The curriculum guide was developed to prepare high-school students for positions as forestry aides or for enrollment in higher education forestry programs. It provides a basic core of instruction in forestry in 20 instructional units grouped according to six areas: Orientation, Related Information, Forest Measurements, Forest Ecology and Silviculture, Forest Protection, and Forest Management. Each instructional unit includes behavioral objectives, suggested activities for teacher and student, information sheets, transparency masters, assignment sheets, job sheets, a test, and test answers. (Author)
FORESTRY
A CURRICULUM GUIDE

Written by

ED CURTIS
CONSULTANT FORESTER
1974

Developed by the Curriculum and Instructional Materials Center
For the Division of Vocational Agriculture
Byrle Killian, State Supervisor

OKLAHOMA STATE BOARD OF VOCATIONAL AND TECHNICAL EDUCATION
Leslie Fisher, Chairman
Francis T. Tuttle, Director
Ronald Meek, Coordinator, Curriculum and Instructional Materials Center
# FORESTRY
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FOREWORD

This publication is designed to provide a basic core of instruction in Forestry for Oklahoma. Today, teachers of vocational agriculture are faced with increasing problems of what to teach and whom to serve. The student of today, who will be the agriculturalist of tomorrow, needs to be a well-educated individual who is constantly seeking information on which to base the many decisions he is required to make. The purpose of this guide is to assist teachers in improving instruction in Forestry in Oklahoma.

Appreciation is expressed to the many individuals who helped in the development of this publication; the teaching of vocational agriculture should become more effective with its use.

Francis T. Tuttle, State Director
State Department of Vocational and Technical Education

Byrle Killian, State Supervisor
Vocational Agriculture
PREFACE

With a rapid increase in technology and technical procedures, the forestry industry is currently hard pressed to fill technical and skilled jobs with qualified people. They recognize the advantage of having school trained personnel that can "hit the ground running."

Every effort has been made to make this publication a basic, usable forestry curriculum to produce a forestry aide capable of filling industries' needs.

The curriculum is designed to be presented in numerical order. Each unit serves as a building block for the units following. However, each unit can be presented out of order, but this will require additional background instruction.

One vital part of instruction—SAFETY—is not included in this publication. Because of the varied laboratory conditions and the numerous types of equipment used, safety procedures would add as much instructional material as is presented in this publication. This author advises that safety not be left out of instruction. Each instructor should supplement this publication with safety materials.

After completion of these twenty units of instruction in a high school program, each instructor should be able to proudly send his students to responsible jobs in the forest industry or to a higher education forestry program.

Ed Curtis
Consultant Forester
ACKNOWLEDGEMENTS

Appreciation is expressed to many individuals who gave their time and knowledge to the preparation of this publication. Without the combined efforts of teachers of vocational agriculture and the supervisory staff of vocational agriculture, State Department of Vocational and Technical Education, this publication would not have been possible.

The content of this publication was prepared and reviewed by:

Instructors of Vocational Agriculture

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Appreciation is expressed to Dean Reeder and Clifton Braker, Curriculum Specialists, who supervised the writing and committee meeting.

Appreciation is also extended to the Forestry Department, Oklahoma State University, for their assistance and cooperation in the final stages of this publication.

Gratitude is expressed to Beth Parker and Sarah Mussett for editing; to Nancy Skach and Barbara Reed for assistance with research; and to Linda Tapp, Cindy Johnson, and the Communications Center for typing.

Much credit goes to Bob Rea, Media/Graphics Designer, and to Susan Bell, Dean Clark, and Beth Akiff, Illustrators, for the illustrations and drawings used in this publication.

The printing staff of the State Department of Vocational and Technical Education are deserving of much credit for printing this publication.

Special appreciation is extended to my wife, Mary Curtis, for her encouragement and assistance in typing while preparing the publication.

Also, special appreciation is extended to Bob Patton, Assistant Coordinator for the Oklahoma Curriculum and Instructional Materials Center, and Cleo Collins, Southeast District Supervisor for Vocational Agriculture, for their counseling and assistance.

Ed Curtis
Consultant Forester
USE OF THIS PUBLICATION

Instructonal Units

The Forestry curriculum includes six areas. Each area consists of one or more units of instruction. Each instructional unit includes behavioral objectives, suggested activities for teacher and student, information sheets, assignment sheets, job sheets, visual aids, a test, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help him determine:

A. The amount of material that can be covered in each class period.
B. The skills which must be demonstrated.
   1. Supplies needed.
   2. Equipment needed
   3. Amount of practice needed
   4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets and filmstrips that must be ordered.
D. Resource people that must be contacted.

Objectives (White)

Each unit of instruction is based on behavioral or measurable objectives. These objectives state the goals of the course in such a way that both teacher and student will know the changes in behavior expected to occur as a result of the instruction. In short, objectives are a means of providing a sense of direction and accomplishment for the student.

Behavioral objectives are stated in two forms: terminal objectives stating the subject matter to be covered in a unit of instruction and specific objectives stating the student performance necessary to reach the terminal objective. Specific objectives are most important in regard to teaching the unit. Before attempting to teach a unit, terminal and specific objectives must be explained to the student in order for him to know what is expected of him.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which were used in this material:

Name
Label
List in writing
List orally
Letter
Record
Repeat
Give
Identify
Select
Mark
Point out
Pick 'out
Choose
Locate
Describe
Define
Discuss in writing
Discuss orally
Interpret
Tell how
Tell what
Explain
Order
Arrange
Sequence
List in order
Classify
Divide
Isolate
Sort

Distinguish
Discriminate

Construct
Draw
Make
Build
Design
Formulate
Reproduce
Transcribe
Reduce
Increase
Figure

Demonstrate
Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of their students and community. When a teacher adds objectives, he should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities (White)

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. The activities are listed according to whether they are the responsibility of the instructor or the student.

Instructor: Duties of the instructor will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheets, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss terminal and specific objectives and information sheets; give tests. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Students: Student activities are listed which will help the student to achieve the objectives for the unit.
Information Sheets (Green)

Information sheets provide content essential for meeting the cognitive (knowledge) objectives of the unit. The teacher will find that information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skills specified in the terminal objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters (White)

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective for such activities as learning and locating the parts of a machine.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion. (NOTE: Stand away from the overhead projector when discussing transparency material. The noise of the projector may cause the teacher to speak too loudly.)

Assignment Sheets (Tan)

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledge which is a necessary prerequisite to skill development. These may be given to the student for completion in class or they may be used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets (Blue)

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for a student to follow if he has missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances he might reasonably expect from a person who has had this training.

Test and Evaluation (Yellow)

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the terminal objective. Test items for objectives added by the teacher should be constructed and added to the test. Progress sheets are provided for student and teacher to record acceptable performance of skills outlined in job sheets.
Test Answers (Pink)

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.
THE FORESTS
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to describe how a tree grows and list the important parts of a tree. He should be able to list the classifications of stands of trees and identify trees based on tree classifications of size and tree crowns. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with tree growth and forests.
2. List the three main parts of a tree.
3. List the four parts of tree crowns.
4. Label the five parts of a tree trunk when given a drawing of an exposed tree trunk.
5. Label the three parts of the tree roots when given a drawing.
6. Describe the general process for photosynthesis when given a list of terms.
7. List the two kinds of wood formed in an annual ring of diameter growth.
8. Name five terms used for classifications of trees by size.
9. Identify tree classifications based on tree crowns when given a drawing of a group of trees.
10. List four classifications of stands for trees.
11. Identify the six forest regions of the United States when given a map drawing.
12. Demonstrate the ability to:
   a. Identify trees using size classifications.
   b. Identify trees using crown classifications.
THE FORESTS
UNIT I

SUGGESTED ACTIVITIES

Instructor:

A. Provide students with objective sheet.
B. Provide students with information and assignment sheets.
C. Make transparencies.
D. Discuss terminal and specific objectives.
E. Discuss information and assignment sheets.
F. Arrange field trip to allow students the opportunity to practice identifying trees using size and crown classifications.
G. Give test.

II. Students:

A. Read objectives.
B. Study information sheet.
C. Complete assignment sheets and turn in to instructor for grading.
D. Participate in field trip.
E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objectives
B. Information sheet
C. Transparency masters

1. TM 1—Main Parts of a Tree
2. TM 2—The Trunk
3. TM 3--Photosynthesis
4. TM 4--Tree Classification by Tree Crown
5. TM 5--Forest Regions of the United States

D. Assignment Sheets
1. Assignment Sheet #1--Identify Trees Using Size Classifications
2. Assignment Sheet #2--Identify Trees Using Crown Classifications

E. Test

F. Answers to test

THE FORESTS
UNIT 1
INFORMATION SHEET

I. Terms and definitions
A. Tree--A woody perennial that attains a height of 8 feet or more, has a single unbranched trunk of at least 2 feet, and is at least 2 inches in diameter at DBH
B. Perennial--A plant living more than 2 years
C. DBH (Diameter Breast High)--Measured at 4 1/2 feet from the ground
D. Softwood--An evergreen tree with needles and scalelike leaves
E. Hardwood--A broadleaf tree that loses its leaves
F. Twig--Current year's growth of the stem
G. Innerbark (Phloem)--That part of the trunk that transports tree food
H. Cambium--That part of the tree that gives growth and produces more wood
I. Sapwood (Xylem)--The living part of tree wood that transports water and nutrients to the leaves
J. Heartwood (Xylem)--The center of the tree that is dead wood
K. Taproot--The largest root of the root system
(NOTE: Not all trees have a taproot.)
L. Lateral root--The side root of the root system
M. Root tip--The very end of the roots where water and nutrients are absorbed into the tree
N. Photosynthesis--Process of making food from water, nutrients, carbon dioxide, and sunlight
O. Annual ring--The layer of wood formed in a season's growth
P. Seedling--A tree up to 3 feet tall
Q. Sapling--A tree taller than 3 feet but less than 4 inches DBH
R. Pole--A tree 4 inches DBH to 11.9 inches DBH
S. Standard--A tree 12 inches DBH to 23.9 inches DBH
INFORMATION SHEET

T. Veteran--A tree 24 inches DBH +

U. Dominant--A tree that receives full sunlight on its crown

V. Codominant--A tree that receives sunlight on the top of its crown and partially on the sides

W. Intermediate--A tree that receives sunlight partially on top of its crown

X. Suppressed--A tree that receives no sunlight

Y. Stand--A group of trees clustered together based on their age, size, composition, or other criterion

Z. Forest--The grouping of stands of trees

II. Main parts of a tree (Transparency 1)

A. Crown

B. Trunk

C. Roots

III. Parts of the crown

A. Leaves

B. Twigs

C. Flowers

D. Fruit

IV. Parts of the trunk (Transparency 2)

A. Bark

B. Innerbark

C. Cambium

D. Sapwood

E. Heartwood

Parts of the roots (Transparency 1)

A. Taproot

B. Lateral root

C. Root tips
VI. Process of photosynthesis (Transparency 3)
   A. Carbon dioxide from the air
   B. Water and nutrients from the soil
   C. Sunlight from sun
   D. Glucose sugar in tree food
   E. Oxygen released to atmosphere
   (NOTE: This process occurs in green leaves.)
   F. Chemical formula:
      \[ \text{Carbon dioxide} + \text{water and nutrients} + \text{sunlight} \rightarrow \text{glucose sugar} + \text{oxygen} \]

VII. Diameter growth (Transparency 2)
   A. Springwood annual ring
   B. Summerwood annual ring

VIII. Tree classifications by size
   A. Seedling
   B. Sapling
   C. Pole
   D. Standard
   E. Can

IX. Tree classifications by tree union (Transparency 4)
   A. Dominant
   B. Codominant
   C. Intermediate
   D. Suppressed

X. Stand classifications for trees
   A. Age
      Example: 30 year old stand
INFORMATION SHEET

B. Size
   Example: Pole timber stand

C. Composition
   1. Pure stand
      Example: Shortleaf pine
   2. Mixed stand
      Example: Pine and hardwood

XI. Forest regions (Transparency 5)
A. Tropical
B. Rocky Mountain
C. Pacific Coast
D. Northern
E. Central Hardwood
F. Southern
Main Parts of a Tree

- CROWN
- Leaves
- Twigs
- Flowers
- Fruit

- TRUNK
- Bark
- Innerbark
- Cambium
- Sapwood
- Heartwood

- ROOTS
- Taproot
- Lateral Root
- Root Tips
Photosynthesis

The Making of Tree Food

\[
\text{CO}_2 + \text{H}_2\text{O} + \text{Sun Light} \rightarrow \text{Glucose} \rightarrow \text{O}_2
\]

Carbon Dioxide  Water and Nutrients  Radiant Energy  Tree Food  Oxygen to the Atmosphere
Tree Classification by Tree Crown

CROWN CLASSIFICATIONS: D = Dominant; CD = Codominant; I = Intermediate; S = Suppressed.
Fig. 3-1. A map showing the natural forest regions of the United States. The Alaskan Forest is seen in the inset. (Courtesy of U.S. Forest Service.)
ASSIGNMENT SHEET #1--IDENTIFY TREES USING SIZE CLASSIFICATIONS

Identify trees indicated by the instructor as to:

- **Seedling**: Up to 3 feet tall
- **Sapling**: 3 feet to less than 4 inches DBH
- **Pole**: 4 inches DBH to 11.9 inches DBH
- **Standard**: 12 inches DBH to 23.9 inches DBH
- **Veteran**: 24 inches DBH +

Place an "X" in the blank indicating the proper identification. When finished, turn in to the instructor for evaluation.

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<tr>
<th>Tree No.</th>
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THE FORESTS UNIT

ASSIGNMENT SHEET #2 IDENTIFY TREES USING CROWN CLASSIFICATIONS

Identify trees indicated by the instructor as to:
- Dominant - Receives full sunlight on its crown
- Codominant - Receives sunlight on top and partially on the sides
- Intermediate - Receives sunlight partially on top of crown
- Suppressed - Receives no sunlight

Place an "X" in the blank indicating the proper identification. When finished, turn in to the instructor for evaluation.

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<th>Tree No.</th>
<th>Dominant</th>
<th>Codominant</th>
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THE FORESTS
UNIT I

TEST

1. Match the terms on the right to the correct definition.

   a. A woody perennial plant attains a height of 8 feet or more, has a single unbranched trunk of at least 2 feet, and is at least 2 inches in diameter at DBH

   b. A plant living more than 2 years

   c. Measured at 4 1/2 feet from the ground

   d. An evergreen tree with needles and scalelike leaves

   e. A broadleaf tree that loses its leaves

   f. Current year's growth of the stem

   g. That part of the trunk that transports tree food

   h. That part of the tree that gives growth and produces more wood

   i. The living part of tree wood that transports water and nutrients to the leaves

   j. The center of the tree that is dead wood

   k. The largest root of the root system

   l. The side root of the root system

   m. The very end of the roots where water and nutrients are absorbed into the tree

   n. Process of making food from water, nutrients, carbon dioxide, and sunlight

   o. The layer of wood formed in a season's growth

   1. Softwood

   2. Cambium

   3. Taproot

   4. Veteran

   5. Pole

   6. Stand

   7. Seedling

   8. Tree

   9. Standard

   10. Sapling

   11. Lateral root

   12. DBH (Diameter Breast High)

   13. Innerbark (Phloem)

   14. Codominant

   15. Annual ring

   16. Root tip

   17. Suppressed

   18. Perennial

   19. Twig

   20. Photosynthesis

   21. Forest

   22. Sapwood (Xylem)
p. A tree up to 23 ft tall

q. A tree taller than 3 ft but less than 7 ft tall

r. A tree 4 in. DBH to 11.9 in. DBH

s. A tree 12 in. DBH to 23.9 in. DBH

t. A tree 24 in. DBH +
u. A tree that receives full sunlight on its crown

v. A tree that receives sunlight on the top of its crown and partially on the sides

w. A tree that receives sunlight partially on top of its crown

x. A tree that receives no sunlight

y. A group of trees clustered together based on their age, size, composition, or other criterion

z. The grouping of stands of trees

2. List the three main parts of a tree.

a.

b.

c.

3. List the four parts of tree crowns

a.

b.

c.

d.
4. Label the parts of this tree trunk below.

5. Label the parts of this tree root system below.
6. Describe the general process for photosynthesis from the list of terms given below:

- sunlight
- glucose sugar
- water and nutrients
- carbon dioxide
- oxygen

A. \[ \text{a. } + \text{b. } \rightarrow \text{c. } + \text{d. } \]
B. \[ \text{e. } \]

7. List the two kinds of wood formed in an annual ring of diameter growth.
   a. 
   b. 

8. Name the five terms used for classifications of trees by size.
   a. 
   b. 
   c. 
   d. 
   e. 

9. Identify tree classifications based on tree crowns from the drawing given below by placing a "D" for dominant, "CD" for codominant, "I" for intermediate, and "S" for suppressed.
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 
   g. 
   h. 

33.
10. List four classifications of stands for trees.
   a. 
   b. 
   c. 
   1) 
   2) 

11. Identify the six forest regions of the United States shown on this map.
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 

12. Demonstrate the ability to:
   a. Identify trees using size classifications.
   b. Identify trees using crown classifications.
THE FORESTS
UNIT I

ANSWERS TO TEST

1. a. 8  b. 73  c. 12  d. 1  e. 25  f. 16
   g. 13  h. 2  i. 22  j. 26  k. 3  l. 5
   m. 16  n. 20  o. 15  p. 7  q. 10  r. 5
   s. 9  t. 4  u. 24  v. 14  w. 23  x. 17
   y. 6  z. 21

   d. Leaves  e. Twigs  f. Flowers  g. Fruit

   f. Sapwood

4. a. Taproot  b. Lateral root  c. Root tips

5. a. Carbon dioxide  b. Water and nutrients
c. Sunlight

d. Glucose sugar

e. Oxygen

7. a. Springwood annual ring
    b. Summerwood annual ring

8. a. Seedling
    b. Sapling
    c. Pole
    d. Standard
    e. Veteran

9. a. D
    b. I
    c. S
    d. D
    e. S
    f. C
    g. S
    h. C

10. a. Age
    b. Size
    c. Composition
        1) Pure
        2) Mixed

11. a. Pacific Coast
    b. Rocky Mountain
    c. Northern
    d. Central Hardwood
    e. Southern
    f. Tropical

12. Performance skills will be evaluated to the satisfaction of the instructor.
IDENTIFYING OKLAHOMA TREES
UNIT 1

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to identify leaves by composition, shape, margin, and arrangement. He should be able to use these terms with a key to identify Oklahoma trees. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with identifying Oklahoma trees to the correct definition.
2. Distinguish between the characteristics for gymnosperms and angiosperms.
3. Label the parts of a simple leaf on a given diagram.
4. Name the four types of veins found in tree leaves.
5. Match the type of compound leaf to the correct definition.
6. Label leaf shapes when given a list of terms.
7. Label leaf margins when given a list of terms.
8. Identify leaf arrangements.
9. Demonstrate the ability to identify trees using a key.
IDENTIFYING OKLAHOMA TREES
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and assignment sheets.
   C. Discuss information and assignment sheets.
   D. Discuss terminal and specific objectives.
   E. Arrange field trips to allow students to collect and identify leaves by shape and margin. Also, provide students with an opportunity to use a key to identify tree species and leaf arrangements.
   F. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Participate in field trips.
   D. Complete assignment sheets.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency masters
      1. TM 1 - Leaf Parts
      2. TM 2 - Simple and Compound Leaves
      3. TM 3 - Leaf Shapes
      4. TM 4 - Leaf Shapes (Continued)
5. TM 5--Leaf Margins
6. TM 6--Leaf Margins (Continued)
7. TM 7--Leaf Arrangements

D. Assignment sheets
   1. Assignment Sheet #1--Identify Leaf Shapes and Margins
   2. Assignment Sheet #2--Identify Leaf Arrangements and Tree Species Using a Key

E. Test

F. Answers to test

II. References:

IDENTIFYING OKLAHOMA TREES
UNIT I
INFORMATION SHEET

I. Terms and definitions

A. Fruit--The seed bearing product of a plant
B. Gymnosperm--Plant bearing naked seeds
C. Evergreen--Always green; year-round
D. Resin duct--Minute opening in wood filled with resin
E. Cone--A fruit formed of overlapping scales
F. Angiosperm--Plant bearing enclosed seeds
G. Deciduous--Leaves fall each autumn
H. Pore--A cell opening in angiosperms; occasionally visible to the naked eye
I. Leaf composition--Refers to compound leaves
J. Simple leaf--One blade
(Note: A blade is the expanded portion of a leaf.)
K. Compound leaf--Several leaflets to form a leaf
L. Key--A system of grouping species to be readily identified using leaves and other characteristics
M. Leaf arrangement--The location of leaves on a stem
N. Sinus--The separation between lobes
O. Dichotomus--Branching by forking in pairs
P. Node--The point on a stem where a leaf is found

II. Characteristics of gymnosperms and angiosperms

A. Gymnosperms--Open seeded
   1. Generally evergreen
   2. Called conifers or softwoods
   3. Wood has no pores, but resin ducts sometimes do
INFORMATION SHEET

4. Leaves are needlelike, scalelike, or awl-like
5. Fruit is a woody or fleshy cone

B. Angiosperms—Closed seeded
1. Generally deciduous
2. Called broadleaf or hardwoods
3. Wood has pores and no resin ducts
4. Leaves are broadened; expanded blades
5. Fruit is dry or fleshy and encloses the seed

III. Simple leaf parts (Transparency 1)
A. Veins—Conduction system
B. Midrib—Main vein extended from twig through a petiole
C. Blade—Expanded portion of a leaf
D. Petiole—Stalk of a leaf
E. Bud—New shoot or flower; also indicates the beginning point of a leaf

IV. Types of veins
A. Pinnate
B. Palmate
C. Arcuate
D. Closed

V. Compound leaves (Transparency 2)
A. Odd-pinnate—Has a terminal leaflet
B. Even-pinnate—Even number of leaflets
C. Pinnately trifoliate—Three leaflets
D. Palmate—All leaflets from the same point on the petiole
E. Palmately trifoliate—Three leaflets from same point on the petiole
F. Bipinnate—Second division of leaflets
G. Tripinnate—Third division of leaflets
INFORMATION SHEET

VI. Leaf shapes (Transparencies 3 and 4)

A. Acicular--Needlelike
B. Scalelike--Small, short, sharp-pointed
C. Linear--Long and narrow
D. Oblong--Long and wide
E. Lanceolate--Lance-shaped
F. Oblanceolate--Inverse lance-shaped
G. Ovate--Egg-shaped
H. Obovate--Inverse egg-shaped
I. Elliptical--Shaped like an ellipse
J. Oval--A broad ellipse
K. Orbicular--Circular
L. Reniform--Kidney-shaped
M. Cordate--Heart-shaped
N. Obcordate--Inverse heart-shaped
O. Cuneate--Wedge shaped
P. Deltoid--Triangular
Q. Obdeltoid--Inverse triangular
R. Rhomboid--Diamond shaped
S. Spatulate--Spatula shaped
T. Sagittate--Arrowhead
U. Hastate--Spearhead
V. Peltate--Shield shaped
W. Subulate--Expanded point

VII. Leaf margins (Transparencies 5 and 6)

A. Revolute--Turned under
B. Entire--Smooth edge
INFORMATION SHEET

C. Repand--Wavy
D. Sinuate--Very wavy
E. Crenate--Rounded teeth
F. Crenulate--Finely rounded teeth
G. Doubly crenate--Large and fine round teeth
H. Dentate--Sharp teeth pointed out
I. Denticulate--Fine dentate teeth
J. Serrate--Sharp teeth turned up
K. Serrulate--Finely serrated
L. Doubly serrate--Coarse and fine serrations
M. Divided--Sinus extends to midrib
N. Lobed--Rounded sinus
O. Pinnately lobed--Lobing from midrib
P. Palmately lobed--Lobing from base of leaf
Q. Cleft--Narrow, sharp sinuses
R. Parted--Cleft extends to midrib

VIII. Leaf arrangements (Transparency 7)
A. Alternate--One leaf at a node
B. Opposite--Two leaves at a node
C. Whorled--More than two leaves at a node

IX. Using a tree key
A. Generally dichotomus
B. Key includes:
   1. Choice of gymnosperms or angiosperms
   2. Choice of leaf arrangement
   3. Choice of type of leaf composition
   4. Continued choice until a species of tree is reached
SUMMER KEY TO THE GENERA OF OKLAHOMA TREES

Based primarily on leaves and fruit

1. Leaves needle-like, scale-like or oval-shaped
2. Leaves alternate on the stem or in fascicles, fruit a cone.
3. Leaves persistent in fascicles of two to five
4. Leaves and branches deciduous (alternate)
5. Leaves opposite or whorled, scale-like or oval-shaped, fruit berry-like with 1 to 4 seeds
6. Leaves broad (not widest)
7. Leaves simple
8. Leaves pinnately lobed
9. Leaves without lobes.
10. Leaf margins entire.
11. Buds and sometimes midrib rusty or tawny
12. Not as above
13. Leaves alternate above the middle, teeth curved, fruit blue-purple, opening and falling in early summer
14. Leaves the full length of margin; fruit opening in fall with scattered seed
15. Leaf margins entire
16. Leaves 3 to 4 inches in length
17. Leaves usually in whorls of 3, tip tapering; fruit blue-purple
18. Leaves broadly ovate, lobes not Andy serrate; fruit a blueberry with a persistent star-like calyx
19. Leaf margins serrate.
20. Leaves deciduous.
21. Leaves persistent, in least during part of winter, scaling off leaving smooth white bark.
22. Leaves broadly ovate, lobes not finely serrate; fruit enclosed by the base of the petiole; outer bark of upper branches and young trunks scaling off leaving smooth white bark
23. Leaf margins serrate or finely toothed; fruits sweet and yield a yellow dye.
24. Leaves distinctly cordate
25. Leaves not distinctly cordate.
26. Sap in leaves and bark milky; spines usually present; fruit orange-like.
27. Sap in leaves and bark milky; spines not conspicuous or absent.
28. Wood, bark and crushed leaves’ spiny aromatic; leaves often 2 or 3 lobed; fruit a blueberry with a persistent scarlet calyx.
29. Not as above.
30. Leaves distinctly cordate
31. Leaves not distinctly cordate.
32. Stipules and stipule scars entire on the twig.
33. Stipules and stipule scars (if present) not encircling twig.
34. Leaves 3-veined from base; fruit small; orange or yellow; lower bark warty; (path often chambered).
35. Leaves not 3 veined from base; fruit various; bark not chambered.
36. Buds in clusters at end of twig; fruit an acorn; path star-shaped; Quercus sp. (Oaks).
37. Buds at end of twig single.
38. Path partitioned by woody plates.
39. Leaves often 10 to 12 inches in length, (disagreeable odor when crushed).
40. Leaves less than 6 inches in length, crowded at ends of lateral branches.
41. Path not partitioned by woody plates.
42. Path chambered at least in most branches; leaves oblong ovate, fruit pulpy with few or many flat seeds.
43. Path not chambered.
44. Leaves often fascicled on lateral branches, spines present; leaves less than 3 inches in length.
45. Leaves never fascicled; branches not spiny; leaves more than 3 inches in length.
46. Leaf margin toothed or serrate.
47. Leaves persistent.
48. Leaves aromatic, resin dotted.
49. Leaves not as above.
50. Leaves sharp-pointed (spiny toothed, rarely entire)
51. Leaves operculate (Holly)
FOREST TREES OF OKLAHOMA

46

1. Leaves not as above.
2. Leaves small, deciduous in the fall, at top of thicket.
3. Leaves large, deciduous in the fall, at top of tree.
4. Leaves large, deciduous in the fall, at base of tree.
5. Leaves large, deciduous in the fall, at middle of tree.
6. Leaves large, deciduous in the fall, at stem of tree.
7. Leaves large, deciduous in the fall, at base of stem.
8. Leaves large, deciduous in the fall, at middle of stem.
9. Leaves large, deciduous in the fall, at top of stem.
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97. Leaves large, deciduous in the fall, at base of stem.
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99. Leaves large, deciduous in the fall, at top of stem.
100. Leaves large, deciduous in the fall, at base of tree.
101. Leaves large, deciduous in the fall, at middle of tree.
102. Leaves large, deciduous in the fall, at stem of tree.
103. Leaves large, deciduous in the fall, at base of stem.
104. Leaves large, deciduous in the fall, at middle of stem.
105. Leaves large, deciduous in the fall, at top of stem.
Leaf Parts

Blade

Node

Vein

Midrib

Petiole

Axillary Bud
Simple and Compound Leaves

Simple Leaf

Compound Leaves

Odd-Pinnate

Even-Pinnate

Palmately Trifoliate

Pinnately Trifoliate

Palmate

Bipinnate Leaf

Tripinnate Leaf
Leaf Shapes

Acicular
Oblong
Linear
Scalelike
Lanceolate
Oblanceolate
Ovate
Obovate
Elliptical
Obcordate
Oval
Cuneate
Leaf Shapes

(Continued)

Orbicular  Reniform  Gordate  Deltoid  Obdeltoid

Rhomboid  Spatulate  Sagittate  Hastate  Peltate  Subulate
Leaf Margins

Revolute
Entire
Repand
Sinuate
Crenate
Crenulate
Doubly Crenate
Dentate
Denticulate
Leaf Margins

(Continued)

- Serrate
- Serrulate
- Doubly Serrate
- Divided
- Lobed
- Pinnately Lobed
- Palmately Lobed
- Cleft
- Parted
Leaf Arrangements

Opposite

Alternate

Whorled
IDENTIFYING OKLAHOMA TREES
UNIT 1

ASSIGNMENT SHEET #1--IDENTIFY LEAF SHAPES AND LEAF MARGINS.

1. Collect leaves from trees the instructor will point out by name. Place the leaves in a fold of newspaper with the name of the tree written on the newspaper.

2. Later place the newspaper with leaves in a warm location with a weight to press out and dry the leaves. The leaves can be left in newspaper, placed in file folders, or glued on cardboard. The leaves serve as a reference for identifying the trees.

3. Identify the collected leaves by filling in the chart on the following page using the terms provided. When finished turn in to the instructor for evaluation.
<table>
<thead>
<tr>
<th>Leaf Shapes</th>
<th>Margins</th>
<th>Tree Name</th>
<th>Leaf Shape</th>
<th>Leaf Margin</th>
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</thead>
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<tr>
<td>Aéicicular</td>
<td>Revolute</td>
<td>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scalelike</td>
<td>Entire</td>
<td>(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td>Repand</td>
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<td>Oblong</td>
<td>Sinuate</td>
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<td>Lanceolate</td>
<td>Crenate</td>
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<td></td>
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<td>Oblanceolate</td>
<td>Crenulate</td>
<td>(6)</td>
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<td></td>
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<tr>
<td>Ovate</td>
<td>Doubly crenate</td>
<td>(7)</td>
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<td>Obovate</td>
<td>Dentate</td>
<td>(8)</td>
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<td>Elliptical</td>
<td>Denticulate</td>
<td>(9)</td>
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<tr>
<td>Oval</td>
<td>Serrate</td>
<td>(10)</td>
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<tr>
<td>Orbicular</td>
<td>Serrulate</td>
<td>(11)</td>
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<tr>
<td>Reniform</td>
<td>Doubly serrate</td>
<td>(12)</td>
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<tr>
<td>Cordate</td>
<td>Divided</td>
<td>(13)</td>
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<tr>
<td>Obcordate</td>
<td>Lobed</td>
<td>(14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuneate</td>
<td>Pinnately lobed</td>
<td>(15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deltoid</td>
<td>Palmately lobed</td>
<td>(16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obdeltoid</td>
<td>Cleft</td>
<td>(17)</td>
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<tr>
<td>Rhomboid</td>
<td>Parted</td>
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<tr>
<td>Spatulate</td>
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<tr>
<td>Sagittate</td>
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<td>Hastate</td>
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<td>Peltate</td>
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<tr>
<td>Subulate</td>
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</tbody>
</table>
IDENTIFYING OKLAHOMA TREES
UNIT I

ASSIGNMENT SHEET #2-IDENTIFY LEAF ARRANGEMENTS AND TREE SPECIES USING A KEY

For each tree the instructor points out, identify the species by name using the key provided in IX of information sheet. Identify the kind of leaf arrangement for each. When completed, turn in to the instructor for evaluation.
IDENTIFYING OKLAHOMA TREES
UNIT I

TEST

1. Match the terms on the right to the correct definition.

   a. The seed bearing product of a plant
   b. Plant bearing naked seeds
   c. Always green; year-round
   d. Minute opening in wood filled with resin
   e. A fruit formed of overlapping scales
   f. Plant bearing enclosed seeds
   g. Leaves fall each autumn
   h. A cell opening in angiosperms; occasionally visible to the naked eye
   i. Refers to compound leaves
   j. One blade
   k. Several leaflets to form a leaf
   l. A system of grouping species to be readily identified using leaves and other characteristics
   m. The location of leaves on a stem
   n. The separation between lobes
   o. Branching by forking in pairs
   p. The point on a stem where a leaf is found

1. Resin duct
2. Leaf composition
3. Sinus
4. Evergreen
5. Pore
6. Dichotomus
7. Fruit
8. Simple leaf
9. Angiosperm
10. Gymnosperm
11. Leaf arrangement
12. Key
13. Cone
14. Compound leaf
15. Deciduous
16. Node
2. Distinguish between the characteristics for each, gymnosperms and angiosperms, by placing a "G." or an "A." accordingly.

   a. Leaves needlelike, scalelike, or awl-like
   b. Called broadleaf or hardwoods
   c. Generally deciduous
   d. Called conifers or softwoods
   e. Fruit is dry or fleshy and encloses seed
   f. Fruit is a woody or fleshy cone
   g. Leaves are broadened; expanded blades
   h. Generally evergreen
   i. Wood has pores and no resin ducts
   j. Wood has no pores, but resin ducts sometimes do

3. Label this drawing of a simple leaf with the terms provided below.

   Vein
   Midrib
   Blade
   Petiole
   Bud
4. Name the four types of veins found in tree leaves.
   a. 
   b. 
   c. 
   d. 

5. Match the compound leaf terms on the right to the correct definitions.
   _____ a. Three leaflets
   1. Odd-pinnate
   _____ b. Three leaflets from the same point on the petiole
   2. Even-pinnate
   _____ c. Has a terminal leaflet
   3. Pinnately trifoliate
   _____ d. Third division of leaflets
   4. Palmate
   _____ e. All leaflets from the same point on the petiole
   5. Palmately trifoliate
   _____ f. Even number of leaflets
   6. Bipinnate
   _____ g. Second division of leaflets
   7. Tripinnate

6. Label the leaf shapes with the correct terms from the list given below.

   Acicular, Scalelike, Linear, Oblong, Lanceolate, Oblanceolate, Ovate, Obovate

   Elliptical, Oval, Orbicular, Reniform, Cordate, Obcordate, Cuneate, Deltoid

   Oblong, Oblanceolate, Ovate, Obovate

   Oval, Reniform, Orbicular, Cordate, Obcordate

   Elliptical, Oval, Orbicular

   Oblong, Oblanceolate, Ovate, Obovate

   Acicular, Scalelike, Linear, Oblong, Lanceolate, Oblanceolate, Ovate, Obovate

   Elliptical, Oval, Orbicular, Reniform, Cordate, Obcordate, Cuneate, Deltoid

   Oblong, Oblanceolate, Ovate, Obovate

   Acicular, Scalelike, Linear, Oblong, Lanceolate, Oblanceolate, Ovate, Obovate

   Elliptical, Oval, Orbicular, Reniform, Cordate, Obcordate, Cuneate, Deltoid

   Oblong, Oblanceolate, Ovate, Obovate
7. Label the leaf margins with the correct term from the list given below.

- Revolute
- Entire
- Repand
- Sinuate
- Crenate
- Crenulate
- Doubly crenate
- Dentate
- Denticulate
- Serrate
- Serrulate
- Doubly serrate
- Divided
- Lobed
- Pinnately lobed
- Palmately lobed
- Cleft (used twice)
- Parted

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<th>b.</th>
<th>c.</th>
<th>d.</th>
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<td>f.</td>
<td>g.</td>
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<td>j.</td>
<td>k.</td>
<td>l.</td>
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<tr>
<td>m.</td>
<td>n.</td>
<td>o.</td>
<td>p.</td>
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<tr>
<td>q.</td>
<td>r.</td>
<td>s.</td>
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</table>
8. Identify the following leaf arrangement by placing the correct number in the blanks provided.

   1. Opposite
   2. Whorled
   3. Alternate

9. Demonstrate the ability to identify trees using a key.

   (NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)
IDENTIFYING OKLAHOMA TREES
UNIT I

ANSWERS TO TEST

1: a. 7 f. 9 k. 14 p. 16
b. 10 g. 15 l. 12
c. 4 h. 5 m. 11
d. 1 i. 2 n. 3
e. 13 j. 8 o. 6

2: a. G f. G
b. A g. A
c. A h. G
d. G i. A
e. A j. G

3. a. Vein
b. Midrib
c. Blade
d. Petiole
e. Bud

4. a. Pinnate
b. Palmate
c. Closed
d. Arcuate

5. a. 3 e. 4
b. 5 f. 2
c. 1 g. 6
d. 7
6. a. Subulate  
   b. Cuneate  
   c. Obovate  
   d. Ovate  
   e. Oblanceolate  
   f. Lanceolate  
   g. Reniform  
   h. Cordate  
   i. Obcordate  
   j. Deltoid  
   k. Obdeltoid  
   l. Rhomboid  

   m. Spatulate  
   n. Acicular  
   o. Scalelike  
   p. Linear  
   q. Oblong  
   r. Sagittate  
   s. Hastate  
   t. Peltate  
   u. Elliptical  
   v. Oval  
   w. Orbicular  
   x. Cleft  
   y. Parted  
   z. Dentate  
   a. Denticulate  
   b. Serrate  
   c. Revolute  
   d. Entire  
   e. Repand  

   p. Cleft  
   q. Lobed  
   r. Pinnately lobed  
   s. Palrnately lobed  
   t. Palmately lobed  
   u. Pinnately lobed  
   v. Doubly crenate  
   w. Doubly serrate  
   x. Crenate  
   y. Crenulate  
   z. Doubly crenulate  

7. a. Cleft  
   b. Parted  
   c. Dentate  
   d. Denticulate  
   e. Serrate  
   f. Revolute  
   g. Entire  
   h. Repand  

   p. Cleft  
   q. Lobed  
   r. Pinnately lobed  
   s. Doubly crenate  
   t. Crenate  
   u. Crenulate  
   v. Doubly serrate  
   w. Serrulate  
   x. Serrate  
   y. Doubly serrate  
   z. Doubly crenulate  

8. a. 3  
   b. 1  
   c. 2  

9. Evaluated to the satisfaction of the instructor.
USING MEASUREMENT UNITS TO SOLVE FORESTRY PROBLEMS
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to use measurement units of length, area, volume, and capacity and conversion factors of these to solve forestry problems. The student should also be able to obtain the correct answers when given essential measurements needed to solve the problems. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with measurement units to solve forestry problems to the correct definition.

2. Select conversion factors for length to obtain a correct answer when given a problem and a list of conversion factors or a map scale.

3. Determine area from conversion factors and from formulas for specific plane figures.

4. Solve for the unknown side of a right triangle.

5. Determine the area of triangles.

6. Determine the area of a circle when given one known measurement.

7. Determine the volume and capacity of various shaped solids using volume units.

8. Solve for the volume of various shaped solids and containers using formulas when given the essential measurements.

9. Solve for the weight of various shaped solids when given the essential measurements to obtain volume and the weight per unit of volume.
USING MEASUREMENT UNITS TO SOLVE FORESTRY PROBLEMS
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and assignment sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information and assignment sheets.
   F. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Complete assignment sheets.
   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency masters
      1. TM 1 - Area by Shape
      2. TM 2 - Right Triangle
      3. TM 3 - The Circle
      4. TM 4 - Volume of Solids
D. Assignment sheets
   1. Assignment Sheet #1-Solve Forestry Problems Using Measurement Units of Length and Area
   2. Assignment Sheet #2-Solve Forestry Problems Using Measurement Units of Volume and Weight

E. Answers to assignment sheets

F. Test

G. Answers to test

II. References:
USING MEASUREMENT UNITS TO SOLVE FORESTRY PROBLEMS
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Area--The total outside surface usually expressed in square units

B. Conversion factor--A number used to change one unit to another

Example: 12 inches = 1 foot; the conversion factor is 12

C. Ratio--The comparison of true quantities by division

D. Proportion--A statement that one ratio is equivalent to another

E. Square--A plane figure with four equal sides and four right angles

F. Rectangle--Any four-sided figure with four right angles

G. Parallelogram--A four-sided figure having opposite sides parallel and equal

H. Right triangle--A triangle that has one right angle and the other two of less than 90 degrees

I. Right angle--One-fourth of a circle or 90 degrees

J. Hypotenuse--The triangle side opposite the right angle

K. Circle--Closed curve upon which every point is equidistant from a fixed point called the center

L. Radius--A line drawn from the center of the circle to the exterior

M. Diameter--Any straight line from one point to another on the circle which goes through the center

N. Circumference--The line around a circle

O. Pi (\(\pi\))--Symbol designating the ratio of the circumference of a circle to its diameter; \(\pi = 3.14159365^+\), usually expressed as 3.14

P. Cubic--Product obtained by multiplying a given number or quantity by its square; three dimensions

Q. Cylinder--Parallel circles for the ends and parallel sides

R. Formula--A conventional method for doing something
II. Measurement units for length

A. Conversion factors for the surveyor’s chain

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<th>Inches</th>
<th>Links</th>
<th>Feet</th>
<th>Yards</th>
<th>Rods</th>
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1 Surveyor’s chain, the engineer’s chain — 100 links of 1 foot each is not used.
2 1 nautical mile (termed “knot” as unit of velocity) = 1.1516 statute miles = 1.60934 kilometers.
3 Both units are defined: 1 foot = 30.48006 centimeters; 1 meter = 100 centimeters.
4 1 yard = 3 feet = 36 inches = 91.44 centimeters = 36 inches = 0.9144 meters.
5 1 inch = 2.54 centimeters = 0.0254 meter.

SOURCE: U.S. DEPT. OF AGRICULTURE

(NOTE: Since there are always more units in the smaller denomination than in the larger, you multiply if your answer is to be in the smaller denomination, and you divide if it is to be in the larger.)
INFORMATION SHEET

B. Scales of maps and drawings as conversion factors

1. Arithmetic terms

Example: 1" = 1 mile and 1:24,000

2. Ratio and proportion

Example: Given a scale of 1:62500 to find the land distance from A to B on a map where the map distance is 4.5 inches. Therefore, 

\[ \frac{X}{45} = \frac{62500}{1} \]

and 

\[ X = \frac{4.5 \times 62500}{1} = 281,250 \]

inches, which divided by 5280=53.26 miles

III. Measurement units for area

A. Conversion factors for area

FACTORS AND TABLES OF EQUIVALENTS USED IN FORESTRY

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<tr>
<th>Square inches</th>
<th>Square links</th>
<th>Square feet</th>
<th>Square yards</th>
<th>Square chains</th>
<th>Acres</th>
<th>Square centimeters</th>
<th>Square meters</th>
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NOTE: Most units of area are squares of units of lengths. The notable exception is the acre which has no corresponding linear unit.

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INFORMATION SHEET

B. Square areas—Side times side (Transparency 1)

C. Rectangles—Base times height

D. Parallelogram—Base times height

IV. Unknown side to the right triangle (Transparency 2)

A. Pythagoras Rule—"The square of the hypotenuse is equal to the sum of the squares of the other two sides."
\[
c = \sqrt{a^2 + b^2} \quad ; \quad a = \sqrt{c^2 - b^2} \quad ; \quad b = \sqrt{c^2 - a^2}
\]

B. Finding the square root of a number

1. Estimate by bracketing—Try 12 and 13; since the square of 12 is 144 and 132 = 169, the square root of 150 (shown as 150) is between 12 and 13; use 12.3 as an estimate

2. Divide 150 by 12.3 = 12.2

3. Average of 12.3 and 12.2 = 12.25

4. Divide 150 by 12.25 = 12.244

5. Average of 12.25 and 12.244 = 12.247

6. Repeat until the average is as near as needed

V. Area of a triangle = 1/2 base times height \( A = \frac{1}{2}bh \) (Transparency 2)

VI. Area of a circle

A. Parts of a circle (Transparency .3)

1. Radius—point out 360°; \( r = \frac{d}{2} \)

2. Diameter—point out \( d = 2r \)

3. Circumference—\( C = \pi d \) or \( 2\pi r \)

B. Formula for the area of a circle—\( A = \pi r^2 \) or \( \pi \frac{d^2}{4} \)

VII. Determining volume and capacity from volume units

A. Volume—Linear units

1. 1728 cu. inches = 1 cu. ft.

2. 27 cu. ft. = 1 cu. yd.
INFORMATION SHEET

3. 35.3145 cu. ft. = 1.3079 cu. yd. = 1 cu. meter
4. 128 cu. ft. = 1 standard cord (4x4x8)

B. Volume-Capacity units
1. 231 cu. in. = 1 gallon
2. 4 quarts = 8 pints = 1 gallon
3. 7.48 gal. = 1 cu. ft.
4. 43,560 cu. ft. = 325,900 gal. = 1 acre-foot
5. 32 qt. = 1.244 cu. ft. = 1 bushel
6. 1.0567 qt. = 1 liter = 0.001 cu. centimeters

VIII. Formula for volume of various shaped solids and containers (Transparency 4)
A. Rectangular: V=lwh=length x width x height
B. Cylinder
1. \( V = \pi r^2h \), where \( B = \text{area of base} \)
2. \( B = \pi r^2 \) for square inches of area
3. \( B = \frac{\pi d^2}{4(144)} \) or \( 0.004543 \) for square feet of area
C. Cone: \( V = \frac{1}{3} \pi r^2h = \frac{1}{3} Bh \)

IX. Measurement of weight
A. Units of weight
1. 16 ounces (oz.) = 1 pound (lb.)
2. 2000 lb. = 1 ton (T.)
3. 2.2046 lb. = 1000 grams = 1 kilogram

B. Weight measurement used with volume measurement. The General Sherman Sequoia tree has a circumference at the base of 102 ft., a base bark thickness of 2 ft., and a height of 272 ft. If we assume the trunk to be a true cone and use 40 lbs. as the weight per cu. ft., what would be the weight of the wood of this tree?
INFORMATION SHEET

1. Subtract the bark from the base to obtain a true wood measurement: 102 ft. \( \div \) 3.14 = 32.48

\[ \text{32.48} - 4 \text{ ft} = 28.48 \text{ ft.} \]

2. Vol. of a cone = \( \frac{1}{3} Bh \)
   
   a. Base = \( \pi d^2 \) = \( \frac{(3.14)(811.11)}{4} \) = 638.72 sq. ft.
   
   b. Base times height= 638.72 sq. ft. x 272 ft. = 173,731.84 cu. ft.
   
   c. \( \frac{1}{3} Bh = \frac{173,731.84}{3} \) cu. ft. = 57,910.61 cu. ft.
   
   d. lbs. per cu. ft. x cu. ft. total = 40 x 57,910.61 = 2,316,424.40 lbs.
Area by Shape

Square

\[ A = \text{area} = a \times a \]

Rectangle

\[ A = \text{area} = a \times b \]

Parallelogram

\[ A = \text{area} = a \times h \]
Right Triangle

\[ A = \text{area} = \frac{1}{2}ab \]

\[ c = \sqrt{a^2 + b^2} \]

\[ a = \sqrt{c^2 - b^2} \]

\[ b = \sqrt{c^2 - a^2} \]
The Circle

\[ r = \text{radius} = \frac{d}{2} \]
\[ d = \text{diameter} = 2r \]
\[ c = \text{circumference} = \pi d \text{ or } 2 \pi r \]
\[ \text{Area} = \pi r^2 \text{ or } \frac{\pi d^2}{4} \]
Volume of Solids

Rectangular
\[ V = \text{length} \times \text{width} \times \text{height} \]
\[ V = a \times b \times c \]

Cylinder
\[ V = \pi r^2 h \]
\[ \pi = 3.14 \]

Cone
\[ V = \frac{1}{3} \pi r^2 h \]
\[ \pi = 3.14 \]
USING MEASUREMENT UNITS TO SOLVE FORESTRY PROBLEMS
UNIT II

ASSIGNMENT SHEET #1 - SOLVE FORESTRY PROBLEMS USING MEASUREMENT UNITS OF LENGTH AND AREA

1. A rectangular parcel of land 136 by 200 ft. contains
   a. how many square chains?
   b. __________ acres?

2. A rectangular piece of land 3.5 by 20 chains contains how many square chains?
   a. __________
   b. __________

3. Timber cruising is sampling the forest for wanted information like board feet per acre of sawlog size trees. One way to sample is by plots as shown here:

a. What is the total tract acres in the above figure? __________ acres
b. If these are 1/5 acre plots, what is the total area measured? __________ acres

4. Many U.S. Geological Survey maps are drawn to the scale of 1:125,000.

Two inches on the map = __________ miles on the ground.
ASSIGNMENT SHEET #1

5. The circular plot is often used for taking samples of forest areas. A commonly used size has a radius of 52.7 feet.
   a. What is its diameter? ______________
   b. What is its circumference? ______________
   c. How many square feet does it have? ______________
   d. What portion of an acre is this expressed as a fraction? ______________

6. On a square area of land that measures 80 chains on a side, find the distance between opposite corners which would form a triangle. __________ chains.
USING MEASUREMENT UNITS TO SOLVE FORESTRY PROBLEMS
UNIT II

ASSIGNMENT SHEET #2—SOLVE FORESTRY PROBLEMS USING MEASUREMENT UNITS OF VOLUME AND WEIGHT

1. A cylindrical tank on a pumper truck used for fire fighting is 14 feet long and has a diameter of 6 feet.
   a. How many cubic feet does it have? 
   b. How many gallons of water will it hold?

2. A pile of chips used to make paper has accumulated in storage until it is 100 feet high and has a base diameter of 240 feet.
   a. How many cubic feet is in the pile?
   b. What does it weigh if a sample shows a cubic foot weighs 36 lbs?

3. Fuel wood can be sold green or dry. A cord of oak weighs about 5700 lbs. green and 4100 lbs. dry. If you had a tag for 9 tons only:
   a. How many cords of green wood could you haul?
   b. Dry wood?

4. How many standard cords are on a railroad car stacked 8 feet wide, 28 feet long, and 7 feet high?

5. Road oil is mostly sold by the ton, but highway specifications call for the oil by the gallon. If 260 gallons of oil weigh a ton, how many feet of road can be oiled by a 4-ton load of oil spread at a rate of 1/2 gallon per lineal foot of road?
USING MEASUREMENT UNITS TO SOLVE FORESTRY PROBLEMS
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1.  a. 6.244  
    b. .62

2.  a. 70  
    b. 7

3.  a. 40  
    b. 4  
    c. 10%, 1/10, 1:10

4.  3.94

5.  a. 105.4  
    b. 330.96'  
    c. 8720.69
    d. 1/5

6.  113.137 chains

Assignment Sheet #2

1.  a. 395.64 cu. ft.  
    b. 2,959.39 gallons

2.  a. 2,260,800 cu. ft.  
    b. 81,388,800 lbs.

3.  a. 3.15  
    b. 39

4.  12.25 cds.

5.  2080 feet
USING MEASUREMENT UNITS TO SOLVE FORESTRY PROBLEMS
UNIT II

TEST

1. Match the terms on the right to the correct definition.

   a. The total outside surface usually expressed in square units
   1. Proportion

   b. A number used to change one unit to another
   2. Right triangle

   c. The comparison of true quantities by division
   3. Circle

   d. A statement that one ratio is equivalent to another
   4. Circumference

   e. A plane figure with four equal sides and four right angles
   5. Hypotenuse

   f. Any four-sided figure with four right angles
   6. Square

   g. A four-sided figure having opposite sides parallel and equal
   7. Diameter

   h. A triangle that has one right angle and the other two of less than 90 degrees
   8. Area

   i. One-fourth of a circle or 90 degrees
   9. Cubic

   j. The triangle side opposite the right angle
   10. Formula

   k. Closed curve upon which every point is equidistant from a fixed point called the center
   11. Rectangle

   l. A line drawn from the center of the circle to the exterior
   12. Cone

   m. Any straight line from one point to another on the circle which goes through the center
   13. \( \pi \) (\( \pi \))

   n. The line around a circle
   14. Ratio

   15. Pyramid

   16. Parallelogram

   17. Conversion factor

   18. Cylinder

   19. Right angle

   20. Radius
o. Symbol designating the ratio of the circumference of a circle to its diameter; \( \pi = 3.14159365+ \), usually expressed as 3.14

p. Product obtained by multiplying a given number or quantity by its square; three dimensions

q. Parallel circles for the ends and parallel sides

r. A conventional method for doing something

s. Has a circle for a base and tapers to a point

t. A polygonal base and sides of triangles that meet at a common point

2. Select conversion factors from the given table to obtain a correct answer for the following problem:

<table>
<thead>
<tr>
<th>Table 1: Length, Conversion Factors, and Equivalent Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
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<td>6</td>
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<tr>
<td>7</td>
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<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

To measure a township line which is about 6 miles long, how many chains would be measured? **a._______** chains

How many feet in length? **b._______** feet

How many rods or poles? **c._______** rods or poles

How many inches on a map with a scale of 1:21,000? **d._______** inches
3. Determine the area around a fire which is square in shape and 8800 yards in total distance around. Using the formula for a square and the given table of area conversion factors, determine:

<table>
<thead>
<tr>
<th>Square inches</th>
<th>Square feet</th>
<th>Square rods</th>
<th>Square chains</th>
<th>Acres</th>
<th>Square centimeters</th>
<th>Square meters</th>
<th>Hectares</th>
<th>Square kilometers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.015942</td>
<td>1</td>
<td>0.0001</td>
<td>6.451626</td>
<td>0.000645</td>
<td>16/12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>62.7264</td>
<td>0.4356</td>
<td>1</td>
<td>0.000207</td>
<td>0.00001</td>
<td>0.000001</td>
<td>1/100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>144</td>
<td>2.295684</td>
<td>1</td>
<td>0.000207</td>
<td>0.000001</td>
<td>0.000001</td>
<td>1/100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,296</td>
<td>20.6812</td>
<td>9</td>
<td>0.000207</td>
<td>0.000001</td>
<td>0.000001</td>
<td>1/100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.156</td>
<td>24.7104</td>
<td>10.67683</td>
<td>0.000207</td>
<td>0.000001</td>
<td>0.000001</td>
<td>1/100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,949.997</td>
<td>10.000</td>
<td>10.000</td>
<td>0.000207</td>
<td>0.000001</td>
<td>0.000001</td>
<td>1/100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.000</td>
<td>4.356</td>
<td>484</td>
<td>0.000207</td>
<td>0.000001</td>
<td>0.000001</td>
<td>1/100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.878,400</td>
<td>43.560</td>
<td>484</td>
<td>0.000207</td>
<td>0.000001</td>
<td>0.000001</td>
<td>1/100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>107,636,671</td>
<td>24.7104</td>
<td>107,636,671</td>
<td>24.7104</td>
<td>0.000361</td>
<td>0.000361</td>
<td>1/100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 mm² = 0.01 cm² = 0.001655 square inch.
2 1 square chain = 16 square rods.
3 1 acre = area 208,710 (210) feet square = 3.16 chainsquare.
4. Using the following diagram as an aid, solve for the unknown side of the right triangles.

![Diagram of a right triangle with sides labeled a, b, and c.]

a. \(a=6\) in., \(c=10\) in. Find \(b\) ______
b. \(a=4\) in., \(b=4\) in. Find \(c\) ______
c. \(a=5\) in., \(b=6\) in. Find \(c\) ______

5. Determine the area of the triangles in problem 4.
   a. Area ______ sq. in.
   b. Area ______ sq. in.
   c. Area ______ sq. in.

6. Determine the area of a circle plot that has a radius of 58.98 feet.

7. From this table of volume units, determine the number of gallons of chemical mix needed to fill a metal tank that has a capacity of 10 cubic yards.
   
   - 231 cu. in. = 1 gal.
   - 1728 cu. in. = 1 cu. ft.
   - 27 cu. ft. = 1 cu. yd.

8. Solve for volume in the following problems using the correct formula from these listed:
   \[V=\text{lwh}, \quad V=\pi r^2h, \quad V=\frac{1}{3}\pi r^2h\]
   
   a. A round pond is 120 ft. across and slopes to a middle depth of 10 ft. What is the volume in cu. ft? ______
   
   b. The volume capacity of a culvert has an inside diameter of 40 in. and is 20 ft long. What is the volume in cu. ft? ______

9. If water weighs 8 lbs per gal. and there are 7.48 gals in a cubic foot, how much weight would there be for a tank of water 10 feet by 8 feet by 20 feet long? ______
USING MEASUREMENT UNITS TO SOLVE FORESTRY PROBLEMS

UNIT 1

ANSWERS TO TEST

1. a. 8 k. 3
   b. 17 l. 20
   c. 14 m. 7
   d. 1 n. 4
   e. 6 o. 13
   f. 11 p. 9
   g. 16 q. 18
   h. 2 r. 10
   i. 19 s. 12
   j. 5 t. 15

2. a. 480 chains
    b. 31,680 feet
    c. 1,920 rods or poles
    d. 18 inches

3. a. 1,000
    b. 10,000
    c. 43,456,000
    d. 750
    e. 7,500
    f. 32,670,000

4. a. b = 8"
    b. c = 5.66"
    c. c = 7.81"

5. 24 sq. in.
    8 sq. in.
    15 sq. in.
6. 10,685.92 (approximately 1/4 acre)

7. 2019.6 gals.

8. a. 37,680 sq. ft.
   b. 174.53 cu. ft.

9. 95,744 lbs.
FOREST SURVEYING
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to use a compass to find bearings and azimuths. He should also be able to "pace" and to use an Abney hand level and steel tape in conjunction with the compass in forest surveying. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with forest surveying to the correct definition.
2. List two methods used to measure horizontal distances.
3. List the types of tapes used in forest surveying.
4. Arrange in order the steps followed in chaining horizontal distances.
5. Arrange in order the steps followed in chaining along slopes.
6. Tell how to measure around obstacles and inaccessible lines with a tape.
7. List the three essential parts and three accessories of a compass.
8. List the two directions obtained from a compass.
9. List three ways to find magnetic declination.
10. List the true azimuths and bearings when given the magnetic declination and magnetic angles.
11. List five guidelines to follow when reading a compass.
12. Demonstrate the ability to:
   a. Develop pacing skill.
   b. Measure horizontal distance along a slope.
FOREST SURVEYING
UNIT I

SUGGESTED ACTIVITIES

Instructor:
A. Provide students with objective sheet.
B. Provide students with information, assignment, and job sheets.
C. Make transparencies.
D. Discuss terminal and specific objectives.
E. Discuss information and assignment sheets.
F. Demonstrate and discuss procedures outlined in the job sheets.
G. Arrange field trips to allow students an opportunity to demonstrate the procedures outlined in the job sheets.
H. Give test.

Students:
A. Read objectives.
B. Study information sheet.
C. Complete assignment sheet.
D. Participate in field trip.
E. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
F. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
C. Transparency masters
   1. TM 1--Chain Slopes
   2. TM 2--Lay Out Right Angles
   3. TM 3--Measure Inaccessible Lines
   4. TM 4--Azimuths and Bearings
   5. TM 5--Isogonic Chart
   6. TM 6--Angle Corrections

D. Assignment Sheet #1--Determine Azimuths and Bearings

E. Answers to assignment sheet

F. Job sheets
   1. Job Sheet #1--Develop Pacing Skill
   2. Job Sheet #2--Measure Horizontal Distance Along a Slope

G. Test

H. Answers to test

II. References:


I. Terms and definitions

A. Pacing—Determining a horizontal distance using a natural walking gait

(NOTE: Each step or every other step can be counted.)

B. Chaining—Measuring a horizontal distance with tape or chain

C. Chain—Gunter's chain, the original tool for measuring distance in the woods, is 66 feet long and is composed of 100 links of stout wire, each 7.92 inches long

(NOTE: Distances on all U.S. Government Land Surveys are measured in chains and links. The simple conversion of chained dimensions to acres is a reason for the continued popularity of the chain. Ten square chains equal one acre. Chains are now marked on steel tapes.)

D. Tape—A narrow strip of steel marked off in graduations for measuring length

E. Pole—One-fourth of a chain or 16 1/2 feet in distance; originated from a chicken house perch pole from England

F. Slope tape—Topographic steel trailer tape for measuring horizontal distance on slopes

G. Abney hand level—An instrument that measures the angle between the horizontal plane and the line of sight along a slope

H. Breaking the chain—Measuring a distance of less than full chains due to an obstacle

I. Throwing the chain—A method of coiling the steel tape for storage and transport

J. Compass—An instrument used to find horizontal angles; gives direction

K. Azimuth—A horizontal angle measured clockwise from 0° to 360°

L. Bearing—A horizontal angle measured from north to south in an east or west direction up to 90°; compass face is divided into four quadrants
INFORMATION SHEET

M. Magnetic declination--The correction in horizontal angle needed to convert magnetic readings to true readings

N. Back sight--A horizontal angle read 180° from a corresponding foresight

II. Methods of measuring horizontal distances
   A. Pacing
      (NOTE: The precise pace achieves an accuracy of 1 part in 80. Adjustment is necessary for obstacles and slopes.)
   B. Chaining

III. Types of tapes
   A. Surveyor's tape--Usually in 2 chains and graduated in links and poles (rods)
   B. Slope tape--Same as surveyor's tape, but has a trailer graduated to adjust for horizontal measurement on slopes
   C. Engineer's tape--Graduated into links of 1 foot each; comes in lengths of 100, 200, and 300 feet

IV. Steps in chaining horizontal distances
   (NOTE: The steps are to be followed by a two-man crew.)
   A. Head chainman pulls "O" end of chain
   B. Head chainman kept in line by rear chainman with the use of a compass
   C. Rear chainman calls "chain" as tape reaches the desired graduation of measurement
   D. Head chainman pulls chain taut (20 lbs.) and if necessary aligns tape
   E. Rear chainman yells "stick" when alignment is adequate
   F. Head chainman plumb bobs the "O" mark or "eyeballs it" and marks with a chaining pin; then he yells "stuck"

V. Chaining slopes (Transparency 1)
   A. Obtain Abney hand level readings along slope
   B. Obtain trailer readings corresponding to the Abney readings
INFORMATION SHEET

C. Extend the tape the distance indicated on the trailer.
   (NOTE: The slope measurement is more than horizontal both up and down the slope.)

VI. Chaining procedures when obstacles are encountered
   A. Lay out a right angle (Transparency 2)
      1. Measure points A and B any distance.
      2. Measure distance clear of the obstacle used as an arc from A and B.
   B. Measure inaccessible lines (Transparency 3)
      1. To measure V-W, set a point O any distance and equal distance in line to Y.
      2. Set U-X in line through O.
      3. Set Z in line with O-W.
      4. Measure Z-Y to equal the distance V-W.

VII. Parts of a compass
   A. Essentials
      1. Magnetized needle
      2. Pivot point
      3. Graduated housing
   B. Accessories
      1. Magnetic declination adjustment
      2. Leveling device
      3. Sighting device

VIII. Directions of a compass (Transparency 4)
   A. Azimuths
   B. Bearings.
INFORMATION SHEET

IX. Magnetic declination determination
   A. Isogonic charts (Transparency 5)
   B. Angle readings on Polaris (North Star)
   C. Reference survey line

X. Correcting magnetic azimuths and bearings to true readings (Transparency 6)
   A. Record true readings
      
      Example:
      
      For 8° East
      Magnetic Declination
      
      Mag. Reading | True Reading
      Azimuth       24°  =  32°

   B. Adjust the compass
      1. Reset magnetic declination screw
      2. Read corrected magnetic angle
         
         Example:
         For 8° East
         Magnetic Declination
         True direction from magnetic reading
         
         True Reading | Mag. Reading
         Azimuth       140°  =  132°

XI. Guidelines to follow when reading the compass
   A. Level the compass
   B. Align sights properly
   C. Check to see that needle swings freely
   D. Read north end of needle
   E. Take back sight
Chain Slopes

NOTE: a' and b' are correction marks held on tape to obtain horizontal distances of one and two chains respectively where the Abney reading is 30.

Topographic Abney In Use
Lay Out Right Angles
Measure Inaccessible Lines
Azimuths and Bearings

Azimuth - Inside Circle
Bearing - Outside Circle
Isogonic Chart

East Declination

Source:
Coast and Geodetic Survey,
U.S. Dept. of Commerce.
Angle Corrections

Reading True Angles From Magnetic Readings

BEARINGS

AZIMUTHS

BEARINGS

AZIMUTHS

East Declination

West Declination
ASSIGNMENT SHEET #1—DETERMINE AZIMUTHS AND BEARINGS

1. Write the azimuths for these bearings.
   a. N61°W
   b. S45°W
   c. S83°E
   d. N83°E

2. Give back sights for both the bearings and azimuths for the above listed bearings.

<table>
<thead>
<tr>
<th>Bearings</th>
<th>Azimuths</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td></td>
</tr>
</tbody>
</table>

Write the true azimuths for the following magnetic readings using a magnetic declination of 8°E.

   a. 47°
   b. 26°
   c. 35°

Correct the following magnetic bearings to true bearings for an area that has a magnetic declination of 10°W.

   a. N61°E
   b. S55°E
   c. N2°W

111
FOREST SURVEYING
UNIT

ANSWERS TO ASSIGNMENT SHEET

1. a. 299°
b. 225°
c. 97°
d. 83°

2. Bearings                Azimuths
   a. S61°E               119°
   b. N45°E               45°
   c. 83°W               277°
   d. S83°W               263°

3. a. 55°
b. 270°
c. 2°

4. a. N51°E
b. S65°E
   c. N12°W
FOREST SURVEYING
UNIT I

JOB SHEET #1--DEVELOP PACING SKILL

(NOTE: Students should be able to pace within an accuracy of 1 part in 80 parts of distance.)

I. Tools and materials needed
   A. Steel tape
   B. Areas indicated by the instructor

II. Procedure
   A. Group in teams of two, head chainman and rear chainman
   B. After demonstration of the use of a tape by the instructor, uncoil the steel tape to avoid kinks
   C. Measure a distance of 10 chains in the direction and area given by the instructor, using these steps:
      1. Head chainman pulls "O" end of chain
      2. Head chainman kept in line by rear chainman with the use of a compass
      3. Rear chainman calls "chain" as tape reaches desired graduation of measurement
      4. Head chainman pulls chain tape (20 lbs.) and if necessary aligns tape
      5. Rear chainman yells "stick" when alignment is adequate
      6. Head chainman marks the pole under the "O" graduation and calls "stuck"
   D. Procedure is repeated until 10 chains are measured
   E. Each member of the teams then paces the 10 chains twice to obtain an average step taken per chain
   F. Fill in the following:
      1. Average steps per chain
      2. Number of feet per chain
      3. Number of links per chain
JOB SHEET #1

4. Distance of one link

5. Distance of one rod

C. Pace the distance in total chains and links indicated by the instructor.

D. Fill in the distance as paced here.

I. Turn in to the instructor for evaluation.
Group students in teams of two. Determine the horizontal distance between two points designated by the instructor. Determine the distance within an accuracy of 1 part in 1,300. When completed, turn in measurement to the instructor for evaluation.

I. Tools and materials needed
   A. Slope
   B. Abney hand level
   C. Two points designated by the instructor
   D. Pencil and paper
   E. Clipboard

II. Procedure
   A. Obtain Abney hand level readings along slope
   B. Obtain trailer readings corresponding to the Abney readings
   C. Extend the tape the distance indicated on the trailer
   D. Use the six steps for measurement with the steel tape as outlined in Job Sheet #1
### 1. Match the terms on the right to the correct definition.

| a. Determining a horizontal distance using a natural walking gait. | 1. Tape |
| b. Measuring a horizontal distance with tape or chain | 2. Compass |
| c. The original tool for measuring distance in the woods; it is 66 feet long and is composed of 100 links of stout wire, each 7.92" long | 3. Abney hand level |
| d. A narrow strip of steel marked off in graduations for measuring length | 4. Magnetic declination |
| e. One-fourth of a chain or 16 1/2 feet in distance; originated from a chicken house perch pole from England | 5. Bearing |
| f. Topographic steel trailer tape for measuring horizontal distance on slopes | 6. Slope tape |
| g. An instrument that measures the angle between the horizontal plane and the line of sight along a slope | 7. Chain |
| h. Measuring a distance of less than full chains due to an obstacle | 8. Throwing-the-chain |
| i. A method of coiling the steel tape for storage and transport | 9. Pacing |
| j. An instrument used to find horizontal angles, gives direction | 10. Pole |
| k. A horizontal angle measured clockwise from 0° to 360° | 11. Azimuth |
| l. Back sight | 12. Back sight |
| m. Chaining | 13. Chaining |
1. A horizontal angle measured from north to south in an each or west direction up to 90°; compass face is divided into four quadrants

m. The correction in horizontal angle needed to convert magnetic readings to true readings.

n. A horizontal angle read 180° from a corresponding foresight.

2. List two methods used to measure horizontal distances.
   a.
   b.

3. List the types of tapes used in forest surveying.
   a.
   b.
   c.

4. Arrange in order the steps followed in chaining horizontal distances. Place in numerical order.
   a. Head chainman pulls chain taut (20 lbs.) and if necessary aligns tape
   b. Head chainman kept in line by rear chainman with the use of a compass
   c. Head chainman plumb bobs the "O" mark or "eyeballs it" and marks with a chaining pin; then he yells "stuck"
   d. Head chainman pulls "O" end of chain
   e. Rear chainman calls "chain" as tape reaches the desired graduation of measurement
   f. Rear chainman yells "stick" when alignment is adequate

5. Arrange in order the steps followed in chaining along slopes.
   a. Obtain trailer readings corresponding to the Abney readings
   b. Obtain Abney hand level readings along slope
   c. Extend the tape the distance indicated on the trailer
6. Tell how to measure around obstacles and inaccessible lines with a tape.

7. List the three essential parts and three accessories of a compass.

   a. Essentials
   1) 1)
   2) 2)
   3) 3)

   b. Accessories

8. List the two directions obtained from a compass.

   a. 
   b. 

9. List three ways to find magnetic declination.

   a. 
   b. 
   c. 

10. List the true azimuths and bearings for a magnetic declinations of 8° east for these magnetic angles:

    | Magnetic Angles | True Azimuths | True Bearings |
    |-----------------|---------------|---------------|
    | Azimuth 24°     | a.            | c.            |
    | Azimuth 142°    | b.            | d.            |
11. List five guidelines to follow when reading a compass.
   a. 
   b. 
   c. 
   d. 
   e. 

12. Demonstrate the ability to:
   a. Develop pacing skill.
   b. Measure horizontal distance along a slope.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
FOREST SURVEYING
UNIT I

ANSWERS TO TEST

1. a. 9     h. 14
   b. 13     i. 8
   c. 7     j. 2
   d. 1     k. 11
   e. 10     l. 5
   f. 6     m. 4
   g. 3     n. 12

2. a. Pacing
   b. Chaining

3. a. Surveyor's tape
   b. Slope tape
   c. Engineer's tape

4. a. 4
   b. 
   c. 6
   d. 1
   e. 3
   f. 5

5. a. 2
   b. 1
   c. 3

120
6. a. Lay out a right angle
   1. Measure points A and B any distance
   2. Measure distance clear of the obstacle used as an arc from A and B
   b. Measure inaccessible lines
      1. To measure V-W, set a point O any distance and equal distance in line to Y
      2. Set U-X in line through O
      3. Set Z in line with O-W
      4. Measure Z-Y to equal the distance V-W

7. a. 1) Magnetized needle  b. 1) Magnetic declination adjustment
      2) Pivot point
      3) Graduated housing  2) Leveling device
      3) Sighting device

8. a. Azimuths
     b. Bearings

9. a. Isogonic charts
     b. Angle readings on Polaris' (North Star)
     c. Reference survey line

10. a. 32°
     b. 150°
     c. N32°E
     d. S30°E

11. a. Level the compass
     b. Align sights properly
     c. Check to see that needle swings freely
     d. Read north end of needle
     e. Take back sight

12. Performance skills will be evaluated to the satisfaction of the instructor.
FOREST LAND LOCATION
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to interpret a legal land description and identify the tract of forest land property in the state of Oklahoma. He should be able to determine the number of acres and prepare a sketch of the property. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with forest land location to the correct definition.

2. List three reasons land location is a necessary forestry task.

3. Select from a list the three methods of land survey systems found in the United States.

4. Match a list of subdivisions of the rectangular system of survey to a sketch.

5. Determine the number of acres from a legal description by reading and by sketching.

6. Locate and label on a map the principle meridians and base lines of Oklahoma.

7. Match the type of public survey to a description of the line marking.

8. Match the survey corner to the correct corner marking description.

9. List three types of witness markings.

10. List five items of entry that can be found in survey field notes.

11. List the two locations where survey field notes may be obtained.
FOREST LAND LOCATION
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and assignment sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information and assignment sheets.
   F. Arrange field trips to allow students an opportunity to locate property corners.
   G. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Complete assignment sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheets
   C. Transparency masters
      1. TM 1 - Land Survey Systems
      2. TM 2 - Rectangular System Subdivisions
      3. TM 3 - System of Section Line Location
4. TM 4: Division of a Section
5. TM 5: STTs
6. TM 6: Principal Meridians and Baselines

D. Assignment

1. Assignment Sheet #1: Identifying Townships and Sections
2. Assignment Sheet #2: Interpreting Legal Descriptions

E. Answers to assignment sheets
F. Test
G. Answers to test

II. References:

Terms and definitions

A. Bearing—Horizontal angle measured from north or south and referenced to one of the quadrants of the compass.

B. Legal description of land—The survey record of the parcelling of land according to a prescribed method by law; the deed description of property.

C. Initial point—The origin of a survey system established by astronomical observation.

D. Base line—The latitude, true east and west line, that intersects the principal meridians at the initial point.

E. Standard parallels—Lines surveyed every degree, four miles north and south of and parallel with the base line.

F. Principal meridian—The longitude, true north and south line, that intersects the base line at the initial point.

G. Guide meridians—True meridians extended north from the base line or from standard parallels at intervals of 24 miles east and west from the principal meridian.

H. Township (T)—Division of territory six miles long on its south, east, and west boundaries and slightly less than six miles on the north, which accounts for the correction lines located every six miles on the standard parallel.

I. Range (R)—Row or line of north-south townships, six miles apart and numbered consecutively east or west from the principal meridian.

J. Section (SEC.)—Composed of approximately 640 acres and measures approximately one square mile.

(NOTE: North and west tier of sections within a township may be more or less than one square mile; usually less.)

K. Quarter-section (1/4)—Consists of approximately 160 acres and designated as northeast (NE), southeast (SE), northwest (NW), or southwest (SW).

(NOTE: Quarter-sections bordering the west and north side of the township do not always contain 160 acres.)
INFORMATION SHEET

L. Correction lot—Fractional 40 acre tracts found on the west and north border of a township

M. River lot—Fractional 40 acre tracts found along rivers that have a mean high water mark of 132 feet or more

(NOTE: Area between high water mark belongs to state thus reducing the size to less than a 40 acre tract.)

II. Reasons for land location in forestry

A. Retrace old lines
B. Locate property boundaries
C. Measure land areas not publicly surveyed

III. United States land survey systems (Transparency 1)

A. Metes and bounds—Original thirteen colonies
B. Varas—In Texas
C. Rectangular system—All states except the above

IV. Rectangular system subdivisions (Transparency 2)

A. Initial point—Formed by the intersection of base line and principal meridian
B. Twenty-four mile correction tracts—Formed by the standard parallels and guide meridians
C. Townships

1. East-west tier of townships is numbered consecutively, north or south from the base line

   Example: Township 16 North (T16N) or Township 3 South (T3S)

2. Each range is numbered consecutively east or west from the

   Example: Range 19 East (R19E) or Range 1 West (R1W)

D. Location of sections within township (Transparency 3)

1. Numbering begins with 1 in upper right hand corner and proceeds in a serpentine fashion to the bottom right-hand corner of township

2. Show survey procedure followed to establish section lines within township
E. Subdivision of sections (Transparency 6)

1. Tracts of 320, 160, 80, 40, 20, and 10 acres with descriptions of halves and quarters
2. Correction lots (Transparency 5)
3. River lots (Transparency 5)

V. Determining the acres of land from a legal description

A. Read and write legal descriptions

1. From right to left
2. Tract subdivisions are continuous; separate tracts are divided by and, & or a ;
   (NCTE: Two letters alone mean 1/4, while a single letter means 1/2.)

B. Sketch to scale

Examples:

NESW; W½SWNE;
NWSE Sec. 10

NW%NE%SW%&NW%/\% NW%NE%SW%&NW%/\% Sec. 10

NSW&SWMNW
& ESE Sec. 30

VI. Principal meridians and base lines of Oklahoma (Transparency 6)

A. Cimarron Meridian (CM)--Intersects with base line; initial point for panhandle counties

B. Indian Meridian (IM)--Intersects with base line in Murray County; initial point for main body of Oklahoma

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INFORMATION SHEET

VII. Survey line markings:

A. Townships—Three blazes and hacks

B. Sections—Two blazes and hacks

C. Section subdivisions—One blaze and hack

(NOTE: On line trees use a hack, a horizontal notch on each side of trees intersected with a survey line. On adjacent trees use a blaze, a vertical scribe usually made with an ax, on trees facing the survey line. Various paint markings are used: J. S. Forest Service uses red; Weyerhaeuser uses white exterior lines and orange interior lines; and other landowners use various colors. There is no standard.)

VIII. Corner markings in legal survey:

A. Township corners

1. Corners placed every mile and one-half mile

2. Marked on two sides along with direction of survey with one notch for each mile of distance to the next intersecting township line

B. Section corner

Marked according to the location of the section corner from the southeast corner of the township

1. Horizontal notches placed on the south and east face of the rock with one notch for each mile of distance to the SE corner of the township

C. Quarter corner:

1. East-West lines—Marked 1/4 on north face

2. North-South lines—Marked 1/4 on west face

D. Legal surveyed corner—Iron pipe with brass capooled with township, section, etc. cap represented

(NOTE: Materials used include sandstone, charred stakes, buried charcoal, glassware, or pieces of metal. Generally, sandstone is used.)

Witness markings:

A. Bearing trees

B. Bearing object

(NOTE: This includes a natural rock formation, railroad trestle, mound of stone, or other durable material chiseled with an "X" or "BO". The distance and bearing are recorded in the field notes.)
INFORMATON SHEET

C. Pits and mounds

(NOTE: Holes are dug in opposite section corners and the dirt is used to build mounds.)

X. Items of entry for survey field notes

A. Precise course and length of lines

B. Kinds and diameter of bearing trees with distance and bearing

C. Corner description

D. Intersections with land objects

E. Intersections with water objects

F. Surface of the land

G. Roads and trails

H. Other entries of report on the character of the land, soil, water, and timber

Example on following page
INFORMATION SHEET

UNITED STATES' PUBLIC LAND SURVEYS

Chains

Beginning the subdivisional survey at the cor. of secs. 1, 2, 35 and 36; on the
S. bdy. of the Tp., which is monumented with a sandstone 8 x 6 x 5
ins. above ground, firmly set, marked and witnessed as described in the
official record.

N. 0° 01' W., be. secs. 35 and 36.

Over level bottom land.

20.00 Enter scattering timber.
29.30 S.E. cor. of field; leave scattering timber.
31.50 A cabin bears W. 6.00 chs. dist.
39.50 Enter State Highway No. 25, bears N. along section line, and E.
40.00 Point for the N. 4 sec. cor. of secs. 35 and 36.

Bury a granite stone 12 x 12 x 12 ins., mkd. X, 2 in. underground, from which
An iron post, 30 ins. long, 2 ins. diam., set 24 ins. in the ground, for a
reference monument, with brass cap mkd. with an arrow pointing to the cor. and 1/4 S. 36 R.M., bears East 46 lks. dist.

An iron post 30 ins. long, 2 ins. diam., set 24 ins. in the ground, for a
reference monument with brass cap mkd. with an arrow pointing to the cor. and 1/4 S. 35 R.M., bears West 46 lks. dist.

50.50 N.E. cor. of field
51.50 Highway turns to N. 54° W.
57.50 Enter heavy timber and dense undergrowth, edge N. 54° E. and S. 54°
W.
72.00 Leave undergrowth.
80.00 Point for the cor. of secs. 25, 26, 35, and 36.

Set an iron post 30 ins. long, 2 ins. diam., 24 ins. in the ground with brass
cap mkd.

from which
A green ash, 13 ins. diam. bears N. 22° E., 26 lks. dist. mkd.
A green ash, 13 ins. diam., bears N. 71/4 W., 17 lks. dist. mkd.
A green ash, 13 ins. diam. bears E. 64 W., 3 lks. dist. mkd.
A cottonwood, 13 ins. diam. bears S. 2° 1' W., 36 lks. dist. mkd. T

Land, level bottom; northern 2' chs. subject: overflow.
Soil, alluvial, silt and loam.
Timber, green ash and cottonwood; undergrowth willow.
XII. Locations of field notes

A. Bureau of Land Management, Washington, D.C.

B. County courthouse in the office of county clerk, county surveyor, or some other similar county official
Land Survey Systems

Principal Meridians of the Federal System of Rectangular Surveys

NOTE: The shading shows the area governed by each principal meridian and its base line.
The location of the initial point, base line, principal meridian, standard parallels, guide meridians, ranges, townships, and sections.
System of Section Line Location

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# Division of a Section

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<th>NW ¼ (160 A.)</th>
<th>NE ¼</th>
<th>S ½ (80 A.)</th>
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<tr>
<td>W ½ (20 A.)</td>
<td>NW ⅛ (10 A.)</td>
<td>NE ⅛ (10 A.)</td>
<td>SW ⅛ (10 A.)</td>
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<tr>
<td>E ½ (20 A.)</td>
<td>S ¼ (40 A.)</td>
<td>SE ¼ (40 A.)</td>
<td>S ⅔ (40 A.)</td>
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Lot numbers usually run downstream to section line then back upstream to line.
Location of the two principal meridians (—) and base lines (—) in Oklahoma. Two guide meridians (-----) and two standard parallel lines (---) are also shown.
1. Identify by writing the legal description of the following townships.

a. 

b. 

c. 

d. 

---

Principal Meridian

Base Line

Initial Point
2. Number the sections within the township drawn below.

3. Give the proper section number for the sections marked in the township:
   a. 
   b. 
   c. 
   d. 
   e. 

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ASSIGNMENT SHEET #2 - INTERPRET LEGAL DESCRIPTIONS

1. For the following plat sheet sketch, determine the total acres in the tract and its complete legal description.

   a. Acres ___________________ 
      Description ___________________ 

Scale 6" = 1 Mile
ASSIGNMENT SHEET #2

Suppose the landowner in the first problem bought 100 acres of land with the following legal description:

NENW and SWNW and S1/2NW Section 16, T6N, R19E

Sketch in the additional acres on the plat sheet.

3. How many acres are in the following described tracts?
   a. SW and N1/2 Sec. 2 ________
   b. S1/2 S1/2 SE and S1/2NE Sec. 14 ________
   c. SE; SESWSE Sec. 3 and N1/2NW Sec. 2 ________
   d. W1/2 Sec. 6 and NWNW Sec. 7 ________
   e. N1/2 SESE Sec. 33 and Sec. 34 ________

4. Describe in legal terms the fractional parts of the following
   a. ________
   b. ________
   c. ________
   d. ________
   e. ________
   f. ________
   g. ________
   h. ________
   i. ________
   j. ________

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<td>60 A.</td>
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<tr>
<td>h</td>
<td>5 A.</td>
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<td>i</td>
<td>20 A.</td>
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5. What is the legal description for the following sketch of property?

Sec 11 T3N R19E
Assignment Sheet #1
1. a. T4N, R3E
   b. T2N, R7E
   c. T3S, R3E
   d. T2S, R4W

2. 

   | 6 | 5 | 4 | 3 | 2 | 1 |
---|---|---|---|---|---|---|
7  | 8 | 9 | 10| 11| 12|
18 | 17| 16| 15| 14| 13|
19 | 20| 21| 22| 23| 24|
30 | 29| 28| 27| 26| 25|
31 | 32| 33| 34| 35| 36|

3. a. 3  b. 8  c. 30  d. 31  e. 36

Assignment Sheet #2
1. a. 200
   b. NWSE; W1/2NE; SENW; NESW

2. 

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3. a. 240
   b. 120
   c. 250
   d. 330
   e. 360

4. a. NWNW
   b. NENW
   c. S1/2NW
   d. NE
   e. N1/2N1/2N1/2SW
   f. S1/2N1/2N1/2SW and S1/2N1/2SW
   g. S1/2N1/2SESE
   h. E1/2N1/2N1/2SESE
   i. S1/2SESE
   j. NESE

5. SWNWNE, SENW, SW, W1/2SW
1. Match the terms on the right to the correct definition.

   a. Horizontal angle, measured from north or south and referenced to one of the quadrants of the compass

   b. The survey record of the parcelling of land according to a prescribed method, by law; the deed description of property

   c. The origin of a survey system, established by astronomical observation

   d. The latitude, true east and west line, that intersects the principal meridians at the initial point

   e. Lines surveyed every 24 miles north and south of and parallel with the base line

   f. The longitude, true north and south line, that intersects the base line at the initial point

   g. True meridians extended north from the base line or from standard parallels at intervals of 24 miles east and west from the principal meridian

   h. Division of territory six miles long on its south, east, and west boundaries and slightly less than six miles on the standard parallel

   i. Row or line of north-south townships, six miles apart and numbered consecutively east or west from the principal meridian

   j. Composed of approximately 640 acres and measures approximately one square mile

   River lot

   2. Initial point

   3. Principal meridian

   4. Standard parallels

   5. Range

   6. Township

   7. Quarter-section

   8. Guide meridians

   9. Bearing

   10. Base line

   11. Correction lot

   12. Section

   13. Legal description of land
k. Consists of approximately 160 acres and designated as northeast (NE), southeast (SE), northwest (NW), or southwest (SW)

i. Fractional 40 acre tracts found on the west and north border of a township

m. Fractional 40 acre tracts found along rivers that have a mean high water mark of 132 feet or more

2. List three reasons land location is a necessary forestry task.
   a. 
   b. 
   c. 

3. Select from the list below the three methods of land survey systems found in the United States by circling the correct answers.
   a. Square-area
   b. Metes and bounds
   c. North and south
   d. Rectangular system
   e. Arpent
   f. Vara
4. Match the following list of subdivisions of the rectangular system of survey to the sketch below, by placing the appropriate number in the blank.

   a. Initial point
   b. Base line
   c. Guide meridian
   d. Range line
   e. Section
   f. Principal meridian
   g. Township
   h. Standard parallel
   i. Correction tract
   j. 6 miles
   k. 24 miles

5. Determine the number of acres from the legal description of SESWNW; NWSE; N1/2SW Section 10 T4N R18E sketching the property on the following section diagram.

   acres
6. Locate and label the principal meridians and base lines of Oklahoma on the following map.

7. Match the type of public survey to the description of the line marking.
   a. Two blazes and hacks
   b. Three blazes and hacks
   c. One blaze and hack

8. Match the survey corner to the correct corner marking description.
   a. Marked on two sides along the direction of survey with one notch for each mile of distance to the next intersecting township line
   b. Horizontal notches placed on the south and east face of the rock with one notch for each mile of distance to the SE corner of the township
   c. Marked with 1/4 on the north or west face

9. List three types of witness markings.
   a.
   b.
   c.

10. List five items of entry that can be found in survey field notes.
    a.
    b.
11. List the two locations where survey field notes may be obtained:
   a. 
   b. 
FOREST LAND LOCATION
UNIT II

ANSWERS TO TEST

1. a. 9 h. 6
   b. 13 i. 5
   c. 2 j. 12
   d. 10 k. 7
   e. 4 l. 11
   f. 3 m. 1
   g. 8

2. a. Retrace old lines
   b. Locate property boundaries
   c. Measure land areas not publicly surveyed

3. b, d, f

4. a. 6
   b. 10
   c. 2
   d. 9
   e. 3
   f. 7
   g. 4
   h. 1
   i. 11
   j. 8
   k. 5
5. 130 acres

6. Cimarron Meridian  Indian Meridian
   Base Line

7. a. 2
   b. 1
   c. 3

8. a. 3
   b. 1
   c. 2

9. a. Bearing trees
   b. Bearing object
   c. Pits and mounds
10. Any five of the following
   a. Precise course and length of lines
   b. Kinds and diameter of bearing trees with distance and bearing
   c. Corner description
   d. Intersections with land objects
   e. Intersections with water objects
   f. Surface of the land
   g. Roads and trails
   h. Other entries of report on the character of the land, soil, water, and timber

    b. County courthouse in the office of county clerk, county surveyor, or some other similar county official
After completion of this unit, the student should be able to measure tree diameters accurately according to the rules for correct measurement. He should be able to measure tree heights according to specified rules. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with tree measurement.
2. Name the common dendrometers used in measuring tree diameters in order of accuracy.
3. Draw a line indicating the correct location of DBH measurements when given illustrations of trees.
4. Classify tree diameters correctly into one and two inch classes when given a list of exact measurements.
5. List three tools used to obtain upper stem diameter measurement by climbing.
6. Describe the correct procedure for using the pentaprism tree caliper to obtain tree diameter.
7. Identify commonly used hypsometers.
8. Draw a diagram illustrating the principle of height measurement of the Merritt hypsometer.
9. Determine the height of trees from readings on the percent scale of the Suunto clinometer.
10. Determine the merchantable height of trees according to U.S. Forest Service tree height classification when given a drawing of trees.
11. Demonstrate the ability to:
   a. Determine diameters.
   b. Determine merchantable tree heights.
TREE MEASUREMENTS
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in the job sheet.
   G. Arrange field trips to allow students an opportunity to complete job sheets on determining diameters and merchantable tree heights.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency masters
      1. TM 1--Dendrometers
      2. TM 2--DBH Measurements
3. TM 3--Climbing Tools
4. TM 4--Pentaprisim Tree Caliper
5. TM 5--Common Hypsometers
6. TM 6--Merchantable Lumber

D. Job sheets
   1. Job Sheet #1--Determine Diameters
   2. Job Sheet #2--Determine Merchantable Tree Heights

E. Test

F. Answers to test

II. References:
I. Terms and definitions
   A. Dendrometer—A collective term for all instruments used for determining diameter
   B. DBH (Diameter Breast High)—Measured at 4 1/2 feet from the ground
   C. Tree caliper—An instrument with two prongs, one fixed and one sliding, used to obtain diameter
   D. Diameter tape—An instrument of thin steel tape graduated in units of diameter
   E. Biltmore cruiser stick—A wooden stick graduated in height units
   F. Hypsometers—A collective term for all instruments used for determining height
   G. U.S. Forest Service—A government organization responsible for the management of the national forests
   H. Bole—The tree trunk
   I. Merchantable height—Height according to specifications of an organization or industry
   J. DOB—Diameter outside the bark

II. Dendrometers used in measuring tree diameters (Transparency 1)
   (NOTE: These are listed in order of accuracy.)
   A. Caliper
   B. Diameter tape
   C. Biltmore cruiser stick

III. Rules for correct measurement of DBH (Transparency 2)
   A. Tree on slope
   B. Tree on level ground
   C. Leaning tree
D. Tree forking at or above 4 1/2 feet

E. Tree forking below 4 1/2 feet

F. Tree deformed at 4 1/2 feet

G. Bottleneck tree

IV. Tree diameter classes

A. One-inch classes

1. 4.6" to 5.5" = 5"
2. 5.6" to 6.5" = 6"
3. 6.6" to 7.5" = 7"
4. 7.6" to 8.5" = 8"

B. Two-inch classes

1. 9.0" to 10.9" = 10"
2. 11.0" to 12.9" = 12"
3. 13.0" to 14.9" = 14"

V. Tools used to obtain upper stem diameter measurement by climbing (Transparency 3)

A. Gaff and harness

B. Tree ladders

C. Tree bicycles

VI. Procedure for using pentaprisrn tree caliper (Transparency 4)

(NOTE: The range of accuracy for the pentaprisrn tree caliper is ten to fifty feet.)

A. Hold caliper 3 to 4 inches from eye

B. Hold pentaprisrn tree caliper horizontal to tree to be measured
C. Slide movable pointer to obtain image below.

D. Place vertical alignment between the two vertical guidelines.

E. Read scale on top for diameter of tree.

VII. Common hypsometers (Transparency 5)
A. Merritt hypsometer on Biltmore cruiser stick
B. Suunto clinometer
C. Haga altimeter
D. Abney hand level

VIII. Principle of height measurement with Merritt hypsometer:

\[ bc = \frac{(Ac)(BC)}{AC} \]
IX. Determining the heights of trees using the Suunto clinometer

A. Measure 100' distance from tree

   (NOTE: A 50' distance can be used by dividing the answer in half for correct total height.)

B. Instrument reading at the top of tree

C. Instrument reading at the bottom of tree

D. Procedure to follow with the above readings

   1. Tree on same level of observer

      a. Top reading (+) with bottom reading (-)

      b. Add for total height

         When base of tree is at same level as feet of observer, measure plus angles in percent, add eye to ground distance in feet. TOTAL TREE HEIGHT is 54.0 feet.

   2. Tree below observer

      a. Top reading (+) with bottom reading (-)

      b. Add for total height

         When base of tree is below the foot level of observer, measure the plus angle in percent; measure minus angle in percent, add the two and you have the total tree height IN FEET.
INFORMATION SHEET

3. Tree above observer.
   a. Top reading (+) with bottom reading (+).
   b. Subtract bottom reading from the top reading for total height.

When base of tree is above observer's eye level, measure total plus angle in percent, subtract from it the angle between eye level and base of tree. Remainder is tree height in percent.

\[63.5' - 13.5 = 50 \text{ feet} \]
TOTAL TREE HEIGHT.

X. U.S. Forest Service tree height classification.

A. Procedure

1. Record the length to the last whole foot of the bole of all sawtimber-size live and salvable dead trees, such as softwoods 9.0 inches DBH and larger, and 11.0 inches DBH and larger for hardwoods.

2. Measure from a 1-foot stump to the point above which no saw log can be produced to meet log grade standards or to a minimum top of 7.0 inches DBH for softwoods and 9.0 inches DBH for hardwoods.

3. Saw log should not extend above a point where taper becomes excessive as evidenced by:
   a. A fork with less than an 8-foot saw log above it (12 feet if this is the only log in the tree)
   b. A limb with a base diameter equal to one-half or more of the stem diameter below the limb, or a group of smaller limbs with equivalent diameter which collectively influence taper to the same degree.

4. Also, saw log length should not extend above a saw log section that does not meet minimum log grade specifications and which has less than 8 feet of saw log length above it.

B. Description of trees (Transparency 6)

1. A sawtimber tree
   a. Saw log length terminates at 9 inch top DBH
INFORMATION SHEET

b. Meets minimum qualifications of a 12-foot saw log

c. Upper stem portion contains on cull and terminates at 4 inches DOB

d. Saw log length is recorded as 12 feet; bole length as 21 feet

2. A sawtimber tree

a. Saw log portion terminated by limbs at 13 inches DOB

b. Contains no cull and meets minimum grade specifications

c. Both bole length and saw log length 14 feet

d. Portion between whorls of limbs is large enough in diameter but not in length to qualify as upper stem, such as less than 4 feet long

3. A rotten cull tree

a. Although saw log portion is 20 feet long, a 13-foot section of rotten cull prevents utilization of a log meeting minimum grade specifications; thus whole saw log portion is culled

b. Because more than half the volume in that portion is rotten, the tree is classed as a rotten cull tree

4. A sawtimber tree

a. Saw log portion terminating because the branching at 15-inch top DOB meets minimum specifications

b. Right-hand fork is too limby to qualify as upper stem, but 7 feet of left-hand fork qualifies as upper stem

5. A rough tree

a. Saw log top terminates by branches 11 feet above crooked butt

b. No saw log meeting minimum qualifications present

6. A sawtimber tree

a. Despite sound cull in the saw log portion due to butt swell, a 12-foot saw log is present

b. Seven feet of right-hand fork qualifies as upper stem

c. Left-hand fork does not qualify due to crook
INFORMATION SHEET

Two sawtimber trees

a. Since lowest fork is below DBH, each fork is appraised and recorded as a separate tree

b. The lower 14-foot section in the left-hand fork meets requirements for a sawtimber tree

c. A 6-foot portion of the largest stem in upper fork qualifies as upper stem material

d. In the main right-hand fork, a 13 1/2-foot saw log plus a 9-foot saw log (with an intervening 1-foot section of sound cull) is recorded as 23 feet of saw log length; bole length is the same.
Dendrometers

Diameter Tape

Calipers

Biltmore Cruiser Stick
DBH Measurements

1. Tree on Slope
2. Tree on Level Ground
3. Leaning Tree
4. Tree Forking at or Above 4 1/2 Feet
5. Tree Forking Below 4 1/2 Feet
6. Tree Deformed at 4 1/2 Feet
7. Bottleneck Tree
Climbing Tools

- Tree Harness
- Tree Gaff
- Tree Bicycle
- Tree Ladder
Pentaprism Tree Caliper

Wheeler Pentaprism Tree Caliper
Common Hypsometers

Haga Altimeter

Abney Level

Suunto Clinometer

Merritt Hypsometer on Biltmore Cruiser Stick
Merchantable Lumber

- Sawlog
- Upper Stem
- Limbs and Sound Cull
- Rotten Cull

4" DOB
- 12'
- 21'

9" DOB
- 13'

DBH Stump

15" DOB
- 14'

5
- 1⅔
- 20'

6
- 12'
- 23'

7
- 14'
- 23'
TREE MEASUREMENTS
UNIT III
JOB SHEET #1--DETERMINE DIAMETERS

I. Tools and materials needed
   A. Diameter tape
   B. Selected trees
   C. Pencil
   D. Clipboard

II. Procedure
   A. Determine the diameter of 10 trees selected by the instructor
   B. Measure 4 1/2 feet on the upper slope side of the tree
   C. Find this height on your body for DBH height reference for following DBH measurements
   D. Extend the tape around the tree from the left side
   E. Grasp the hook end of tape with the right hand
   F. Pull tape taut with hands crossed over each other, left hand on top
   G. Read the tape at the point of intersection of "o" mark and diameter marks
   H. Follow the rules for correct DBH measurement
   I. Read the tape to the nearest 1/10 inch of diameter and record the measurement below

<table>
<thead>
<tr>
<th>Tree No.</th>
<th>DBH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
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<td>9</td>
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<td>10</td>
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</tbody>
</table>

J. Turn in to instructor for evaluation
JOB SHEET #2 - DETERMINE MERCHANTABLE TREE HEIGHTS

I. Tools and materials needed
   A. Suunto clinometer
   B. 100' tape
   C. Selected trees
   D. Pencil and clipboard

II. Procedure
   A. Determine the merchantable height of 10 trees selected by the instructor
   B. Measure a distance of 100 feet from the tree to a point where both, top and bottom of the tree can be seen
   C. Estimate the point of top merchantability using these guides:
      1) Minimum top of 7.0 inches outside the bark
      2) A fork with less than 8 feet in either fork
      3) A limb with a diameter equal to 1/2 or more the bole diameter at the point of occurrence
      4) A group of limbs with a one-foot section of the bole with a total sum of diameters equal to 1/2 or more the bole diameter at the point of occurrence
   D. Read the percent scale of the Suunto at the point of top merchantability
   E. Read the scale at the base of the tree one foot from the ground
   F. If the readings of the percent scale were on opposite sides of the scale, that is, positive and negative, add the readings together for height of the tree
   G. If the readings are both positive or both negative, subtract the readings for height of the tree
JOB SHEET #2

H. Record the merchantable height of the tree below.

<table>
<thead>
<tr>
<th>Tree No.</th>
<th>Merchantable Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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<tr>
<td>3</td>
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<td>9</td>
<td></td>
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<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

I. When completed, turn in to the instructor for evaluation.
## TREE MEASUREMENTS
### UNIT III

## TEST

1. Match the terms on the right to the correct definition:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>A collective term for all instruments used for determining diameter</td>
<td>1.</td>
<td>Tree caliper</td>
</tr>
<tr>
<td>b.</td>
<td>Measured at 4 1/2 feet from the ground</td>
<td>2.</td>
<td>Hypsometers</td>
</tr>
<tr>
<td>c.</td>
<td>An instrument with two prongs, one fixed and one sliding, used to obtain diameter</td>
<td>3.</td>
<td>Merchantable height</td>
</tr>
<tr>
<td>d.</td>
<td>An instrument of thin steel tape graduated in units of diameter</td>
<td>4.</td>
<td>Dendrometer</td>
</tr>
<tr>
<td>e.</td>
<td>A wooden stick graduated in height units</td>
<td>5.</td>
<td>U.S. Forest Service</td>
</tr>
<tr>
<td>f.</td>
<td>A collective term for all instruments used for determining height</td>
<td>6.</td>
<td>Diameter tape</td>
</tr>
<tr>
<td>g.</td>
<td>A government organization responsible for the management of the national forests</td>
<td>7.</td>
<td>Bole</td>
</tr>
<tr>
<td>h.</td>
<td>The tree trunk</td>
<td>8.</td>
<td>DBH</td>
</tr>
<tr>
<td>i.</td>
<td>Height according to specifications of an organization or industry</td>
<td>9.</td>
<td>Biltmore cruiser stick</td>
</tr>
<tr>
<td>j.</td>
<td>Diameter outside the bark</td>
<td>10.</td>
<td>DOB</td>
</tr>
</tbody>
</table>

2. Name the common dendrometers used in measuring tree diameters in order of accuracy:

   a. 
   b. 
   c. 

---

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3. Draw a line indicating the correct location of DBH measurements from the illustrations given below.

1. Tree on Slope
2. Tree on Level Ground
3. Leaning Tree
4. Tree Forking at or Above 4 1/2 Feet
5. Tree Forking Below 4 1/2 Feet
6. Tree Deformed at 4 1/2 Feet
7. Bottleneck Tree

4. Classify the following measurements of DBH into the correct diameter classes.

<table>
<thead>
<tr>
<th>One-inch</th>
<th>Two-inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 5.9&quot;</td>
<td>d. 9.6&quot;</td>
</tr>
<tr>
<td>b. 4.0&quot;</td>
<td>e. 11.1&quot;</td>
</tr>
<tr>
<td>c. 8.3&quot;</td>
<td>f. 14.5&quot;</td>
</tr>
</tbody>
</table>

5. List three tools used to obtain upper stem diameter measurements by climbing.

a.

b.

c.

6. Describe the correct procedure for using the pentaprism tree caliper to obtain tree diameter.

a.

b.

c.

d.

e.
7. Identify four commonly used hypsometers.
   a.
   b.
   c.
   d.

8. Draw a diagram of the Merritt hypsometer principle.
9. Determine the height of these trees from the readings indicated using the Suunto clinometer.
10. **Determine the height in feet of the trees in these drawings using U.S. Forest Service merchantable heights.**

- Sawlog
- Upper Stem
- Limbs and Sound Cull
- Rotten Cull

![Tree Diagrams](image)

11. **Demonstrate the ability to:**

a. Determine diameters.

b. Determine merchantable tree heights.

*(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)*
1. a. 4
   b. 2
   c. 1
   d. 6
   e. 9
   f. 2
   g. 5
   h. 7
   i. 3
   j. 10

2. a. Caliper
   b. Diameter tape
   c. Biltmore cruiser stick
4. a. 6"  
   b. 5"  
   c. 8"  
   d. 10"  
   e. 12"  
   f. 14"
5. a. Gaff and harness  
   b. Tree ladders  
   c. Tree bicycles
6. a. Hold caliper 3 to 4 inches from eye  
   b. Hold pentaprism tree caliper horizontal to tree to be measured  
   c. Slide movable pointer to obtain correct image  
   d. Place vertical alignment between the two vertical guidelines  
   e. Read scale on top for diameter of tree
7. a. Suunto clinometer  
   b. Haga altimeter  
   c. Merritt hypsometer on the Biltmore cruiser stick  
   d. Abney hand level
8. Merritt
   [Diagram of triangle A-B-C with measurements]
   Ac: AC (both set, AC paced)  
   BC: is ready directly from intercept  
   bc: Any graduation  
   \[ bc = \frac{(Ac) (BC)}{AC} \]
9. a. 54  
   b. 50
Performance skills will be evaluated according to the satisfaction of the instructor.

10. a. 12'
    b. 14'
    c. 0
    d. 14'
    e. 0
    f. 12'
    g. 14' and 23' or 37'
After completion of this unit, the student should be able to scale downed logs to obtain net volume. He should be able to recognize scale defects and deduct appropriate reductions of volume. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with log scaling to the correct definition.
2. List in order of accuracy, the commonly used log rules in the South.
3. List the three parts of a scale stick.
4. List the five steps in the procedure of log scaling.
5. List kinds of defects for each of the four classes of defects given.
6. Write the formulas for the five types of defect deductions.
7. Determine scaling deduction for the five types of defect deductions.
8. Demonstrate the ability to:
   a. Identify types of defects.
   b. Scale net volume of logs.
LOG SCALING
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information, assignment, and job sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information and assignment sheets.
   F. Demonstrate and discuss procedures, outlined in the job sheets.
   G. Arrange field trips to allow students an opportunity to practice identifying types of defects and scaling logs.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures, outlined in the job sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

Included in this unit:

A. Objectives
B. Information sheet
C. Transparency master: TM 1-Parts of a Scale Stick
D. Assignment Sheet #1-Determine Scaling Deduction
E. Answers to Assignment Sheet.

F. Job sheets
   1. Job Sheet #1-Identify Types of Defects
   2. Job Sheet #2-Scale Net Volume of Logs

G. Test

H. Answers to test

II. References
LOG SCALING
UNIT IV

INFORMATION SHEET

I. Terms and definitions
A. Log scaling—The art of estimating volume of downed logs
B. Log rule—A table showing the volume of straight, sound logs of various lengths and diameters
C. Scale stick—A rule of inches with log volumes for varying lengths
D. Scaling diameter—Average diameter of the small end of the log
E. Volume—Board-foot content

(NOTE: This refers also to cubic feet, cords of pulpwood, and other commonly used volume measurements.)

F. Scale defect—An imperfection that would reduce the volume

(NOTE: Any defect that would reduce the volume of sawn boards is a scale defect, and those defects that reduce the quality of sawn boards is a grade defect.)

G. Net volume—The scale of sound volume after deduction of defect

H. Heartrot—Decay of the heartwood
I. Ring shake—Separation of the rings
J. Checks—Splitting of the wood around the exterior
K. Catface—A fire scar or other damage on the side of the log
L. Brooming—The pulling and separation of wood from the core of the log; wood strips left on the stump
M. Sweep—a scaling defect consisting of a curve in a log that extends its full length
N. Hollow—Generally an interior defect due to rotten or decayed wood
O. Cruising—A forest estimation by sampling
II. Log rules used in the South
(NOTE: These are listed according to accuracy.)
A. International 1/4"
B. Scribner decimal C
C. Doyle

III. Parts of scale stick (Transparency 1)
A. Scaling diameter
B. Length
C. Volume

IV. Procedures for scaling
A. Find and measure scaling diameter
   Measure to length class
   (NOTE: Three inches of trim are needed. Drop back to lower length class
   if these inches are not available.)
C. Record volume from scale stick
D. Determine scale defect and percent loss.
E. Record net volume

V. Classes and kind of defects
A. Interior
   1. Heartrot
   2. Hollow
   3. Ring shake
B. Exterior
   1. Basal bark
   2. Checks
   3. Catface
INFORMATION SHEET

C. Crook
   1. Sweeps
   2. Crook
   3. Forked

D. Operating
   1. Breakage
   2. Splits
   3. Brooming

VI. Defect deductions
A. Defect section
   \[
   \frac{\text{length of defective section}}{\text{length of log}} = \text{cull percent}
   \]

B. Defect sector
   \[
   \frac{\text{length of defective section} \times \text{angle of defect}}{\text{length of log} \times 360^\circ} = \text{cull percent}
   \]

C. Sweep
   \[
   \frac{\text{maximum departure minus 2''}}{\text{scaling diameter}} = \text{cull percent}
   \]

D. Crook
   \[
   \frac{\text{length of deflecting section} \times \text{maximum deflection}}{\text{length of log} \times \text{scaling diameter}} = \text{cull percent}
   \]

E. Interior defect
   \[
   \frac{(\text{major defect diameter}) (\text{minor defect diameter}) X}{(\text{scaling diameter} - 1)^2} = \frac{\text{length of defect}}{\text{cull percent}} \frac{\text{length of log}}{
   \}

In practice each ellipse axis can be divided by (20-1) and rounded to nearest tenth, if desired.
Parts of a Scale Stick

Scaling Diameter

Volume

Length
ASSIGNMENT SHEET #1

5. Interior defect

\[
\text{Percent deduction} = \frac{4}{20} \times 100\%
\]

ASSIGNMENT SHEET #1 - DETERMINE SCALING DEDUCTION

Determine the scaling deduction for the five types of defects based on a sixteen foot log with a twenty inch scaling diameter.

1. Defect section
   Percent deduction = 

2. Defect sector
   Percent deduction =

3. Sweep
   Percent deduction =

4. Crook
   Percent deduction =
ANSWERS TO ASSIGNMENT SHEET

1. \( \frac{4}{16} = 25\% \)

2. \( \frac{6}{16} \cdot \frac{60}{360} = 6 \frac{1}{4}\% \)

3. \( \frac{8.2}{20} = 30\% \)

4. \( \frac{10}{20} \cdot \frac{4}{16} = 12 \frac{1}{2}\% \)

5. \( \frac{(8) \cdot (10)}{20 \cdot 12} \cdot \frac{4}{16} = 5 \frac{5}{9}\% \)

In practice each ellipse axis can be divided by (20-1) and rounded to nearest tenth if desired.

Thus \( \frac{8}{19} = .4, \frac{10}{19} = .5, \text{ and } (4) \cdot (5) \cdot \frac{4}{16} = 5\% \).
LOG SCALING
UNIT IV

JOB SHEET #1--IDENTIFY TYPES OF DEFECTS

Tools and materials needed
A. Scale stick
B. Hatchet
C. Logs indicated by instructor
D. Clipboard and pencil

Procedure
A. Identify the types of defects in logs indicated by instructor
B. Examine both end and surface features of each log
C. Indicate type of defect
D. Place an X in the correct space provided
E. When completed, turn in to instructor for evaluation

<table>
<thead>
<tr>
<th>Log No.</th>
<th>Interior</th>
<th>Exterior</th>
<th>Crooks</th>
<th>Operating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</table>
LOG SCALING
UNIT IV

JOB SHEET #2–SCALE NET VOLUME OF LOGS

I. Tools and materials needed
   A. Scale stick (Doyle Rule)
   B. Hatchet
   C. Logs indicated by instructor
   D. Clipboard, pencil, and scale tally form

II. Procedure
   A. Find and measure scaling diameter
   B. Measure to length class
   C. Record volume from scale stick
   D. Determine scale defect and percent loss
   E. Record net volume
   F. Complete the form on the following page
   G. When completed, turn in to instructor for evaluation
<table>
<thead>
<tr>
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<tr>
<td>Totals</td>
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</tbody>
</table>

**JOB SHEET #2**

**SCALE TALLY**

Location: __________________________

Species: __________________________

Scaler: ____________________________

Date: ____________________________

Log Rule: _________________________

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LOG SCALING
UNIT IV

TEST

1. Match the terms on the right to the correct definition.

   a. The art of estimating volume of downed logs
   1. Scaling diameter
   
   b. A table showing the volume of straight, sound logs of various lengths and diameters
   2. Heartrot
   
   c. A rule of inches with log volumes for varying lengths
   3. Scale defect
   
   d. Average diameter of the small end of the log
   4. Checks
   
   e. Board-foot content
   5. Scale stick
   
   f. An imperfection that would reduce the volume
   6. Brooming
   
   g. The scale of sound volume after deduction of defect
   7. Net volume
   
   h. Decay of the heartwood
   8. Catface
   
   i. Separation of the rings
   9. Log scaling
   
   j. Splitting of the wood around the exterior
   10. Ring shake
   
   k. A fire scar or other damage on the side of the log
   11. Volume
   
   l. The pulling and separation of wood from the core of the log; wood strips left on the stump
   12. Log rule
   
   m. A scaling defect consisting of a curve in a log that extends its full length
   13. Sweep
   
   n. A forest estimation by sampling
   14. Hollow
   
   o. Generally an interior defect due to rotten or decayed wood
   15. Cruising
2. List in order of accuracy, the commonly used log rules in the South.
   a.
   b.
   c.

3. List the three parts of a scale stick:
   a.
   b.
   c.

4. List the five steps in the procedure of log scaling.
   a.
   b.
   c.
   d.
   e.

5. List one kind of defect for each of the following classes of defects.
   a. Interior
   b. Exterior
   c. Crook
   d. Operating

6. Write the formulas for the following percent defect deductions of logs.
   a. Defect section
   b. Defect sector
   c. Sweep
   d. Crook
   e. Interior defect
7. Determine scaling deduction for the five types of defect deductions.  
   (NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)

8. Demonstrate the ability to  
   a. Identify type of defects.  
   b. Scale net volume of logs.  
   (NOTE: If these have not been accomplished prior to this test, ask the instructor when the above activities should be completed.)
LOG SCALING
UNIT IV

ANSWERS TO TEST

1.  
   a. 9  
   b. 12  
   c. 5  
   d. 1  
   e. 11  
   f. 3  
   g. 7  
   h. 2  
   i. 10  
   j. 4  
   k. 8  
   l. 6  
   m. 13  
   n. 15  
   o. 14

2.  
   a. International 1/4"  
   b. Scribner decimal C  
   c. Doyle

3.  
   a. Scaling diameter  
   b. Length  
   c. Volume

4.  
   a. Find and measure scaling diameter  
   b. Measure to length class  
   c. Record volume from scale stick  
   d. Determine scale defect and percent loss  
   e. Record net volume

5. Any one of the following for each defect
   a. Heartrot, hollow, or ring shake  
   b. Sap rot, checks, or catface  
   c. Sweeps, crooks, or forked  
   d. Breakage, splits, or brooming

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6. a. \( \frac{\text{length of defective section}}{\text{length of log}} = \text{cull percent} \)

b. \( \frac{\text{length of defective section} \times \text{angle of defect}}{\text{length of log} \times 360^\circ} = \text{cull percent} \)

c. \( \frac{\text{maximum departure minus } 2''}{\text{scaling diameter}} = \text{cull percent} \)

d. \( \frac{\text{length of deflecting section} \times \text{maximum deflection}}{\text{length of log} \times \text{scaling diameter}} = \text{cull percent} \)

e. \( \frac{(\text{major defect diameter}) (\text{minor defect diameter}) \times \text{length of defect}}{(\text{scaling diameter} - 1)^2 \times \text{length of log}} = \text{cull percent} \)

7. Evaluated to the satisfaction of the instructor.

8. Performance skills will be evaluated to the satisfaction of the instructor.
PINE TREE GRADING
UNIT V

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to grade southern pine trees. He should be able to measure log heights and upper stem diameters. This knowledge will be evidenced by demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with pine tree grading to the correct definition.
2. Choose from a list two reasons pine trees are graded.
3. Arrange in order the procedure to find the height of trees in logs.
4. List three common tools used to obtain upper stem diameters.
5. List the procedure to establish tentative log grades.
6. List the three defects that degrade the tentative grade to a final grade.
7. Demonstrate the ability to:
   a. Measure log heights.
   b. Measure upper stem diameters.
   c. Grade pine trees.
SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Discuss terminal and specific objectives.
   D. Discuss information sheet.
   E. Demonstrate and discuss procedures outlined in the job sheets.
   F. Arrange field trips to allow students an opportunity to practice measuring log heights, measuring upper stem diameter, and grading pine trees.
   G. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheets.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Job sheets
      1. Job Sheet #1—Measure Log Heights
      2. Job Sheet #2—Measure Upper Stem Diameter
      3. Job Sheet #3—Grade Pine Trees
D. Test

E. Answers to test

I. Terms and definitions

A. Grading - The judging of logs and trees into specific classes based on quality of products

B. Upper stem diameter - Any diameter on a tree above DRH

C. Spiegel relaskop - A versatile instrument used to find diameters, heights, basal area, and feet rise in 100' or 66'

D. Scaling diameter - The small end or top end of the log

E. Log - Any tree section between 8' and 20' long (plus trim), measuring at least 4 1/2" in diameter at the small end

F. Log face - A portion of the log surface equal to 1/4 circumference extending the full length of the log

   NOTE: Each log has four faces.

G. Quarter face - A portion of the log surface equal to 1/4 circumference extending 1/4 the length of a quarter-face area can be located anywhere in a log

H. Average diameter at small end of log inside bark nearest whole inch - usually called "scaled diameter"

I. Log knot - Any visible branch, stub, or socket over 1" in average diameter or evidence thereof

   NOTE: Diameter of log knots is measured to nearest whole inch outside bark at junction of limb with collar or outside limb growth ring if limb is cut flush with log surface

J. Sound - Any log knot which does not contain any decay or does not contain a hole larger than 1/4" in diameter and 2 or more inches deep

K. Unsound - Any log knot containing advance decay or over 2" in diameter and 2 or more inches deep

L. Overgrown - Any log knot buried below the barked area indicated by a disturbance of the bark pattern

M. Oversize - Any sound log knot with diameter larger than 6"
INFORMATION SHEET

N. K count—A numerical log knot factor used in association with log diameter for placing a log in its tentative grade.

(NOTE: It is the number of visible overgrown log knots, plus the sum of average diameters of sound log knots, plus twice the sum of the average diameters of unsound log knots.)

O. Sweep—The general deviation of the longitudinal log axis from a straight line connecting geometric centers of the log ends.

(NOTE: It is measured to the nearest whole inch at the point of greatest deviation. Sweep must measure 3" and equal or exceed D/3 to constitute a defect.)

P. Conk—A fruiting body of a fungus.

Q. Hyphae—The vegetative body of a fungus.

II. Reasons for grading pine trees

A. Separate logs and trees into product manufacture class.

B. Determine the relative qualities of products possible.

III. Procedure for measuring log heights

A. Measure out 50' from tree.

B. Shoot base of tree with suunto or abney.

C. Subtract reading from 34.6.

D. Set suunto or abney at the answer of above.

E. Sight on tree = 17.3' (the top of first log).

F. Repeat for each log in tree.

(NOTE: For each log, the height reading increases 34.6.)

IV. Common tools used for upper stem diameters

A. Estimation.

B. Wheeler pentaprism.

C. Spiegel reliskop.
V. Tentative grade procedure

A. Divide tree into log sections

B. Determine scaling diameters of logs

C. Determine (K) count

Example:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum scaling diameter (D) (inches)</th>
<th>Maximum knot count (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>D/5</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>D/2</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>no limit</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>no limit</td>
</tr>
</tbody>
</table>

VI. Final grade defect sequence

A. Sweep-Debrade any tentative 1, 2, or 3 grade log one grade if sweep is at least 3 inches and equals or exceeds D/2.

(NOTE: This is the final grade if the log has no evidence of heart rot and no unsound or oversize knots.)

B. Heart rot-Debrade any tentative 1, 2, or 3 grade log one grade if conk, massed hyphae, or other evidence of advance heart rot is found.

(NOTE: This is the final grade if log has no unsound or oversize knots.)

C. Unsound or oversize knots-Debrade any tentative grade 3 log to grade 4 if unsound or oversize log knots are dispersed so that they cannot be contained in one quarter face.

Example:
**INFORMATION SHEET**

**4-FACE GRADING**

<table>
<thead>
<tr>
<th>D.i.b.</th>
<th>Log grade No.</th>
<th>Degrading (G3 to G4 in not if 1/4 face)</th>
<th>Bad knot (Unsound or oversize)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>dib</td>
<td>dib</td>
<td>unlimited</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0-7</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0-5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>0-5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>0-6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>0-6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>0-7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>0-7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0-8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>0-3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>0-3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>0-3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0-4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>0-4</td>
<td>5-10</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>0-4</td>
<td>5-11</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>0-4</td>
<td>5-12</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>0-4</td>
<td>5-13</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>0-5</td>
<td>6-2</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>0-5</td>
<td>6-3</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>0-5</td>
<td>6-13</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>0-5</td>
<td>6-14</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>0-5</td>
<td>6-15</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>0-6</td>
<td>7-15</td>
</tr>
</tbody>
</table>

**Limits of K**

- **Inches**
- **Unlimited**
- **Dib**

**NOTE:** For heart rot, degrade minus one grade.

**FACTOR K:** Number of overgrown knots, plus the sum of diameters of sound exposed knots, plus twice the sum of diameters of unsound knots. Diameters to nearest whole inch at point of trimming.
PINE TREE-GRADING
UNIT-V

JOB SHEET #1-MEASURE LOG HEIGHTS

Measure logs by using a suunto clinometer and the procedures given. When completed, turn in to the instructor for evaluation.

I. Tools and materials needed
   A. Suunto Clinometer
   B. 50 foot tape
   C. Tree, indicated by instructor
   D. Clipboard, paper, and pencil

II. Procedure
   A. Measure out 5' from tree
   B. Shoot base of tree with suunto or abney
   C. Subtract reading from 34.6
   D. Set suunto or abney at the answer of above
   E. Sight on tree = 17.3' (the top of first log)
   F. Repeat for each log in tree

   (NOTE: For each log, the height reading increases 34.6.)

G. Record an "X" in the space below for the number of 16' logs determined

<table>
<thead>
<tr>
<th>Tree No.</th>
<th>16'</th>
<th>32'</th>
<th>48'</th>
<th>64'</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Measure upper stem diameters using a wheeler pentaprism and the procedure given. When completed, turn in to the instructor for evaluation.

I. Tools and materials needed
   A. Wheeler, pentaprism
   B. Diameter tape
   C. Suunto clinometer
   D. 50' tape
   E. Clipboard and pencil
   F. Attached example of use of wheeler pentaprism
   G. Trees indicated by instructor

II. Procedure
   A. Using the attached example—practice measuring trees at DBH
   B. Check measurements with diameter tape
   C. Measure out 50' from tree
   D. Shoot base of tree with suunto or abney
   E. Subtract reading from 34.6
   F. Set suunto or abney at the above answer
   G. Sight on tree = 17.3' (the top of the first log)
   H. Repeat for each log in tree
      (NOTE: For each log, the height increases 34.6.)

I. Fill in the correct diameter measurement below:

<table>
<thead>
<tr>
<th>Tree No.</th>
<th>Diameter at 17.3'</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
Grade pine trees using the procedure given. When completed, turn in to the instructor for evaluation.

I. Tools and materials needed
   A. Suunto clinometer
   B. Wheeler pentaprism
   C. 50' tape
   D. Clipboard and pencil
   E. Attached 4-face grading table

II. Procedure
   A. Divide tree into log sections
   B. Determine scaling diameter of logs
   C. Determine (K) count

   Example:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum scaling diameter (D)</th>
<th>Maximum knot count (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>D/5</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>D/2</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>no limit</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>no limit</td>
</tr>
</tbody>
</table>

   D. For sweep, degrade any tentative 1, 2, or 3 grade log one grade if sweep is at least 3 inches and equals or exceeds D/3

   (NOTE: This is the final grade if the log has no evidence of heart rot and no unsound or oversize knots.)

   E. For heart rot, degrade any tentative 1, 2, or 3 grade log one grade if conk, marred hyphae or other evidence of advanced heart rot is found

   (NOTE: This is the final grade if log has no unsound or oversize knots.)
F. For unsound or oversize knots, degrade any tentative grade 3 log to grade 4 if unsound or oversize log knots are dispersed so that they cannot be contained in one quarter face.

G. Fill in the appropriate information below for the first 16' log of each tree.

<table>
<thead>
<tr>
<th>Tree No.</th>
<th>Scaling Diameter</th>
<th>K Count</th>
<th>Tentative Grade</th>
<th>Degrade Defect</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Match the terms on the right to the correct definition.

| a. The judging of logs and trees into specific classes based on quality of products | 1. Sound |
| b. Any diameter on a tree above DBH | 2. Overgrown |
| c. A versatile instrument used to find diameters, heights, basal area, and feet rise in 100' or 66' | 3. D |
| d. The small end or top end of the log | 4. K count |
| e. Any tree section between 8' and 20' long (plus trim), measuring at least 4 1/2" in diameter at the small end | 5. Upper stem diameter |
| f. A portion of the log surface equal to 1/4 the circumference extending full length of the log | 6. Hyphae |
| g. A portion of the log surface equal to 1/4 the circumference extending 1/4 the log length; a quarter-face area can be outlined anywhere on a log | 7. Log face |
| h. Average diameter at small end of log inside bark to nearest whole inch—usually called "scaling diameter" | 8. Oversize |
| i. Any visible branch, stub, or socket over 1/2" in average diameter, or evidence thereof | 9. Grading |
| j. Any log knot which does not contain advance decay or does not contain a hole larger than 1/4" in diameter and extending into the log 2 or more inches | 10. Conk |
|  | 11. Log knot |
|  | 12. Sweep |
|  | 13. Scaling diameter |
|  | 14. Quarter face |
|  | 15. Spiegel relaskop |
|  | 16. Unsound |
|  | 17. Log |
k. Any log knot containing advance decay or a hole larger than 1/4" in diameter and 2 or more inches deep
l. Any log knot buried below the bark surface but indicated by a disturbance of the bark pattern
m. Any sound log knot with diameter larger than D/6
n. A numerical log knot factor used in association with log diameter for placing a log in its tentative grade
o. The general deviation of the longitudinal log axis from a straight line connecting geometric centers of the log ends
p. A fruiting body of a fungus
q. The vegetative body of a fungus

2. Choose from this list the two reasons pine trees are graded.
   a. To determine volume of boards
   b. To separate logs and trees into product manufacture class
   c. To determine the relative qualities of products possible
   d. To estimate the number of sizes of trees

3. Arrange in order the procedure to find the height of trees in logs.
   a. Sight on tree = 17.3' (the top of first log)
   b. Repeat for each log in tree
   c. Shoot base of tree with suunto or abney
   d. Subtract reading from 34.6
   e. Measure out 50' from tree
   f. Set suunto or abney at the answer of above
4. List the three common tools used to obtain upper stem diameters.
   a. 
   b. 
   c. 

5. List the steps taken to establish tentative log grades using this table.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum scaling diameter (D) (inches)</th>
<th>Maximum knot count (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>D/5</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>D/2</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>no limit</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>no limit</td>
</tr>
</tbody>
</table>

a. 

6. List the three defects that degrade a tentative grade to a final grade.

a. 

7. Demonstrate the ability to:

a. Measure log heights.

b. Measure upper stem diameter.

c. Grade pine trees.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
PINE TREE GRADING
UNIT V

ANSWERS TO TEST

1. a. 9
   b. 5
   c. 15
   d. 13
   e. 17
   f. 7
   g. 14
   h. 3
   i. 11
   j. 1
   k. 16
   l. 2
   m. 8
   n. 4
   o. 12
   p. 10
   q. 6

2. b
   c

3. a. 5
   b. 6
   c. 2
   d. 3
4. a. Estimation
   b. Wheeler pentaprism
   c. Speigel relaskop
5. a. Divide tree into log sections
   b. Determine scaling diameters of logs
   c. Determine (K) count
6. a. Sweep
   b. Heart rot
   c. Unsound or oversize knots
7. Performance skills will be evaluated to the satisfaction of the instructor.
HARDWOOD TREE GRADING
UNIT VI

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to recognize and classify hardwood trees into various grades of factory lumber classes. He should be able to recognize and evaluate these defects. This knowledge will be evidenced through demonstration and by scoring eighty percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with hardwood tree grading to the correct definition.
2. List three classes that trees can be cut into as logs.
3. List five major factors affecting grades of the factory class.
4. Match the rules for grade defect evaluation to the correct grade defect.
5. Label the grading zones when given a drawing of a log end.
6. State the principle of factory grades.
7. Arrange in numerical order the procedure for grading logs when given a list of the steps.
8. Demonstrate the ability to:
   a. Identify grade defects.
   b. Grade hardwood trees.
HARDWOOD TREE GRADING
UNIT VI

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in the job sheets.
   G. Arrange field trips to allow students an opportunity to practice identifying grade defects and grading hardwood trees.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Participate in field trips.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
C. Transparency masters
   1. TM 1—Evaluation of Bumps
   2. TM 2—Evaluation of Seams
   3. TM 3—Grading Zones

D. Job Sheets
   1. Job Sheet #1—Identify Grade Defects
   2. Job Sheet #2—Grade Hardwood Trees

E. Test

G. Answers to test

HARDWOOD TREE GRADING
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Grading—Judging logs and trees into specific classes based on quality of products

B. Scalable defect—An imperfection that would reduce the volume

C. Grade defect—An imperfection that reduces the quality of sawn boards

D. Epicormic bud clusters—Group of sprouts on the side of the tree

E. Hard hardwoods—Types of wood including sugar maple, beech, birch, sycamore, hackberry, oak, ash, and hickory

F. Soft hardwoods—Types of wood including soft maple, basswood, yellow-poplar, gum magnolia, willow, cottonwood, and elm

G. Grut holes—Holes bored into the wood or the tree caused by various insects

H. Bumps—Log knots including those buried below the bark surface, but indicated by a disturbance of the bark pattern

I. Seam—A line of overgrowth indicating an old wound

J. Bird peck—Damage of sap-suckers and woodpeckers made past the bark and into the wood of the tree

K. Log face—A portion of the log surface equal to one-fourth the circumference, extending the full length of the log

L. Heart center—Wood in a cylinder in the center of the log with a radius equal to one-fifth of the scaling diameter

M. Slab zone—A zone starting at the surface and extending inward for a distance one-fifth of the diameter

N. Grading doughnut—Wood that is left for grading purposes after the heart center and slab zone are eliminated

II. Log classes

A. Factory

B. Construction

C. Local use
III. Major factors of grading factory class logs

A. Position in tree

B. Size

C. Straightness

D. Scalable defect

E. Grade defect

Examples:

**HARDWOOD FACTORY GRADE 1**

A 16-foot butt log 13 inches in diameter at the small end. More than 5/6 of its grading-face length is clear in two sections 7 and 8 feet long. Less than 40 percent scaling deduction.

**HARDWOOD FACTORY GRADE 2**

A 10-foot log 16 inches in diameter at the small end. More than 5/6 of its grading-face length is clear in one section 8 feet long. Less than 15 percent deduction for sweep; total deduction is less than 40 percent.

**HARDWOOD FACTORY GRADE 3**

A 4-foot log 11 inches in diameter at the small end. More than 2/3 of its grading-face length is clear in two sections each 4 feet long. Less than 50 percent scaling deduction.
A 9-foot log, 12 inches in diameter at the small end. More than 3/4 of its grading-face length is clear in two sections 4 and 3 feet long. Less than 50 percent scaling deduction.

**HARDWOOD FACTORY GRADE 3**

2 1/4' 2 1/2'

An 8-foot log, 8 inches in diameter at the small end. More than 1/2 of its grading-face length is clear in two sections of 2 feet or longer. Less than 50 percent deduction for rot and sweep.

A 12-foot log, 14 inches in diameter at the small end. Interior rot outside the rot zone limits cuttings. However, more than 1/2 of its grading-face is clear in two sections, four and three feet long. No sweep. 15 percent deduction for rot is within the 50 percent maximum permitted.

**IV. Grade defects**

Sorcut: epicormic bud clusters and knots

1. Large (more than 3/8 inch diameter)—full defect on logs of all sizes, grades, and species
2. Small (3/8 inch diameter or less)
   a. All grades—Hard hardwoods
      1. Logs less than 14 inches defect
      2. Logs 14 inches and more—One half defect or skip every other one
INFORMATION SHEET

b. All grades—Soft hardwoods
   1. Grades 1 and 2—Full defect on logs less than 14 inches
   2. One-half defect on logs more than 14 inches
   3. Grade 3—No defect

B. Grub holes and grub-caused overgrowths
   1. Progressive on face
      a. On logs 8-15 inches—Each is a full defect
      b. On logs 16-19 inches—Disregard every sixth one
      c. On logs 20-23 inches—Disregard every fifth one
      d. On logs 24-27 inches—Disregard every fourth one
      e. On logs 28 inches or more—Disregard every third one
   2. Nonprogressive, horizontally aligned on face—When two or more of these defects are found in a band not more than 6 inches wide across the width of the face, they may be considered as one

Bumps (Transparency 1)
   1. Bumps must be considered on all logs although in some species low bumps can sometimes be disregarded
   2. When bumps are to be log defects, measurements of length affecting clear-cuttings can vary as given:
      a. Abrupt bump
         - Length less than three times height
         - Example: 6 inches long and 4 inches high
         - Stop clear-cutting at change in contour
         - Do not enter bump with clear-cuttings

225
INFORMATION SHEET

b. Medium bump

1) Length three to six times height
   Example: 12 inches long and 2 to 4 inches high

2) Let clear-cutting enter bump one-eighth the length on each side

c. Low bump

1) Length six to twelve times height
   Example: 12 inches long and 1 to 2 inches high

2) Let clear-cutting enter bump one-fourth the length on each side

d. Surface rise.

1) Length more than twelve times height

2) Disregard it

D. Straight seams, frost, cracks, and splits which are not superficial (Transparency 2)

1. Straight seams extending full or part length of the log that can be considered as a line dividing two grading faces can be disregarded

2. Straight seams not confinable to line dividing grading faces
   a. When full length of log, a full defect
   b. When extending from one end of log towards middle, include one-third the length on interior end in the clear-cutting
   c. When completely in log, extend cuttings one-fourth the length from each end

E. Spiral seams, frost, cracks, and splits which are not superficial—Stop clear-cutting where defect enters face being graded

F. Bird peck

1. Individual pecks are not counted
INFORMATION SHEET

2. Length of pecked area is measured.
   (NOTE: A pecked area consists of four or more pecks per square foot.)
   a. Lightly pecked area or fewer than four pecks per square foot—Disregard it
   b. In otherwise No. 3 logs—Disregard all pecked areas
   c. In logs otherwise No. 1 and No. 2 with heavily pecked areas or more than four pecks per square foot
      1) If pecks are open, disregard
      2) If pecks are partially or completely occluded, the pecked area is a defect.
         (NOTE: Age of peck does not matter. The test is whether callus tissue has formed in the peck holes.)

V. Grading zones (Transparency 3)
   A. Heart center—One-fifth of the diameter in the center is not graded
   B. Slab zone—One-fifth of the diameter on the surface is not graded
   C. Grading doughnut

VI. Principle of factory grades—Divide the log into four faces; the poorest face of the three best faces is the log grade

Example:
VII. Procedure for grading logs

A. Determine the species of the log to be graded

B. Determine the position the log occupied in the standing tree

C. Establish the scaling diameter

D. Measure the length of usable material in the log or the part that will actually be sawn into boards

(NOTE: Be sure to make sufficient allowance for end trim, usually about three inches of length.)

E. Divide the log pole surface into quarter widths and obtain the greatest number of good faces

F. Determine the best possible grade the log can obtain based on the minimum scaling diameter, log position, and species

(NOTE: The above step gives the maximum number and minimum length of feet for clear-cuttings for the possible grade as given in the Forest Service Standard Specifications for Hardwood Factory Lumber Logs. The chart appears on the following page.)

G. Measure clear-cuttings in each face and check against the specifications for required length needed for the grade to be established

H. If the required clear-cutting length is obtained, proceed to the next step; if the required length is not met, drop back a grade, check specifications for number of cuts and lengths, and regrade face

I. When all four faces have been graded, the log grade is established as the third best face of the total four faces
### VIII. Forest Service Standard Specifications for Hardwood Factory Lumber Logs

#### Grading Factors

<table>
<thead>
<tr>
<th>Position in tree</th>
<th>F1 Butts only</th>
<th>F1 Butts &amp; uppers</th>
<th>F2 Butts &amp; uppers</th>
<th>F2 Butts &amp; uppers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter, scaling, inches</td>
<td>1/3-15</td>
<td>16-19</td>
<td>20+</td>
<td>2</td>
</tr>
<tr>
<td>Length without trim, feet</td>
<td>10+</td>
<td>10-</td>
<td>8-9</td>
<td>10-11</td>
</tr>
<tr>
<td>Clear cuttings on each 3 best faces</td>
<td>Length, min., feet</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Number, maximum</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Fraction of log length required in clear cutting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sweep and crook allowance (maximum) in percent gross volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For logs with less than 1/4 of end in sound defects</td>
<td>15%</td>
<td>30%</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>For logs with more than 1/4 of end in sound defects</td>
<td>10%</td>
<td>20%</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>Total scaling deductions including sweep and crook</td>
<td>5</td>
<td>40%</td>
<td>6</td>
</tr>
</tbody>
</table>

#### End Defects:

1. Ash and basswood butts can be 12 inches if otherwise meeting requirements for small No. 1’s.
2. Ten-inch logs of all species can be No. 2 if otherwise meeting requirements for small No. 1’s.
3. A clear cutting is a portion of a face free of defects, extending the width of the face.
4. See Table 46.
5. Otherwise No. 1 logs with 41-60% deductions can be No. 2.
6. Otherwise No. 2 logs with 51-60% deductions can be No. 3.

#### TOTAL CUTTING LENGTH FOR HARDWOOD LOG GRADES

<table>
<thead>
<tr>
<th>Log Length (feet)</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Lose</td>
<td>8’4”</td>
<td>1’8”</td>
<td>6’8”</td>
</tr>
<tr>
<td>Clear Lose</td>
<td>10’</td>
<td>2’</td>
<td>8’</td>
</tr>
<tr>
<td>Clear Lose</td>
<td>11’8”</td>
<td>2’4”</td>
<td>9’4”</td>
</tr>
<tr>
<td>Clear Lose</td>
<td>13’4”</td>
<td>2’8”</td>
<td>10’8”</td>
</tr>
</tbody>
</table>

For #1: Length times 2 gives inches can lose.
For #2: Length times 4 gives inches can lose.
For #3: Length times 6 gives inches can lose.
Evaluation of Bumps

Point of Change in Log Contour

Length (L)

Abrupt Bump-H:L=1:3 or less

High Bump-H:L=1:6/1:3

Low Bump-H:L=1:12/1:6

Surface Swell-H:L=less than 1:12

Abrupt-Stop Cutting at Change in Contour

High-Enter Bump 1/8 Length on Each End

Low-Enter Bump ¼ Length on Each End

Surface Swell-No Defect
Evaluation of Seams
HARDWOOD TREE GRADING
UNIT VI

JOB SHEET #1--IDENTIFY GRADE DEFECTS

I. Tools and materials needed
A. Hatchet
B. Logger's tape
C. Scale stick
D. Logs or trees indicated by the instructor
E. Clipboard, paper, and pencil

II. Procedure
A. Divide log or tree into four faces; pick the worst face first to align other faces
B. Use the loggers tape to locate the distance between defects and the ends of the log
C. On paper, draw the four faces of the log
D. On the diagram made, locate and identify the type of defects as shown (Figure 1)

<table>
<thead>
<tr>
<th>Face No.</th>
<th>Face Grade No.</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
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<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

E. When completed, turn in to the instructor for evaluation
HARDWOOD TREE GRADING
UNIT VI

JOB SHEET #2--GRADE HARDWOOD TREES

I. Tools and materials needed
   A. Hatchet
   B. Logger's tape
   C. Scale stick
   D. Logs or trees indicated by the instructor
   E. Tally form
   F. Clipboard and pencil

II. Procedure
   A. Determine the species of the log to be graded
   B. Determine the position of the log occupied in the standing tree
   C. Establish the scaling diameter
   D. Measure the length of usable material in the log or the part that will actually be sawn into boards
   E. Divide the log pole surface into quarter widths and obtain the greatest number of good faces
   F. Determine the best possible grade the log can obtain based on the minimum scaling diameter, log position, and species
   G. Measure clear-cuttings in each face and check against the specifications for the required length needed for the grade to be established
   H. If the required clear-cutting length is obtained, proceed to the next step; if the required length is not met, drop back a grade, check specifications for number of cuts and lengths, and regrade face
   I. When all four faces have been graded, the log grade is established as the third best face of the total four faces
   J. Complete the attached form and turn in to the instructor for evaluation
| No. | 1 | 2 | 3 | 4 | 5 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|-----|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Log. Pos. |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Cause of Degradation |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Grade |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Net Scale |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Deductions |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| S.W. % |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Gross Scale |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Scal. Dia. |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Length |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

*D-S: Log Defect; S-Internal Scale Deduction; E-End Defect; C-Crook or Sweep; O-Other
HARDWOOD TREE GRADING
UNIT VI

TEST

1. Match the terms on the right to the correct definition:

   a. Judging logs and trees into specific classes based on quality of products
   b. An imperfection that would reduce the volume
   c. An imperfection that reduces the quality of sawn boards
   d. Group of sprouts on the side of the tree
   e. Types of wood including sugar maple, beech, birch, sycamore, hackberry, oak, ash, and hickory
   f. Types of wood including soft maple, basswood, yellow-poplar, gum magnolia, willow, cottonwood, and elm
   g. Holes bored into the wood of the tree caused by various insects
   h. Log knots including those buried below the bark surface but indicated by a disturbance of the bark pattern
   i. A line of overgrowth indicating an old wound
   j. Damage of sap-suckers and woodpeckers made past the bark and into the wood of the tree
   k. A portion of the log surface equal to one-fourth the circumference, extending the full length of the log

   1. Epicormic bud cluster
   2. Grub holes
   3. Seam
   4. Scalable defect
   5. Grading doughnut
   6. Slab zone
   7. Hard hardwoods
   8. Heart center
   9. Grade defect
   10. Log face
   11. Bird peck
   12. Grading
   13. Bumps
I. Wood in a cylinder in the center of the log with a radius equal to one-fifth of the scaling diameter.

m. A zone starting at the surface and extending into the log for a distance one-fifth of the diameter.

n. Wood that is left for grading purposes after the heart center and slab zone are eliminated.

2. List the three classes that trees can be cut into as logs:
   a.
   b.
   c.

3. List the five major factors affecting grades of the factory class.
   a.
   b.
   c.
   d.
   e.

4. Match the rules for grade defect evaluation to the defects below.
   a. Full defect on all grades
   b. Full defect on less than 14"; 1/2 defect on larger diameter
   c. Disregard every fifth one as a defect
   d. Stop clear-cutting where defects enters face being graded
   e. When full length of log, a full defect
   f. Enter bump 1/4 the length on each side
   g. Disregard

1. Small sprout 3/8" diameter on an oak
2. Low bump
3. Spiral seam
4. Straight seam
5. Sprout 1/2" diameter
6. Bird peck on otherwise No. 3 log
7. Grub hole on 20" log
5. Label the grading zones on the drawing of a log end given below.

![Log diagram](image)

---

6. State the principle of factory grades.

---

Arrange in numerical order the procedure for grading logs:

a. Determine the best possible grade the log can obtain based on the minimum scaling diameter, log position, and species.

b. Determine the position the log occupied in the standing tree.

c. Measure clear-cuttings in each face and check against the specifications for required length needed for the grade to be established.

d. When all four faces have been graded, the log grade is established as the third best face of the total four faces.

e. Measure the length of usable material in the log or the part that will actually be sawn into boards.

f. Divide the log pole surface into quarter widths and obtain the greatest number of good faces.

g. If the required clear-cutting length is obtained, proceed to the next step; if the required length is not met, drop back a grade, check specifications for number of cuts and lengths, and regrade face.

h. Establish the scaling diameter.

i. Determine the species of the log to be graded.
8. Demonstrate the ability to:
   a. Identify grade defects.
   b. Grade hardwood trees.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
HARDWOOD TREE GRADING
UNIT VI

ANSWERS TO TEST

1. a. 12
   b. 4
   c. 9
   d. 1
   e. 7
   f. 14
   g. 2
   h. 13
   i. 
   j. 11
   k. 10
   l. 8
   m. 6
   n. 5

2. a. Factory
   b. Construction
   c. Local use

3. a. Position in tree
   b. Size
   c. Straightness
   d. Scalable defect
   e. Grade defect

4. a. 5
   b. 1
   c. 7
   d. 3
   e. 4
   f. 2
   g. 6
5. a. Slab zone 1/5 D  
b. Grading doughnut  
c. Heartcenter 1/5 D

6. Divide the log into four faces; the poorest face of the three best faces is the log grade.

7. a. 6  
b. 2  
c. 7  
d. 9  
e. 4  
f. 5  
g. 8  
h. 3  
i. 1  

8. Performance skills will be evaluated to the satisfaction of the instructor.
STRIP CRUISING
UNIT VII

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to lay out a strip cruise and perform a strip cruise to determine sawtimber volume. He should be able to determine blow-up factor and tract acreage from strip cruising. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with strip cruising to the correct definition.
2. Select from a list four reasons for cruising.
3. Determine cruise intensity when given the necessary information for calculation.
4. Arrange in numerical order the procedure for laying out a strip cruise.
5. Name the two methods used to determine the blow-up factor for a strip cruise.
6. List the four steps used to determine total tract acreage from a strip cruise.
7. Name and describe the duties of a two-man strip cruise crew.
8. List the advantages and disadvantages of strip cruising.
9. Demonstrate the ability to:
   a. Lay out a strip cruise.
   b. Determine sawtimber volume by strip cruising.
STRIP CRUISING
UNIT VII

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparency.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in the job sheets.
   G. Arrange field trips to allow students an opportunity to practice laying out a strip cruise and determining volume by strip cruising.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet

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C. Transparency Master: TM 1-Strip Cruise Design

D. Job sheets

1. Job Sheet #1--Lay Out a Strip Cruise

2. Job Sheet #2--Determine Sawtimber Volume by Strip Cruising

E. Test

F. Answers to test

STRIP CRUISING
UNIT VII

INFORMATION SHEET

I. Terms and definitions

A. Cruising--A forest estimation by sampling

B. Sample--A part of the whole; plots and strips

C. Strip cruising--Sampling using continuous strips of uniform width and strips of equal intervals of spacing across the forest acreage

(NOTE: These are usually one chain strips.)

D. Cruise, intensity--The percent of area actually occupied and measured as a sample; expressed as a percent of area

E. Strip interval--The distance in chains between the strip centerlines

F. Blow-up factor--A numerical value used to expand a sample volume or acres to total tract volume or acres

G. Tallying--Recording trees by diameter and height on a form

Example: Dot-Dash system used:

```
. = 1   : = 3   . = 5   Q = 7   O = 9
. = 2   : = 4   = 6   O = 8   X = 10
```

H. Borderline trees--Trees just on the edge of the sample area

I. Compassman--A worker responsible for keeping accurate direction

J. Estimator--A worker that measures sample plots or strips

K. Tree volume table--Shows content of trees of various DBH and heights based on a log rule

II. Reasons for cruising

A. Land and timber appraisal

B. Timber sales

C. Management plans

D. Special surveys: TSI needs, planting areas, insect and disease damage, timber trespass, and blown-down timber

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III. Determining cruise intensity
   A. Determine acreage sampled in strips
   B. Divide sampled acreage into total tract acreage
      Examples: 2 1/2%, 10%, 20%
      (NOTE: Cruise intensity is dependent on value of the timber products, allowable costs, and desired precision.)

IV. Procedure for strip cruise design (Transparency 1)
   A. Determine acreage to sample from cruise intensity
   B. Determine strip size
      1. One chain most commonly used
      2. One-half chain for dense stands
      3. Two chains for sparse stands
   C. Determine strip interval based on acreage
   D. Determine starting point
   E. Determine strip direction
      (NOTE: Strips should cross topography and drainage at right angles.)
   F. Locate first strip one-half the strip interval from starting point
      (NOTE: This will end with the last strip one-half the strip interval instead of on the tract boundary.)

V. Methods used to determine blow-up factor
   A. Divide cruise intensity into 100%
   B. Divide tract acreage by sample acres
      (NOTE: Sample timber volumes are expanded by blow-up factor.)
      Examples:

<table>
<thead>
<tr>
<th>Cruise Intensity</th>
<th>Blow-up Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 1/2%</td>
<td>40</td>
</tr>
<tr>
<td>5%</td>
<td>20</td>
</tr>
<tr>
<td>10%</td>
<td>10</td>
</tr>
<tr>
<td>20%</td>
<td>5</td>
</tr>
</tbody>
</table>

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INFORMATION SHEET

VI. Steps used to determine acreage from strip cruising
   A. Determine total length of strips in chains
   B. Multiply strip width times lineal distance to find the number of square chains
   C. Divide square chains by ten to determine sample acres
   D. Multiply sample acres times blow-up factor to find total tract acreage

VII. Duties of a two-man strip cruise crew
   A. Compassman-Locates centerline of strip using a compass, topographic tape, and Abney hand level; tallies for estimator
   B. Estimator-Acts as rear chainman; paces out from chain for strip width and estimates or measures tree diameters and heights

VIII. Strip cruising
   A. Advantages
      1. No loss of time in sampling as compared to plot locations of sampling
      2. Less problems with borderline trees than plot cruising
      3. Less risk than working alone in the woods
   B. Disadvantages
      1. Errors from estimating strip width
      2. Tendency to underestimate tree heights
      3. Brush more hindersome than plot cruising
Strip Cruise Design

- Center Line of Strip
- Tract
- Boundary
- Finish
- Strip Width Chain
- Distance Between Strips 5 Chains
After dividing into groups of two, design a strip cruise on forty acres of timberland indicated by the instructor. Plan for a cruise intensity of 10%. When completed, turn in to the instructor for evaluation.

I. Tools and materials needed
   A. Compass
   B. Topographic tape
   C. Abney hand level
   D. Clipboard and pencil
   E. Area indicated by instructor

II. Procedure
   A. Determine acreage to sample from cruise intensity
   B. Determine strip size
      1. One chain most commonly used
      2. One-half chain for dense stands
      3. Two chains for sparse stands
   C. Determine strip interval based on acreage
   D. Determine starting point
   E. Determine strip direction
      (NOTE: Strips should cross topography and drainage at right angles.)
   F. Locate first strip one-half the strip interval from starting point
      (NOTE: This will end with the last strip one-half the strip interval instead of on the tract boundary.)
   G. Draw in the 40 acre diagram given
      1. Starting point
      2. Strip width
JOB SHEET #1

3. Strip interval
4. Strip direction
5. Total strips to take

40 ACRES
STRIP CRUISING
UNIT VII

JOB SHEET #2-DETERMINE SAWTIMBER VOLUME
BY STRIP CRUISING.

After dividing into groups of two, use the plan developed in Job-Sheet #1 of this unit (after evaluation and correction by the instructor). When completed, turn in to the instructor for evaluation.

I. Tools and materials needed

A. Compass
B. Topographic tape
C. Abney hand level
D. Diameter tape
E. 50' tape
F. Clipboard and pencil
G. Tally sheet
H. Tree volume table

II. Procedure

A. Compassman

1. Locate the centerline of each strip using a compass
2. Act as head chairman using a topographic tape
3. Measure slopes with Abney hand level
4. Tally for estimator

B. Estimator

1. Act as rear chairman
2. Determine strip by pacing and by measuring with a 50' tape
3. Estimate DBH and heights of trees found on the strip
4. Call out estimates to the compassman for tally
C. Alternate jobs on each strip

D. Tally all sawtimber trees 9.0" DBH and larger and up to 7" diameter top on the strips using the attached tally sheet

E. Estimate DBH and heights; measure every tenth tree to develop skill in estimation

F. Use dot-dash system of tally in blanks provided on the tally sheet for appropriate DBH and merchantable heights

G. When strips are completed, figure sawtimber volume found on the strips using the attached tree volume table

H. Determine blow-up factor

I. Expand strip volume for total 40 acre volume

Total 40 acre volume of sawtimber ________ bd. ft.
## JOB SHEET #2

### TIMBER MARKETING TALLY SHEET

**FORESTRY DIVISION**
**STATE DEPARTMENT OF AGRICULTURE**
**OKLAHOMA CITY, OKLA. 73108**

### POST & POLES

<table>
<thead>
<tr>
<th>DIA.</th>
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Adjust volumes 4% for each 1% change in FC.
1. Match the terms on the right to the correct definition.

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<th>Term</th>
<th>Definition</th>
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<td>1. Blow-up factor</td>
<td>A numerical value used to expand a sample volume or acres to total tract volume or acres</td>
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<td>2. Cruise intensity</td>
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<td>3. Compassman</td>
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<td>6. Tree volume table</td>
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<td>7. Borderline trees</td>
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<td>8. Estimator</td>
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<td>10. Strip interval</td>
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<td>11. Strip cruising</td>
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2. A forest estimation by sampling
3. A part of the whole; plots and strips
4. Sampling using continuous strips of uniform width and strips of equal intervals of spacing across the forest acreage
5. The percent of area actually occupied and measured as a sample; expressed as a percent of area
6. The distance in chains between the strip centerlines
7. A numerical value used to expand a sample volume or acres to total tract volume or acres
8. Recording trees by diameter and height on a form
9. Trees just on the edge of the sample area
10. A worker responsible for keeping accurate direction
11. A worker that measures sample plots or strips
12. Shows content of trees of various DBH and heights based on a log rule
2. Select from the list below the four reasons for cruising by placing an "X" in the blanks provided.

   ___ a. Land ownership
   ___ b. Land and timber appraisal
   ___ c. Management plans
   ___ d. Land location
   ___ e. Survey of timber trespass
   ___ f. Timber sales

3. Determine the cruise intensity for this cruise: 4 strips 1 chain wide and 80 chains long on 640 acres.

4. Arrange in numerical order the procedure for laying out a strip cruise.

   ___ a. Determine strip direction
   ___ b. Determine starting point
   ___ c. Determine strip interval based on acreage
   ___ d. Determine acreage to sample from cruise intensity
   ___ e. Locate first strip one-half the strip interval from starting point
   ___ f. Determine strip size

5. Name the two methods used to determine the blow-up factor for a strip cruise.

   a.
   b.

6. List the four steps used to determine total tract acreage from a strip cruise.

   a.
   b.
   c.
   d.
7. Name and describe the duties of each man in a two-man strip cruise crew.
   a.
   b.

8. List the advantages and disadvantages of strip cruising:
   a. Advantages
      1)
      2)
      3)
   b. Disadvantages
      1)
      2)
      3)

9. Demonstrate the ability to:
   a. Lay out a strip cruise.
   b. Determine sawtimber volume by strip cruising.
1. a. 5
   b. 9
   c. 11
   d. 2
   e. 10
   f. 1

2. b, c, e

3. 20%

4. a. 5
   b. 4
   c. 3
   d. 1
   e. 6
   f. 2

5. a. Divide cruise intensity into 100%
   b. Divide tract acreage by sample acres

6. a. Determine total length of strips in chains
   b. Multiply strip width times linear distance to find the number of square chains
c. Divide square chains by ten to determine sample acres

d. Multiply sample acres times blow-up factor to find total tract acreage

7. a. Compassman--Locates centerline of strip using a compass, topographic tape, and Abney hand level; tallies for estimator

b. Estimator--Acts as rear chairman; paces out from chain for strip width and estimates or measures tree diameters and heights

8. a. Advantages

1) No loss of time in sampling as compared to plot locations of sampling

2) Less problems with borderline trees than plot cruising

3) Less risk than working alone in the woods

b. Disadvantages

1) Errors from estimating strip width

2) Tendency to underestimate tree heights

3) Brush more hindersome than plot cruising

9. Performance skills will be evaluated to the satisfaction of the instructor.
PLOT CRUISING
UNIT VIII

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to select from a list methods of planning a sample layout and distinguish between advantages and disadvantages of plot cruising. He should also be able to complete a plot cruise layout and perform a plot cruise to determine sawtimber and pulpwood volume. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with plot cruising to the correct definition.
2. Select from a list the commonly used plot forms and sizes.
3. State the commonly used plot sizes when given the plot radii.
4. List two methods of determining cruise intensity for plot cruising.
5. Select from a list three methods of planning a sampling layout.
6. Arrange in numerical order the steps to complete a systematic plot cruise layout.
7. Arrange in numerical order the steps for plot cruising.
8. Distinguish between the advantages and disadvantages of plot cruising as compared to strip cruising.
9. Demonstrate the ability to:
   a. Complete a systematic grid sample plot cruise layout.
   b. Determine sawtimber and pulpwood volume by plot cruising.
PLOT CRUISING
UNIT VIII

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparency.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in the job sheets.
   G. Arrange field trips to allow students an opportunity to perform the activities outlined in the job sheets.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency master: TM 1-Plot Cruise Layout
D. Job sheets

1. Job Sheet #1—Complete a Systematic Grid Sample Plot Cruise Layout

2. Job Sheet #2—Determine Sawtimber and Pulpwood Volume by Plot Cruising

E. Test

F. Answers to test

I. Terms and definitions

A. Plot cruising—Sampling using plots of a pre-determined size and arranged systematically or randomly

B. Pulpwood—Small trees and defective larger trees used to make pulp for paper

C. Radii—Plural for radius, the distance from the center of a circle to the border

D. Systematic grid sample—A sampling layout where the plots to be sampled are arranged equidistant over the tract

E. Simple random sample—A sampling layout where the plots to be sampled are selected at random or by chance

F. Stratified random sample—A sampling layout where the plots to be sampled are randomly selected for each known division of a tract

G. Layout—A plan or design

H. Cardinal—The principal points of a compass or north, south, east, and west

II. Plot sizes commonly used

A. Forms
   1. Circular
   2. Square

B. Area sizes in acres
   1. 1/100
   2. 1/10
   3. 1/5
   4. 1/4
INFORMATION SHEET

III. Radius of commonly used plot sizes

<table>
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<th>Plot Size (Acres)</th>
<th>Plot Radius (Feet)</th>
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<td>C. 1/5</td>
<td>52.7</td>
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<td>D. 1/4</td>
<td>58.9</td>
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IV. Methods of determining cruise intensity

A. \[
\frac{\text{Acres cruised}}{\text{Total tract acres}}
\]

B. \[
\frac{\text{Plot size in acres}}{\text{Acres represented by each plot}} \times 100
\]

V. Methods of planning a sampling layout

A. Systematic grid sample

Example:

![Diagram of systematic grid sample]
B. Simple random sample
Example:

C. Stratified random sample
Example:
VI. Steps to complete a systematic plot cruise layout (Transparency 1)

A. Determine cruise intensity needed
B. Determine acres to cruise
C. Determine number and size of plots needed
D. Determine tract acres each plot represents
E. Determine grid pattern based on the square chains in the acres of the above step
F. Determine plot interval and line interval locations
G. Locate starting point
H. Example of a systematic grid sample plot cruise:
   1. Cruise intensity, 10%
   2. Plot size, 1/4 acre
   3. Tract, 40 acres
      a. Number of plots = \(0.1 \times 40 = 4\) acres; \(4 \times 4 = 16\) plots
      b. Representative acres = \(40 \div 16 = 2.5\) acres
      c. Representative square chains = \(2.5 \times 10 = 25\) square chains
      d. Square root of representative square chains = \(\sqrt{25} = 5\) chains or 5 chains by 5 chains grid pattern
INFORMATION SHEET

Starting point, lines, and plot locations

40 Acres

VII. Steps for plot cruising (one-man crew)

A. From starting point, use cardinal points for direction

B. Locate first line one-half the interval distance

C. Locate first point one-half the plot interval

D. Establish plot radius using tape, measure

E. Estimate or measure the size of all trees on the plot and indicate the species desired

F. Measure radius to all borderline trees

G. Pace or chain the distance to the next plot and repeat
VIII. Advantages and disadvantages of plot cruising as compared to strip cruising

A. Advantages
   1. Suitable for one-man crews
   2. Brush not a hinderance
   3. Easier to make a more detailed study of trees

B. Disadvantages
   1. Hazardous for one man to work alone
   2. Generally requires more measurement of borderline trees
   3. Considerable time spent walking from one plot to another
JOB SHEET #1-COMPLETE A SYSTEMATIC GRID SAMPLE
PLOT CRUISE LAYOUT

I. Tools and materials needed
   A. Compass
   B. Pacing skill
   C. Clipboard and pencil

II. Procedure
   A. Group in teams of two
   B. Plan for a cruise intensity of 10% and 1/5 acre plots on 40 acres of timberland indicated by the instructor
   C. Determine number of plots for the cruise intensity and size of tract
   D. Determine representative acres for each plot
   E. Convert the representative acres to square chains
   F. Obtain the square root in chains for the representative square chains or for the appropriate rectangle grid
   G. Locate plots and lines on the following 40 acre diagram and indicate the starting point
   H. Be sure to locate first line and first plot one-half the distance determined as the interval
   I. When completed, turn in to the instructor for evaluation

   40 acres
JOB SHEET #2-DETERMINE SAWTIMBER AND PULPWOOD VOLUME BY PLOT CRUISING

I. Tools and materials needed
   A. Compass
   B. Suunto clinometer
   C. 100' tape
   D. Diameter tape
   E. Clipboard and pencil
   F. Tally sheet
   G. Tree volume tables

II. Procedure
   A. Group in teams of two (compassman and estimator)
   B. Locate first plot using compass and pacing
   C. Tally all sawtimber trees 9.0" DBH and larger up to 7" diameter top on the plot using the attached tally sheet
   D. Tally all pulpwood trees 4.6" DBH up to 8.9" DBH and to a 4" diameter on the plot using the attached tally sheet
   E. Estimate DBH and measure every tenth tree to develop skill in estimation
   F. Use dot/dash system of tally in blanks provided on the tally sheet for appropriate DBH and merchantable heights
   G. Alternate jobs on each pair of plots
   H. When plots are completed, figure sawtimber and pulpwood volume found on the plots using the attached tree volume table
   I. Determine blow-up factor
   J. Expand plot volumes for total 40 acre volume

   Total 40 acre volume
   1. Sawtimber _______ bd. ft.
   2. Pulpwood _______ cu. ft.

   K. When completed, turn in tally sheet to instructor for evaluation
# JOB SHEET #2

## TIMBER MARKETING TALLY SHEET

**DATE** | **TOTAL TALLY**
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<td>2059</td>
<td>2260</td>
<td>2448</td>
<td>2636</td>
</tr>
</tbody>
</table>

Adjust volumes 4% for each 1% change in FC.
1. Match the terms on the right to the correct definition.

   a. Sampling using plots of a predetermined size and arranged systematically or randomly
   b. Small trees and defective larger trees used to make pulp for paper
   c. Plural for radius, the distance from the center of a circle to the border
   d. A sampling layout where the plots to be sampled are arranged equidistant over the tract
   e. A sampling layout where the plots to be sampled are selected at random or by chance
   f. A sampling layout where the plots to be sampled are randomly selected for each known division of a tract
   g. A plan or design
   h. The principal points of a compass or north, south, east, and west

2. Select from the list below the commonly used plot forms and sizes. Place an "X" in the appropriate blanks.

   a. 1/3   e. 1/20   i. 1/50
   b. 1/8   f. 1/5
   c. 1/10   g. 1/4
   d. 1/16   h. 1/10   m. Square
   j. Triangle
   k. Circular
   l. Rectangle
3. State the commonly used plot sizes for the plot radii given.
   a. 52.7'
   b. 11.8'
   c. 58.9'
   d. 37.2'

4. List two methods of determining cruise intensity for plot cruising.
   a. 
   b. 

5. Select from this list three methods of planning a sampling layout by placing an "X" in the appropriate blanks.
   a. Systematic strip sample
   b. Systematic grid sample
   c. Systematic random sample
   d. Simple random sample
   e. Stratified random sample
   f. Simple systematic sample

6. Arrange in numerical order the following steps to complete a systematic plot cruise layout.
   a. Determine number and size of plots needed
   b. Locate starting point
   c. Determine cruise intensity needed
   d. Determine grid pattern based on the square chains in the acres of the above step
   e. Determine tract acres each plot represents
   f. Determine acres to cruise
   g. Determine plot interval and line interval locations

7. Arrange in numerical order the following steps for plot cruising.
   a. Measure radius to all borderline trees
   b. Locate first line one half the interval distance
   c. Establish plot radius using tape measure
   d. From starting point, use cardinal points for direction
_e. Pace or chain the distance to the next plot and repeat
_f. Locate first point at half the plot interval
_g. Estimate or measure the size of all trees on the plot and indicate the species desired

8. Distinguish between the advantages and disadvantages of plot cruising as compared to strip cruising from the list below. Place an "A" for advantage or a "D" for disadvantage in the correct blanks.

___ a. Generally requires more measurement of borderline trees
___ b. Suitable for one-man crews
___ c. Considerable time spent walking from one plot to another
___ d. Easier to make more detailed study of trees
___ e. Brush not a hindrance
___ f. Hazardous for one man to work alone

9. Demonstrate the ability to:
   a. Complete a systematic grid sample plot cruise layout.
   b. Determine sawtimber and pulpwood volume by plot cruising.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
## PLOT CRUISING
### UNIT VIII

### ANSWERS TO TEST

1. a. 6  
   b. 3  
   c. 8  
   d. 1  
   e. 4  
   f. 2  
   g. 5  
   h. 7

2. c, f, g, h, k, m

3. a. 1/5  
   b. 1/100  
   c. 1/4  
   d. 1/10

4. a. \( \frac{\text{Acres cruised}}{\text{Total tract acres}} \)  
   b. \( \frac{\text{Plot size in acres}}{\text{Acres represented by each plot}} \times 100 \)

5. b, d, e

6. a. 3  
   b. 7  
   c. 1  
   d. 5  
   e. 4  
   f. 2  
   g. 6

7. a. 6  
   b. 2  
   c. 4  
   d. 1  
   e. 7  
   f. 3  
   g. 5

8. a. D  
   b. A  
   c. D  
   d. A  
   e. A  
   f. D

9. Performance skills will be evaluated to the satisfaction of the instructor.
After completion of this unit, the student should be able to complete a point sample cruise layout to determine sawtimber volume. He should be able to select the correct basal-area factor tool to use and perform the point sample measurements accurately. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

**SPECIFIC OBJECTIVES**

After completion of this unit, the student should be able to:

1. Match terms associated with point sampling to the correct definition.
2. Select from a list other names for point sampling.
3. Draw a diagram illustrating the principle of point sampling.
4. Identify the commonly used tools for point sampling.
5. Select from a list the three principles used to determine BAF.
6. Match the commonly used BAF's to the correct angle size.
7. State the rule to use PRF.
8. Match the commonly used BAF to the correct PRF.
9. Select from a list statements on the proper use of a prism.
10. Arrange in numerical order the steps taken to correct for slope when using the prism.
11. State the rules for determining the number of points to take in a point sample cruise.
12. Demonstrate the ability to:
   a. Complete a point sample cruise layout.
   b. Determine sawtimber volume by point sampling.
SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparency.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in the job sheets.
   G. Arrange field trips to allow students an opportunity to complete a point sample cruise layout and perform a cruise.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives.
   B. Information sheet
   C. Transparency master: TM 1-Use of the Prism
D. Job sheets

1. Job Sheet #1—Complete a Point Sample Cruise Layout
2. Job Sheet #2—Determine Sawtimber Volume by Point Sampling

E. Test

F. Answers to test

POINT SAMPLING
UNIT IX

INFORMATION SHEET.

I. Terms and definitions

A. Point sampling—A system of cruising using an angle-gauge instrument

B. Basal area (BA) — The area of a circle

C. Basal area factor (BAF) — The numerical value of the angle gauge instrument that gives that basal area per acre for each tally tree

D. Angle gauge—An instrument with a fixed angle the size needed for a particular BAF

E. Wedge prism—A piece of glass-ground to specification that bends the light rays for a particular angle

F. Point—The reference point from which a point sample is taken

G. Plot radius factor (PRF) — A numerical value multiplied times the tree diameter at DBH which gives the distance in feet the tree can be within and be tallied

H. Ready-made volume factors—A table that gives an approximation of volume for point sampling

I. Grid-interval—The distance between points

J. Cruise line—A direction taken where a plot or point is sampled at specified grid intervals

II. Names for point sampling

A. Bitterlich method

B. Variable plot cruising

C. Angle gauge cruising

D. Relaskop cruising

E. Multi-plot method

F. Plotless cruising

G. Wedge prism cruising
III. Principle of point sampling—Trees are selected as a sample on the basis of their sizes rather than the frequency of their appearance on a fixed plot sample. Trees are selected using a fixed-angle instrument and represent a corresponding basal area per acre.

Diagram of the principle.

SOURCE: T. Eugene Avery, *Forest Measurements*

(NOTE: C, D, E, F are used. Tally trees (plots) must enclose sample point. Sampling point must be within imaginary plot to tally trees.)

IV. Tools used for point sampling

A. Basal area angle gauge
B. Wedge prism

/ Square

C. Relaskop

Rectangular
INFORMATION SHEET

V. Principles used to determine BAF
   A. Tally an average of 7 trees per point for best representative measurement
   B. Use small numerical value BAF tools for small trees and sparse numbers of trees
   C. Use larger numerical value BAF tools for large trees and dense numbers of trees

VI. Common basal area factors and angle sizes

<table>
<thead>
<tr>
<th>Basal Area Factors</th>
<th>Angle Sizes (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 5</td>
<td>73.66</td>
</tr>
<tr>
<td>B. 10</td>
<td>104.18</td>
</tr>
<tr>
<td>C. 20</td>
<td>147.34</td>
</tr>
<tr>
<td>D. 40</td>
<td>208.38</td>
</tr>
</tbody>
</table>

VII. Rule for plot radius factor (PRF) - PRF X DBH = Distance in feet the tree can be within and be tallied.
INFORMATION SHEET

VIII. Table of PRF's for commonly used BAF's

<table>
<thead>
<tr>
<th>BAF</th>
<th>PRF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 5</td>
<td>3.889</td>
</tr>
<tr>
<td>B. 10</td>
<td>2.750</td>
</tr>
<tr>
<td>C. 20</td>
<td>1.944</td>
</tr>
<tr>
<td>D. 40</td>
<td>1.375</td>
</tr>
</tbody>
</table>

IX. Proper use of the prism (Transparency 1)

A. Hold at right angle to the eye, vertical and horizontal
B. Hold prism over the sample
C. Rotate prism horizontally to the angle of leaning trees
D. Measure distance to borderline trees and apply PRF
E. Correct for slope

X. Slope correction for the prism

A. Measure the slope with a Suunto clinometer
B. Place the prism on the top of the Suunto and hold both horizontal with the Suunto scale facing the observer
C. Rotate the Suunto until the scale reads the slope measurements
D. Read the tree through the prism while held in the above manner

XI. Rules for determining number of points to take in a point sample cruise

A. Never use less than 20 points per cruise
B. Use the same number of points as would be needed for a 10% cruise of 1/5 acre plots
Use of the Prism

Prism Offsets a Portion of the Tree Stem

Offset Complete
Don't Count
This Tree

Partial Offset
Do Count
This Tree

Borderline
POINT SAMPLING
UNIT 1X

JOB SHEET #1 - COMPLETE A POINT SAMPLE CRUISE LAYOUT

I. Tools and materials needed
   A. Compass
   B. Clipboard and pencil

II. Procedure
   A. Complete the point sample cruise on 40 acres of timberland indicated by
      the instructor
   B. Use 20 points for the total cruise
   C. Determine the number of acres each point would represent
   D. Determine the number of square chains in the representative acres found
      in the above step
   E. Determine a square grid pattern by finding the square root of the square
      chains found in the above step or by finding a rectangle grid pattern of
      whole chains the nearest possible to a square shape
   F. Locate points on the following 40 acre diagram using the above grid interval
   G. Be sure to run cruise lines across drainage and topography
   H. Be sure to locate first line and first point one-half the distance determined
      as the grid interval

I. Draw the following characteristics in the 40 acre diagram below:
   1. Drainage and topography direction
   2. Starting point
   3. Cruise lines
   4. Cruise direction
   5. Grid interval for points
JOB SHEET #1

6. Grid interval for cruise lines

40 Acres

J. When completed, turn in to the instructor for evaluation
POINT SAMPLING
UNIT IX

JOB SHEET #2—DETERMINE SAWTIMBER VOLUME BY POINT SAMPLING

I. Tools and materials needed
   A. Compass
   B. BAF 10 prism
   C. Diameter tape
   D. Suunto clinometer
   E. 50' tape
   F. Clipboard and pencil
   G. Tally sheet

II. Procedure
   A. Locate first point according to the layout developed in Job Sheet #1 of this unit.
   B. In a clockwise direction from the north, observe all trees of sawtimber size that can be seen from the point.
      (NOTE: Apply the rules for the proper use of the prism.)
   C. Tally all sawtimber, count trees 9.0" DBH and larger up to a 7.0" top DOB.
      (NOTE: Apply the rules for U.S. Forest Service's merchantable heights.)
   D. Estimate DBH and heights and measure every tenth tree to develop skill in estimation.
   E. Use dot-dash system of tally in the blanks provided on the tally sheet for appropriate DBH and merchantable heights.
   F. For borderline trees, multiply the trees DBH times 2.75 to obtain the maximum distance in feet for tree count.
   G. Apply the rules for slope correction on all trees on a slope of 10% or more from the point.
      1. Measure the slope with a Suunto clinometer.
      2. Place the prism on the top of the Suunto and hold both horizontal with the Suunto scale facing the observer.
JOB SHEET #2

3. Rotate the Suunto until the scale reads the slope measurements.

4. Read the tree through the prism while held in the above manner.

H. When all points have been tallied, add the total trees found in each log height class.

I. Obtain the volume for the tract using this ready-made volume table for point sampling.

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<tr>
<th>Merchantable Ht. (logs)</th>
<th>Volume Factor</th>
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</thead>
<tbody>
<tr>
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<td>4</td>
</tr>
<tr>
<td>1 1/2</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>2 1/2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>3 1/2</td>
<td>13.5</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>4 1/2</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
</tr>
</tbody>
</table>

J. Multiply the number of trees tallied in each log height class by the appropriate factor.

K. Add the products obtained in the above step and apply to this formula:

\[
\text{Volume per acre} = 100 \times \frac{\text{sum of products}}{\text{no. of points taken}}
\]

40 acre tract sawtimber volume = \underline{\phantom{123456789012345678901234567890}} bd. ft.
### JOB SHEET # 2

**POINT SAMPLE TALLY SHEET**

**Date**

**CREW #**

**Pulpwood-H.T. (ft.)**

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<tr>
<th>Diameter</th>
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<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>Point No.</th>
<th>Tally Count</th>
<th>Point No.</th>
<th>Tally Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6 - 4.5</td>
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<td></td>
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<td></td>
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</table>

**Sawtimber 16 ft. Logs**

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<th>2</th>
<th>2 1/2</th>
<th>3</th>
<th>3 1/2</th>
<th>4</th>
<th>Point No.</th>
<th>Tally Count</th>
<th>Point No.</th>
<th>Tally Count</th>
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<td>15.0 - 16.9</td>
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</table>

295
1. Match the terms on the right to the correct definitions.

   a. A system of cruising using an angle gauge instrument
   b. The area of a circle
   c. The numerical value of the angle gauge instrument that gives the basal area per acre for each tally tree
   d. An instrument with a fixed angle the size needed for a particular BAF
   e. A piece of glass ground to specification that bends the light rays for a particular angle
   f. The reference point from which a point sample is taken
   g. A numerical value used to multiply times the tree diameter at DBH which gives the distance in feet the tree can be within and be tallied
   h. A table that gives an approximation of volume for point sampling
   i. The distance between points
   j. A direction taken where a plot or point is sampled at specified grid intervals

2. Select from the list below other names used for point sampling by circling the correct letters.

   a. Plot cruising
   b. Bitterlich method
c. Variable plot cruising  

d. Strip cruising  

e. Relaskop cruising  

f. Multi-plot method  

g. Plotless cruising  

h. Area cruising  

i. Wedge prism cruising  

j. Angle gauge cruising  

3. Draw a diagram illustrating the principle of point sampling.
4. Identify the following tools used for point sampling.

   a. 
   
   b. 

5. Select from the list below three principles used to determine BAF. Place an "X" by the correct statements.

   a. Tally an average of 7 trees per point for best representative measurement

   b. Tally an average of 20 trees per point for best representative measurement

   c. Use small BAF tools for small trees and sparse numbers of trees

   d. Use larger BAF tools for large trees and dense numbers of trees

   e. Use only 10 BAF
6. Match these commonly used BAF's to the correct angle size.
   
   a. 5  
   b. 10 
   c. 20 
   d. 40 

   1. 147.34 minutes
   2. 104.18 minutes
   3. 208.38 minutes
   4. 73.66 minutes

7. State the rule to use PRF.

8. Match these commonly used BAF's to the correct PRF's.

<table>
<thead>
<tr>
<th>BAF</th>
<th>PRF</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 5</td>
<td>1. 1.944</td>
</tr>
<tr>
<td>b. 10</td>
<td>2. 1.375</td>
</tr>
<tr>
<td>c. 20</td>
<td>3. 3.889</td>
</tr>
<tr>
<td>d. 40</td>
<td>4. 2.750</td>
</tr>
</tbody>
</table>

9. Select from the list below statements that properly use the prism by circling the correct letters.
   
   a. Hold at right angle to the eye, vertical and horizontal
   b. Hold prism 25 inches from the eye
   c. Hold prism over the sample
   d. Rotate prism horizontally to the angle of leaning trees
   e. Hold prism with the thin edge to the right
   f. Measure distance to borderline and apply PR
   g. Correct for slope

10. Arrange in numeric order the steps needed to correct for slope when using the Suunto clinometer.
   
   a. Rotate the Suunto under the eye and read the slope measurements
   b. Measure the slope with a Suunto clinometer
   c. Read the tree through the prism while held in the above manner
   d. Place the prism on the top of the Suunto and hold both horizontal with the Suunto scale facing the observer
11. State the rules for determining the number of points to take in a point sample cruise.
   a.
   b.

12. Demonstrate the ability to:
   a. Complete a point sample cruise layout.
   b. Determine sawtimber volume by point sampling.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
POINT SAMPLING
UNIT IX

ANSWERS TO TEST

1. a. 7      f. 5
   b. 9      g. 2
   c. 4      h. 8
   d. 1      i. 6
   e. 10     j. 3

2. b, c, d, f, g, i, j

3. 

4. a. Relaskop
    b. Basal area angle gauge
    c. Wedge prism

5. a, c, d

301
6. a. 4
   b. 2
   c. 1
   d. 3

7. PRF X DBH = Distance in feet the tree can be within and be tallied

8. a. 3
   b. 4
   c. 1
   d. 2

9. a, c, d, f, g

10. a. 3
    b. 2
    c. 4
    d. 2

11. a. Never use less than 20 points per cruise
    b. Use the same number of points as would be needed for a 10% cruise of 1/5 acre plots

12. Performance skills will be evaluated to the satisfaction of the instructor.
THE SILVICULTURAL SYSTEMS
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to classify trees into Grosenbaugh's tree classes. He should be able to name characteristics used in selecting harvest trees and types of natural and artificial reproduction methods. He should also be able to interpret the selection method. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

1. Match terms associated with the silvicultral systems to the correct definition.
2. Name the types of reproduction methods under the classes of natural and artificial reproduction methods.
3. Arrange in numerical order the classes of reproduction methods.
4. Select from a list of statements the two principles of the selection method.
5. Select from a list the types of modifications of the selection method.
6. Name the four characteristics used in selecting harvest trees in the selection method when given a list of the descriptive factor.
7. Match Grosenbaugh's tree classes with the correct definition.
8. Demonstrate the ability to classify trees according to Grosenbaugh's tree classification system.
THE SIVICULTURAL SYSTEMS
UNIT I

SUGGESTED ACTIVITIES

Instructor:
A. Provide students with objective sheet.
B. Provide students with information and job sheets.
C. Make transparency.
D. Discuss terminal and specific objectives.
E. Discuss information sheet.
F. Demonstrate and discuss procedure outlined in the job sheet.
G. Arrange field trips to allow students an opportunity to classify trees.
H. Give test.

II. Students:
A. Read objectives.
B. Study information sheet.
C. Demonstrate the ability to accomplish the procedure outlined in the job sheet.
D. Participate in field trip.
E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
A. Objectives
B. Information sheet
C. Transparency master: TM 1--Groenenbaugh's Classification System
D. Job Sheet #1--Classify Trees by Groenenbaugh's System
E. Test

F. Answers to test

I. Terms and definitions

A. Siviculture—Art of producing and tending a forest

B. Sivicultural system—Plan of sivicultural treatment during the life of a stand or forest

C. Reproduction—Seedlings of a forest; generally used as regeneration

D. Regeneration—Process of forming a new forest; used as reproduction

E. Reproduction method—Procedure by which a stand or forest is renewed

F. Sprout—Plant from vegetative origin rather than from flower and seed

G. High forest—Regenerating stands from seed

H. Low forest—Regenerating stands from sprouts

I. Even aged—Stands of trees of approximately the same age

J. Uneven aged—Stands of trees of wide ranges of ages

K. Clearcutting—Removal of the entire stand of trees at the same time and regenerated artificially or naturally

L. Seed tree—Removal of an entire stand except for approximately one-tenth of the trees left to seeding

M. Shelterwood—Removal of a stand of trees in a series of cuttings for the purpose of seeding and protection

N. Selection—Removal of mature trees at repeated intervals

O. Coppice—Cutting with dependence on sprouts for regeneration

P. Coppice with standards—Cutting with a combination of seed trees and sprouts for regeneration

Q. Rotation—Period of time trees are grown based on economic factors

R. Cutting cycle—Period of time between visits to a stand of timber for cutting
INFORMATION SHEET

B. Thinning--Cuttings made in young stands to stimulate growth of the trees left

T. Single-tree selection--Timber marking and harvest based on the merits of individual trees in a stand

U. Group selection--Cuttings of small groups of trees as a unit of uneven age stands

V. Strip selection--Arrangement and cutting of strips of trees of even age in an uneven age stand

W. Continuous forest--Selection cutting of trees with no rotation age but based on the economic merits of each individual tree

II. Reproduction methods

A. Natural
   1. Seed fall
   2. Sprouts

B. Artificial
   1. Seeding
   2. Planting

III. Classes of reproduction methods (silvicultural systems)

A. High forest
   1. Even aged
      a. Clearcutting
      b. Seed tree
      c. Shelterwood
   2. Uneven aged--Selection

B. Low Forest
   1. Coppice
   2. Coppice with standards
IV. Principles of the selection method
   A. Principle one--Economically mature trees of rotation age are harvested periodically in cutting cycles and the openings left are seeded in by the surrounding trees
   B. Principle two--During the harvest cut of mature trees, the younger age classes are thinned

V. Modifications of the selection method
   A. Single-tree
   B. Group
   C. Strip
   D. Continuous forest

VI. Characteristics of harvest trees of the selection method
   A. Age
      1. Rotation age
      2. Diameter limit
   B. Merchantability
      1. Product specifications
      2. Market availability
   C. Health
      1. Insect or disease damage
      2. Reduced growth
   D. Capacity for growth
      1. Low quality
      2. Low volume potential
VII. Grosenbaugh's definitions of tree classes

A. Grown-up--Tree of salable dimensions whose salability depends on other factors

1. Payer--Salable tree whose stumpage has a current market value greater than zero

   a. Grower--Payer whose expectancy of living for the next 10 years is at least 9/10 while its expected ratio of stumpage value 10 years hence to stumpage value now will be at least 4/3 if it survives and is given adequate space

   b. Cipher--Payer whose expectancy of living for the next 10-year period exceeds 9/10 but which does not have an expected ratio of stumpage value 10 years hence to stumpage value now equal to at least 4/3 and which does not compete with any grower, doll, or cub.

   (NOTE: Some people call such trees financially mature.)

   c. Topper--Payer similar to a cipher but overtopping a doll or cub

   d. Slower--Least potentially productive of several payers competing in inadequate growing space

   (NOTE: It should be cut in thinning.)

   e. Risker--Payer whose expectancy of living for the next 10-year period is less than 9/10

   (NOTE: It should be cut to salvage potential loss through mortality.)

   f. Killer--Payer infested with contagious pathogens

2. Crud--Grown-up which cannot be sold because of species, form, knots, rot, insects, or other defects

   a. Null--Crud not competing with any grower, doll, or cub

   b. Cork--Crud overtopping a doll or cub

   c. Pang--Crud seriously competing with a grower or harboring contagious pathogens
INFORMATION SHEET

B. Deb--Tree at least 4 1/2 feet tall but smaller than a grown-up
   1. Doll--Desirable deb which is a potential grower, given adequate space and time
   2. Drip--Undesirable deb which is unlikely to become a grower, even though given space and time, but which is not interfering with a doll or cub
   3. Drag--Undesirable deb which is interfering with a doll or cub

C. Kid--Tree seedling, less than 4 1/2 feet tall
   1. Cub--Desirable kid which is a potential doll
   2. Cur--Undesirable kid which will probably become a drip or drag
Groesenbaugh's Classification System

Groesenbaugh's Classes

(Growth Potential)

Grown Up

(3.6" D.B.H. and up)

Payer

(Merchantable)

Growner

Cipher

Topper

Slower

Risker

Killer

Deb

(4½' to 3.6'')

Doll

(Desirable)

Drill

(Undesirable)

null

(Noncompeting)

Drag

(Undesirable)

Cork

(Overtopping Doll or Cub)

Pang

(Serious Competition with Grower)

Kid

(under 4½'')

Cub

Cur

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THE SIVICULTURAL SYSTEMS
UNIT I

JOB SHEET #1-CLASSIFY TREES BY GROSENBAUGH'S SYSTEM

I. Tools and materials needed
   A. Diameter tape
   B. Increment borer
   C. Clipboard
   D. Tally sheet
   E. Schneider's growth graph
   F. Grosenbaugh's tree classes sheet
   G. One-fifth acre indicated by the instructor
   H. Pencil

II. Procedure
   A. On the area indicated by the instructor, classify each living tree into the classes by Grosenbaugh
      (NOTE: Use the information sheet if necessary.)
   B. For each tree, identify in which major class it belongs according to size such as kid, deb, or grown-up.
   C. For the grown-up major class, identify in which value class it belongs such as payer or crud.
   D. For the payer and crud classes, start at the bottom class and go up until the tree fits the definition
      (NOTE: Use TM 1 as a guide.)
   E. For a decision between cipher and grower, use the attached Schneider's growth graph
      1. Bore into the tree until you have entered into the solid wood of the tree for 2 inches
         (NOTE: See the instructor for use of the increment borer if you do not know the proper way to use it at this point.)
2. Count the number of annual rings found in the cross section of wood farmed on the tree.

   **NOTE:** Use the inside edge of the diameter tape for one inch measure.

   Measure the diameter.

   - Read the corresponding growth percent and DR (D=DBH inches and R=rings per inch) count on the graph.

   **(NOTE: If DR is more than 133 and growth less than 3%, the tree is a cipher. If DR is less than 133 and growth 3% or more, the tree is a grower.)**

   F. Tally each tree on the attached tally sheet in the appropriate blanks using the dot-dash system of tally.

   G. When all trees have been tallied, turn in to the instructor for evaluation.
1. Match the terms on the right to the correct definition.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Art of producing and tending a forest</td>
</tr>
<tr>
<td>b</td>
<td>Plan of sivicultural treatment during the life of a stand or forest</td>
</tr>
<tr>
<td>c</td>
<td>Seedlings of a forest; generally used as regeneration</td>
</tr>
<tr>
<td>d</td>
<td>Process of forming a new forest; used as reproduction</td>
</tr>
<tr>
<td>e</td>
<td>Procedure by which a stand or forest is renewed</td>
</tr>
<tr>
<td>f</td>
<td>Regenerating stands from seed</td>
</tr>
<tr>
<td>g</td>
<td>Regenerating stands from sprouts</td>
</tr>
<tr>
<td>h</td>
<td>Plant from vegetative origin rather than from flower and seed</td>
</tr>
<tr>
<td>i</td>
<td>Stands of trees of approximately the same age</td>
</tr>
<tr>
<td>j</td>
<td>Stands of trees of wide ranges of ages</td>
</tr>
<tr>
<td>k</td>
<td>Removal of the entire stand of trees at the same time and regenerated artificially or naturally</td>
</tr>
<tr>
<td>l</td>
<td>Removal of an entire stand except for approximately one-tenth of the trees left for seeding</td>
</tr>
<tr>
<td></td>
<td>13. <strong>Single-tree selection</strong></td>
</tr>
<tr>
<td></td>
<td>14. <strong>Sprout</strong></td>
</tr>
<tr>
<td></td>
<td>15. <strong>Thinning</strong></td>
</tr>
<tr>
<td></td>
<td>16. <strong>Coppice with standards</strong></td>
</tr>
<tr>
<td></td>
<td>17. <strong>Seed tree</strong></td>
</tr>
<tr>
<td></td>
<td>18. <strong>Siviculture system</strong></td>
</tr>
<tr>
<td></td>
<td>19. <strong>Selection</strong></td>
</tr>
</tbody>
</table>
2. Name the types of reproduction methods under the classes of natural and artificial reproduction methods.

a. Natural

1) 
2) 

b. Artificial

1) 
2)
3. Arrange in numerical order the classes of reproduction methods by writing the correct word(s) in the blanks provided.

a. High forest
   1) __________________________
      a) ________________________
      b) ________________________
      c) ________________________
   2) __________________________

b. Low forest
   1) __________________________
   2) __________________________

4. Select from the list below the two principles of the selection method by placing an "X" in the blank provided.
   a. During the harvest cut of mature trees, the younger age classes are thinned.
   b. Each area that reached the rotation age is clearcut for harvest.
   c. Economically mature trees of rotation age are harvested periodically in cutting cycles and the openings left are seeded in by the surrounding trees.
   d. Seed trees are left to regenerate the area while all other trees are removed.

5. Select from the list below the four types of modifications of the selection method.
   a. Clearcut
   b. Shelterwood
   c. Continuous forest
   d. Single-tree
   e. Group
   f. Seed tree
   g. Strip
   h. Coppice

5. Name the four main characteristics used in selecting harvest trees in the selection method.
   a.
   b.
   c.
   d.
7. Match Groenbaugh’s tree classes with the correct definitions.

   a. Tree of salable dimensions whose salability depends on other factors

   b. Payer whose expectancy of living for the next 10 years is at least 9/10 while its expected ratio of stumpage value 10 years hence/stumpage value now will be at least 4/3 if it survives and is given adequate space.

   c. Least potentially productive of several payers competing in inadequate growing space.

   d. Undesirable kid which will probably become a drip or drag.

   e. Payer whose expectancy of living for the next 10-year period exceeds 9/10, but which does not have an expected ratio of stumpage value 10 years hence/stumpage value now equal to at least 4/3 and which does not compete with any grower, doll, or cub.

   f. Salable tree whose stumpage has a current market value greater than zero.

   g. Tree seedling less than 4 1/2 feet tall.

   h. Undesirable bed which is interfering with a doll or cub.

   i. Payer whose expectancy of living for the next 10-year period is less than 9/10.

   j. Tree at least 4 1/2 feet tall but smaller than a grown-up.

   k. Crud overtopping a doll or cub.

   l. Desirable deb which is a potential grower, given adequate space and time.

   1. Cork

   2. Payer

   3. Grower

   4. Cipher

   5. Topper

   6. Slower

   7. Killer

   8. Crud

   9. Null

   10. Grown-up

   11. Pang

   12. Deb

   13. Doll

   14. Drip

   15. Drag

   16. Kid

   17. Cub

   18. "ir
m. Payer similar to a cipher but overtopping a doll or cub

n. Desirable kid which is a potential doll

o. Crud seriously competing with a grower or harboring contagious pathogens

p. Undesirable deb which is unlikely to become a grower, even though given space and time, but which is not interfering with a doll or cub

q. Crud not competing with any grower, doll, or cub

r. Grown-up which cannot be sold because of species, form, knots, rot, insects, or other defects

s. Payer infested with contagious pathogens

8. Demonstrate the ability to classify trees according to Grosenbaugh's tree classification system.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)
THE SILVICULTURAL SYSTEMS
UNIT I

ANSWERS TO TEST

1. a. 11 m. 21
   b. 18 n. 19
   c. 9 o. 4
   d. 1 p. 16
   e. 7 q. 6
   f. 20 r. 8
   g. 3 s. 15
   h. 14 t. 13
   i. 5 u. 22
   j. 10 v. 12
   k. 2 w. 23
   l. 17

2. a. Natural b. Artificial
   1) Seed fall 1) Seeding
      2) Sprouts 2) Planting

3. a. High forest
   1) Even aged
      a) Clearcutting
      b) Seed tree
      c) Shelterwood
   2) Uneven aged—Selection
   b. Low forest
   1) Coppice
   2) Coppice with standards
4. a, c

5. c, d, e, g

6. a. Age
   b. Merchantability
   c. Health
   d. Capacity for growth

7. a. 11  
   b. 3   
   c. 6   
   d. 19  
   e. 4   
   f. 2   
   g. 17  
   h. 16  
   i. 7   
   j. 13  
   k. 1   
   l. 14  
   m. 5   
   n. 18  
   o. 12  
   p. 15  
   q. 10  
   r. 9   
   s. 8   

8. Performance skill will be evaluated to the satisfaction of the instructor
MARKING TIMBER IN THINNINGS
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to select methods of marking timber, factors for crown spacing, and reasons for removing diseased trees. He should also be able to mark timber to be harvested in a thinning operation. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with marking timber in thinnings to the correct definition.
2. Select from a list of statements the silvicultural and thinning principles applied to thinning.
3. Match the methods of thinning to the correct definition.
4. Select from a list the most commonly used methods of marking timber.
5. Arrange in numerical order the priority of marking trees in a thinning.
6. Select from a list the correct factors for crown spacing.
7. Select from a list three reasons for removing diseased trees and snags.
8. Demonstrate the ability to mark timber.
MARKING TIMBER IN THINNINGS
UNIT-11

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Discuss terminal and specific objectives.
   D. Discuss information sheet.
   E. Demonstrate and discuss procedure outlined in the job sheet.
   F. Arrange field trips to allow students an opportunity to mark timber.
   G. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish procedure outlined in the job sheet.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Job Sheet #1, Mark Timber
   D. Test
   E. Answers to test

II. Reference: Hawley, Ralph C. and David M. Smith. The Practice of Silviculture.
       New York: Wiley and Sons.
MARKING TIMBER IN THINNINGS
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Thinning—Cutting in young stands to stimulate the growth of the trees left
B. Marking timber—Method used to indicate trees to be cut
C. Growth—Production of a stand including increment of wood and ingrowth of small trees
D. Snag—Any damaged tree such as a dead, dying, or broken topped tree
E. Crown—That part of the tree consisting of leaves, twigs, flowers, and fruit
F. Stand vigor—The growth potential of a group of trees
G. Site—An area of land having the same potential to produce trees and growth
H. Fire risk—A source of ignition of fires such as a snag that could contribute sparks to the wind when on fire

II. Silvicultural and thinning principles

A. Silvicultural principle—"A given area of timberland produces a given amount of growth that fluctuates very little from one year to the next, and man can only influence which plants receive that growth."

B. Thinning principles based on the silvicultural principle

1. "Redistribute the growth potential to optimum advantage."
2. "Utilize all possible merchantable material produced by the stand."

III. Methods of thinning

A. Low thinning—Cutting the overtopped and intermediate crown classes first
B. Crown thinning—Removing a portion of codominants and dominants to favor the remaining codominants and dominants
C. Selection thinning—Cutting the upper crown classes in order to favor the lower crown classes
D. Mechanical thinning-Cutting trees regardless of crown position by rows or by spacing of stems

IV. Methods of marking timber
A. Painting
   (NOTE: This is most commonly used.)
B. Ax blazes
C. Flagging ribbon
D. Lime sock

V. Priority of trees to mark
A. Dead trees
B. Dying trees
C. Broken topped trees
D. Leaning trees
E. Poor bole form trees
F. Crown competitors

VI. Factors for crown spacing
A. Stand age
   (NOTE: Use stand age when crowns are in rigorous competition.)
B. Stand vigor
   (NOTE: This refers to growth potential and site.)
C. Site quality
   (NOTE: There is more crown spacing on a good site.)
D. Crown quality
   (NOTE: High quality crown requires more space.)
E. Cutting cycle
   (NOTE: The cutting cycle is the period of time between cutting. Estimate space to leave.)
VII. Reasons for removing diseased trees and snags
   A. Saves merchantable volume
   B. Prevents and controls disease
   C. Reduces fire risk
MARKING TIMBER IN THINNINGS
UNIT II

JOB SHEET #1—MARK TIMBER

I. Tools and materials needed

A. Diameter tape
B. Suunto clinometer
C. 50' tape
D. Marking gun and paint
E. Area of trees to thin as indicated by the instructor
F. Clipboard and pencil

II. Procedure

A. Mark and tally pine trees to be removed in thinning
B. Select trees according to the priority of trees to mark:
   1. Dead trees (those with usable material)
   2. Dying trees
   3. Broken topped trees
   4. Leaning trees
   5. Poor bole form (sweep, crook, or forked)
   6. Crown competitors
C. Of the crown competitors, select trees to thin using the low thinning method
D. Plan on a cutting cycle of five years
E. Ask the instructor to demonstrate how to identify and use the factors for crown spacing if he has not done so at this point
F. Pick the leave trees in the dominant and codominant classes first
G. Thin as necessary the trees left using the instructions given
JOB SHEET #1

H. Mark thinning trees with paint

I. Mark sawtimber with one spot of paint six feet from the ground and two spots at the ground line

J. Mark pulpwood trees with one spot of paint six feet from the ground and one spot of paint at the ground line

(NOTE: The paint spots at head level are for visibility. The paint spots on the stumps leave a record of marked and nonmarked trees after the cutting is completed.)

K. Mark all paint spots facing the same direction on the selected trees

L. Tally trees by diameter and height on the attached tally form; use the standard diameter and height specifications used previously in cruising job sheets

M. Ask the instructor to evaluate your marking procedure

N. When completed with marking and tallying the area designated, turn in the completed tally sheet to the instructor for evaluation.
# JOB SHEET #1

**TIMBER MARKETING TALLY SHEET**

**FORESTRY DIVISION**

**STATE DEPARTMENT OF AGRICULTURE**

**OKLAHOMA CITY, OKLA. 73105**

**POST & POLES**

**TOTAL MERCHANDABLE HT. — FEET**

<table>
<thead>
<tr>
<th>DIA.</th>
<th>0 6</th>
<th>0 10</th>
<th>0 12</th>
<th>0 14</th>
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<th>0 30</th>
<th>0 32</th>
<th>0 34</th>
<th>0 36</th>
<th>0 38</th>
<th>0 40</th>
<th>0 42</th>
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<td>3.0</td>
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</tr>
</tbody>
</table>

**TREE TALLY**

**SAW TIMBER—100% Tally 16 Ft. Logs**

| DIA. | 1/2 | 1   | 1½  | 2   | 2½  | 3   | 3½  | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 3.0  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

**DATE**

**TOTAL TALLY**

---

**Notes:**

- **POST & POLES** section is left blank.
- **TREE TALLY** section has data for different diameter classes (DIA.) and total merchantable height in feet.
- **SAW TIMBER—100% Tally 16 Ft. Logs** section is divided into columns for different diameter classes and height ranges, with data indicating sound and defective trees.
MARKING TIMBER IN THINNINGS
UNIT II

TEST

1. Match the terms on the right to the correct definition.

   a. Cutting young stands to stimulate the growth of the trees left

   b. Method used to indicate trees to be cut

   c. Production of a stand including increment of wood and ingrowth of small trees

   d. Any damaged tree such as a dead, dying, or broken topped tree

   e. That part of the tree consisting of leaves, twigs, flowers, and fruit

   f. The growth potential of a group of trees

   g. An area of land having the same potential to produce trees and growth

   h. A source of ignition of fires such as a snag that could contribute sparks to the wind when on fire

2. Select from the list below the principles of silviculture and thinning by placing an "X" in the proper blanks.

   a. "Man changes the growth of timber land."

   b. "A given area of timber land produces a given amount of growth that fluctuates very little from one year to the next, and man can only influence which plants receive that growth."

   c. "Redistribute the growth potential to optimum advantage."
3. Match the methods of thinning to the correct definition.

   a. Removing a portion of codominants and dominants to favor the remaining codominants and dominants
   1. Low thinning
   2. Crown thinning
   3. Selection thinning

   b. Cutting the overtopped and intermediate crown classes first
   4. Mechanical thinning

   c. Cutting trees regardless of crown position by rows or by spacing of stems

   d. Cutting the upper crown classes in order to favor the lower crown classes

4. Select from the list below the most commonly used methods of marking timber:

   a. Lime sock
   b. Talc powder
   Flagging ribbon
   d. Painting
   e. Grease stick
   f. Ax blazes

5. Arrange in numerical order the priority of marking trees in a thinning.

   a. Broken topped trees
   b. Crown competitors
   c. Leaning trees
   d. Dead trees
   e. Poor bole form trees
   f. Dying trees
6. Select from the list below the correct factors for crown spacing.

   a. Tree species        e. Site quality
   b. Stand age          f. Bole length
   c. Stand vigor        g. Crown quality
   d. Tree diameter      h. Cutting cycle

7. Select from the list below three reasons for removing diseased trees and snags.

   a. Reduces fire risk
   b. Increases human safety
   c. Prevents and controls disease
   d. Saves merchantable volume
   e. Reduces eyesore

8. Demonstrate the ability to mark timber.

   (NOTE: If this has not been accomplished prior to the test ask the instructor when the above activity should be completed.)
MARKING TIMBER IN THINNINGS
UNIT II

ANSWERS TO TEST

1. a. 7    e. 5
   b. 4    f. 2
   c. 8    g. 1
   d. 6    h. 3

2. b, c, e

3. a. 2
   b. 1
   c. 4
   d. 3

4. a, c, d, f

5. a. 3
   b. 6
   c. 4
   d. 1
   e. 5
   f. 2

6. b, c, e, g, h

7. a, c, d

8. Performance skills will be evaluated to the satisfaction of the instructor.
SEEDING AND PLANTING
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to describe ways to store seedlings and classifications of planting stock. He should also be able to select from a list factors for spacing seedlings, identify tools used in hand planting, arrange in order the procedure for seed treatment, and complete a seeding or planting project. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with seeding and planting to the correct definition.
2. Name two sources of seed for seeding and planting.
3. List two sources of seedling production in Oklahoma.
4. List two types of seedling packaging.
5. Select from a list the correct procedure for the care of seedlings in transport.
6. Describe ways to store seedlings for both short and long storage.
7. Describe classifications of planting stock.
8. Select from a list the factors for spacing seedlings.
9. Identify the tools used in hand planting.
10. Select from a list the four methods of hand planting seedlings.
11. Describe the time to collect shortleaf pine cones.
12. Arrange in order the procedure for seed treatment before seeding.
13. Match the types of seeding applications to the methods of seeding.
14. Demonstrate the ability to hand plant seedlings.
SEEDING AND PLANTING  
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide student with objective sheet.
   B. Provide student with information and job sheets.
   C. Discuss terminal and specific objectives.
   D. Discuss information sheet.
   E. Discuss the procedure outlined in the job sheet.
   F. Arrange field trips to allow students an opportunity to plant seedlings.
   G. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedure outlined in the job sheet.
   E. Participate in field trip.
   F. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency masters
      1. TM #1--Classification of Planting Stock
      2. TM #2--Hand Planting Tools
D. Job Sheet #1-Hand Plant Seedlings

E. Test

F. Answers to test

SEEDING AND PLANTING
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Seeding—A method of artificial regeneration by direct seeding of forest tree seed.

B. Planting—A method of artificial regeneration by planting forest tree seedlings.

C. Seed orchards—A group of trees, natural or artificially created, managed for the purpose of providing seed.

D. Superior tree—A native tree that has genetic characteristics of fast growth, high quality wood, and resistance to disease and insects.

(Note: These trees produce scion wood and seed which are collected to provide clones and seed orchards.)

E. Scion—The growing terminals on twigs cut from the superior trees for grafting on common root stock.

F. Clone—A growing tree developed from the grafting of scions on root stock.

G. Root stock—The root system from an average seedling from a nursery.

H. Heeling-in—The temporary planting of seedlings in a trench for storage until needed for forest planting.

I. Standard sphagnum bale—The packaging of seedlings with sphagnum moss around the roots, reinforced kraft paper wrapping, and the seedling tops exposed.

J. Kraft-polyethylene bag—The packaging of seedlings in a specially designed kraft bag with polyethylene liner of the thickness to allow the escape of gases and not water.

K. Seedbed—A site in a nursery where seeds are germinated and seedlings are grown in close arrangement.

L. Transplant bed—A site in a nursery where seedlings are grown after they have been lifted from a seedbed and replanted.

M. Stratification—A period of cold storage necessary for the chemical reactions in seed to allow germination.
INFORMATION SHEET

N. Germination—The growth of a new plant emerging from the seed structure.

O. Seed coating—The covering of seed with various chemicals.

P. Broadcast seeding—A method of direct seeding with a sowing rate on a per acre basis and by aerial or ground application.

Q. Spot seeding—A method of direct seeding with a sowing rate of a number of seeds per spot and the spacing of spots based on the same factors needed for spacing of seedlings.

II. Sources of seed

A. Seed orchards

B. Superior trees

C. Commercial seed house or firms

III. Sources of seedling production in Oklahoma

A. State nursery at Broken Bow—Produces Southern Pine

B. State nursery at Washington—Produces hardwood and other pine

Application form for obtaining tree seedling on the following page.
APPLICATION FOR FOREST TREE SEEDLINGS

(PLEASE FILL OUT THIS FORM IN ITS ENTIRETY. FAILURE TO DO SO MAY DELAY PROCESSING OF YOUR ORDER.)

Order trees in multiples of 50 (100-150-200, etc.)
Minimum order: 100 plants.

Name: ________________
Address: ________________
City: ________________ State: ________________ Zip Code: ________________

First Phone: ________________

LAND DESCRIPTION: ________________

OWNER CLASS: ________________

PURPOSE: ________________

CIRCLE ONLY ONE

MAIL DIRECTOR, FORESTRY DIVISION
State Department of Agriculture
122 State Capitol
Oklahoma City, Oklahoma 73105

Send NO MONEY. You will be billed following confirmation of your order. Trees will not be shipped until receipt of payment following billing.
INFORMATION SHEET

IV. Seedling packaging
   A. Standard sphagnum bale
   B. Kraft-polyethylene bags

V. Care of seedlings in transport
   (NOTE: Water and temperature are very critical in transporting seedlings.)
   A. Cover from sun and wind
   B. Water bales every two hours and turn kraft-polyethylene bags over
   C. Store on stack to insure free air circulation (or)
   D. Refrigerate at 35°F
      (NOTE: Never refrigerate below 35° to prevent freezing and to protect during winter months.)

VI. Storage of seedlings (both package types)
   A. Short storage up to four weeks
      1. Racks
      2. Water bales every day
         (NOTE: Use one quart per bale.)
   B. Long storage over four weeks
      1. Refrigerate at 35°F (or)
      2. Heeling-in at the planting site

VII. Classification of planting stock (seedlings) (Transparency 1)
   A. Seedbeds-First number
   B. Transplant beds-Second number

VIII. Factors for spacing seedlings
   A. Site
   B. Growth habit of the species
   C. Class of planting stock
D. Expected survival
E. Management objective
F. Future silvicultural treatment
IX. Tools used in hand planting (Transparency 2)
   A. Planting bar
   B. KBC bar
   C. Tree planting hoe
   D. Tree planting bag
X. Methods of hand planting seedlings
   A. Bar-slit
   B. Grub-hoe-slit
   C. Side-hole
   D. Wedge
XI. Shortleaf pine cone collection—Core matures from October 10 to 30
    (NOTE: One bushel of cones will produce approximately one pound of seed or 48,000 seeds.)
XII. Procedure for seed treatment before seeding
    A. Stratification
       (NOTE: Some species require scarification, roughing the seed coat, prior to stratification.)
    B. Germination tests
       (NOTE: Germination tests are an important factor in determining sowing rate of seed.)
    C. Seed coating
       (NOTE: Seed coating with various chemicals in latex serves as a camouflage and poison against birds and rodents.)
XIII. Seeding methods and applications

A. Broadcast seeding
   1. Aerial application
   2. Ground application

B. Spot seeding
   1. Rake, drop, and step application
   2. Panama seeder application
Classification of Planting Stock

1 - 2

FIRST NUMBER
(Number of Seasons in Seed Bed - 1 Season)

SECOND NUMBER
(Number of Seasons in Transplant Bed - 2 Seasons)

2 - 2

(2 Seasons in Seed Bed) (2 Seasons in Transplant Bed)
Hand Planting Tools

Tree Planting Bag

Tree Planting Hoe

Planting Bar

KBC Bar
SEEDING AND PLANTING
UNIT III

JOB SHEET #1-HAND PLANT SEEDLINGS

I. Tools and materials needed

A. Planting bar and planting bag
B. 50' tape
C. 200 pine seedlings
D. An area to plant indicated by the instructor

II. Procedure

A. Plant seedlings on a 6' X 8' spacing with 8 feet between rows and 6 feet between seedlings in the row
B. Measure out the required spacing and pace the required distance until satisfied the distance can be obtained by pacing
C. Plant seedlings using the following procedure for the bar-slit method:

   (NOTE: Make sure seedling roots are kept moist.)

1. Insert bar, at angle shown and push forward to upright position
2. Remove bar and place seeding at correct depth
3. Insert bar 2 inches toward yourself from seedling

1. Insert bar, at angle shown and push forward to upright position
2. Remove bar and place seeding at correct depth
3. Insert bar 2 inches toward yourself from seedling
JOB SHEET #1

4. Pull handle of bar toward yourself to firm soil at bottom of roots

5. Push handle of bar forward to firm soil at top of roots

6. Insert bar 2 inches from last hole

7. Push forward then pull backward to fill hole

8. Fill in last hole by stamping with heel

9. Firm soil around seedling with the foot
D. After planting the seedlings, choose at random and dig up ten seedlings for inspection of correct planting technique.

E. Use the following guides to check faults in planting technique:

1. Seedling loose, pulls up using three needles to pull
2. Packing hole not filled
3. Seedling U-rooted
4. Lateral roots wrapped around seedling
5. Seedling planted too deep (more than 2" on the root crown)
6. Seedling planted too shallow (root crown exposed)
7. Air space in the planting hole
8. Planting hole open at the top

G. Replant the seedling

H. Place an "X" in the correct space in the chart below for each seedling inspected.

I. When chart is completed, hand in to the instructor for evaluation.

<table>
<thead>
<tr>
<th>Seedlings Inspected</th>
<th>Correctly Planted</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</table>

Coded as Item E above
SEEDING AND PLANTING
UNIT III

TEST

1. Match the terms on the right to the correct definition.

   a. A method of artificial regeneration by direct seeding of forest tree seed

   b. A method of artificial regeneration by planting forest tree seedlings

   c. A group of trees, natural or artificially created, managed for the purpose of providing seed

   d. A native tree that has genetic characteristics of fast growth, high quality wood, and resistance to disease and insects

   e. The growing terminals on twigs cut from the superior trees for grafting on common root stock

   f. A growing tree developed from the grafting of scions on root stock

   g. The root system from an average seedling from a nursery

   h. The temporary planting of seedlings in a trench for storage until needed for forest planting

   i. The packaging of seedlings with sphagnum moss around the roots, reinforced kraft paper wrapping, and the seedling tops exposed

   1. Clone

   2. Standard sphagnum bale

   3. Scion

   4. Broadcast seeding

   5. Seedbed

   6. Spot seeding

   7. Seed coating

   8. Superior tree

   9. Germination

   10. Transplant bed

   11. Root stock

   12. Seeding

   13. Stratification

   14. Seed orchards

   15. Kraft-polyethylene bag

   16. Heeling-in

   17. Planting
j. The packaging of seedlings in a specially designed kraft bag with polyethylene liner of the thickness to allow the escape of gases and not water.

k. A site in a nursery where seeds are germinated and seedlings are grown in close arrangement.

l. A site in a nursery where seedlings are grown after they have been lifted from a seedbed and replanted.

m. A period of cold storage necessary for the chemical reactions in seed to allow germination.

n. The growth of a new plant emerging from the seed structure.

o. The covering of seed with various chemicals.

p. A method of direct seeding with a sowing rate on a per acre basis and by aerial or ground application.

q. A method of direct seeding with a sowing rate of a number of seeds per spot and the spacing of spots based on the same factors needed for spacing of seedlings.

2. Name two sources of seed for seeding and planting.

a.

b.

3. List two sources of seedling production in Oklahoma.

a.

b.
4. List two types of seedling packaging.
   a. 
   b. 

5. Select from the list below the correct procedure for the care of seedlings in transport.
   a. Cover from sun and wind
   b. Water bales every 30 minutes
   c. Water bales every two hours and turn K-P bags over
   d. Pack in tightly
   e. Store or stack to insure free air circulation
   f. Refrigerate at 35°F

6. Describe ways to store seedlings for both short and long storage.
   **Short Storage**
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 
   g. 
   h. 
   i. 
   j. 
   k. 

   **Long Storage**
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 
   g. 
   h. 
   i. 
   j. 
   k. 

7. Describe classifications of planting stock.
   a. 
   b. 

8. Select from the list below the factors for spacing seedlings. Circle the correct answers.
   a. Expected survival
   b. Time of day
   c. Class of planting stock
   d. Temperature
   e. Type of seedling packaging
   f. Site
   g. Wind conditions
   h. Growth habit of the species
   i. Management objective
   j. Future silvicultural treatment
   k. Length of storage
9. Identify the tools used in hand planting by placing the proper numbers in the blanks provided.

1. Tree planting hoe
2. KBC bar
3. Tree planting bag
4. Planting bar

10. Select from this list the four methods of hand planting seedlings by placing an "X" in the blanks provided.

   a. Square
   b. Wedge
   c. Grub-hoe-slit
   d. Shovel-hole
   e. Side hole
   f. Bar-slit
11. Describe time to collect shortleaf pine cones.

12. Arrange in order the procedure for seed treatment before seeding.
   a. Germination tests
   b. Seed coating
   c. Stratification

13. Match the types of seeding applications to the methods of seeding.

<table>
<thead>
<tr>
<th>Broadcast Seeding</th>
<th>Spot Seeding</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>b.</td>
<td>1. Rake, drop, and step</td>
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<tr>
<td></td>
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<td>2. Ground</td>
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<td></td>
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<td>3. Aerial</td>
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<td>4. Panama seeder</td>
</tr>
</tbody>
</table>

14. Demonstrate the ability to hand plant seedlings.

   (NOTE: If this has not been accomplished prior to the test, ask the instructor when it should be completed.)
SEEDING AND PLANTING
UNIT III

ANSWERS TO TEST

1. a. 12  j. 15
   b. 17  k. 5
   c. 14  l. 10
   d. 8   m. 13
   e. 3   n. 9
   f. 1   o. 7
   g. 11  p. 4
   h. 16  q. 6
   i. 2

2. Any two of the following
   a. Seed orchards
   b. Superior trees
   c. Commercial seed houses or firms

3. a. State Nursery at Broken Bow
   b. State Nursery at Washington

4. a. Standard sphagnum bale
   b. Kraft-polyethylene bags

5. a, c, e, f

6. a. Racks
   b. Water bales every day
   c. Refrigerate 35°F (or)
   d. Heel-in at planting site

7. a. Seedbeds-First number
   b. Transplant beds-Second number
a, c, f, h, i, j
a. 4
b. 2
c. 1
d. 3
b, c, e, f
October 10 to 30
a. 2
b. 3
c. 1
a. 2, 3
b. 1, 4
Performance skill will be evaluated to the satisfaction of the instructor.
TIMBER STAND IMPROVEMENT
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to select from a list the methods for cleaning, liberation, and improvement of timber stands. He should also be able to complete a tree injection. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES.

After completion of this unit, the student should be able to:

1. Match terms associated with timber stand improvement to the correct definition.
2. Select from a list of terms the correct classifications of intermediate cuttings.
3. Select from a list of methods those recommended for cleaning.
4. Select from a list of methods those recommended for liberation.
5. Select from a list of methods those recommended for improvement.
6. List four agents of damage requiring salvage cutting.
7. Select from a list the correct factors influencing pruning.
8. Match the chemical compounds to the correct herbicide type.
9. Identify the hand tools used to apply herbicides.
10. Demonstrate the ability to:
    A. Classify timber stand improvement needs.
    B. Complete a tree injection.
TIMBER STAND IMPROVEMENT
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in the job sheets.
   G. Arrange field trips to allow students an opportunity to identify timber stand improvement classes and to inject trees.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency masters
      1. TM 1--Cleaning
      2. TM 2--Liberation
3. TM 3–Improvement

4. TM 4–Herbicide Hand Tools

D. Job sheets
   1. Job Sheet #1–Classify Timber Stand Improvement Needs
   2. Job Sheet #2–Complete a Tree Injection

E. Test

F. Answers to test

TIMBER STAND IMPROVEMENT
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Intermediate cuttings—All cuttings made through the rotation period except those cuttings made for the purpose of regeneration.

B. Timber stand improvement (TSI)—The intermediate cuttings that involve an investment rather than revenue.

C. Cleaning—A cutting in a stand not past the sapling stage in order to free the best trees of the same size.

D. Liberation—A cutting in a young stand to release it from overhead competition from older trees.

E. Thinning—A cutting in a young stand to stimulate growth in the trees left.

F. Improvement—A cutting in an immature stand of merchantable size in order to improve composition.

G. Composition—The species of trees in a stand.

H. Salvage cutting—A cutting made to remove dead or damaged trees from a stand.

I. Pruning—A cutting in which the branches of trees are removed in order to increase the quality of the final product.

J. Herbicide—A chemical used to kill plants.

K. Basal herbicide application—A method of applying herbicide to the base of young trees, one to two feet in height, usually by spraying.

L. Stump herbicide application—A method of applying herbicide to a fresh cut stump of a tree.

(Note: Stump herbicide is usually applied by painting, pouring, or spraying.)

M. Foliage herbicide application—A method of applying herbicide to the leaves of plants either by aerial or ground spraying.

N. Girdling—The cutting around the stem of a tree completely into the wood and the removal of the cambium layer in the form of chips or sawdust.

O. Injection—A method of applying herbicide into the system of a tree.

(Note: There are various tools designed for this purpose.)
INFORMATION SHEET

P. Phytotoxin—A plant poison

Q. Auxin—A hormone produced by plants that regulates the growth of the plant

R. 2,4-D herbicide—A synthetic auxin, dichlorophenoxyacetic acid sold as amine or ester in pounds of acid equivalent per gallon

S. 2,4,5-T herbicide—A synthetic auxin, trichlorophenoxyacetic acid sold as amine or ester in pounds of acid equivalent per gallon

T. Tree injectors—Tools used to inject herbicide into trees

U. Backpack mist blower—A gasoline motor operated fan blower that combines herbicide into an air stream as a mist and is used in foliage herbicide application

V. Amine—A chemical compound formed using ammonia

W. Ester—A chemical compound formed from an acid and alcohol

II. Classifications of intermediate cuttings

A. Cleaning

B. Liberation

C. Thinning

D. Improvement

E. Salvage cutting

F. Pruning

III. Methods of cleaning (Transparency 1)

A. Cutting

B. Herbicide application

1. Basal

2. Stump

3. Foliage

360
IV. Methods of liberation (Transparency 2)
   A. Cutting
   B. Girdling
   C. Injection
   D. Foliage herbicide application
      (NOTE: Applicable only in some cases such as to liberate pine from hardwood.)

V. Methods of improvement (Transparency 3)
   A. Mark and sell
   B. Cutting
   C. Girdling
   D. Injection
   E. Foliage herbicide application

VI. Agents of damage requiring salvage cutting
   A. Disease
   B. Insects
   C. Fire
   D. Wind
   E. Snow and ice
   F. Environmental pollution

VII. Factors influencing pruning
   A. End value
      (NOTE: Will end value justify pruning cost?)
   B. Rotation period
      (NOTE: Is the rotation period to justify cost or to produce quality wood?)
   C. Number of crop trees per acre at the end of rotation to justify pruning cost
   D. Cost of pruning
VIII. Herbicides (silvicides) and chemical compounds

A. Phytotoxins
   1. Ammate (ammonium sulfamate)
   2. Arsenic compounds

B. Synthetic auxins
   1. 2,4-D
   2. 2,4,5-T

IX. Hand tools used to apply herbicides (Transparency 4)

A. Tree injector

B. Backpack mist blowers
A Stand of Shortleaf Pine Before (above) and After (below) the Removal of Overtopping, Inferior Hardwoods in a Cleaning. This Represents an Extreme Type of Cleaning in which all Trees Overtopping the Desirable Ones Must be Removed Because the Hardwoods Grow so much Faster than Pine. The Large Pine has been Cut Because it might otherwise Develop into a Limby Wolf Tree.
A Young Stand of Reproduction at the Stage Where a Liberation Cutting could be Carried Out to Best Advantage. The Overtopping Wolf Trees have not yet caused any Deformities or Serious Reductions of Growth in the New Crop.
Improvement

INFERIOR SPECIES
A=Aspen D=Dogwood
G-B=Gray Birch S-M=Soft Maple

VALUABLE SPECIES
R-O=Red Oak H-M=Hard Maple
W-A=White Ash W-P=White Pine

A 50-year-old Mixed Stand Marked for an Improvement Cutting. The Trees to be cut are indicated by Dashes. The Removal of Trees 3, 11, 13, 16, 19, and 22 constitutes the True Improvement Cutting and resembles a Cleaning. Because Dominant Trees of Inferior Species are Cut to favor more Valuable Individuals, the Cutting of Trees 1, 7, 8, and 10 corresponds to a C-grade Low Thinning. Trees 4, 14, 17, and 21 are, however, left standing to fill openings created by the Removal of Dominant Trees of Poor Species.
Herbicide Hand Tools

Tree Injector

Back Pack Mist Blower
I. Materials needed
   A. Clipboard and pencil
      (NOTE: A knowledge of tree species identification, local timber market, and species merchantability is very important.)
   B. Areas to classify indicated by the instructor

II. Procedure
   A. Place an "X" in the correct space in the chart below
   B. When completed, turn in to the instructor for evaluation

<table>
<thead>
<tr>
<th>Timber Stand</th>
<th>Clearing</th>
<th>Liberation</th>
<th>Improvement</th>
<th>Salvage Cutting</th>
<th>Pruning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area 1</td>
<td></td>
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<td>Area 2</td>
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<td>Area 3</td>
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<td>Area 4</td>
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<tr>
<td>Area 5</td>
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</tbody>
</table>
TIMBER STAND IMPROVEMENT
UNIT IV

JOB SHEET #2--COMPLETE A TREE INJECTION

I. Tools and materials needed
   A. Tree injector
   B. 5/16" open end wrench
   C. Milliliter volume measure
   D. Hand ax
   E. Trees indicated by the instructor
   F. 2.4-D herbicide (4 lb. acid equivalent) or recommended herbicide

II. Procedure
   A. Place the discharge tube into the milliliter measure
      (NOTE: See attached parts diagram.)
   B. Pump the operating handle ten times
   C. The milliliter measure should read ten milliliters; if not, then adjust as follows:
      1. For less than ten, move the locknut clockwise (down toward the point of the injector) until a correct measurement of milliliters is obtained
      2. For more than ten, move the locknut counterclockwise until a correct measurement is obtained
   D. Inject trees at the base of the stem within a range of twelve inches to the groundline
   E. Space injections three inches apart
   F. Make sure the bit cuts through the bark and into the wood of the tree before releasing the herbicide
   G. Use the hand ax to chop limbs out of the way when the limbs hinder injection
JOB SHEET #2

H. When all trees designated have been injected, wait two hours

I. After two hours, select ten trees at random and chop out one injection per tree

J. Above the injection there should be black to dark brown streaks in the sapwood if the tree was injected correctly

K. Ask the instructor to evaluate your sample tree

L. Inspect the area two weeks later for signs of herbicide effect
TIMBER STAND IMPROVEMENT
UNIT IV
TEST

1. Match the terms on the right to the correct definition.

a. All cuttings made through the rotation period except those cuttings made for the purpose of regeneration

1. Liberation

b. The intermediate cuttings that involve an investment rather than revenue

2. Stump herbicide application

c. A cutting in a stand not past the sapling stage in order to free the best trees of the same size

3. Pruning

d. A cutting in a young stand to release it from overhead competition from older trees

4. Auxin

e. A cutting in a young stand to stimulate growth in the trees left

5. Composition

f. A cutting in an immature stand of merchantable size in order to improve composition

6. Backpack mist blower

g. The species of trees in a stand

7. Ester

h. A cutting made to remove dead or damaged trees from a stand

8. Tree injectors

i. A cutting in which the branches of trees are removed in order to increase the quality of the final product

9. Amine

j. A chemical used to kill plants

10. Herbicide

k. A method of applying herbicide to the base of young trees, one or two feet in height, usually by spraying

11. 2,4-D herbicide

l. Intermediate cuttings

12. 2,4,5-T herbicide

m. A species of trees in a stand

13. Salvage cutting

n. A species of trees in a stand

14. Phytotoxin

o. A method of applying herbicide to the base of young trees, one or two feet in height, usually by spraying

15. Thinning

p. A method of applying herbicide to the base of young trees, one or two feet in height, usually by spraying

16. Timber stand improvement (TSI)

q. A method of applying herbicide to the base of young trees, one or two feet in height, usually by spraying

17. Foliage herbicide application

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l. A method of applying herbicide to the leaves of plants either by aerial or ground spraying

m. A method of applying herbicide to a fresh cut stump of a tree

n. The cutting around the stem of a tree completely into the wood and the removal of the cambium layer in the form of chips or sawdust

o. A method of applying herbicide into the system of a tree

p. A plant poison

q. A hormone produced by plants that regulates the growth of the plant

r. A synthetic auxin, dichlorophenoxyacetic acid sold as amine or ester in pounds of acid equivalent per gallon

s. A synthetic auxin, trichlorophenoxyacetic acid sold as amine or ester in pounds of acid equivalent per gallon

t. Tools used to inject herbicide into trees

u. A gasoline motor operated fan blower that combines herbicide into an air stream as a mist and is used in foliage herbicide application

v. A chemical compound formed using ammonia

w. A chemical compound formed from an acid and alcohol

19. Injection

20. Cleaning

21. Girdling

22. Basal herbicide application

23. Improvement
2. Select from the list of terms below the correct classifications of intermediate cuttings. Circle the correct answers:
   a. Pruning
   b. Felling
   c. Thinning
   d. Improvement
   e. Competitors
   f. Liberation
   g. Tree girdling
   h. Salvage cutting
   i. Cleaning
   j. Injection

3. Select from the list below the TSI methods recommended for cleaning by circling the correct answers:
   a. Foliage herbicide application
   b. Injection
   c. Girdling
   d. Cutting
   e. Stump herbicide application
   f. Basal herbicide application
   g. Mark and sell

4. Select from the list below the TSI methods recommended for liberation by circling the correct answers:
   a. Foliage herbicide application
   b. Injection
   c. Girdling
   d. Cutting
   e. Stump herbicide application
   f. Basal herbicide application
   g. Mark and sell

5. Select from the list below the TSI methods recommended for improvement by circling the correct answers:
   a. Foliage herbicide application
   b. Injection
Stump, herbicide application
f. Basal herbicide application
g. Mark and sell

6. List four agents of damage requiring salvage cutting.
a.
b.
c.
d.

7. Select from the list below the correct factors influencing pruning by placing an "X" in the blanks provided.
   a. Number of crop trees per acre at the end of rotation
   b. Cost of pruning
   c. Type of tools available
   d. Rotation period
   e. The presence or absence of disease
   f. End value
   g. The presence or absence of insects

8. Match the chemical compounds to the correct herbicide type.
   a. Phytotoxins   b. Synthetic Auxins
      1. Ammate (ammonium sulfate)
      2. 2,4-D
      3. Arsenic compounds
      4. 2,4,5-T
9. Identify the hand tools used to apply herbicides.

   a. 
   
   b. 

10. Demonstrate the ability to:

   a. Classify timber stand improvement needs.

   b. Complete a tree injection.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
TIMBER STAND IMPROVEMENT
UNIT IV

ANSWERS TO TEST

1. a. 12  i. 3  q. 4  
   b. 17  j. 10  r. 11  
   c. 20  k. 22  s. 13  
   d. 1  l. 18  t. 8  
   e. 16  m. 2  u. 6  
   f. 23  n. 21  v. 9  
   g. 5  o. 19  w. 7  
   h. 14  p. 15

2. a, c, d, f, h, i

3. a, d, e, f

4. a, b, c, d

5. a, b, c, d, g

6. Any four of the following
   a. Disease
   b. Insects
   c. Fire
   d. Wind
   e. Snow and ice
   f. Environmental pollution

7. a, b, d, f

8. a. 1, 3
   b. 2, 4

9. a. Tree injector
   b. Backpack mist blower

10. Performance skills will be evaluated to the satisfaction of the instructor.
TERMINAL OBJECTIVE

After completion of this unit, the student should be able to name the parts of the fire triangle, the classes of fire, the methods of fire attack, and the methods of crew organization. The student should also be able to arrange in order of occurrence the standard fire causes in Oklahoma and use the hand tools to function as a member of a fire crew. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with fire fighting to the correct definition.
2. Name the three elements of the fire triangle.
3. Arrange in numerical order of occurrence the standard fire causes in Oklahoma.
4. Name the three purposes of fire control organizations.
5. Select from a list the two means of fire prevention.
6. Match the individual items of work responsibility to the fire presuppression duty.
7. Name the three classes of fire.
8. Name the four methods of fire attack.
9. Name the four methods of crew organization using hand tools.
10. Match the hand tools to the correct tool class.
11. Demonstrate the ability to use hand tools and function as a member of a fire crew.
FIRE FIGHTING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate the procedure outlined in the job sheet.
   G. Arrange field trips to allow students an opportunity to practice use of hand tools and fire crew organization.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedure outlined in the job sheet.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency masters:
      1. TM 1-The Fire Triangle
      2. TM 2-Fire Hand Tools
      3. TM 3-Backfiring Tools

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D. Job Sheet #1: Operate Hand Tools for a Fire Crew

E. Test

F. Answers to test

I. Terms and definitions

A. Wildfire--The uncontrolled burning of fire

B. Incendiary--The unlawful and intentional setting of fire

C. Debris burning--Wildfire caused by the burning of trash

D. Smoker--Any fire starting from the use of tobacco

E. Campfire--Any fire resulting from cooking or warming or from campfires

F. Lumbering--Any fire resulting from a logging or sawmilling operation

G. Railroads--Any fire resulting from the operation of railroads

H. Lightning--Any fire resulting from lightning strikes

I. Miscellaneous--Any fire than cannot be placed in one of the other standard causes of fire

J. Prevention--Any action associated with stopping a wildfire before it gets started

K. Presuppression--Any action associated with being ready in case a wildfire occurs

L. Suppression--Any action associated with stopping a wildfire

M. Detection--The planned observance from the occurrence of wildfire

N. Fire danger rating--The measurement and resultant rating of the variables that determine whether fires will start, spread, and do damage

O. Fire break--A strip of land cleared of fuels that could burn

P. Prescribed burning--The controlled use of fire

Q. Ground fire class--A fire that burns underground such as duff and peat fires

R. Surface fire class--A fire that burns only the surface fuels
INFORMATION SHEET

S. Crown fire class--A fire that burns through the tops of trees

T. Direct attack--A method using various means such as water, soil, and beating to attack the fire directly at the flames

U. Two-foot attack--A method of attack where the fuel is removed from an eighteen inch strip two feet from the fire edge, and the strip is known as the fire line

V. Parallel--A method of attack where the fire is too hot to fight directly, or two feet from the edge, and a strip eighteen inches wide (fire line) is made by removing the fuel at a distance of more than three feet from the fire

W. Backfiring--A method of attack where the fire is extremely hot and advancing rapidly in which a fire line is constructed, then a fire is set to meet the advancing fire

X. Sector fire crew--A method of crew organization where each individual is assigned a segment of fire line to construct and after he completes the sector, he moves to the front of the progressing crew

Y. One-lick--A method of crew organization where each man in the crew walks at a slow pace along a line to construct and make one lick with the hand tool as he walks

(Note: The pace is regulated according to the size of crew. When the last man has passed along the line, the intention is that the fire line should be finished.)

Z. Progressive--A method of crew organization where each man is assigned a short sector (usually about ten feet) of fire line to construct, and as each member finishes his sector of fire line, he says "bump" and moves up to finish the sector of the man in front of him

AA. Rotary--A method of fire crew organization where the direct attack method with shovels and soil is used in which the first man throws a shovel of soil on the fire and steps aside to obtain another shovel of soil and moves to the end of the line

(Note: This usually works best with five men or less and has the appearance of a revolving wheel moving along the fire line.)

II. Elements of the fire triangle (Transparency 1)

A. Air (O<sub>2</sub>)

B. Fuel

C. Heat

(Note: You must have all three elements to have a fire.)
INFORMATION SHEET

III. Standard fire causes in order of occurrence in Oklahoma
   A. Incendiary
   B. Debris burning
   C. Smoker
   D. Campfires
   E. Lumbering
   F. Railroads
   G. Lightning
   H. Miscellaneous

IV. Purposes of fire control organizations
   A. Prevention
   B. Presuppression
   C. Suppression

V. Means of fire prevention
   A. Public education
   B. Law enforcement

VI. Fire presuppression duties
   A. Detection system maintenance
      1. Fire towers
      2. Aerial patrol
      3. Ground patrol
   B. Communication system maintenance
      1. Radios
      2. Telephone
INFORMATION SHEET

C. Transportation system maintenance
   1. Crew and equipment carriers
   2. Roads and trails

D. Equipment
   1. Equipment maintenance
   2. Equipment distribution

E. Personnel
   1. Training
   2. Distribution of crews

F. Fire danger rating
   1. Maintenance of weather stations
   2. Fire danger measurements

G. Firebreaks and fuel reduction
   1. Development and maintenance of firebreaks
   2. Prescribed burning

VII. Fire classes
    A. Ground
    B. Surface
    C. Crown

VIII. Methods of fire attack
    A. Direct
    B. Two-foot
    C. Parallel
    D. Backfiring
information sheet

IX. Methods of fire crew organization using hand tools
   A. Sector
   B. One-lick
   C. Progressive
   D. Rotary

X. Classes of hand tools (Transparency 2)
   A. Cutting and felling
      1. Axes and brushhooks
      2. Saws
   B. Raking
      1. Council rake
      2. Mcleod rake
   C. Beating
      1. Fire swatter
      2. Any wet material
   D. Digging
      1. Shovel
      2. Pulaski
   E. Water
      1. Backpack pump
      2. Portable power pump and hose
   F. Backfiring (Transparency 3)
      1. Torches
      2. Fuses
The Fire Triangle

To produce fire, three things must be present at the same time.

OXYGEN

If any one of the three is missing, a fire cannot be started, or with the removal of any one, the fire will be extinguished.
Fire Hand Tools

Pulaski or Forester Axe

Fire Swatter

Council Fire Rake
Backfiring Tools

Forest Firing Torch or "Fusee" Torch

Forester "Sealtite" Drip Torch

Panama Stainless Steel Drip Torch
FIRE FIGHTING
UNIT I

JOB SHEET #1—OPERATE HAND TOOLS FOR A FIRE CREW

I. Tools needed
   A. Council rake
   B. Shovel

II. Procedure
   A. Instructor will indicate where the mock fire is burning by using flagging ribbon
   B. Obtain a council tool
   C. Instructions for sector crew
      1. Obtain position and fire line sector from the instructor
      2. Construct an 18" width fire line down to mineral soil along the fire line
      3. Pull the council parallel and then outward away from the fire edge with each stroke
      4. Ask the instructor for evaluation when completed
   D. Instructions for one-lick crew
      1. Use the council rake
      2. Obtain position from the instructor
      3. Advance following the man in front when given the signal to advance
      4. Hit a stroke with the council with each step
      5. Attempt to build an 18" fire line while walking
      6. The instructor will regulate the pace and evaluate the fire line and use of tools
JOB SHEET #1

E. Instructions for progressive crew

1. Use the council rake

2. Obtain position from the instructor

3. Complete the fire line as described in item C on the preceding page

4. When the sector is complete, say "bump" to the man in front and complete the sector he was working on

5. Move up a sector whenever the man behind says "bump"

Instructions for rotary crew

1. Use the shovel

2. Obtain position from the instructor

3. Obtain a shovel full of dirt

4. After the man in front has thrown his dirt on the fire, advance and throw dirt on the fire

5. If advancing along the fire clockwise, step to the left after throwing dirt

6. Obtain another shovel full of dirt and repeat the procedure

7. The instructor will regulate the pace and evaluate crew action
JOB SHEET #1

E. Instructions for progressive crew

1. Use the council rake
2. Obtain position from the instructor
3. Complete the fire line as described in item C on the preceding page
4. When the sector is complete, say "bump" to the man in front and complete the sector he was working on
5. Move up a sector whenever the man behinds says, "bump"

Instructions for rotary crew

1. Use the shovel
2. Obtain position from the instructor
3. Obtain a shovel full of dirt
4. After the man in front has thrown his dirt on the fire, advance and throw dirt on the fire
5. If advancing along the fire clockwise, step to the left after throwing dirt
6. Obtain another shovel full of dirt and repeat the procedure
7. The instructor will regulate the pace and evaluate crew action
<table>
<thead>
<tr>
<th>Number</th>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>1</td>
<td>Campfire</td>
<td>The uncontrolled burning of fire</td>
</tr>
<tr>
<td>2</td>
<td>Miscellaneous</td>
<td>The unlawful and intentional setting of fire</td>
</tr>
<tr>
<td>3</td>
<td>Suppression</td>
<td>Wildfire caused by the burning of trash</td>
</tr>
<tr>
<td>4</td>
<td>Prevention</td>
<td>Any fire starting from the use of tobacco</td>
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<tr>
<td>5</td>
<td>Railroads</td>
<td>Any fire resulting from cooking or warming or from campfires</td>
</tr>
<tr>
<td>6</td>
<td>Wildfire</td>
<td>Any fire resulting from a logging or sawmilling operation</td>
</tr>
<tr>
<td>7</td>
<td>Presuppression</td>
<td>Any fire resulting from the operation of railroads</td>
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<tr>
<td>8</td>
<td>Smoker</td>
<td>Any fire resulting from lightning strikes</td>
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<td>Detection</td>
<td>Any fire that cannot be placed in one of the other standard causes of fire</td>
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<td>Incendiary</td>
<td>Any action associated with being ready in case a wildfire occurs</td>
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<td>12</td>
<td>Lumbering</td>
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<td>13</td>
<td>Debris burning</td>
<td>The planned observance from the occurrence of wildfire</td>
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<td>14</td>
<td>Ground fire class</td>
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<td>15</td>
<td>Two-foot attack</td>
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<td>16</td>
<td>Crown fire class</td>
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<td>17</td>
<td>Sector fire crew</td>
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<td>18</td>
<td>Fire break</td>
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<td>19</td>
<td>Rotary</td>
<td></td>
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<tr>
<td>20</td>
<td>Backfiring</td>
<td></td>
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<tr>
<td>21</td>
<td>Progressive</td>
<td></td>
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The measurement and resultant rating of the variables that determine whether fires will start, spread, and do damage.

The controlled use of fire.

A strip of land cleared of fuels that could burn.

A fire that burns underground such as duff and peat fires.

A fire that burns only the surface fuels.

A fire that burns through the tops of trees.

A method using various means such as water, soil, and beating to attack the fire directly at the flames.

A method of attack where the fuel is removed from an eighteen inch strip two feet from the fire edge, and the strip is known as the fire line.

A method of attack where the fire is too hot to fight directly, or two feet from the edge, and a strip eighteen inches wide (fire line) is made by removing the fuel at a distance of more than three feet from the fire.

A method of attack where the fire is extremely hot and advancing rapidly in which a fire line is constructed, then a fire is set to meet the advancing fire.

A method of crew organization where each individual is assigned a segment of fire line to construct and after he completes the sector, he moves to the front of the progressing crew.

Surface fire class
One-lick
Parallel
Prescribed burning
Fire danger rating
Direct attack
A method of crew organization where each man in the crew walks at a slow pace along a line to construct and make one lick with the hand tool as he walks.

A method of crew organization where each man is assigned a short sector (usually about ten feet) of fire line to construct and as each member finishes his sector of fire line, he says "bump" and moves up to finish the sector of the man in front of him.

A method of fire crew organization where the direct attack method with shovels and soil is used in which the first man throws a shovel of soil on the fire and steps aside to obtain another shovel of soil and moves to the end of the line.

2. Name the three elements of the fire triangle.
   a.
   b.
   c.

3. Arrange in numerical order of occurrence the standard fire causes in Oklahoma:
   a. Lumbering
   b. Railroads
   c. Miscellaneous
   d. Lightning
   e. Debris burning
   f. Incendiary
   g. Smoker
   h. Campfires

4. Name the three purposes of fire control organizations.
   a.
   b.
   c.
5. Select from the list below the two means of fire prevention.
   - a. Fire fighting
   - b. Law enforcement
   - c. Maintaining equipment
   - d. Public education

6. Match the individual items of work responsibility to the fire suppression duty. (There is more than one answer for each duty.)

<table>
<thead>
<tr>
<th>Fire Suppression Duties</th>
<th>Items of Work Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Detection system maintenance</td>
<td>1. Telephone</td>
</tr>
<tr>
<td>b. Communication system maintenance</td>
<td>2. Crew and equipment carriers</td>
</tr>
<tr>
<td>c. Transportation system maintenance</td>
<td>3. Ground patrol</td>
</tr>
<tr>
<td>d. Equipment</td>
<td>4. Aerial patrol</td>
</tr>
<tr>
<td>e. Personnel</td>
<td>5. Maintenance of weather station</td>
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<td>f. Fire danger rating</td>
<td>6. Radios</td>
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<td>Firebreaks and fuel reduction</td>
<td>7. Fire towers</td>
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<td>8. Training</td>
<td></td>
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<td>9. Equipment maintenance</td>
<td></td>
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<td>10. Prescribed burning</td>
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</tr>
<tr>
<td>11. Roads and trails</td>
<td></td>
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<tr>
<td>12. Equipment distribution</td>
<td></td>
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<tr>
<td>13. Development and maintenance of firebreaks</td>
<td></td>
</tr>
<tr>
<td>14. Distribution of crews</td>
<td></td>
</tr>
<tr>
<td>15. Fire danger measurements</td>
<td></td>
</tr>
</tbody>
</table>

7. Name the three classes of fire:
   a. 
   b. 
   c. 
8. Name the four methods of fire attack.
   a. 
   b. 
   c. 
   d. 

9. Name the four methods of crew organization using hand tools.
   a. 
   b. 
   c. 
   d. 

10. Match the hand tools to the correct tool class. (There is more than one answer for each tool class.)

   _____ a. Cutting and felling
   _____ b. Raking
   _____ c. Beating
   _____ d. Digging
   _____ e. Water
   _____ f. Backfiring

11. Demonstrate the ability to use hand tools and function as a member of a fire crew.

   NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)
**FIRE FIGHTING**  
**UNIT 1**

**ANSWERS TO TEST**

1.  
   a. 9  
   b. 11  
   c. 13  
   d. 8  
   e. 1  
   f. 12  
   g. 5  
   h. 10  
   i. 2  
   j. 4  
   k. 7  
   l. 3  
   m. 9  
   n. 26  
   o. 25  
   p. 18  
   q. 14  
   r. 22  
   s. 16  
   t. 27  
   u. 15  
   v. 24  
   w. 20  
   x. 17  
   y. 23  
   z. 21  
   aa. 19  

2.  
   a. Air \((\text{O}_2)\)  
   b. Fuel  
   c. Heat

3.  
   a. 5  
   b. 6  
   c. 8  
   d. 7  
   e. 2  
   f. 1  
   g. 3  
   h. 4

4.  
   a. Prevention  
   b. Presuppression  
   c. Suppression

5.  
   b, d
6. a. 4, 7
   b. 1, 6
   c. 2, 11
   d. 9, 12
   e. 8, 14
   f. 5, 15
   g. 10, 13

7. a. Ground
   b. Surface

8. Direct
   b. Two-foot
   c. Parallel
   d. Backfiring

9. Sector
   a. One-lick
   c. Progressive
   c. Rotary

10. a. 3, 12
    b. 5, 11
    c. 6, 9
    d. 2, 8
    e. 4, 10
    f. 1, 7

11. Performance skill will be evaluated to the satisfaction of the instructor.
PRESCRIBED BURNING
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to recognize prescribed burning techniques used for various areas, interpret wind, relative humidity, and temperature for a successful burn, and arrange in order the steps of a burning plan. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

1. Match terms associated with prescribed burning to the correct definition.
2. Select from a list the six correct reasons for prescribed burning.
3. Select from a list the most desirable wind direction and velocity.
4. List the range of preferred relative humidity and the effects of temperature change on relative humidity.
5. Name the desired range of temperature for prescribed burning.
6. Identify correctly illustrations of an anemometer and a psychrometer.
7. Arrange in numerical order the steps of a burning plan.
8. Select from a list the factors which determine the use of the backfire, strip head fire, spot fire, and flank fire techniques in prescribed burning.
9. Demonstrate the ability to:
   a. Determine wind direction and velocity, relative humidity, and temperature.
   b. Determine the prescribed burning technique to use.
PRÉSCRIBED BURNING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparencies.
   D. Discuss termina and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in the job sheets.
   G. Arrange field trips to allow students an opportunity to determine wind velocity and direction, relative humidity, temperature, and prescribed burning techniques.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency masters

   1. TM 1--Relative Humidity Affects Fuels
   2. TM 2--Backfire Technique
I. Terms and definitions

A. Prescribed burning--Controlled use of fire
B. Wind velocity--Speed of wind, usually measured in miles per hour
C. Relative humidity--Actual amount of moisture in air as compared to the amount that air could hold.
   (NOTE: High relative humidity means that there is more moisture available for fuels to absorb and thus fuels are hard to ignite and burn.)
D. Anemometer--Instrument that gives wind speed
E. Psychrometer--Instrument that gives temperature and relative humidity
F. Mop-up--Act of making a fire safe, after it has been controlled or burned, by putting out all embers and sparks at a prescribed distance from the fire line.
G. Heavy fuel--Contains a high percent of thick material, such as logs, tree tops, and large limbs
H. Medium fuel--Contains light material, such as limbs and tree tops less than 4 inches in diameter
I. Light fuel--Contains grass and leaves with some small limbs and twigs
J. Backfire--Burning against the wind
K. Strip head fire--Burning with the wind using short headfires for a safe fire line
L. Spot fire (also called checkerboard or area ignition)--Setting of a series of small fires that burn together before the momentum of an uncontrolled fire is reached
M. Flank fire--Line of fire set into the wind so that it burns at right angles to the wind.
N. Fahrenheit--Measure of temperature with 212° at boiling and 32° at freezing
INFORMATION SHEET

II. Reasons for prescribed burning

A. Reducing hazardous excessive fuels
B. Controlling disease
C. Controlling hardwood
D. Preparing seedbeds
E. Preparing planting sites
F. Improving wildlife habitat

III. Desirable wind conditions (as measured on the burn site)

A. Direction
   1. Southwest or north
   2. East winds not reliable

B. Velocity
   1. Minimum 2 mph
   2. Maximum 7 mph

   (NOTE: Wind velocity generally increases from morning to late afternoon.)

IV. Relative humidity (Transparency 1)

A. Preferred relative humidity range
   1. Minimum 30%
   2. Maximum 50%
B. Effects of temperature on relative humidity

1. Increase of temperature decreases relative humidity
2. Decrease of temperature increases relative humidity

Relative Humidity Chart

<table>
<thead>
<tr>
<th>TEMP</th>
<th>RELATIVE HUMIDITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>86° F</td>
<td>16%  24%  31%  45%  57%  100%</td>
</tr>
<tr>
<td>68° F</td>
<td>28%  42%  54%  79%  100%</td>
</tr>
<tr>
<td>61° F</td>
<td>36%  53%  69%  100%</td>
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<tr>
<td>50° F</td>
<td>52%  77%  100%</td>
</tr>
<tr>
<td>43° F</td>
<td>67%  100%</td>
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<tr>
<td>32° F</td>
<td>100%</td>
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<td>4.85  7.27  9.41  13.65  17.31  30.4</td>
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</tbody>
</table>

GRAMS OF WATER VAPOR PER CUBIC METER

V. Temperature range for prescribed burning

A. Maximum 50°F.

B. Minimum 20°F.

(Note: This applies to winter burn and burning in stands, but not to summer burn or timber burn.)
VI. Tools for determining wind, relative humidity, and temperature
   A. Anemometer

   B. Psychrometer

VII. Steps of a burning plan
   A. Note weather conditions
      1. Days since last rain
      2. Wind direction and velocity
      3. Temperature range
      4. Relative humidity range
INFORMATION SHEET

VI: Tools for determining wind, relative humidity, and temperature

A. Anemometer

B. Psychrometer

VII. Steps of a burning plan

A. Note weather conditions

1. Days since last rain
2. Wind direction and velocity
3. Temperature range
4. Relative humidity range
INFORMATION SHEET

B. Determine prescribed burning technique

C. Survey manpower needs
   1. Firing
   2. Holding
   3. Patrol and mop-up

D. Survey equipment needs
   1. Tools, number and kind
   2. Radios
   3. Heavy equipment

E. Survey reinforcement crews
   1. Number
   2. Location

F. Determine fire behavior expected

G. Give overhead instructions
   (NOTE: These instructions are for crew leader, fire boss, and construction leaders.)

H. Determine test plot

VIII. Factors which determine the use of the backfire, strip head fire, spot fire, and flank fire techniques (Transparencies 2, 3, 4, and 5)

A. Backfire technique
   1. Heavy fuels
   2. Small timber (15-24 feet)
   3. Minimum scorch
   4. Not flexible (after fire lines are plowed)
   5. Large area ignited
   6. Most expensive technique
INFORMATION SHEET

B. Strip head fire technique
   1. Low temperature
   2. All fuels
   3. Medium to large timber (30 feet +)
   4. Large areas
   5. High relative humidity
   6. Flexible
   7. Variable winds

C. Spot fire technique
   1. Low temperature
   2. Large timber only (45 feet +)
   3. Light to medium fuels
   4. Variable winds
   5. Experienced personnel
   6. Cheapest technique

D. Flank fire technique
   1. Reliable wind
   2. Small areas only
   3. Inside area when exterior areas are made safe using backfire or strip head fire techniques
   4. Light fuels, not to be used in heavy fuels
   5. Medium to large timber
   6. Experienced personnel
Relative Humidity Affects Fuels

When relative humidity is low, fine fuels lose moisture to the atmosphere.

When relative humidity is high, fine fuels gain moisture from the atmosphere.
Backfire Technique

North

Wind

Walk Plow Up Creek Bank

Plow

Cultivated Field

Start and End Plowing

Start Fire

Successful Backfires Need Strong Wind

Wind

Dispersed Heat Prevents Crown Scorch
Strip Head Fire Technique

When Using 5 Men Set All 5 Lines At Once

North Wind

Plow this line if swamp is dry

Plow

Plow

Plow

Plow

Plow

Start Fire

Start Plowing

Dirt Road

Highway
Spot Fire Technique

Wind

North

Plowed Line

County Road
Flank Fire Technique
PRESCRIBED BURNING
UNIT

JOB SHEET #1—DETERMINE WIND DIRECTION AND VELOCITY,
RELATIVE HUMIDITY, AND TEMPERATURE.

I. Tools and materials needed
   A. Anemometer
   B. Compass
   C. Psychrometer
   D. Bottle or water
   E. Clipboard
   F. Pencil

II. Procedure
   A. Wind direction
      1. Use anything high enough to move with the wind, such as a
         handkerchief, cloth, or a filled balloon
      2. Locate the direction which gives maximum movement
      3. Use the compass to obtain the cardinal point
   B. Wind velocity
      1. Use the anemometer
         (Note: Ask the instructor to demonstrate the correct use of the
         anemometer if he has not done so.)
      2. Hold the anemometer with the windspeed scale facing you
      3. Read the scale at maximum movement
   C. Relative humidity
      Use the psychrometer
      (Note: Ask the instructor to demonstrate its correct use if he
      has not done so.)
JOB SHEET #1

2. Notice the three functional parts of the psychrometer
   a. Dry-bulb shows the temperature in Fahrenheit
   b. Wet bulb shows the evaporation rate temperature
   c. Relative humidity scales use the temperature reading of both dry and wet bulbs to give relative humidity

3. Fill the wet bulb moisture chamber with clean water

4. Open the psychrometer to sling position

5. Sling the psychrometer for one full minute

6. Read and record findings below

7. When completed, turn in to the instructor for evaluation

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</table>
PRESCRIBED, BURNING
UNIT II

JOB SHEET #2--DETERMINE PRESCRIBED BURNING TECHNIQUES

I. Tools and materials needed
   A. Clipboard
   B. Pencil
   C. Areas indicated by the instructor

II. Procedure
   A. Review the information sheet
   B. For each of the areas indicated by the instructor, list the burning technique to use
   C. Observe the timber height and fuel types
   D. Place an "X" under the technique which best describes the specific area in question
   E. Turn in to the instructor when completed

<table>
<thead>
<tr>
<th>Area No.</th>
<th>Backfire</th>
<th>Strip Head Fire</th>
<th>Spot Fire</th>
<th>Flank Fire</th>
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</tbody>
</table>
PRESCRIBED BURNING
UNIT II

TEST

1. Match the terms on the right to the correct definition.

   a. Controlled use of fire

   b. Speed of wind, usually measured in miles per hour

   c. Actual amount of moisture in air as compared to the amount that air could hold

   d. Instrument that gives wind speed

   e. Instrument that gives temperature and relative humidity

   f. Act of making a fire safe, after it has been controlled or burned, by putting out all embers and sparks at a prescribed distance from the fire line

   g. Contains a high percent of thick material, such as logs, tree tops, and large limbs

   h. Contains light material, such as limbs and tree tops less than 4 inches in diameter

   i. Contains grass and leaves with some small limbs and twigs

   j. Burning against the wind

   k. Burning with the wind using short headfires for a safe fire line

   l. Setting of a series of small fires that burn together before the momentum of an uncontrolled fire is reached

   1. Anemometer

   2. Light fuel

   3. Mop-up

   4. Fahrenheit

   5. Spot fire

   6. Medium fuel

   7. Prescribed burning

   8. Flank fire

   9. Strip head fire

   10. Psychrometer

   11. Backfire

   12. Wind velocity

   13. Heavy fuel

   14. Relative humidity

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m. Line of fire set into the wind so that it burns at right angles to the wind.

n. Measure of temperature with 212°C at boiling and 32°C at freezing.

2. Select from the list below the six correct reasons for prescribed burning by placing an "X" in the space provided.
   a. Controlling pine
   b. Improving wildlife habitat
   c. Controlling disease
   d. Improving seed germination
   e. Improving hardwood
   f. Reducing hazardous excessive fuels
   g. Controlling hardwood
   h. Preparing planting sites
   i. Preparing seedbeds

3. Select from the list below the most desirable wind direction and velocity.
   a. East wind
   b. West wind
   c. North wind
   d. South wind
   e. 7 mph
   f. 10 mph
   g. 17 mph
   h. 20 mph

4. List the range of preferred relative humidity and the effects of temperature change on relative humidity.
   a. Range
      1) 
      2)
Line of fire set into the wind so that it burns at right angles to the wind

Measure of temperature with 212° at boiling and 32° at freezing

2. Select from the list below the six correct reasons for prescribed burning by placing an "X" in the space provided.

_____ a. Controlling pine

_____ b. Improving wildlife habitat

_____ c. Controlling disease

_____ d. Improving seed germination

_____ e. Improving hardwood

_____ f. Reducing hazardous excessive fuels

_____ g. Controlling hardwood

_____ h. Preparing planting sites

_____ i. Preparing seedbeds

3. Select from the list below the most desirable wind direction and velocity.

_____ a. East wind

_____ b. West wind

_____ c. North wind

_____ d. South wind

_____ e. 7 mph

_____ f. 10 mph

_____ g. 17 mph

_____ h. 20 mph

4. List the range of preferred relative humidity and the effects of temperature change on relative humidity.

a. Range

1) 

2)
b. Effects
   1) 
   2) 

5. Name the desired range of temperature for prescribed burning.

6. Identify these illustrations by name.
   a. ____________________________ b. ____________________________
7. Arrange in numerical order the steps of a burning plan.
   a. Survey manpower needs
   b. Determine fire behavior expected
   c. Note weather conditions
   d. Determine prescribed burning technique
   e. Determine test plot
   f. Give overhead instructions
   g. Survey equipment needs
   h. Survey reinforcement crews

8. Distinguish between the prescribed burning techniques. Place a "B" in front of the factors that determine the use of the backfire technique, an "SH" for the strip head technique, an "S" for the spot fire technique, and an "F" for the flank fire technique. There may be more than one technique used for each determining factor given.
   a. Heavy fuels
   b. Medium fuels
   c. Light fuels
   d. Small timber
   e. Medium timber
   f. Large timber
   g. All fuels
   h. Not flexible
   i. Flexible
   j. Most expensive technique
   k. Cheapest technique
   l. Minimum scorch
   m. Low temperature
   n. High relative humidity
   o. Reliable wind
9. Demonstrate the ability to:

a. Determine wind direction and velocity, relative humidity, and temperature.

b. Determine the prescribed burning technique to use.

(Note: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
PREScribed Burning
unit ii

Answers to Test

1. a. 7     e. 10     i. 2     m. 8
   b. 12     f. 3     j. 11     n. 4
   c. 14     g. 13     k. 9
   d. 1*     h. 6     l. 5

2. b, c, f, g, h, i

3. c, e

4. a. Range
   1) Minimum 30%
   2) Maximum 50%

b. Effects
   1) Increase of temperature decreases relative humidity
   2) Decrease of temperature increases relative humidity

5. 20° to 50°

6. a. Psychrometer
    b. Anemometer

7. a. 3     e. 8
    b. 6     f. 7
    c. 1     g. 4
    d. 2     h. 5

8. a. B     h. B     o. F
    b. S     i. SH     p. SH or S
    c. S or F     j. B     q. S or F
    d. B     k. S     r. F
    e. SH or F     l. B     s. B or SH
    f. S, SH, or F     m. S or SH
    g. SH     n. SH

9. Performance skills will be evaluated to the satisfaction of the instructor.
INSECT DAMAGE IDENTIFICATION
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to list reasons for identifying insect damage and match direct and indirect control methods to the correct control class. He should also be able to identify classes of insect damage. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with insect damage identification to the correct definition.
2. List two reasons for identifying insect damage.
3. Match the symptoms to the damage class of insects.
4. Match the direct control methods to the correct control class.
5. Match the indirect control methods to the correct control class.
6. Demonstrate the ability to collect and identify insect damage.
INSECT DAMAGE IDENTIFICATION
UNIT III.

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Discuss terminal and specific objectives.
   D. Discuss information sheet.
   E. Demonstrate the ability to accomplish the procedure outlined in the job sheet.
   F. Arrange field trips to allow students an opportunity to practice identifying insect damage.
   G. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedure outlined in the job sheet.
   D. Participate in field trip.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Job Sheet #1-Collect and Identify Insect Damage
   D. Test
   E. Answers to test

I. Terms and definitions

A. Insect damage—Death, killing of plant organs, or the degrading of quality of wood and wood products

B. Epidemic—Explosion of insect population

(NOTE: The insects that cause damage are generally present, but in small numbers or endemic population

C. Sap suckers—Insects that have sucking mouth parts and live on the sap of plants

D. Leaf eaters—Insects that have chewing mouth parts and obtain food by eating leaves

E. Terminal feeders—Insects that attack the growing aerial tips of plants

F. Root feeders—Insects that live underground that suck sap or eat roots of plants

G. Seed and cone borers—Insects that bore into seeds and cones to lay eggs; the seeds are used as food in the larval stage

H. Larvae—A wormlike immature insect such as a caterpillar

I. Phloem eaters—Insects that eat the phloem tissue of plants

J. Phloem-wood eaters—Insects that eat both the phloem and wood of plants

K. Wood eaters—Insects that attack wood or wood products

L. Necrotic spots—Areas in the plant consisting of dead tissue

M. Galls—An abnormal growth on an organ of the plant which in many cases serves as a habitat for larvae

N. Wilting—The flacid shape of plant tissue that ceases to obtain water

O. Miners—Leaf eaters that eat only the inside tissue of leaves

P. Skeletonizers—Leaf eaters that eat all but the veins of leaves, thus, giving the appearance of a skeleton

Q. Defoliators—Leaf eaters that consume the entire leaf
INFORMATION SHEET

R. Leaf curlers--Insects that cause the plant to curl upon itself and to serve as a habitat

S. Flagging--The dying of branch tips

T. Pitch tubes--The massing of resin and frass at the entrance of an insect attack on the side of a tree

U. Frass--Insect excrement

V. Galleries--The tunnels formed by insects chewing through the inner bark

W. Scars--Dead and dying trees that turn a red color

X. Habitat--An environment suitable for a particular organism

Y. Shot pattern--The exit holes of insects that appear as a shotgun pattern on the side of a tree

Z. Biotic--Of a living condition

AA. Predators--Insects that eat other insects

BB. Parasites--Microscopic organisms that live within or on the body of insects

CC. Quarantine--A law that prohibits movement of any insect habitat such as live plants or certain wood material to another locality until preventative or control measures are met

DD. Embargo--A law that prohibits movement of an insect habitat to another locality

EE. Inspection--An orderly search of an insect habitat for eggs, larvae, or the adult insect

FF. Certification--A document which indicates that an inspection was performed and no evidence of insect infestation was found

II. Reasons for identifying insect damage

A. Rapid epidemic potential--Prevents epidemics

B. Most volume loss through death of timber--Prevents volume loss

III. Symptoms of damage class insects

A. Sap suckers
   1. Necrotic spots or galls on leaves and twigs
   2. Wilting

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INFORMATION SHEET

B. Leaf eaters
   1. Mining
   2. Skeletonizing
   3. Defoliating
   4. Leaf curling

C. Terminal feeders
   1. Flagging
   2. Resinous flow on conifers

D. Root feeders
   1. Wilting, eventual death
   2. Death on one side of the plant with no apparent reason

E. Seed and cone borers
   1. Hollow see h and cones
   2. Resinous flow from cones

F. Phloem eaters
   1. Pitch tubes
   2. Galleries inside bark
   3. Sorrels
   4. Emergent holes

G. Phloem-wood eaters
   1. Sawdust from entry holes
   2. Wood with sap flow

H. Wood eaters
   1. Sawdust
   2. Shot pattern
INFORMATION SHEET

IV. Direct control methods by classes
   A. Mechanical
      1. Collecting
      2. Trapping
      3. Destroying in habitat
      4. Debarking to kill eggs and larvae
   B. Biotic
      1. Predators
      2. Parasites
   C. Chemical
      1. Dusting
      2. Spraying
      3. Fumigating
      4. Poisonous bait

V. Indirect-control methods
   A. Mechanical
      1. Modify food supply
      2. Modify moisture conditions
      3. Modify temperature
   B. Biotic
      1. Increase competition
      2. Encourage parasites and predators
   C. Silvicultural
      1. Regulate composition or species improvement
      2. Regulate species vigor
INFORMATION SHEET

D. Statutory regulations

1. Quarantines
2. Embargoes
3. Inspection
4. Certification
INSECT DAMAGE IDENTIFICATION
UNIT III

JOB SHEET #1: COLLECT AND IDENTIFY INSECT DAMAGE

I. Materials needed:
   A. Pencil and paper
   B. Chart
   C. Insect damage chart, pictures, or key

II. Procedure
   A. Fill in the necessary information on the following chart
   B. Label the specimen with the same number used on the chart
   C. Sign your name to each specimen
   D. When completed, turn in to the instructor for evaluation
<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Tree Species</th>
<th>Date Found</th>
<th>Tree Organ Effected</th>
<th>Sap Sucker</th>
<th>Leaf Eater</th>
<th>Terminal Eater</th>
<th>Seed &amp; Cone</th>
<th>Root Eater</th>
<th>Phloem</th>
<th>Phloem-Wood</th>
<th>Wood</th>
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<td>8</td>
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</tr>
</tbody>
</table>

Place an "x" in the correct space for insect damage class.
### INSECT DAMAGE IDENTIFICATION

#### UNIT III

#### TEST

Match the terms on the right to the correct definition.

<table>
<thead>
<tr>
<th>a. Death, killing of plant organs, or the degrading of quality of wood and wood products</th>
<th>1. Larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. Explosion of insect population</td>
<td>2. Miners</td>
</tr>
<tr>
<td>c. Insects that have sucking mouth parts and live on the sap of plants</td>
<td>3. Wood eaters</td>
</tr>
<tr>
<td>d. Insects that have chewing mouth parts and obtain food by eating leaves</td>
<td>4. Sorrels</td>
</tr>
<tr>
<td>e. Insects that attack the growing aerial tips of plants</td>
<td>5. Flagging</td>
</tr>
<tr>
<td>f. Insects that live underground that suck sap or eat roots of plants</td>
<td>6. Certification</td>
</tr>
<tr>
<td>g. Insects that bore into seeds and cones to lay eggs; the seeds are used as food in the larvae stage</td>
<td>7. Biotic</td>
</tr>
<tr>
<td>h. A wormlike immature insect such as a caterpillar</td>
<td>8. Embargo</td>
</tr>
<tr>
<td>i. Insects that eat the phloem tissue of plants</td>
<td>9. Root feeders</td>
</tr>
<tr>
<td>j. Insects that eat both the phloem and wood of plants</td>
<td>10. Pitch tubes</td>
</tr>
<tr>
<td>k. Insects that attack wood or wood products</td>
<td>11. Leaf eaters</td>
</tr>
<tr>
<td></td>
<td>12. Phloem-wood eaters</td>
</tr>
<tr>
<td></td>
<td>13. Shot pattern</td>
</tr>
<tr>
<td></td>
<td>14. Leaf curlers</td>
</tr>
<tr>
<td></td>
<td>15. Insect damage</td>
</tr>
<tr>
<td></td>
<td>16. Skeletonizers</td>
</tr>
<tr>
<td></td>
<td>17. Inspection</td>
</tr>
<tr>
<td></td>
<td>18. Phloem eaters</td>
</tr>
<tr>
<td></td>
<td>19. Quarantine</td>
</tr>
<tr>
<td></td>
<td>20. Predators</td>
</tr>
<tr>
<td></td>
<td>21. Epidemic</td>
</tr>
</tbody>
</table>
INSECT DAMAGE IDENTIFICATION
UNIT III

TEST

1. Match the terms on the right to the correct definition.

   a. Death, killing of plant organs, or the degrading of quality of wood and wood products
   b. Explosion of insect population
   c. Insects that have sucking mouth parts and live on the sap of plants
   d. Insects that have chewing mouth parts and obtain food by eating leaves
   e. Insects that attack the growing aerial tips of plants
   f. Insects that live underground that suck sap or eat roots of plants
   g. Insects that bore into seeds and cones to lay eggs; the seeds are used as food in the larvae stage
   h. A wormlike immature insect such as a caterpillar
   i. Insects that eat the phloem tissue of plants
   j. Insects that eat both the phloem and wood of plants
   k. Insects that attack wood or wood products

   1. Larvae
   2. Miners
   3. Wood eaters
   4. Sorrels
   5. Flagging
   6. Certification
   7. Biotic
   8. Embargo
   9. Root feeders
   10. Pitch tubes
   11. Leaf eaters
   12. Phloem-wood eaters
   13. Shot pattern
   14. Leaf curlers
   15. Insect damage
   16. Skeletonizers
   17. Inspection
   18. Phloem-eaters
   19. Quarantine
   20. Predators
   21. Epidemic
17. Areas in the plant consisting of dead tissue
18. An abnormal growth on an organ of the plant which, in many cases serves as a habitat for larvae
19. The flacid shape of plant tissue that ceases to obtain water
20. Leaf eaters that eat only the inside tissue of leaves
21. Leaf eaters that eat all but the veins of leaves, thus, giving the appearance of a skeleton
22. Leaf eaters that consume the entire leaf
23. Insects that cause the plant to curl upon itself and to serve as a habitat
24. The dying of branch tips
25. The massing of resin and frass at the entrance of an insect attack on the side of a tree
26. Insect excrement
27. The tunnels formed by insects chewing through the inner bark
28. An environment suitable for a particular organism
29. Dead and dying trees that turn a red color
30. The exit holes of insects that appear as a shotgun pattern on the side of a tree
31. Of a living condition
aa. Insects that eat other insects

bb. Microscopic organisms that live within or on the body of insects

c. A law that prohibits movement of any insect habitat such as live plants or certain wood material to another locality until insect preventative or control measures are met

d. A law that prohibits movement of an insect habitat to another locality

e. An orderly search of an insect habitat for eggs, larvae, or the adult insect

ff. A document which indicates that an inspection was performed and no evidence of insect infestation was found

2. List two reasons for identifying insect damage.

a.

b.

3. Match the symptoms on the right to the specific damage class of insects by placing the correct numbers in the blanks provided. (Answers may be used more than once.)

a. Sap suckers 1. Mining

b. Leaf eaters 2. Leaf curling

c. Terminal feeders 3. Necrotic spots or galls on leaves and twigs

d. Root feeders 4. Sorrels

e. Seed and cone borers 5. Sawdust

f. Phloem eaters 6. Flagging

g. Phloem-wood eaters 7. Pitch tubes (Continued on next page)
<table>
<thead>
<tr>
<th>DIRECT CONTROL CLASSES</th>
<th>DIRECT CONTROL METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Mechanical</td>
<td>1. Dusting</td>
</tr>
<tr>
<td>b. Biotic</td>
<td>2. Predators</td>
</tr>
<tr>
<td>c. Chemical</td>
<td>3. Spraying</td>
</tr>
<tr>
<td></td>
<td>4. Destroying in habitat</td>
</tr>
<tr>
<td></td>
<td>5. Parasites</td>
</tr>
<tr>
<td></td>
<td>6. Collecting</td>
</tr>
<tr>
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<td>7. Fumigating</td>
</tr>
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<td></td>
<td>8. Trapping</td>
</tr>
<tr>
<td></td>
<td>9. Poisonous bait</td>
</tr>
<tr>
<td></td>
<td>10. Debarking to kill eggs and larvae</td>
</tr>
</tbody>
</table>
5. Match the indirect control methods on the right to the correct control class by placing the correct numbers in the blanks provided.

<table>
<thead>
<tr>
<th>INDIRECT CONTROL CLASSES</th>
<th>INDIRECT CONTROL METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Mechanical</td>
<td>1. Increase competition</td>
</tr>
<tr>
<td>b. Biotic</td>
<td>2. Quarantines</td>
</tr>
<tr>
<td>c. Sivicultural</td>
<td>3. Regulate composition</td>
</tr>
<tr>
<td></td>
<td>or species improvement</td>
</tr>
<tr>
<td>d. Statutory regulations</td>
<td>4. Embargoes</td>
</tr>
<tr>
<td></td>
<td>5. Inspection</td>
</tr>
<tr>
<td></td>
<td>6. Regulate species vigor</td>
</tr>
<tr>
<td></td>
<td>7. Modify food supply</td>
</tr>
<tr>
<td></td>
<td>8. Certification</td>
</tr>
<tr>
<td></td>
<td>9. Modify moisture</td>
</tr>
<tr>
<td></td>
<td>conditions</td>
</tr>
<tr>
<td></td>
<td>10. Encourage parasites</td>
</tr>
<tr>
<td></td>
<td>and predators</td>
</tr>
<tr>
<td></td>
<td>11. Modify temperature</td>
</tr>
</tbody>
</table>

6. Demonstrate the ability to collect and identify insect damage.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)
INSECT DAMAGE IDENTIFICATION
UNIT III

ANSWERS TO TEST

1. a. 15  l. 32  w. 27
   b. 21  m. 24  x. 4
   c. 28  n. 29  y. 13
   d. 11  o. 2  z. 7
   e. 31  p. 16  aa. 20
   f. 9  q. 22  bb. 25
   g. 23  r. 14  cc. 19
   h. 1  s. 5  dd. 8
   i. 18  t. 10  ee. 17
   j. 12  u. 30  ff. 6
   k. 3  v. 26

2. a. Rapid epidemic potential--Prevents epidemics
   b. Most volume loss through death of timber--Prevents volume loss

3. a. 3, 9
   b. 1, 2, 8, 11
   c. 6, 15
   d. 9, 17
   e. 13, 16
   f. 4, 7, 10, 18
   g. 12, 14
   h. 5, 19

4. a. 4, 6, 8, 10
   b. 2, 5
   c. 1, 3, 7, 9
5.  a. 7, 9, 11
    b. 1, 10
    c. 3, 6
    d. 2, 4, 5, 8

6. Performance skills will be evaluated to the satisfaction of the instructor.
FOREST BUSINESS METHODS
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to inspect a current timber sale for contract compliance and list the six basic items of selling timber. He should also be able to select from a list essential elements of an offer, items which may result in the termination of an offer, and the essential parts of a contract. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with forest business methods to the correct definition.
2. List eight categories of records necessary in a forest business operation.
3. List six basic items of selling timber.
4. Arrange in numerical order the steps of the bidding procedure.
5. Select from a list four essential elements of an offer.
6. Select from a list the seven items which may result in the termination of an offer.
7. Select from a list four essential parts of a contract.
8. Identify the parts of a contract.
9. Demonstrate the ability to inspect a timber sale for contract compliance.
FOREST BUSINESS METHODS
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information, assignment, and job sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information and assignment sheets.
   F. Demonstrate and discuss procedure outlined in the job sheet.
   G. Arrange field trips to allow students an opportunity to practice contract compliance.
   H. Give test.

II. Students:
   A. Read objectives.
   B. Study information sheet.
   C. Complete assignment sheet.
   D. Demonstrate the ability to accomplish the procedure outlined in the job sheet.
   E. Participate in field trip.
   F. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Assignment Sheet #1-Identify the Parts of a Contract
D. Job Sheet #1--Inspect a Timber Sale for Contract Compliance

E. Test

F. Answers to test

I. Terms and definitions

A. Need--In timber sales, the silvicultural need of the timber stand

B. Bidding procedure--The act of soliciting buyers to bid on a timber sale

C. Contract--An enforceable agreement between two or more parties

D. Contract compliance--The inspection of a going timber sale to check for adherence to the terms of the contract

E. Offer--A proposal by one person to enter into a legal relation with another

F. Offeror--The one who proposed the offer

G. Offeree--The one who accepts the proposal

H. Revocation--A withdrawal of an offer before it has been accepted

I. Rejection--To turn down an offer

J. Counteroffer--To make another offer instead of accepting the original offer

K. Consideration--A kind of bargained for price, not necessarily money

L. Competent parties--Persons having the legal right to form a contract

M. Legal objective--To contract for legal merchandise

N. Prospectus--Particulars of a sale of timber such as location, products, method of bidding, when to sell, and how timber is sold

II. Forest business records

A. Bookkeeping

B. Labor

C. Equipment

D. Inventory
INFORMATION SHEET

E. Timber tract
F. Cutting
G. Forest improvement
H. Maps

III. Basic items of selling timber
A. Need
B. Products available
C. Designation and measurement of products
D. Bidding procedure
E. Contract
F. Contract compliance

IV. Bidding procedure
A. Prospectus
B. Advertisement
C. Offer
D. Acceptance of offer

V. Essential elements of the offer
A. Offered with the intention of forming a contract
B. Considered more than a negotiating instrument
C. Definite and complete in content
D. Communicated from offeror to offeree

VI. Items which may result in the termination of an offer
A. Revocation
B. Unacceptable terms in the offer
C. Lapse of reasonable time
INFORMATION SHEET

D. Rejection
E. Counteroffer
F. Destruction of subject matter
G. Subsequent illegality

VII. Essential parts of a contract
A. Offer and acceptance
B. Consideration
C. Competent parties
D. Legal objective
ASSIGNMENT SHEET #1-IDENTIFY THE PARTS OF A CONTRACT

On the contract given on the following page locate, circle in pencil, and identify by number these parts:

1. Offer and acceptance
2. Consideration
3. Competent parties
4. Legal objective

When completed, turn in to the instructor for evaluation.
FOREST LANDOWNER-LOGGING OPERATOR CONTRACT

This CONTRACT made and entered into this _______ day of _________, 19____ by and between ___________________________ of ___________________________ (state), owner of timber to be cut hereinafter referred to as the Owner, and ___________________________ of ___________________________, hereinafter referred to as the Operator.

WITNESSETH:

Whereas, the Owner owns standing timber located in ___________________________ and whereas, the Operator desires to contract with the Owner to ___________________________ for the requirements of the Owner, now, therefore, it is agreed between the parties.

I. The Operator agrees that he will ___________________________ and ___________________________ all the marked or designated timber, standing and being on the ___________________________ owned by the Owner and situated in ___________________________.

II. The owner agrees to pay for the ___________________________ and ___________________________ of said timber the sum of ___________________________ per ___________________________ as measured by the ___________________________ rule by ___________________________ at the ___________________________. Payment for these services shall be made to the Operator on ___________________________.

III. The Operator agrees to use proper precautions to avoid damage to fences and other property of the Owner; and agrees to indemnify the Owner against any and all damage and injury to any person or persons, including employees of the Operator caused or arising out of said operation.

IV. The Operator further agrees that the work will be done in a workmanlike manner and completed on or before ___________________________.

V. The Operator agrees to comply with all federal and state laws or regulations controlling his operations, including state forest practices laws governing leaving of seed trees. The Operator agrees to indemnify and hold harmless the Owner from any and all claims or demands which may be made against him by reason of the Operator’s operation or violation by the Operator of any laws or regulations governing said operation.

VI. It is mutually understood by the parties hereto that the Operator is not an employee of the Owner, but that he is an independent contractor; also that if the Operator subcontracts any portion of the operation, the Operator as primary contractor shall be responsible for all acts by subcontractor.

VII. It is agreed between the Owner and Operator that the payment of ___________________________ per ___________________________ of timber cut as hereinbefore specified shall include full payment for the use of any and all equipment used in connection with the operation.
VIII. It is agreed that the Owner may terminate the cutting at any time by providing the Operator with written notice of date of termination at least \( \text{in advance of date of termination and by paying in full as above specified for all material} \) \( \text{by the Operator.} \)

In Witness Whereof, the parties have hereunto set their hands the day and the year first above written.

WITNESSES:

SIGNED:

(For the Operator) \hspace{1cm} \text{Operator}

(For the Owner) \hspace{1cm} \text{Owner}
JOB SHEET #1--INSPECT A TIMBER SALE FOR CONTRACT COMPLIANCE

I. Tools and materials needed
   A. Compass
   B. Copy of the sale contract
   C. Sale contract compliance summary form

II. Procedure
   A. Instructor will assign a plot of timber for sale
   B. Fill in the blanks provided on the attached sale contract compliance summary form on the following pages
   C. When completed, turn in to the instructor for evaluation
**JOB SHEET #1**

**SALE CONTRACT COMPLIANCE INSPECTION SUMMARY**

1. **SALE DESIGNATION**
   - (FOREST, COMPARTMENT, PURCHASER, DATE)

2. **DATE OF INSPECTION**
   - PAYMENT UNIT
   - PERCENT OF UNIT COMPLETED

3. **SUMMARY OF THE SALE AREA CONDITIONS AS REPORTED OR NOTED PRIOR TO INSPECTION FROM PREVIOUS INSPECTIONS OR "SPOT CHECKS"**

4. **PREVIOUS ACTION TAKEN TO SECURE CONTRACT COMPLIANCE; ORAL**
   - **WRITTEN**
   - BY
   - TO
   - (FOREST OFFICER)
   - (COMPANY REPRESENTATIVE)
   - (DATE)
   - NATURE OF REQUESTED COMPLIANCE

5. **COMPLAINTS REGISTERED BY PURCHASER**
   - (DATE)
   - (NATURE OF COMPLAINT)
   - (CITE ACTION TAKEN TO SETTLE WHEN TAKEN, WHO WITH, WRITTEN OR VERBAL, ETC. AND RESULTS)

6. **CONDITION FOUND (BASED ON SYSTEMATIC INSPECTION, STRIP LOCATED ON SALE AREA MAP):**
   - A. CUTTING OPERATION: LENGTH OF '1' CHAIN'STRIP ______ CHAINS = ______ ACRES INSPECTED:

<table>
<thead>
<tr>
<th>UNCut Marked Trees</th>
<th>Cut Trees/Logs Left</th>
<th>Trees Damaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIES</td>
<td>DBH</td>
<td>NO. LOGS</td>
</tr>
<tr>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
</tbody>
</table>

   | NUMBER OF 1/5 ACRE PLOTS CHECKED | ACRES INSPECTED |
   | _______ | _______ |

   | Stump Height | Waste-Long Butt & Top Breakage | Unmarked Trees Cut |
   | NO. OK | TOO HIGH | SPECIES | DIB | LGTH | VOLUME MBF OR CUFT | BUTT (D) TOP (T) BREAK (BR) | SPECIES | STUMP | NO. LOGS | VOLUME MBF OR CUFT |
   | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ |

   | Stump Height | Waste-Long Butt & Top Breakage | Unmarked Trees Cut |
   | NO. OK | TOO HIGH | SPECIES | DIB | LGTH | VOLUME MBF OR CUFT | BUTT (D) TOP (T) BREAK (BR) | SPECIES | STUMP | NO. LOGS | VOLUME MBF OR CUFT |
   | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ |

   | SPECIES | DIB | LGTH | VOLUME MBF OR CUFT | BUTT (D) TOP (T) BREAK (BR) | SPECIES | STUMP | NO. LOGS | VOLUME MBF OR CUFT |
   | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ | _______ |

B. **Log Making:** (Inormal) (Long Log) or (Tree Length)
   1. AVERAGE TRIM ALLOWANCE AS CUT ______ INCHES
   2. NUMBER OF LOGS MEASURES ______ NUMBER EXCEEDING TRIM ALLOWANCE ______

C. **Condition of Marking Paint**

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7. ROADS

A. ARE TEMPORARY LOGGING ROADS, SKID TRAILS, AND LOG LANDINGS CONSTRUCTED, MAINTAINED AND LAID-BY IN ACCORDANCE WITH CONTRACT SPECIFICATIONS? (IF "NO", EXPLAIN)

B. STATE PROGRESS AND COMPLIANCE WITH CONTRACT SPECIFICATIONS, OF SPECIFIED ROAD CONSTRUCTION

C. IS PURCHASER DOING HIS OWN REQUIRED SHARE OF SYSTEM ROAD MAINTENANCE, IS HE PERFORMING IN ACCORDANCE WITH A WRITTEN AGREEMENT DEFINING "HIS SHARE"? (IF "NO", EXPLAIN)

8. EROSION CONTROL

A. SEEDING DONE AS REQUIRED? (IF "NO", EXPLAIN)

B. ARE MILL SETS, CAMPS, ETC., PROPERLY LAID-BY AFTER ABANDONMENTS? (IF "NO", EXPLAIN)

9. SLASH DISPOSAL: ARE SLASH DISPOSAL REQUIREMENTS BEING MET CURRENTLY? (IF "NO", EXPLAIN)

10. FIRE CONTROL:

A. HAVE MILL SITES AND CAMPS BEEN FIRE-PROOFED; ARE SAFE ARRANGEMENTS FOR SLAB AND SAWDUST BURNING IN EFFECT? (IF "NO", EXPLAIN)

B. HAS PURCHASER MET OTHER CONTRACTUAL FIRE PREVENTION AND CONTROL REQUIREMENTS?

11. CONSUMER RETURN SCALE:

ANY OBSERVATION ON SALE AREA LEADING TO QUESTION ON RELIABILITY OF CONSUMER RETURNS:

12. OTHER: ADEQUACY OF PURCHASER SUPERVISION, SANITATION, SAFETY PRACTICES, PAYMENTS, ETC.

13. SUMMARY OF ACTION REQUIRED OF PURCHASER TO MEET REQUIREMENTS FOR ACCEPTANCE

14. FOLLOW-UP ACTION: ORAL WITH

(Name of Company Representative) (By) (Date)

(WRITTEN TO)

(PURCHASER) (By) (DATE) (RESULTS)

REVIEWED & APPROVED BY

(DISTRICT RANGER)

15. SUBMITTED: (DATE) (FOREST OFFICER) (DATE)

FINAL SPOT CHECK

(BY) (FOREST OFFICER)

NOTIFICATION OF PURCHASER IN WRITING

16. PAYMENT UNIT ACCEPTED (DATE) (DISTRICT RANGER)
FOREST BUSINESS METHODS
UNIT I

TEST

1. Match the terms on the right to the correct definition.

   a. In timber sales, the silvicultural need of the timber stand
   b. The act of soliciting buyers to bid on a timber sale
   c. An enforceable agreement between two or more parties
   d. The inspection of a going timber sale to check for adherence to the terms of the contract
   e. A proposal by one person to enter into a legal relation with another
   f. The one who proposed the offer
   g. The one who accepts the proposal
   h. A withdrawal of an offer before it has been accepted
   i. To turn down an offer
   j. To make another offer instead of accepting the original offer
   k. A kind of bargained for price not necessarily money
   l. Persons having the legal right to form a contract
   m. To contract for legal merchandise
   n. Particulars of a sale of timber such as location, products, method of bidding, when to sell, and how timber is sold

   1. Offer
   2. Counteroffer
   3. Competent parties
   4. Contract compliance
   5. Revocation
   6. Need
   7. Consideration
   8. Offeror
   9. Bidding procedure
   10. Legal objective
   11. Rejection
   12. Contract
   13. Ofference
   14. Prospectus
2. List eight categories of records necessary in a forest business operation.
   a.  
   b.  
   c.  
   d.  
   e.  
   f.  
   g.  
   h.  

3. List six basic items of selling timber.
   a.  
   b.  
   c.  
   d.  
   e.  
   f.  

4. Arrange in numerical order the steps of the bidding procedure.
   ______ a. Offer
   ______ b. Advertisement
   ______ c. Acceptance of offer
   ______ d. Prospectus

5. Select from the list below the four essential elements of an offer by placing an "X" in the blanks provided.
   ______ a. Definite and complete in content
   ______ b. Advertised for thirty days
   ______ c. Considered more than a negotiating instrument
   ______ d. Communicated from offeror to offeree
   ______ e. Offered with the intention of forming a contract
   ______ f. Written by a lawyer

6. Select from the list below the seven ways to terminate an offer by placing an "X" in the blanks provided.
   ______ a. Change of mind
   ______ b. Destruction of subject matter
   ______ c. Revocation
   ______ d. Lapse of reasonable time
   ______ e. Acceptance
   ______ f. Unacceptable terms in the offer
   ______ g. Subsequent illegality
   ______ h. Lack of advertisement
   ______ i. Rejection
   ______ j. Counteroffer

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7. Select from the list below the four essential parts to a contract by placing an "X" in the blanks provided.

- a. Legal objective
- b. Heading
- c. Competent parties
- d. Subject matter
- e. Consideration
- f. Offer and acceptance

8. Identify the parts of a contract.

9. Demonstrate the ability to determine a timber sale contract compliance.

(NOTE: If test questions 8 and 9 have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
FOREST BUSINESS METHODS
UNIT I

ANSWERS TO TEST

1. a. 6  f.  8  k.  7
    b. 9  g. 13  l.  3
    c. 12  h.  5  m. 10
    d. 4  i. 11  n. 14
    e. 1  j.  2

2. a. Bookkeeping  e. Timber tract
    b. Labor  f. Cutting
    c. Equipment  g. Forest improvement
    d. Inventory  h. Maps

3. a. Need  d. Bidding procedure
    b. Products available  e. Contract
    c. Designation and measurement of products  f. Contract compliance

4. a. 3
    b. 2
    c. 4
    d. 1

5. a, c, d, e

6. b, c, d, f, g, i, j

7. a, c, e, f

8. Evaluated to the satisfaction of the instructor.

9. Performance skill will be evaluated to the satisfaction of the instructor.