrub-part of a tree bearing limbs or branches, including twigs, leaves, flowers and fruit.
Crown Class - tree crowns are classified as to the position in which they are found. The following are the main generally recognized classes:

- **Dominant** - Trees with crowns that extend above the average of the tree crowns and receives light from directly above and some from the sides.

- **Co-Dominant** - Trees with crowns that form the general level of the crown cover and receive full light from the top, but very little from the sides.
- **Intermediate** - Trees that are shorter than the two preceding classes but with some branches extending into the general crown cover. Receives little light from above and none from the sides.
- **Suppressed** - Trees with crown entirely below the general crown level and receiving no direct light either from above or below.

Cuttings - short piece of vigorous branch or stem of the past season's growth used in artificial reproduction of trees.
Deciduous – trees that lose their leaves in the fall. Trees such as maple, ash, cherry, and larch are deciduous.
Dendrology - the "study of trees" leading to their identification.
Determinate growth - growth whose structures are initiated by a meristem in one year but do not complete development until the meristem resumes growth in the following year, tree forms buds for next year before the growing season is over.
Dicots - are a subdivision of angiosperms including plants (both tree and non-trees) that have two cotyledons or seed leaves that emerge following seed germination. Most trees are dicots. Plants in the other subdivision of angiosperms are referred to as monocots. These include a few trees such as palm trees. The older portions of palm tree trunks do not grow in diameter over the course of their lives.
Dioecious - Having unisexual cones or flowers with only one sex per plant, thereby having separate male and female plants.
Drupe - A one-seeded fruit which remains closed at maturity (cherry, for example).
Epicormic branching - branches that grow out of the main stem of a tree from buds produced under the bark. Severe epicormic branching increases knottiness and reduces lumber quality.
Evergreens - plants that retain foliage year-round. These trees retain some of their leaves for at least one winter. Most evergreens do drop foliage in the fall, they simply do not drop all of them. The term evergreen includes most gymnosperms and some angiosperms growing in warm climates. Some gymnosperms (e.g., larch and baldcypress) drop all their needles each fall.
Exotic Species - those organisms introduced into habitats where they are not native.
Foliage - the mass of leaves of a plant.
Fork - a tree defect characterized by the division of a bole or main stem into two or more stems.
Form - trees are often divided into two classes based on their form. Excurrent trees have a terminal leader that does not fork and grows consistently faster than lateral branches, resulting in a crown of conical shape. Examples include most conifers and some hardwoods, including yellow-poplar, sweetgum, and pin oak. Trees with decurrent branching patterns have a spreading crown shape that is the result of multiple forking of the terminal leader and growth of lateral branches that is as fast or faster than the terminal leader such as American elm or sycamore.
Genus - level of classification between species and family; closely related species form a genus.
Genera - plural of genus; all genera make up a family.
Germinate - to begin to grow, refers to the seed sprouting or growing.
Germination - the beginning of growth of a seedling from a generally dormant seed — characterized by rupture of the seed coat, and the emergence of a radicle or root.
Girdle - to chop or remove a strip of bark or a section of wood containing the food-carrying tissue of a tree in an even strip around the perimeter of the tree or twig
Glabrous - free from hair or down, smooth.
Glaucous - covered with a whitish powder or waxy coating.
Graft - method of reproducing a tree by joining the scion from one plant to the root-stock of a like plant called the host tree.

Growth (annual) rings - the layers of wood a tree adds each season; also called annual rings. These rings frequently are visible when a tree is cut and can be used to determine its age and growth rate.
Gymnosperms - tree species are split into two broad categories, Angiosperms and Gymnosperms. Gymnosperms are a taxonomic class that includes plants whose seeds are not enclosed in an ovary. Gymnosperms (which translates as "naked seeds") have an exposed ovule at the time of pollination. Gymnosperms include pine, juniper, hemlock, spruce, cypress, fir and ginkgo to name a few. Gymnosperm trees, with the exception of ginkgo, are also called conifers because they bear their seeds in cones. Gymnosperms are often referred to as softwoods, because of their relatively light weight but high strength wood which makes them very valuable for use in the construction industry.
Hardwoods - a general term encompassing broadleaf, deciduous trees.
Heartwood - the inner core of a woody stem composed of nonliving cells and usually differentiated from the outer wood layer (sapwood) by its darker color.
Host - the root-stock to which the scion is grafted.
Hybrid - the offspring of two different species or genera. Often has greater vigor than the parent stock.
Indeterminate growth - develops only lateral buds and never a terminal bud. Keeps on growing until cold or drought stops growth.
Intolerant (shade) - describes trees that need full sunlight to grow well and which cannot live in full shade.
Invasive exotic species - organisms not native to a region and whose introduction causes economic or environmental harm or harm to human health.
Lateral roots - roots of nearly equal size growing from the bottom of the trunk at ground level or just below.
Leader - the primary or terminal shoot above the topmost whorl. Shows growth during most recent growing season.
Legume - trees with bean-like seed pods such as black locust.
Lenticels - a pore in the stem of woody plants that is the path of exchange of gasses between the atmosphere and stem tissues.
Mast - nuts and seeds, such as acorns, beechnuts, cherries, and chestnuts, of trees that serve as food for wildlife.
Meristems - places of cell division in trees. Meristems are zones of rapid cell division and expansion that differentiate to form new tissues or organs. After meristematic division, expansion and differentiation, cell maturation occurs. Cell maturation is usually what results in actual plant growth.
Monoecious - having unisexual cones or flowers with female and male reproductive structures on the same plant.
Natural reproduction - the reproduction or growing of trees from seed.
Naval stores - resin products such as tar, pitch, turpentine, pine oil and rosin obtained from pines and other coniferous trees.
Over winter - period of time required for some seed coats to reach a point where moisture can penetrate to start growth.
Phloem - inner bark, the main tissue which carries food or sugar made in the leaves
Photosynthesis - process through which plants manufacture carbohydrates in the chlorophyll cells of leaves from carbon dioxide, water, and enzymes in the presence of light as the energy source
Pith - small core of soft, spongy tissue at the growth center of the stem.
Pome - fleshy fruit consisting of a central core with usually five seeds enclosed in a capsule and an outer fleshy layer.
Pubescent - with a hairy surface.
Radial - wood growth rings developing around a central axis.
Resin blisters - lumps or blisters of a yellowish to brown natural organic substance formed by plant secretions.
Rugose - wrinkled, typical leaves of the mint family.

Samara - one-seeded, winged fruit (e.g., ash, elm, maple, yellow-poplar).
Sapling - a young tree's period of growth from the time it reaches one inch in diameter until it is three inches in diameter measured at DBH.
Scion - a vigorous twig or cutting used in grafting to artificially reproduce trees
Sessile - not stalked.
Seed - a ripened ovule consisting of an embryo, food store, and protective coat.
Seedling - a tree grown from seed. Used to define a young tree before it reaches sapling size, less than 1" in diameter at DBH.
Sheath - annual layering of wood over the entire tree added by growth activity of the cambium. Top of each sheath shows height of the tree at the end of a given growing season.
Softwood - any tree in the gymnosperm group, including pines, hemlocks, larches, spruces, firs, and junipers. Softwoods are often called conifers although some, such as junipers and yews do not produce cones.
Species - a grouping of similar plants or animals having similar characteristics, showing close relationship to each other, and capable of reproducing fertile offspring, typically using sexual reproduction.
Springwood - the part of the annual growth ring formed during the early part of the season's growth.
Stomata – plural for stomate. The pores in plant leaves that control the gas exchange (CO_2 and O_2) and transpiration (H_2O) of a plant
Stratify - to store seeds in layers, alternating with moisture holding materials such as earth or Peat.
Sucker - new growth from buds hidden in the bark and previously shaded by other growth may occur as a result of severe trimming of the crown.
Summerwood - the portion of the annual growth ring formed after springwood formation has stopped, often called latewood.
Tap root - a deep central or primary root growing vertically downward.
Terminal bud - the bud at the apex or tip of the twig. Buds below or behind are referred to as lateral buds.
Tree - for our purposes, a tree is a woody plant that will be 20+ feet tall at maturity, with a single trunk that is unbranched for several feet, and with a more or less well-defined crown. Trees are the tallest and most massive plants in the world. Trees not only survive seasonal changes, but also have to cope with long-term climatic changes.
Tolerant (shade) - a tree species capable of becoming established and growing in the shade beneath overtopping vegetation.
Umbo - protuberance or swollen part of a cone scale.
Whorl - the layering or grouping of branches at the beginning of each year's growth.
Xylem - plant tissue whose basic function is to transport water. Xylem tissue is wood which strengthens branches, stems, and roots.

FORESTS & FOREST ECOLOGY

Anemometer - an instrument for measuring the speed or force of wind.
Aspect - compass reading taken facing down a slope in the direction water would run, the compass direction a slope faces.
All-aged stand - all, or almost all, age classes of trees are represented.
Artificial regeneration - a group or stand of young trees created by planting seedlings or cuttings.
Backfire - fire intentionally set, backing into the wind or downslope, in front of an advancing fire in an effort to control the prescribed burn or wildfire by cutting off its fuel supply.
Blaze - to mark a tree, usually by painting or cutting the bark. Forest properties often are delineated by blazing trees along the boundary lines.
Canopy - the continuous cover formed by tree crowns in a forest.

Carnivores - flesh-eating animals.
Climate - all air and weather, such as temperature, moisture, wind and evaporation.
Climax forest - the final stage of a tree and plant community which has stabilized its population; this community stays the same as long as the climate and soil remain unchanged by nature or people.
Coppice - a stand of trees originating from the stumps or roots of trees previously cut. Most hardwood species sprout readily when cut young. Very few conifers will sprout from the stump or coppice.
Decomposers - bacteria, fungi and micro-organisms that live in the soil and help break down dead plants and animals.
Duff - often referred to as litter which is made up of materials of the upper layer of the forest floor, includes freshly fallen leaves, twigs and slightly decomposed organic matter.
Erosion - the wearing away of the soil and minerals by climatic agents such as wind and water.
Evaporation - water vapor passing back into the atmosphere.
Even-aged stand - a stand of trees composed of a single age class in which the range of tree ages is usually no greater than 10-20 years. Even-aged stands are perpetuated by cutting all the trees within a relatively short period of time.
Exposure - the portion of a slope that is directly in the path of wind, rain, sun, etc. The part of a slope open to action by the elements. Southern exposure faces south, northern exposure faces north.
Firebreak - a strip of land maintained clear of trees and other fuel, used to stop or control the spread of fire.
Food chain - the energy cycle where one species feeds on another, fixing or releasing energy in the process.
Forest - a biological community dominated by trees and other woody plants.
Forest land capability classes - the productivity of the land for growing trees as it relates to soil depth, slope percent, aspect, and slope position: Class 1 = Excellent; Class II = Good; Class III = Fair; Class IV = Poor.
Forest types - classification of forest land indicating the majority of the tree species represented in an area.
Habitat - place or type of site (including food, cover, water, and space) where an animal, plant or population naturally lives and develops.
Herbivores - animals that feed only on plants.
Hormone - a substance that is formed in a living cell and that influences the activity of other cells.
Hydrologic or water cycle - Provides a continuous supply of water to us. Water evaporates from solar-heated oceans, lakes, rivers, and other water surfaces in the form of water vapor. Water vapor is small droplets of water suspended in air and carried inland by air currents to higher and colder air. When the air has cooled to the point where it can hold no more water vapor, it condenses to form fog, rain or snow. This precipitation, upon reaching the ground, either directly evaporates or becomes runoff that flows to large bodies of water, and the cycle is repeated.
Microorganisms - organisms that are so small they are microscopic (invisible to the naked eye). Often decomposers living in the soil are microorganisms.
Monoculture - a stand of a single species, often planted, generally even-aged.
Multiple-land-use - term used to indicate the management of timber, wildlife, water, and recreation in an integral, consolidated program**.**
Natural regeneration - a group or stand of young trees established by natural seeding, sprouting, suckering, or layering
Non-timber forest products - any product or service, other than timber, that is produced in forests, includes such things as fruits and nuts, vegetables, fish and game, medicinal plants, resins, and syrups.
Old-growth forest - a wooded area that has attained great age, usually greater than 200 years, and that has never been altered or harvested by humans. An old-growth forest often has large individual trees, a multi-layered crown canopy, and a significant accumulation of coarse woody debris including snags and fallen logs.

Omnivore - an animal that feeds on both plants and animals.
Overstory - the level of forest canopy that includes the crowns of dominant, codominant, and intermediate trees.
Pioneer Species - plants in the early stages of succession capable of invading bare sites (e.g., newly exposed soil) typically in large numbers and over considerable areas.
Plantation - forest stand originating from planted seedlings; regenerated artificially either by sowing or planting.
Porous - said of a substance that allows water or other liquids to flow through it.
Predator - a species that feeds on another species.
Prescribed Fire - A management tool which can be used to manage competing vegetation, prevent fuel accumulation, and improve wildlife habitat without damaging crop trees, also known as a controlled burn.
Preservation - in natural resources, other than wood preservation, this term is related to land use. The meaning stems from 19th century land reserves wherein areas and resources were set aside for limited or restricted use and development. Preservation often restricts land to recreation or scientific study. Preservation may be contrasted to the principle of multiple use which rather intensively develops one or more of an area's resources.
Regeneration - the beginning of a new forest's life cycle, established either naturally or artificially. Regeneration usually is done promptly after the previous stand or forest was removed.
Reproduction - Trees grown from seed and sprout origin, less than 1 inch in diameter
Runoff - the portion of water from rain, snow and fog that flows over land and eventually reaches streams.
Site - the habitat or environment in which a plant or plant community lives.
Slope percent - the number of feet of rise or fall in 100 feet of horizontal distance.
Snag - a dead tree that is still standing. Snags provide important food and cover for a wide variety of wildlife species.
Soil - a natural body developed from weathered minerals and decaying organic matter covering the earth in a thin layer; a natural medium on the surface of the earth in which plants may grow.
Soil compaction - when soil particles are crushed together eliminating pore spaces, the soil becomes denser and loses its ability to allow air and water to pass through.
Soil Depth - distance from the soil surface down to unweathered rock or an impermeable layer which restricts water movement and root penetration.
Sprout - a tree originating from a root or stump; a tree growing from a cut stump or previously established root system.
Stand - a group of trees sufficiently uniform in age, species composition, and structure, and growing on a site of uniform quality, to be a distinguished and managed as a unit
Subclimax species - a species in a temporary stage in nature's movement toward climax.
Succession - the natural progression from pioneer plants to climax forest as one plant community is replaced by another over time in the absence of disturbance. Primary succession (by pioneers) occurs on sites that have not previously held vegetation (e.g., bare rock), secondary succession occurs after the original vegetation has been disturbed.
Temperate zone - either of two climatic zones (the north or south temperate zone) between the tropics and the polar circles.
Understory - the level of forest vegetation beneath the canopy.
Uplands - Terrain not affected by water table or surface water or else affected only for short periods so that riparian (hydrophilic) vegetation or aquatic processes do not persist.
Urban trees - an essential part of the landscape in cities. Trees not only beautify their surroundings, but also improve the quality of life for urban dwellers in many other ways including: 1) Beautification; 2) Pollution Control; 3) Temperature Moderation; 4) Windbreaks; 5) Snow Fences; 6) Highway Safety; and 7) Wildlife Food & Cover.

Watershed - an area of land defined by patterns of stream drainage. A watershed includes all the land that contributes water to a particular stream or river. *Urban sprawl and development, poor agricultural practices, careless logging* and *wildfires* are sources of damage to watersheds.
Wilderness - In the strictest sense, this means that an area that has never been developed by man. The 1964 Wilderness Act defined it as: "A Wilderness, in contrast with those areas where man and his own works dominated landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor and does not remain." In some cases, man-made items are dismantled to reduce the area to a primitive state. Some roadless areas are considered wilderness when the access is limited to hiking, canoeing, or horseback riding and the use is set aside for recreation. To most of the general public, wilderness experiences are gained in a number of settings involving wild but not necessarily true Wilderness areas.
Wildfire - Fires burning out of control regardless of how or why they were started.
Wolf tree - a large older tree with a spreading crown and little or no timber value, but often great value for wildlife. A tree that occupies more than its fair share of growing space.

FORESTRY INDUSTRY

Best management practices (BMPs) – a practice, or combination of practices, determined by a state to be the most effective, practicable means of preventing or reducing the amount of pollution generated by nonpoint sources (such as managed forests) to a level compatible with water quality goals.
Conservation - Gifford Pinchot, a turn of the century forester closely associated with President Teddy Roosevelt, applied the word to describe a natural resource philosophy. It meant "wise use." Through the years it has taken on an extended meaning that really says "wise use over a period of time." The time factor forces us to consider the consequences of current use compared to future use.
Drip torch - firefighters use these torches that drip a flaming liquid mixture of diesel fuel and gasoline to ignite fires in burnout operations and prescribed fires.
Extension forester - a Cooperative Extension Service professional who educates woodland owners and natural resource professionals on how they can effectively manage forests.
Fire shelter - firefighters use this personal protection as a last resort if a wildfire traps them and they cannot escape. Firefighters can get into the tent-like shelter, made of heat reflective material, in about 25 seconds.
Forester - a degreed professional trained in forestry and forest management.
Forestry - the art and science of tending forests and woodlands. Profession embracing the science, art, and practice of creating, managing, using, and conserving forests and associated resources for human benefit and in a sustainable manner to meet desired goals, needs, and values.
Geographic information system (GIS) - a computer system that creates maps using GPS. The maps are linked to a database that stores important information about the map.
Global positioning system (GPS) - a computer that uses satellites in space to pinpoint where you are on the earth.
National Forests - managed by the United States Forest Service, part of the United States Department of Agriculture, focusing on multiple uses including; conservation, timber harvesting, livestock grazing, watershed protection, wildlife, and recreation. Differ from National Parks in that recreation is not their only use. They are managed for productive and sustained yields according to the land's capability.
National Parks - managed by the National Park Service, of the United States Department of the Interior. The National Park Service was established by Congress to promote and regulate the use of national parks, monuments, and reservations and to conserve the scenery and the natural and historic objects and the wildlife therein. The Service manages some areas for historical or recreational uses. Each of the 35 national parks was established to preserve a unique natural area for our enjoyment and study.

Natural Resources Conservation Service (NRCS) - the branch of the U.S. Department of Agriculture that coordinates and implements soil conservation practices on private lands. The NRCS can provide woodland owners with detailed information on his or her soil.
Sustainable Forestry Initiative (SFI) - a comprehensive program of forestry and conservation practices designed to ensure that future generations of Americans will have the same abundant forests and wildlife that we enjoy today. SFI is sponsored by the American Forest & Paper Association (AF&PA). AF&PA member companies have agreed to use sustainable forestry practices on the forestland they manage and to promote sustainable forestry on the forestlands of others.
TIMO - Timberland Investment Management Organization.

FOREST MEASUREMENTS & HARVESTING

Abney Level - an instrument used to determine the percent of slope of a site.
Acre - unit of measurement equivalent to 43,560 square feet, measures one chain wide and one furlong, or 10 chains in length. An area of land equivalent to 10 square chains.
Basal area (of a tree) - the cross-sectional area of the trunk measured 4 1/2 feet above the ground; **(per acre)** the sum of the basal areas of the trees on an acre; used as a measure of forest density.
Biltmore stick - a tool calibrated to measure the diameter of a tree at breast height.
Biltmore sticks can be calibrated with different scales depending on the users' arm length.
Biomass - total woody material in a forest. Refers to both merchantable material and material left following a conventional logging operation.
Board foot - a unit for measuring wood volume in a tree, log, or board. A board foot is commonly 1 foot by 1 foot by 1 inch, but any shape containing 144 cubic inches of wood equals one board foot.
Butt rot - Decay or rot characteristically confined to the base or lower bole of a tree.
Buck - to cut trees into shorter lengths, such as logs or cordwood.
Butt log - a log cut from the bole or stem immediately above the stump.
Chain or Gunter's chain - a measuring device designed and introduced in 1620 by English clergyman and mathematician Edmund Gunter (1581-1626). Gunter used an actual measuring chain of 100 links marked off into groups of 10 by brass rings which simplify measurement. Each link is 7.92 inches long, with 10 links making lightly less than 6 feet 8 inches. The full length of the chain is 66 feet.
Chip-n-saw - trade name for small timber, usually 8 to 12 inches DBH, of which the outer part is chipped away for use in papermaking and the inner part is sawn into lumber.
Clearcutting - a regeneration method that involves the removal of the entire stand in one cutting to create an even-aged stand. Regeneration is provided for naturally or artificially through planting.
Clinometer - an instrument used to determine tree height and slope percent.
Convertible - Refers to land that can be efficiently converted to a pine plantation.
Cord - a stack of fuelwood, pulpwood, or other material that measures 4 × 4 × 8 ft, or 128 cubic feet including wood, bark, and empty space within the stack.
Cordwood - small diameter or low-quality wood suitable for firewood, pulp, or chips. Cordwood is typically not suitable for sawlogs.
Crook - a tree defect characterized by a sharp bend in the main stem.
Cruise - collecting information about timber volume, growth and other factors used to make management decisions about the forest. Typically, the first step of a timber sale.
Cull - tree or log of merchantable size, but no market value.
Cutting cycle - the period of time between major harvests in a stand.
Defects - characteristics of an individual tree or board that reduce its quality and utility.
Diameter at breast height (DBH) - standard measurement of a tree's diameter, taken at 4 ½ feet above the ground on the uphill side of the tree (if the tree is on a slope).
Diameter tape - tape measure specially graduated so that diameter may be read directly when the tape is placed around the circumference of a tree stem or log.

Dibble - A tool used to make holes in the ground for planting tree seedlings.
Feller-buncher - A tractor equipped with hydraulic shears or a saw designed to fell standing trees and arrange them in bunches on the ground for pickup by a skidder
Felling - the cutting of standing trees.
Forest Mensuration - the science of measuring the contents of standing or felled timber, and estimating growth and yields.
Harvest - the removal of marketable products from the forest.
High grading - removing all mature, high-quality trees from a stand and leaving inferior species and individuals. Also referred to as select cutting and diameter limit cutting. Not to be confused with "selection" harvesting or uneven-aged management.
Hypsometer - any of several tools or instruments designed to measure the height of trees. The clinometer is such a tool.
Increment borer - an auger-like tool with a hollow bit designed to extract wood cores from trees for determination of age and growth rate.
Kerf - width of the cut made by a saw blade.
Log - section of the main stem of a harvested tree. A standard logs is a 16-feet long tree segment.
Log rule - a formula for estimating the volume (usually in board feet) of lumber that may be sawed from logs by using small end diameter and length (e.g., Doyle rule, International 1/4-inch rule, and Scribner rule).
Mature tree - a tree that has reached a maximum growth that the forest manager decides is a merchantable product.
MBF - abbreviation for thousand board feet.
Merchantable - wood that is saleable.
Merchantable height - the distance from the stump height to the top of the merchantable material in the tree and varies depending on the products to be made from the tree, implies the ability to cut lumber, veneer, or other products from the logs.
Merritt hypsometer - a scaled instrument used for measuring heights of trees**.**
Mixed stand - a stand composed of two or more tree species.
Overstocked - the situation in which trees are so closely spaced they compete for resources and do not reach full growth potential.
Pacing - an expedient, but crude, method of determining ground distances. A pace is two steps. On level, open ground, pacing can become fairly accurate with practice. But, on slopes, and in brushy or rocky areas, its accuracy diminishes.
Partial cut - method of cutting mature trees such as shelterwood cut, selection cut, or seed tree cut where some trees are left standing.
Peelers - logs that are used to make plywood or veneer.
Plot - a carefully measured area laid out for experimentation or measurement.
Plylogs - logs that are used to make plywood.
Pole timber - trees 4 to 10 inches in diameter at DBH.
Prism - an optical instrument used as an angle gauge, consisting of a thin wedge of glass which establishes a fixed (critical) angle of projection in a point sample.
Pulp - soft, moist mass of wood fiber used in paper manufacture. Pulp is made by reducing wood chips to fibers, either mechanically or chemically, then mixing with water. Mechanically ground or chemically digested wood used in manufacturing paper and allied products.
Pulp mill - mill that converts pulpwood to wood pulp.
Pulpwood - trees or logs used to make purified cellulose, oleoresin and paper. Typically, pulpwood is too small or too low in quality to be used for lumber.
Release - to remove overtopping trees that compete with understory or suppressed trees.
Residual stand - that portion of trees left after any partial cut.
Rotation - the number of years required to grow a stand to a desired size or maturity.

Rut - a depression in access roads made by continuous passage of logging vehicles.
Salvage - the removal of dead, damaged, or diseased trees to recover maximum value prior to deterioration.
Sanitation harvest - the removal of dead, damaged or susceptible trees; essentially to prevent the spread of pests or pathogens and so promote forest hygiene.
Sapling - trees from 1 to 3 inches in diameter at DBH
Sawlog - a log large enough to be sawed economically on a sawmill. Sawlogs are usually at least 8 inches in diameter at the small end.
Sawtimber - Trees more than 10 inches in diameter at DBH
Section – an area normally one square mile, containing 640 acres, with 36 sections making up one survey **Township** on a rectangular grid. One reason for creating sections of 640 acres was the ease of dividing into halves and quarters while still maintaining whole number of acres. A section can be halved seven times in this way, down to a 5-acre parcel. This system was of great practical value on the American frontier, where surveyors often had a shaky grasp on mathematics and were required to work quickly.
Seed tree - a mature tree left uncut to provide seed for regeneration of a harvested stand.
Seed-tree harvest - a regeneration method designed to create an even-aged timber stand. The initial harvest removes the mature stand leaving only a few trees to drop seed on the area. Seed is typically wind dispersed.
Seedling - a tree grown from seed; used to define a young tree before it reaches sapling size, less than 1" in diameter at DBH.
Selection harvest - a regeneration method used in uneven-aged stands, or to create uneven-aged stands, in which individual trees or groups of trees are removed. Some trees in each age class are removed including mature trees, poorly-formed trees, and trees of undesirable species.
Shelterwood harvest - a regeneration method designed to create an even-aged timber stand. The initial harvest removes the mature stand leaving only a few trees to shelter the new stand. Years later, the remaining overstory trees are removed.
Silviculture - 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.
Site index - a measure of the quality of a site based on the height of dominate trees at a specified age (usually 25 or 50 years), depending on the species.
Skidder - machine designed to transport trees or logs by trailing or dragging.
Skidding - the act of moving trees from the site of felling to a loading area or landing. Tractors, horses, or specialized logging equipment can be used for skidding. Skidding methods vary in their impact on soils and the residual stand.
Slash - branches and other woody material left on a site after logging.
Stocking - A measure of the proportion of the area actually occupied by trees, used to describe how well the trees in a stand utilize the available space. Stands are often classified as understocked, well-stocked or overstocked.
Streamside management zone (SMZ) - a strip of land adjacent to a water body or stream channel where vegetation is managed to protect the quality of surface water entering the water body during forestry operations. An SMZ also may be called a "filter strip" or "buffer zone."
Stumpage - the value of standing trees in a forest.
Sustained yield - Management of a forest stand to provide a constant supply of timber and revenue.
Sweep - a tree defect characterized by a gradual curve in the main stem.
Thinning - a partial cut in even-aged timber stands designed to improve future growth by regulating density. Thinnings can be commercial, where some or all of the wood harvested is put to use, or precommercial, where no wood is utilized.
Timber stand improvement (TSI) - any practice designed to improve a stand of timber by removal of vines, culls, and undesirable species. Pruning and thinning are considered TSI. practices.

Top - to cut off the unmerchantable top and limbs of a tree.
Tree scale stick - a calibrated stick used to estimate wood volume in a tree.
Understocked - a stand of trees so widely spaced that even with full growth potential realized, crown closure will not occur.
Variable plot radius - a method of timber cruising commonly used for industrial timber cruising in which sampling area (plot size) varies with tree diameter.
Veneer log - a high-quality log of a desirable species suitable for conversion to veneer.
Well-stocked - the situation in which a forest stand contains trees spaced widely enough to prevent competition yet closely enough to utilize the entire site.

TREE HEALTH (INSECTS, DISEASED & OTHER STRESSES)

Caterpillar – common name for the larvae of butterflies and moths.
Chlorosis - blanched or yellowish coloring in plants caused by nutrient or light deficiency.
Cocoon – protective covering around the pupa of some insects, especially moths. The cocoon is made by the larval stage before pupation.
Crawler – the mobile, first nymphal growth stage of scale insects.
Fusiform rust - a fungus-caused disease which produces spindle-shaped swellings or cankers on the boles and branches of pines. Infections sometimes kill young trees and deform older trees, resulting in wind breakage or reduced value at harvest.
Larva - the immature stage of an insect. Usage of the term is limited to those insects that undergo complete metamorphosis (i.e. pass through the pupa stage before becoming adults). The larval form is often markedly different in appearance to the adult.
Lichen - any of a number of plants made up of algae and fungus growing together on a solid surface, such as a rock.
Metamorphosis - the series of changes through which an insect passes in its growth from the immature stage to an adult. Insects that undergo incomplete (or simple) metamorphosis pass through three distinct life stages: egg, nymph, and adult. Insects that undergo complete metamorphosis pass through four distinct life stages: egg, larva, pupa, and adult.
Nymph - the immature stage of an insect. Usage of the term is limited to those insects that undergo incomplete (or simple) metamorphosis. Unlike a larva, the nymph does not pass through a pupa stage before becoming an adult. The nymphal form is often similar in appearance to the adult.
Pest - any organism that interferes with human activities.
Prolegs - fleshy, foot-like structure on the hind region of a caterpillar.
Pupa - stage of development between larva and adult. During this life stage the larval body is rearranged into the adult form.

TOPOGRAPHY & MAPS

Abney level - an instrument used to determine the percent slope of a site.
Aspect - the compass direction toward which a slope faces.
Compass - an instrument used to determine the direction of magnetic north.
Contour - an imaginary line on the surface of the earth connecting points of the same elevation. A line drawn on a map connecting the points of the same elevation.
Latitude - a measure of distance north and south of the Equator
Elevation - height above sea level.
Intermittent stream - a watercourse that flows in a well-defined channel only in direct response to a precipitation event, it may be dry for a large part of the year.

Perennial stream - a watercourse that flows throughout a majority of the year in a well-defined channel.
Slope position - a particular location on a slope defined as: upper, middle, or lower slope; ridge top; or bottom land. A specific topographic location.
Topography - the shape or form of the land surface, such as flat lands, hills and mountains

COMPASS & PACING

Azimuth compass - compass dial is divided into 360 degrees. North is 0 degrees or 360 degrees. Angles are measured clockwise from North; therefore, East is 90 degrees, South is 180 degrees and West is 270 degrees.
Bearing tree - tree marked to identify the nearby location of a survey corner, also known as a witness tree.
Compass - instrument used to determine the direction of magnetic north.
Quadrant compass - compass dial is divided into four quadrants, namely NE, SE, SW and NW. North and South are at 0 degrees and depending on the quadrant, angles (up to 90 degrees) are measured away from the north or south (whichever is nearer) toward East and West directions.

FOREST UNDERSTANDINGS AND FACTS

The following concepts and facts cover the broad range of forestry. An understanding of each statement will benefit resource managers, well rounded citizens, and forestry team members. Some are so logical or simple that they may be taken for granted and overlooked.

Characteristics, Distribution, and Status of Forest Resources

1. Trees have distinctive characteristics by which they can be identified.

2. Trees depend upon water, soil nutrients, sunlight, and air for growth.

3. Climate, soil, and topography influence the natural range and distribution of the different types of forest communities.
4. Forest communities influence their climate and their soil.
5. Forest litter, humus, and roots give forest soils an exceptional ability to absorb moisture and resist erosion.

6. In the forest some organisms are adapted to living in the forest soil, some on the forest floor, some in the undergrowth, and some in trees.

7. Forests are constantly undergoing change, and as they mature and are harvested or die, some species of plants and animals may be replaced by others.

8. The interrelationships among the plant and animal members of forest communities and their environments determine the characteristics of a particular forest.

a. Each plant and animal in a forest community influence that community.

b. Forest communities influence the plants and animals of which they are composed.

9. Fires, diseases, insects, man, and animals may be harmful or beneficial to the forest.

10. Some lands are better adapted for the growing of forests than for other uses.

11. Forests have certain characteristics which make them attractive for recreational activities.

12. An expanding population and new uses for forest products and services make necessary more intensive multiple purpose management of forest resources.

Understanding the Uses of Forest Resources and Their Importance to Man

1. The original forests of the nation were primary sources of building the nation.

2. Forests yield many essential products for man's use.

3. Many communities are highly dependent upon local forests, forest industries, and forest recreation for economic stability.

4. New uses for the products of the forest are being discovered through research and development.

5. Forests provide a wide variety of recreational opportunities.

6. Forests are important in helping to protect watershed from floods and droughts.

Understanding Problems and Techniques of Management

1. Forests can be managed to produce a continuous supply of wood and wood products, wildlife, water, and recreational opportunity.

2. Foresters use various practices in managing forest resources:
    a. Insects and disease control
    b. Fire control
    c. Harvesting practices
    d. Thinning and pruning operations
    e. Reforestation

3. Volume and growth data are essential in determining management practices necessary to produce the optimum amount of forest products.

4. Research is essential for the development of new and improved forest management practices and the more efficient utilization of forest products and services.

Understanding Policy and Administrative Techniques

1. Public use of forest land carries an obligation for good citizenship.

2. Small woodland owners control a major portion of commercial forest lands which are a potential source of larger quantities of forest products and services.

3. The woodland owner can obtain technical advice and assistance in forest management from many public and private organizations and agencies.

4. Current state and federal programs provide financial assistance as incentives for better management of forest resources.

5. Many progressive public and private owners of forest lands are managing forests for multiple uses rather than solely for timber production.

6. Forest owners have responsibilities as well as rights in the management and use of forests under democratic living.

7. Cooperation between public agencies, private owners, and the general public is necessary in protecting forests against fires, diseases, insects, and excessive animal populations.

8. Policy decisions must be made to settle differences of opinion which arise from competing uses of the forests.

Forestry Facts

1. America's forests cover about 737 million acres, or 32% of the nation's land area.

2. America's forests still cover about 70% of the area they covered when the Pilgrims landed in 1620.

3. Private individuals own about 59% of the U.S. forest land base; local, state and federal governments own about 27%; and the forest products industry owns about 14%.

4. Growth rates exceed harvest rates in America's forests by a wide margin. In 1992 net growth was 21.6 billion cubic feet and harvest was only 16.3 billion cubic feet.

5. More than 244 million acres, about 33% of America's forests, are preserved in wilderness areas, national parks, wildlife refuges, and other parks and preserves where no commercial activity is permitted.
6. The U.S. is a net importer of most raw materials used to sustain the domestic economy, including wood and wood products.
7. The U.S. population is presently growing at the rate of 1% each year. If this rate is sustained the population will double in less than 100 years.

8. The per-person use of wood in the U.S. is about 80 cubic feet each year, an increase of more than 30% since 1970.

9. Wood is the only natural resource on earth that is at once renewable, recyclable, reusable, and biodegradable.

10. The energy required to grow our wood supply is free. It comes from the Sun.

A SUMMARY OF FEDERAL LAWS AFFECTING FORESTRY

Laws form the legal basis for using and managing our nation's forests. Since 1890, more than 140 laws affecting forestry have been passed by the United States Congress and signed by the President. In the early years, most laws enabled or authorized the protection and management of the nation's forests. Many of the laws passed in recent years restrict or regulate the use and management of these forests. Some of the more important Federal laws are described below:

Creative Act of 1891 -- Authorized the President of the United States to set aside public lands bearing forests as public reservations commonly called *Forest Reserves*.

Organic Administration Act of 1897 -- Provided that the Forest Reserves, later to be called *National Forests*, were established to improve and protect the forest, to secure favorable conditions of water flow, and to furnish a continuous supply of timber.

Transfer Act of 1905 -- Transferred the administration of the Forest Reserves from the United States Department of the Interior to the United States Department of Agriculture.

Twenty-five Percent Fund Act of 1908 -- Established the procedure for paying the states twenty-five percent of the monies received from national forest timber sales to benefit public schools and public roads in counties where national forests are located. These payments are made in lieu of taxes.

Weeks Law of 1911 -- Authorized purchasing and adding to the National Forest System forested, cut-over, or denuded lands within the watersheds of navigable streams which are necessary to regulate the flow of navigable streams or to produce timber.

Smith-Lever Act of 1914 -- Established a Federal-State Cooperative Extension program to provide education for the public in agriculture and natural resources.

Clarke-McNary Act of 1924 -- Authorized technical and financial assistance to the states for forest fire control and for production and distribution of forest tree seedlings. (Sections 1 through 4 were repealed by the Cooperative Forestry Assistance Act of 1978.)

McSweeney-McNary Act of 1928 -- Authorized a comprehensive Forest Service research program. (This act was repealed and supplanted by the Forest and Rangeland Renewable Resources Research Act of 1978.)

Multiple Use - Sustained Yield Act of 1960 -- Established a policy of multiple use, sustained yield management for the renewable resources of the National Forest System.

McIntyre-Stennis Act of 1962 -- Established a cooperative forestry research program for state land-grant colleges and universities.

Clean Air Act of 1963 -- Gave the Federal government enforcement powers regarding air pollution for the first time. This act and subsequent amendments impact the forest industry by affecting prescribed burning for forest management and emissions from forest products manufacturing plants.

Wilderness Act of 1964 -- Established the National Wilderness Preservation System by setting aside sections of federal forest land as wilderness.

National Environmental Policy Act of 1969 -- Required that environmental considerations be incorporated into all Federal policies and activities, and that all Federal agencies prepare environmental impact statements for any actions significantly affecting the environment.

Federal Water Pollution Control Act Amendments of 1972 -- Established as a national objective restoring and maintaining the chemical, physical, and biological integrity of the nation's water and required area wide planning to prevent future water pollution that could be associated with growth, development, and land use, including timber management.

Endangered Species Act of 1973 -- Provided for the protection and conservation of threatened and endangered fish, wildlife, and plant species. Directs all Federal agencies to utilize their authorities and programs to further the purpose of the act.

National Forest Management Act of 1976 -- Established additional standards and guidelines for managing the national forests, including directives for national forest land management planning and public participation.

Cooperative Forestry Assistance Act of 1978 -- Authorized the Secretary of Agriculture to work in cooperation with State Foresters in nine cooperative forestry assistance programs. Among these programs is the *Forestry Incentives Program*, a federal cost-share program designed to encourage the management of private forest lands.

Renewable Resources Extension Act of 1978 -- Authorized expanding the forest and rangeland renewable resources portion of the extension education program.

Forest and Rangeland Renewable Resources Research Act of 1978 – Authorized expanding forest and rangeland renewable resources research.

Reforestation Tax Incentives (part of the Recreational Boating Safety and Facilities Improvement Act of 1980) -- Provided tax credits and deductions for landowners who reforest their property, as an incentive to encourage reforestation.

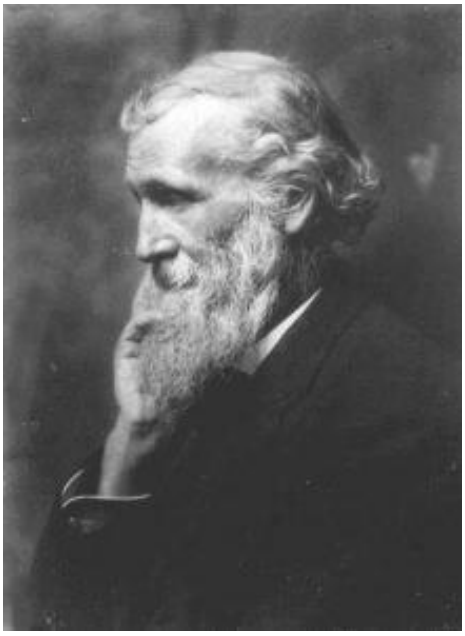
Food Security Act of 1985 (1985 Farm Bill) -- Established the *Conservation Reserve Program*. The program was designed conserve 40 to 45 million acres of highly erodible cropland by paying landowners to plant permanent vegetative cover, such as grass or trees, and maintain that vegetative cover for 10 years.

Food, Agriculture, Conservation, and Trade Act of 1990 (1990 Farm Bill) -- Established the *Forest Stewardship Program*, a program designed to encourage multiple resource forest management on nonindustrial private forest lands. A companion program, the *Stewardship Incentives Program*, was designed to provide cost-share assistance funding to encourage the implementation of management practices.

Coastal Zone Act Reauthorization Amendments of 1990 -- Required that states with Coastal Zone Management Programs develop and implement Coastal Nonpoint Pollution Control Programs to control sources of nonpoint pollution (including managed forests) which impact coastal water quality.

Forest History

John Muir (1838-1914)



Farmer, inventor, sheepherder, naturalist, explorer, writer, and conservationist – **John Muir** was born on April 21, 1838 in Dunbar, Scotland. In 1849, the Muir family emigrated to the United States, settling first at Fountain Lake and then moving to Hickory Hill Farm near Portage, Wisconsin.

In 1867, while working at a carriage parts shop in Indianapolis, Muir suffered a blinding eye injury that would change his life. When he regained his sight one month later, Muir resolved to turn his eyes to the fields and woods. There began his years of wanderlust. He walked a thousand miles from Indianapolis to the Gulf of Mexico. He sailed to Cuba , and later to Panama, where he crossed the Isthmus and sailed up the West Coast, landing in San Francisco in March, 1868. From that moment on, though he would travel around the world, California became his home.

It was California's Sierra Nevada and Yosemite that truly claimed him. By 1871 he had found living glaciers in the Sierra and had conceived his controversial theory of the glaciation of Yosemite Valley. He began to be known throughout the country. Beginning in 1874, a series of articles by Muir entitled "Studies in the Sierra" launched his successful career as a writer. In 1880, he married Louie Wanda Strentzel and moved to Martinez, California to manage his father-in-law's fruit ranch with great success. But ten years of active ranching did not quell Muir's wanderlust. His travels took him to Alaska many more times, to Australia, South America, Africa, Europe, China, Japan, and of course, again and again to his beloved Sierra Nevada.

In later years he turned more seriously to writing, publishing 300 articles and 10 major books that recounted his travels, expounded his naturalist philosophy, and beckoned everyone to "Climb the mountains and get their good tidings." Muir's love of the high country gave his writings a spiritual quality. His readers, whether they be presidents, congressmen, or plain folks, were inspired and often moved to action by the enthusiasm of Muir's own unbounded love of nature.

Through a series of articles appearing in *Century* magazine, Muir drew attention to the devastation of mountain meadows and forests by sheep and cattle. With the help of *Century*'s associate editor, Robert Underwood Johnson, Muir worked to remedy this destruction. In 1890, due in large part to the efforts of Muir and Johnson, an act of Congress created Yosemite National Park. Muir was also personally involved in the creation of Sequoia, Mount Rainier , Petrified Forest and Grand Canyon national parks. Muir deservedly is often called the "Father of Our National Park System".

Johnson and others suggested to Muir that an association be formed to protect the newly created Yosemite National Park from the assaults of stockmen and others who would diminish its boundaries. In 1892, Muir and a number of his supporters founded the Sierra Club to, in Muir's words, "do something for wildness and make the mountains glad." Muir served as the Club's president until his death in 1914.

In 1901, Muir published *Our National Parks*, the book that brought him to the attention of President Theodore Roosevelt. In 1903, Roosevelt visited Muir in Yosemite. There, together, beneath the trees, they laid the foundation of Roosevelt's innovative and notable conservation programs.

Muir and the Sierra Club fought many battles to protect Yosemite and the Sierra Nevada, the most dramatic being the campaign to prevent the damming of the Hetch Hetchy Valley within Yosemite National Park. In 1913, after years of effort, the battle was lost and the valley that Muir likened to Yosemite itself was doomed to become a reservoir to supply the water needs of a growing San Francisco. The following year, after a short illness, Muir died in a Los Angeles hospital after visiting his daughter Wanda.

John Muir was perhaps this country's most famous and influential naturalist and conservationist. He taught the people of his time and ours the importance of experiencing and protecting our natural heritage. His words have heightened our perception of nature. His personal and determined involvement in the great conservation questions of the day was and remains an inspiration for environmental activists everywhere.

Carl Schenck and the Biltmore Forest School: First in Forestry

In the late 1880s one of America's richest men, **George Vanderbuilt**, visited Asheville, North Carolina and fell in love with the beautiful mountain Town. He decided to build his sprawling **Biltmore** estate there. He hired famed landscape architect **Frederick Law Olmsted** to design the grounds and gardens of the 5,800-acre estate. Olmsted, in turn, wanted to make it a showcase for the world.

At Olmsted's urging, Vanderbilt decided to hire a forester to scientifically manage the woodlands. So, in 1892 he hired **Gifford Pinchot**, who later became known as the "Father of American Forestry" and established the U.S. Forest Service. Over the next three years, Pinchot initiated the first large-scale forest management plan in the United States, making a name for himself and the Biltmore Estate. Before Pinchot left in 1895, Vanderbilt purchased 100,000 additional acres of mountainous woodlands and asked Pinchot to find a man to manage the land. At Pinchot's recommendation, Vanderbilt hired **Dr. Carl Alwin Schenck,** a German forester, to replace him.

Schenck came to the United States knowing little about the forest conditions he faced. But word quickly spread about the tall man with the funny-looking mustache who could be seen on his hands

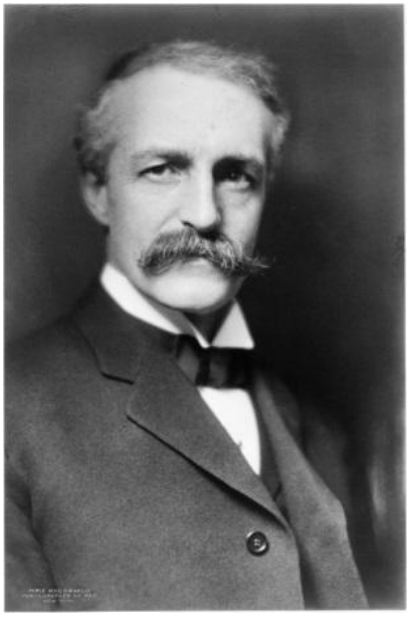
and knees planting acorns, or refused to cut down every tree in the woods. Curious young men began showing up looking for work, and soon were asking questions about this new science called forestry. To answer their questions, Schenck opened the **Biltmore Forest School** (BFS) in 1898, the first school of forestry in America. Essentially a one-man operation, he'd lecture to them in the morning and show them the practical side in the afternoon. As Schenck noted with pride, "My boys worked continuously in the woods, while those at other schools saw wood only on their desks." Filled with school pride and thoroughly versed in the art and science of forestry after just a year's training, many of his students went on to become leaders of the forestry movement.

BFS students initially were sons of wealthy lumber and timber barons. However, within 15 years the school would graduate over 400 forestry students who introduced scientific forestry methods throughout North America. Established universities such as Cornell, Minnesota, and Yale each created forestry schools of their own shortly after the Biltmore Forest School experiment began. But unlike these university-based classrooms, Schenck's Biltmore School emphasized the practical side of the profession. Students devoted an intensive twelve months to forestry in the field. Following Schenck's course of work, BFS students could only graduate after completing an internship on the Biltmore Estate or elsewhere in the timber industry.

When Vanderbilt fell on hard times in 1909, he fired Schenck. Undeterred, Schenck simply took the school on the road, traveling across America and throughout Europe, showing his "boys" forestry and logging operations in different places. He taught them in railroad cars and lumber camps. Everywhere they went was a classroom. But when Schenck's school began losing money and students, he closed it and returned home to Germany in 1913.

He never forgot his boys, and they never forgot him. Some fifty years after the school closed, those students still remaining gathered at the old school grounds high in the mountains of North Carolina to dedicate the Cradle of Forestry in America National Historic Site.

Gifford Pinchot (1865-1946)

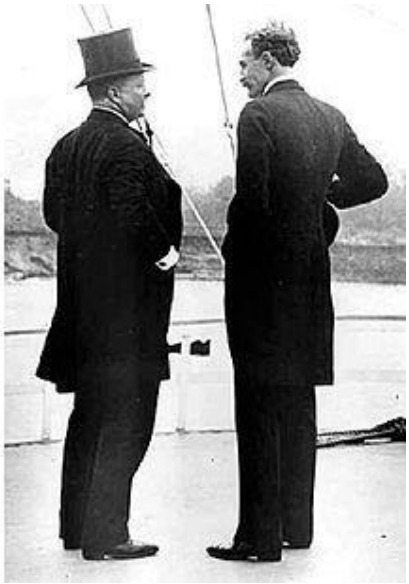


Perhaps no other American in history affected the quality of the landscape of our country as dramatically as did **Gifford Pinchot**. He was a man ahead of his time and implemented scientific forestry nationwide as the first chief of the National Forest Service. Pinchot advocated a balance between the total preservation hands off management policies advocated by his contemporary and political advisory John Muir and the industrial scale clear cut logging that had devastate the forests of Pennsylvania and the northeast by 1900.

"Conservation is the foresighted utilization, preservation and/or renewal of forests, waters, lands and minerals, for the Greatest Good of the Greatest Number in the Long Run"

The principal of managing forests to achieve greatest good for the greatest number first articulated by Pinchot is still one of the basic principles of American conservation.

Pinchot was born into a wealthy family that mingled with America's rich and powerful. The family estate, **Gray Towers**, in Milford, PA is a national historic site. Pinchot attended forestry school in Nancy, France. Becoming the first American born forester to have a formal education in the discipline. He was a personal friend and political ally of Theodore Roosevelt, a relationship that eventually led him into the halls of power in Washington DC. After serving as Chief of the Forest Service from 1905 to 1910 Pinchot lost his job in a political squabble. But the acreage of National Forest land more than tripled under his leadership.



He became Pennsylvania's Forest Commissioner in 1920 and instituted programs that resulted in more effective public relations and fire detection as well as an increased focus on professionalism and the contribution of wise use of forest resources to economic development. A skilled politician Pinchot served two terms as Governor of Pennsylvania. 1922-1926 and 1930-1934. In 1946 Gifford Pinchot died at the age of 81. One year later his autobiography "Breaking Ground" was published. In the final chapter he wrote:

> "The conservation policy has three great purposes. First, to wisely use and renew the natural resources of the earth. Second, to control natural resources and their products in the common interest. Third, to see to it that the rights of the people shall not be controlled by the great monopolies through their power over natural resources. "

A State Park in Pennsylvania and a major National Forest in Washington State are named in Gifford Pinchot's honor. Pinchot's legacy of sustainable principles continues today as the standard for forestry management practices nationwide.

Smokey Bear

The **Smokey Bear** campaign's power is reflected by the fact that anybody over the age of 4 knows who Smokey is and his favorite one liner: "Only you." Smokey was born out of a fear for our natural resources. World War II brought a concern that our forest resources might be attacked or sabotaged at a time when they were greatly needed. The U.S. Forest Service organized a fire prevention program in 1942 to encourage citizens to make a personal effort to prevent forest fires. To help convey this message an organization called the War Advertising Council began a campaign that encouraged people to assist in the war effort by doing what they could to prevent forest fires. Timber was after all a primary commodity for many products used in warfare. In 1944 they produced a poster featuring the Walt Disney's Bambi character. The success of this poster demonstrated that an animal of the forest was the best messenger to promote forest fire prevention.

On Aug. 9, 1944, the forest service and the War Advertising Council introduced a bear as the campaign symbol. This bear was to be black or brown and his expression intelligent, appealing and slightly quizzical. To look his part, he would wear a traditional campaign hat. As the campaign grew Smoky reached out to Americans from posters, billboards, magazines, newspapers and over the air from hundreds of broadcasting stations. Many corporations donated valuable advertising time and space. The result was a great success for the Smokey Bear symbol and a decrease in human-caused forest fires. Smokey's fame snowballed from there.

In 1950 a burned bear cub survived a terrible forest fire in the Lincoln National Forest near Capitan, New Mexico. News of the bear won the love and admiration of the American public, and so many people mistakenly believe the cub was the original Smokey Bear. But in reality, Smokey advertising was already six years old. After being nursed back to health, the cub was named Smokey and came to live at the National Zoo in Washington D.C. as a living counterpart to the fire prevention program.

The original Smoky died in 1976. I was in college studying forestry that year, and we all wore black armbands the week he died. That's how powerful this symbol is. Smokey continues to tell us to be careful, and his message is even more important now that many people are choosing to build homes in or near forests. There is also the challenge of teaching the public that fire properly used can be a tool to improve some forests. "Prescribed fire" requires special knowledge and skill to carry out properly and safely. The forest continues to be an important resource for our nation, and the need to prevent wildfire and use prescribed fire is greater than ever. Remember: "Only you" can prevent forest fires.

The Tree Scale Stick or Cruiser Stick

Based on the relatively simple trigonometric principle of similar triangles, a **tree scale stick or cruiser stick** is a yardstick-styled "instrument" used to measure tree diameters and tree heights without climbing the tree or wrapping a tape around the trunk. Using this one stick, a tree's dimensions can be easily determined very quickly for approximate values and checking eyeball estimates.

Foresters often use the cruiser stick tool to keep their ocular estimates honed but most timber estimation data is measured and compiled using more sophisticated and accurate tools like diameter tapes and clinometers to measure diameter and heights.

The cruiser stick was developed for forestry students in the late 1800's at Professor **Carl Schenck's Biltmore Forest School** on the Biltmore estate near Ashville, North Carolina. The instrument has passed the time test and is included in every forester's tool kit.

It is fascinating to think that you can use a two-dimensional stick scale to measure the diameter of a tree. Remember that the diameter of a tree is the measured length of a straight line running through the center or pith of a tree from bark edge to bark edge. That is compared to radius (measured from tree center to bark edge) and circumference (measuring the entire circular bark edge).

This concept is captured in the mathematics and by using a fairly simple concept dealing with the principle of similar triangles. Use the math, define the points and you have a very useful tool that will accurately estimate diameters at breast height (DBH). The reason for breast height diameters is that most tree volume tables are developed at DBH or 4.5 feet from the tree stump.

The tree height scale on the edge or flip side of a cruiser stick is just as important as the diameter side. You have to record both the tree's diameter and the tree's height to calculate tree volume. These two measurements are used to estimate the usable wood content. There are hundreds of tables that use diameter and height to determine volume.

Merchantable tree height refers to the length of the usable part of a tree. Height is measured from stump height, which is usually 1 foot above ground, to an end point where the tree's marketable wood potential stops. This cutoff height will vary with the wood product(s) being considered and where excessive limbs or top diameter becomes too small to The tree height side of the scale stick has been calibrated so that if you stand 66 feet from the tree being measured and hold the stick 25 inches from your eye in a vertical position, you can read the number of merchantable logs, usually in 16-foot increments, from the stick. Like with the diameter side, it is important not to move the stick or your head when taking a measurement. Position the bottom of the vertical stick at stump level and estimate the height where merchantable height stops.

Typically, cruiser sticks are marked for whole logs. The shortest sticks are generally marked for 1 thru 4 full 16-foot log heights. Some may even include a mid-point mark to indicate half logs. The starting point for the first log mark should be calculated from the left end of the stick according to the following consecutive point list. From the left and zero end of the stick, the first 16’ log mark will be at 6.1 inches; the second 16’ log (32 feet) at 12.1"; the third 16’ log (48 feet) at 18.2"; and the fourth 16’ log (64 feet) at 24.2".

The formula for each hypsometer increment:
Hypsometer (Height) Increment = (Biltmore Length x Log Length) / 66 ft.

Land Surveying

Various units of length used for surveying in the English-speaking world, all consisting of 100 links. The surveyor’s chain of 100 links is identified with Edmund Gunter, who introduced such a

chain in *1620,* although chains divided decimally had existed earlier. The convenience of this decimal division was the cause of the chain's success; among other advantages, an area 1 chain by 10 chains was an acre.

There are two kinds of chain in common use, the Surveyor's (or Gunter's) Chain, and the Engineer's Chain. **Gunter's chain** is 66 feet long, and its use is confined chiefly to land surveying on account of its simple relation to the acre and to the mile. The 66' long chain is divided into 100 links, each link measuring 7.92", and is very convenient when it is required to calculate areas in acres and decimals of an acre, since 10 sq. chains = 1 acre : also, when linear dimensions are required in miles and furlongs, since 10 chains = 1 furlong and 80 chains = 1 mile. When the term "chain" or "link" is used in a general sense, without reference to any particular unit of measurement, the Gunter's chain is inferred.

1 Gunter's Chain = 4 Perches or Rods = 100 Links =1/10 furlong = 66 feet
1 Mile = 80 Chains
1 Acre = 10 Square Chains

The Chain is generally divided into 100 links, sometimes into 50- but there are several varieties and lengths in ordinary use. The links are composed of lengths of iron or steel wire, and—except at the center of the chain, and at the 25th link from each end, where swivel joints (Fig. 2) are provided—these are connected at their extremities by three small oval rings, preferably welded. At every 10th link from each end of the chain a brass tag or teller is fastened to the small central connecting ring. The teller which has only one point indicates ten links from either end of the chain—i.e., the 10th or the 90th link measuring in the same direction; that with two points marks the 20th or the 80th link ; three points indicate the 30th or the 70th link; four points the 40th or the 60th link; and a circular tag the center of the chain. The ends of the chain are furnished with brass handles attached by means of swivel joints, and the length of 100 links is measured from the outside of one handle to the outside of the other.

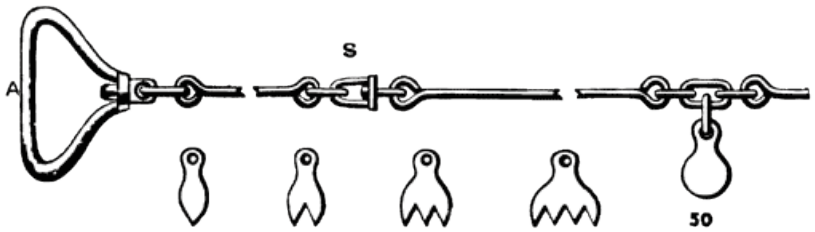


FIG. 2.—Brass Tellers.

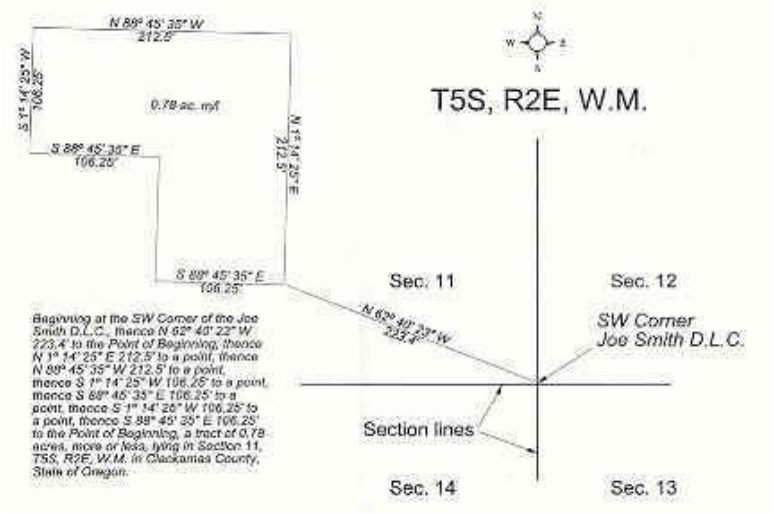
Land descriptions within the United States can generally be classified as one of these basic types (1) the "metes and bounds" system; (2) the US Public Land Survey system (PLSS); and (3) the "lot and block" survey system. Most forest lands are either described in metes & bound or PLSS.

Metes and bounds have been used in England for many centuries, and is still used there in the definition of general boundaries. By custom, it was applied in the original Thirteen Colonies that became the United States, and in many other land jurisdictions based on English common law.

Typically, the system uses physical features of the local geography, along with directions and distances, to define and describe the boundaries of a parcel of land. The boundaries are described in a running prose style, working around the parcel in sequence, from a point of beginning, returning to the same point; compare with the oral ritual of beating the bounds. It may include references to other adjoining parcels (and their owners), and it, in turn, could also be referred to in later surveys. At the

time the description is compiled, it may have been marked on the ground with permanent monuments placed where there were no suitable natural monuments.

- **Metes.** The term "metes" refers to a boundary defined by the measurement of each straight run, specified by a distance between the terminal points, and an orientation or direction. A direction may be a simple compass bearing, or a precise orientation determined by accurate survey methods.
- **Bounds.** The term "bounds" refers to a more general boundary description, such as along a certain watercourse, a stone wall, an adjoining public road way, or an existing building.



The **Public Land Survey System (PLSS)** or rectangular land survey system was adopted by the federal government in 1785. It is used in all states except for the original 13 colonies, the states created from these colonies and Kentucky, West Virginia and Texas.

There are geographical locations all over the US that serve as a base reference in land surveys. The principal meridians running North-South and East-West intersect at these locations.

In Florida for instance, they cross at a point in Tallahassee. Beginning at these points, the surveyors established lines every 6 miles North, South, East and West of the crossing point. Each of these squares are called townships. They are 6 miles by 6 miles, thus have an area of 36 square miles. lines running East-West are called township lines. The lines running North-South are called range lines. They are further divided up into areas of 1 square mile called sections. Thus, there are 36 sections in a township. Each section contains 640 acres.