

Trees + Me =



Forestry

FOREST RESOURCES MEMBER'S MANUAL
INTERMEDIATE
 MINNESOTA EXTENSION SERVICE

UNIVERSITY OF MINNESOTA
 4-H YOUTH DEVELOPMENT



Trees +

Me =

Forestry



4-H Youth Development Forest Resources Project Intermediate Level

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4-H ENVIRONMENTAL PLEDGE

I WILL BECOME A LAND STEWARD
A PERSON WHO TAKES CARE OF THE EARTH.
I WILL EQUIP MYSELF WITH KNOWLEDGE,
SO THAT I CAN MAKE WISE DECISIONS ABOUT
FORESTS, WATERS, WILDLIFE, AIR, AND SOILS.
I WILL TEACH OTHERS TO RESPECT THE EARTH,
FOR IT IS OUR ONLY HOME.

SOARING EAGLES
PLEDGE



WRITE YOUR OWN ENVIRONMENTAL PLEDGE:

“ MY SPIRIT IS ONE WITH YOU,
GREAT SPIRIT. YOU STRENGTHEN
ME DAY AND NIGHT TO SHARE MY
VERY BEST WITH MY BROTHERS AND SISTERS. YOU,
WHOM MY PEOPLE SEE IN ALL OF CREATION AND IN
ALL PEOPLE, SHOW YOUR LOVE FOR US. HELP ME TO
KNOW, LIKE THE SOARING EAGLE, THE HEIGHTS OF
KNOWLEDGE. FROM THE FOUR DIRECTIONS, FILL ME WITH
THE FOUR VIRTUES OF FORTITUDE, GENEROSITY, RESPECT AND
WISDOM; SO THAT I WILL HELP MY PEOPLE WALK IN THE
PATH OF UNDERSTANDING AND PEACE. ”

- AN AMERICAN INDIAN PRAYER, AUTHOR UNKNOWN
COURTESY OF THE SOARING EAGLES 4-H CLUB,
MINNEAPOLIS, MINNESOTA

Chapter 1

TREES + ME = FORESTRY

AN INTRODUCTION TO FOREST RESOURCES

Visiting A New World

Imagine that you're an alien from another planet. You have just landed in the middle of a strange, yet beautiful, place. Giant living plants surround you. Brown furry creatures chatter from hidden branches. The air smells clean and fresh. Welcome to a forest!

A forest is an area of plants and animals made up mostly of trees. Every forest has layers of plants. These main layers are the **canopy**, the **understory**, and the **forest floor**.

The canopy is formed by the branches and leaves from the tallest trees. Beneath the canopy is the understory, where shorter trees and shrubs grow. The forest floor has seedlings, grasses, ferns, and crumbling plants and logs. Different kinds of plants and animals live in different layers of the forest.

Different kinds of plants and animals live in different kinds of forests, too. Why? Because forests have different soils, climates, and amounts of water. For example, a black spruce tree grows best in a wet, chilly forest. A red oak grows better where it is dry and warm.

Forest ecology is the study of how soils, sunlight, water, and other parts of nature work together to make a unique forest.

Any product that comes from the forest, or any use of a forest, is a **forest resource**.

On page 3 you'll find a crossword puzzle of forest resources.

Fill in the blanks to learn what the forest has to offer!





CANOPY

UNDERSTORY

FOREST FLOOR



**FORESTS ARE IMPORTANT
BECAUSE THEY:**

-  *feed and shelter wildlife*
-  *protect soil from blowing
or washing away*
-  *make the world beautiful*
-  *provide a place for
recreation*
-  *filter loud noises and
clean the air*
-  *provide timber for wood
products*

Forests help all of us in many ways.



Each person in the United States uses enough wood products in one year to make up a tree 100 feet tall and 16 inches in diameter!

**Resources
for Everyone**

Forestry is the study and practice of managing wooded lands. Forestry is a science. It also is a business and an art. Forestry is part of the field of **conservation**—the wise use of natural resources. **Foresters** are people who oversee the woods. They make sure that the forest makes the resources we need. They also make sure we will be able to enjoy these same things in the future.

Forests are **renewable resources**. For example, even though millions of Christmas trees are cut every year, there will be more in the future because they are renewable. If forests are taken care of, they will regrow.

Managing a forest for more than one use or product is **multiple-use management**. Foresters take care of forests not just for wood but also for wildlife. They plan for hikers. They make sure the forest stays healthy. They protect the soil and water. Foresters find the best balance among all products and uses.

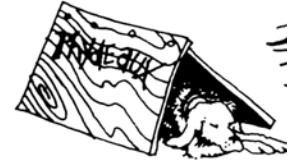
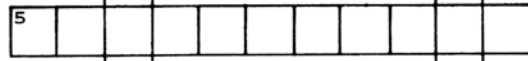
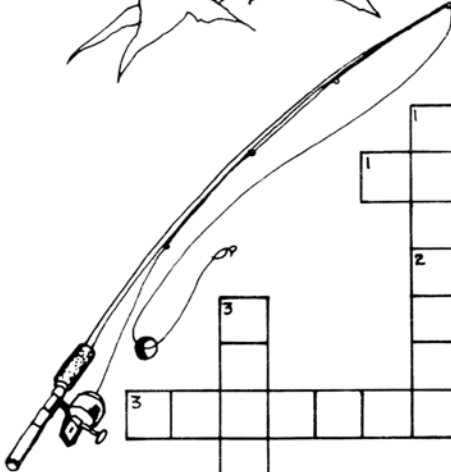
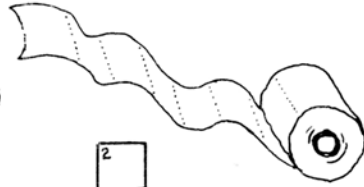
In the Lake States of Minnesota, Michigan, and Wisconsin, the wood products industry is a very important user of forest resources. The industry employs thousands of people. They make billions of dollars worth of wood products each year.



*Place an R by the items below that are renewable resources.
Place an N by the items that are nonrenewable
(cannot be replaced once used).*

- | | |
|--|-----------------------------------|
| <input type="checkbox"/> white cedar | <input type="checkbox"/> sunfish |
| <input type="checkbox"/> natural gas | <input type="checkbox"/> red pine |
| <input type="checkbox"/> raccoons | <input type="checkbox"/> diamonds |
| <input type="checkbox"/> garter snakes | <input type="checkbox"/> zinc |
| <input type="checkbox"/> copper | <input type="checkbox"/> coal |

Re-Tree-ve the resource!



ACROSS

- 1.) THIS SWEET, STICKY SUBSTANCE COMES FROM THE SAP OF A SUGAR MAPLE TREE.
- 2.) THIS INVOLVES LUNCHES, FUN, AND ANTS.
- 3.) THIS NEEDS A WORM, HOOK, AND LOTS OF LUCK.
- 4.) THESE COME FROM MAPLE, AND LIKE TO BE "KNOCKED OUT" WHEN YOU BOWL.
- 5.) MADE FROM THE PULP OF TREES, THIS CAN BE FOUND "ROLLING AROUND" IN BATHROOMS.
- 6.) THESE ARE MADE FROM TREE PULP, AND HOLD LOTS OF LEMONADE.

DOWN

- 1.) THIS REQUIRES A TENT, COOKSTOVE, AND LANTERN.
- 2.) WHEN TREES BREATHE, THEY MAKE THIS.
- 3.) THESE COME FROM WHITE ASH TREES, AND TURN KIDS INTO REAL SLUGGERS.
- 4.) MADE FROM WOOD, THESE HELP YOU DO YOUR HOMEWORK.
- 5.) TREES PROTECT THIS BY KEEPING SOIL AND POLLUTION FROM ENTERING STREAMS.
- 6.) THIS REQUIRES HEALTHY MINDS, STRONG FEET, AND A WALKING STICK.
- 7.) THIS COMES FROM LOGS, AND IS USED TO BUILD HOUSES.

Forests provide many jobs

CAN YOU MATCH EACH DRAWING WITH A CAREER?



Minnesota State Fair

4-H Forest Resources Premium List rules are:

1. The exhibit should not exceed 12" deep x 18" wide x 22" high.
2. Exhibits should include a project title and your name.

See the booklet *State Fair Premium Guidelines*, available from your local county extension agent for information.

TIPS FOR MAKING A THREE-SIDED DISPLAY:

- ✓ It's a good idea to get your leader, parent, or other adult to help you.
- ✓ Use a material such as hardboard, particleboard, or plywood. Poster board is not as sturdy.
- ✓ Open displayed dimensions should not exceed 12 inches deep by 18 inches wide by 22 inches high.
- ✓ Use hinges to attach the sections to each other.
- ✓ Paint or cover the background with adhesive paper, if you'd like.

Points to Ponder

on your nature walk

🌲 Which trees and plants are sun-loving? 🌲 What animals did you see on your walk? 🌲 Which layers of the forest did they use? 🌲 What insects did you see on the forest floor? 🌲 In the understory? 🌲 In the canopy? 🌲 Which layer of trees or plants gets the most rain? 🌲 Which layer gets the least?

Plan a family outing to a park or forest. Look at the types of resources that are provided for visitors and answer these questions:

🌲 What evidence of logging (trees being cut) do you see in the woods? 🌲 Describe any hiking trails, snowmobile trails, docks on lakes, or other signs of recreation. 🌲 What things were done to keep the woods beautiful? 🌲 Were trees left standing along the major roads? 🌲 What signs of wildlife did you see? 🌲 What information is posted about bears or other animals? 🌲 Does the air smell clean, and is the water clear?

Take this chance to tell your family what you know about multiple-use management.

Exhibits & Fair Projects

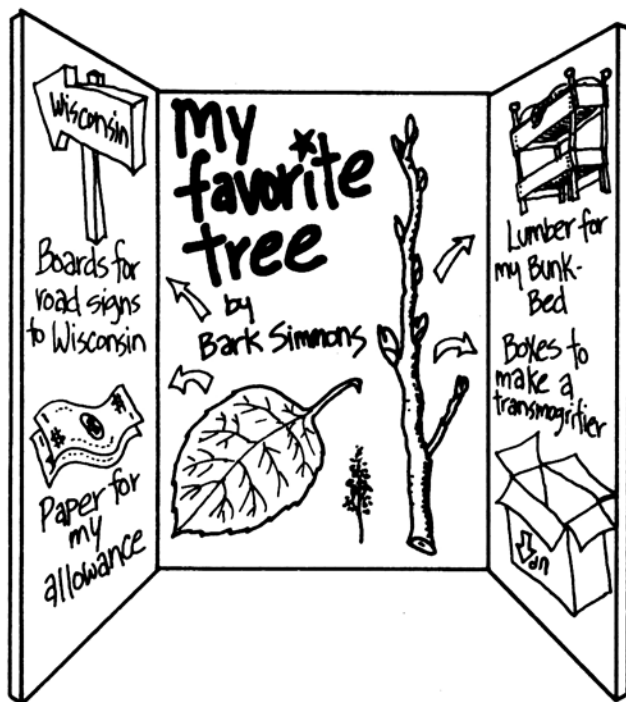
Prepare a display of items collected from the canopy, understory, and forest floor. Use items that are compact enough mount on a three-sided display board or in a box. You can press mosses, grasses, and small plants in a telephone book or thick catalog, or dry them in a sunny place for a few days before mounting. Mount dead insects or worms with pins (see *Your 4-H Entomology Project*, available from your county extension agent, for instructions). Record where you found each item—canopy, understory, or forest floor. Collect at least six examples from each forest layer.



Draw your favorite tree. Mount the drawing on poster board. Draw some products and uses we can get from this tree (for example, furniture or a place to hang a swing). You'll have to do a little research (try an encyclopedia or a book on trees) to list the right products, since different kinds of trees give us different items.

Prepare a display of renewable and nonrenewable resources, using samples (a small piece of wood or a rock, for example) or drawings and photographs. Mount the items on a three-sided display board. Label which items are renewable and which are nonrenewable.

Prepare a display on a job related to the forest (for example, wildlife biologist or forester). Include photos or drawings of different job duties, such as checking survival in tree plantations or managing a timber sale. Mount these drawings on a three-sided display board.



Answers

RE-TREE-VE THE RESOURCE:

ACROSS:

1. maple syrup
2. picnicking
3. fishing
4. bowling pins
5. toilet paper
6. paper cups

DOWN:

1. camping
2. clean air
3. baseball bats
4. pencils
5. clean water
6. hiking
7. lumber

.....

RENEWABLE/NONRENEWABLE QUIZ:

Renewable resources
white cedar, raccoons, sunfish, red pine,
and garter snakes.

Nonrenewable resources
natural gas, copper, zinc, diamonds,
and coal.

.....

JOB MATCH:

- | | |
|--------------------------|---------------------------|
| <u>A</u> soil scientist | <u>E</u> hydrologist |
| <u>B</u> truck driver | <u>F</u> logger |
| <u>C</u> mill technician | <u>G</u> wildlife manager |
| <u>D</u> forester | <u>H</u> park ranger |

.....

QUIZ FOR THE REAL WHIZZES:

- | | |
|-------------------|-----------------------|
| 1. canopy | 5. multiple-use |
| 2. forest ecology | 6. renewable resource |
| 3. conservation | 7. understory |
| 4. forestry | 8. forest floor |



Below is a puzzle that has the common names of 15 trees hidden within the letters. Circle the tree names when you find them. The letters can be used more than once and the names can run across, up, down, or diagonally.

HCTAMCAKLOBLO
 ISSWALNUTRJWL
 CEBUROAKAKAHL
 KLBIGDEDCLCIY
 OUFIRAEANEKTS
 RCSLICRUCCPEH
 YRATGAHMEUIPO
 IEMOMQEVARNIZ
 LHHAZLLASPENT
 RETARPMOHSLEL
 TNUPFREDDPINEE
 BLPNREHTUOSFA



- sugar maple
- bur oak
- tamarack
- white pine
- elm
- jack pine
- spruce
- birch
- hickory
- red pine
- fir
- cedar
- ash
- walnut
- aspen

Chapter 2

NAME THAT TREE!

AN INTRODUCTION TO DENDROLOGY

Dendrology For You and Me

Have you ever wondered what to call a tree? Each kind of tree has its own name. You need to know how to identify trees if you want to explore each tree's individual traits and uses. The science of tree identification is called **dendrology**.

Trees, just like all other living things, have both a **common name** and a **scientific name**. Most people use the common name of a tree. Jack pine, red maple, and American elm are common names for three trees.

A Naming Practice

Scientists and technicians use the scientific name for a tree. A tree has only one scientific name, but might have more than one common name, and may even have the same common name as another tree.

For example, red pine also is called Norway pine, but it has only one scientific name, *Pinus resinosa*.

Lodgepole pine in the Rocky Mountains is often called tamarack, but tamarack also is an accepted name of the eastern larch that grows in Minnesota. The scientific name for lodgepole pine is *Pinus contorta*, while the scientific name for eastern larch is *Larix laricina*.

The scientific system of classifying and naming plants, called **taxonomy**, helps foresters and others communicate clearly about trees. Taxonomy organizes living things into groups according to whether they have similar traits.



All living things are divided into two big groups called **kingdoms**. Every living thing belongs to either the plant or the animal kingdom. Each kingdom is then divided into smaller groups, and then those groups are divided into still smaller groups. The last, and smallest, group is **species**.

Below is an example of the classification of red (Norway) pine:

Kingdom.....Plant
 Division.....Spermatophyta
 Subdivision.....Gymnospermae
 Order.....Coniferales
 Family.....Pinaceae
 Genus.....Pinus
 Species.....resinosa

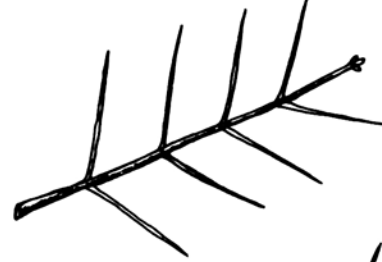
The scientific naming system is based upon the Latin language. Although the Latin names are important for foresters, you will not have to learn them here. Instead, we will focus on common names and tree identification.

Did you know that leaves are the most common identifying trait of a tree? But what happens when you try to use leaves to identify a tree when it is winter? You'll find some trees no longer have their leaves! **Coniferous** (remember "cone") trees retain their needles or leaves all winter in the Lake States. **Deciduous** trees drop their leaves in the fall in the Lake States. That's why it is smart to learn other special features of a tree, too, including:

fruit	cones
bark	growth form
twigs	buds
flowers	peculiar odor

Some specific identifying traits of trees are illustrated on this page and the next. Outside in your backyard or in a neighborhood park, collect as many leaves and twigs with these traits as you can find.

OPPOSITE BRANCHING



ALTERNATE BRANCHING

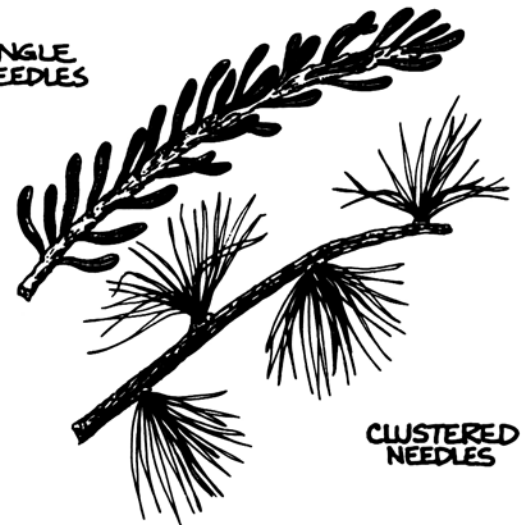


SIMPLE LEAF

COMPOUND LEAF

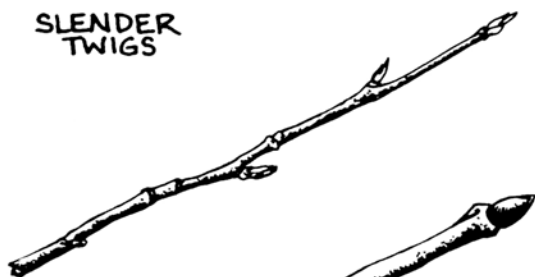


SINGLE NEEDLES



CLUSTERED NEEDLES

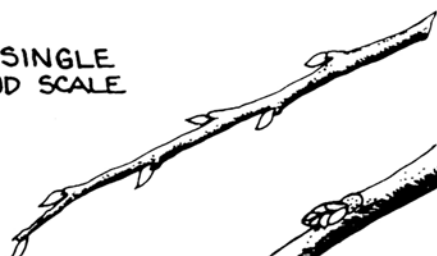
SLENDER TWIGS



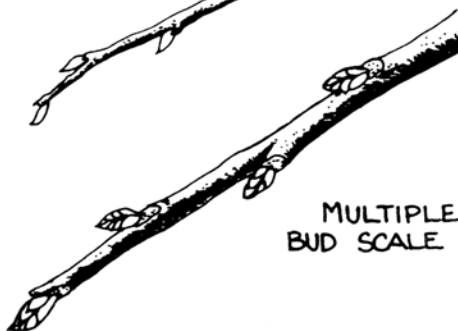
STOUT TWIGS



SINGLE BUD SCALE



MULTIPLE BUD SCALE



SERRATED LEAF MARGIN



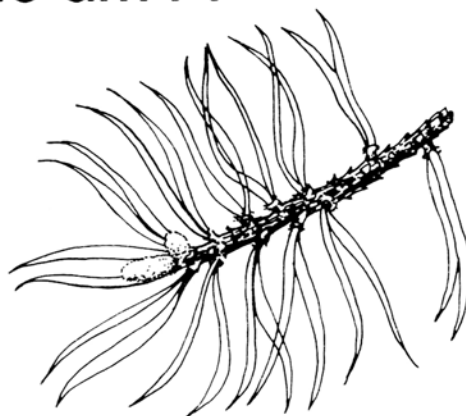
LOBED LEAF MARGIN



To help people identify unfamiliar trees, foresters and taxonomists have developed special identification charts called **keys**. Keys help you unlock the identity of a tree species by giving you choices based on traits of the tree. Each time you make a choice, you advance one step closer to learning a tree's name.

You can try your hand at a key by discovering which terrific tree is described below! Start at # 1 and follow the instructions until you reach the right answer!

Who am I ?



Tree Identification Key

1. Are my needles overlapping? NO! GO TO # 2.
2. Are my needles borne in clusters? NO! If they were, I'd be an eastern larch. Try the next # 2.
2. Are my needles borne singly? NO! Try the next # 2.
2. Are my needles borne in groups of two, two and three, or five? YES! GOOD! GO TO # 3.
3. Are my needles borne in groups of five? NO! If they were, I'd be a white pine! Try the next # 3.
3. Are my needles borne in groups of two and three, with long needles? NO! I only have groups of two needles. Try the next # 3.
3. Are my needles borne in groups of two? YES! GO TO # 4.
4. Are my needles bluish-green & twisted? NO! I'm not twisted! Try the next # 4.
4. Are my needles short and forked, like jackrabbit ears? YES! Who am I ?

Hi! MY NAME IS JACK! JACK PINE.

I have certain traits that make me different from all the other tree species in the forest. I am special! My needles are borne in groups of two, called a **fascicle**. They are short and forked, like jackrabbit ears. Do you think that could be where I got my name?

A Key Practice

Minnesota's Forest Trees

by Harold Scholten

Item NR-BU-0486

may be ordered from:

Distribution Center

Room 3 Coffey Hall, 1420 Eckles Ave.

St. Paul, Minnesota 55108

Let's classify the tree species in the **opposite-branching** drawing below. Use the summer key found on page 21 of *Minnesota's Forest Trees* (see ordering information above).

First, decide whether the tree is coniferous or deciduous. This tree is deciduous. Go to #1 in the deciduous key.

Next, determine if the leaves are **opposite** or **alternate**. These leaves are opposite, so advance to #2.

Are these leaves **simple**, or **compound**? The leaves are simple, so the next step is #3.



Compare the leaf with the two choices. Choose the rounded crotch and sparsely toothed options, and you have identified this tree as a **sugar maple!**

HERE'S THE SCORE

Using your yard or a nearby wooded lot, "key out" (identify) the tree species present. For each tree species you identify, write down its common name and the characteristics that helped you identify it.

Species

Identifiers

Species	Identifiers

🌲 How many deciduous trees did you identify? 🌲 How many conifers did you find? 🌲 How many trees did you identify using the leaves only? 🌲 How many trees did you identify using other characteristics? 🌲 What trait helped you the most in identifying the trees?

Practice using the keys on other trees. First practice on trees you can already name. After you have successfully keyed out trees you know, try to identify unknown trees. The more you practice, the more expert a "dendrologist" you'll become!

Quiz for the Real Whizzes

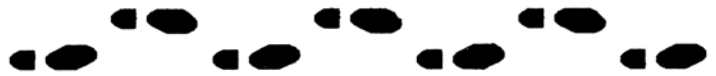
Fill in the blanks below using the words at the end. Whiz through this!

1. The smallest taxonomic group is the _____ .
2. The study of tree identification is called _____ .
3. _____ is the scientific naming system.
4. The largest taxonomic group is the _____ .
5. _____ help unlock the identity of different tree types.



keys
species
kingdom
dendrology
taxonomy

Career Considerations



A **silviculturist** (silviculture means growing trees) decides which tree species will grow best in a certain area. The silviculturist also helps trees reproduce and grow quickly by making sure they have enough sunlight, shade, water, and nutrients. To become a silviculturist, you really have to know your trees and the places they grow best! If you want to be a silviculturist, you can learn about trees at a university or college.

Leave the Answer To Me . . .

Choose several tree species you have identified. Pretend that you are in charge of naming them. What names would you give them? Why?

Tree-vial Pursuit

Mothers have Mothers Day, and ghosts and goblins have Halloween. But do trees have a special day? Yes! Arbor Day is a day set aside each year to honor trees. The first Arbor Day was celebrated in Nebraska on April 10, 1872. Today, Nebraska and all the other states, as well as some parts of Canada, celebrate Arbor Day.

How do you celebrate Arbor Day?
Plant a tree!



Yearning to Learn . . . ADDITIONAL ACTIVITIES

In the following activities, remember some basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

Make some Forest Flash Cards. You will need:

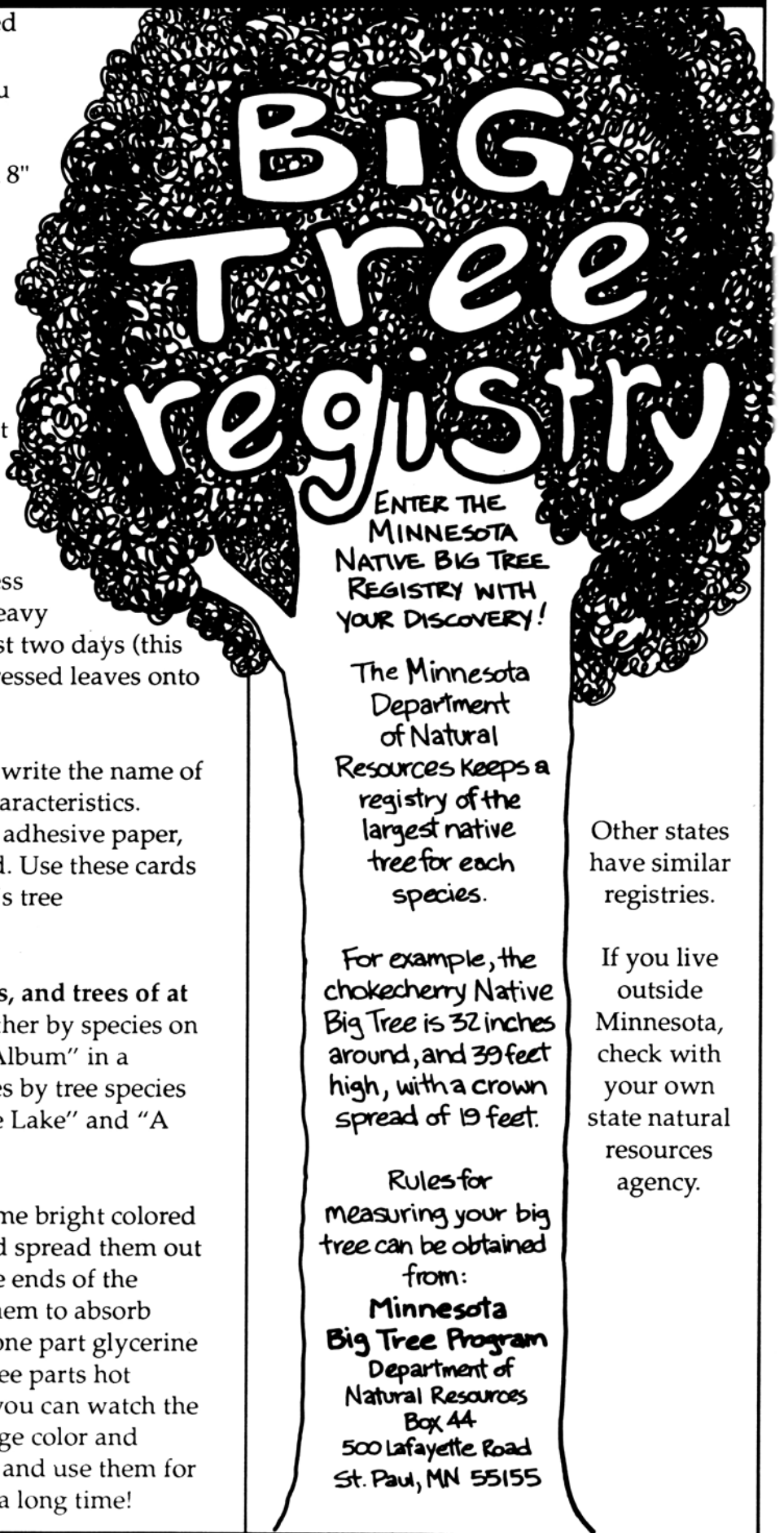
- ✓ stiff cardboard, cut into 5" x 8" pieces, or index cards
- ✓ leaves from different tree species
- ✓ a heavy telephone book or catalog
- ✓ a glue stick or rubber cement
- ✓ clear adhesive paper

Collect and identify leaves from at least eight different tree species. Press the leaves between the pages of a heavy telephone book or catalog for at least two days (this will help them dry out). Glue the pressed leaves onto the cards.

On the back of each, in bold letters, write the name of the species and some identifying characteristics. Cover the front and back with clear adhesive paper, trimming the edges close to the card. Use these cards with your friends to test each other's tree identification skills.

Photograph the leaves, twigs, seeds, and trees of at least ten species. Mount these together by species on a poster board, or make a "Family Album" in a regular photo album. Group pictures by tree species (for example, "A Linden Leaf by the Lake" and "A Linden Seed Lying on Loose Soil").

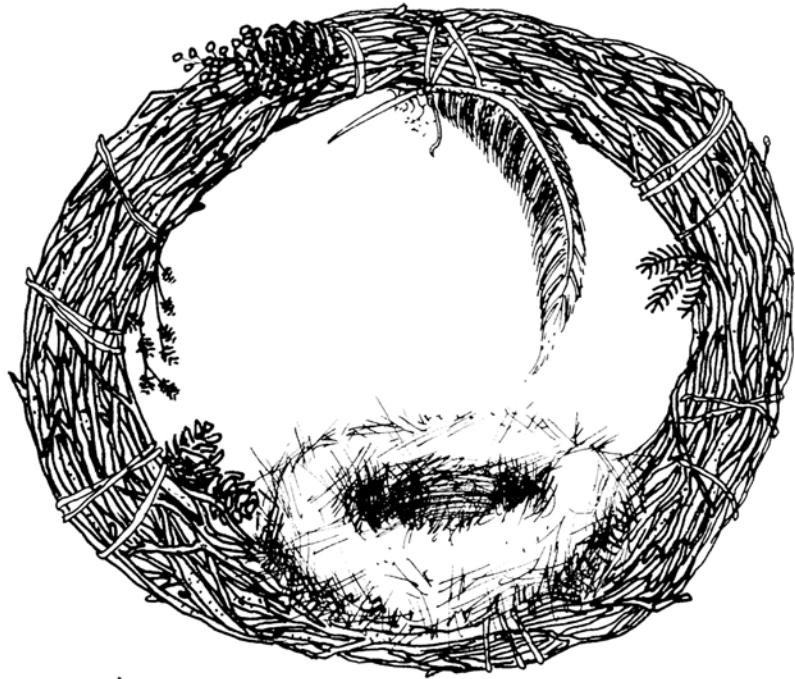
Preserve autumn leaves. Gather some bright colored leaves and small, leafy branches and spread them out on newspapers. Carefully smash the ends of the branches with a hammer to allow them to absorb water. Put them in a jar containing one part glycerine (available from drug stores) and three parts hot water. Set the jar someplace where you can watch the leaves for a week or so as they change color and texture. Then you can remove them and use them for decorations—they will stay soft for a long time!



Shape twigs into wreaths

Yearning to Learn... continued

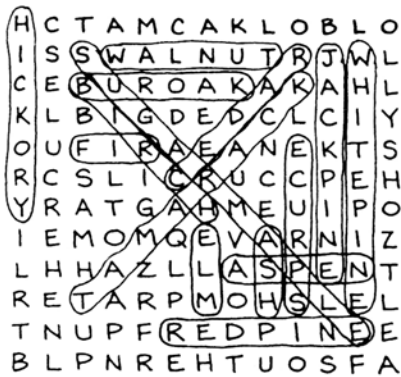
First, identify a tree such as paper birch or willow that has slender, pliable twigs. Get permission from the tree's owner to remove twigs from the tree. Cut some twigs and bend them into a wreath or circle. You may need several layers of twigs to form a complete circle. You can use the bottom of a bucket for a form. Lash the twigs together using twine or natural string. Decorate the wreath by gluing on moss, berries, feathers or other natural material.



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Answers

TREE PUZZLE:



.....

QUIZ FOR THE REAL WHIZZES:

1. species
2. dendrology
3. taxonomy
4. kingdom
5. keys

Exhibits & Fair Projects

Collect and display leaves, twigs, seeds, or stem/branch cross sections from six or more tree species. The cross section must be at least one inch in diameter, with bark. Label each species. Mount the collection on a three-sided display board or other backing. Your tree samples also can be arranged into a book. If you choose this option, use a leaf collection so the book will close flat.

Make a road map or key to identify six tree species from a collection of leaves. Use just one main group (coniferous or deciduous). Construct the road map to identify these leaves, and attach it to the leaf collection. Point out characteristics used to distinguish each leaf. Draw your road map on poster board, and mount your leaves at points along the way. Use your imagination!

Draw a yard map showing the location of your home and the trees around it. Name the tree species. Collect a leaf, twig, or seed from each tree, and glue it next to the drawing of the tree. Draw the map directly on white or art paper and mount it onto a three-sided display board or other backing.

THE LIFE OF A TREE

SEEDS AND TREE GROWTH

A New Beginning

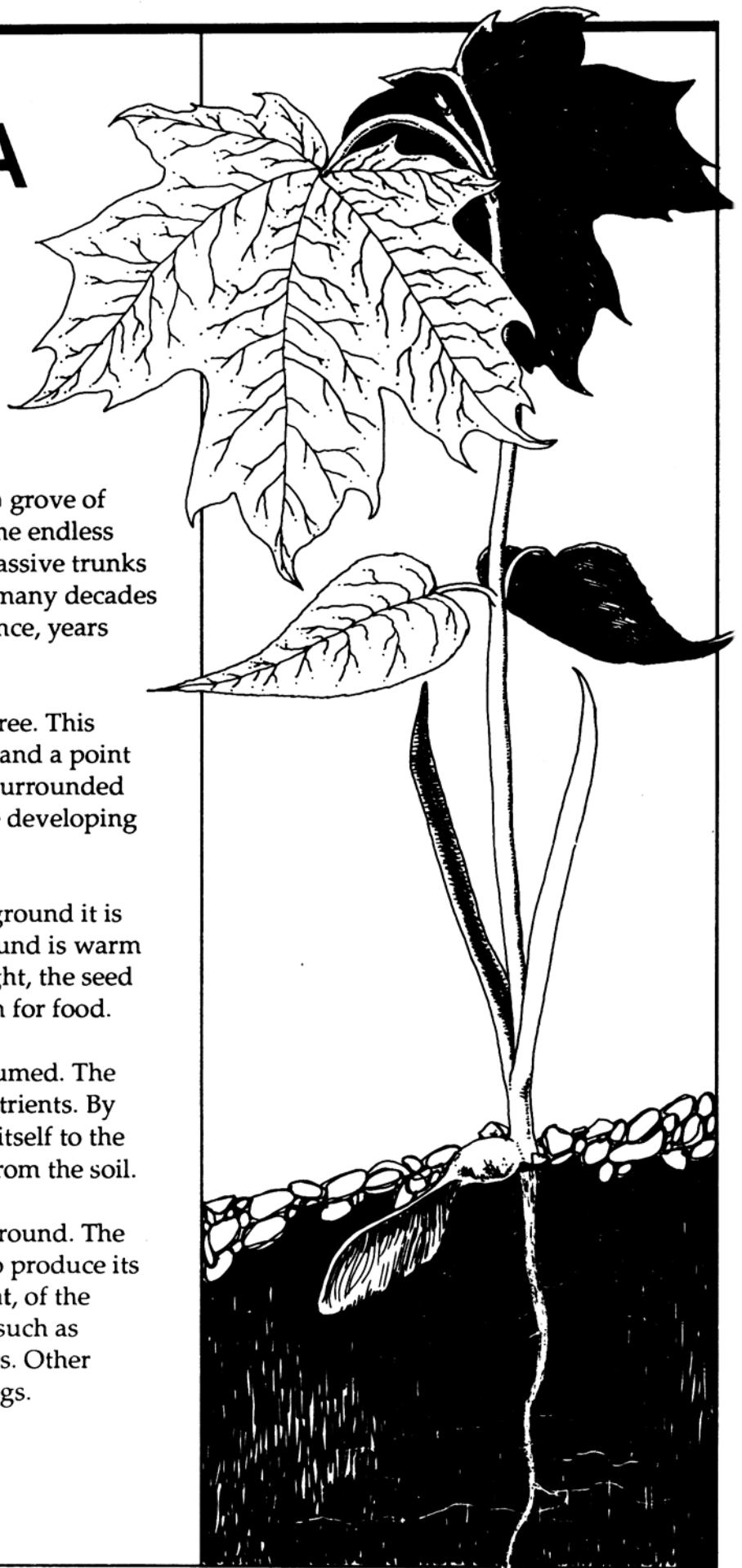
In the woods surrounding Lake Itasca, a grove of Norway pine stands silent, embracing the endless blue sky of an August day. The trees' massive trunks are deeply scarred by fires that burned many decades ago. They are old and grand now. But once, years ago, these giants were tiny seeds.

A tree seed contains an embryo (baby) tree. This embryo already has tiny leaves, a stem, and a point that will become a root. The embryo is surrounded by **endosperm**—the food supply for the developing tree.

Once the seed falls from the tree to the ground it is covered by leaves or dirt. When the ground is warm enough and other conditions are just right, the seed will begin to grow, using the endosperm for food.

Eventually, the endosperm will be consumed. The seed then must seek other sources of nutrients. By sending out a root, the seed can anchor itself to the ground and draw water and nutrients from the soil.

Finally, the tiny tree emerges from the ground. The leaves, which enable the growing tree to produce its own food, appear. The shell, or **seed coat**, of the embryo tree then falls off. Some seeds, such as acorns, have tough, protective seed coats. Other seeds, such as maple, have light coverings.



Seed Shuffle

Seeds are useful not only for reproducing trees, but also as sources of food for people and animals such as bears, squirrels, and songbirds.



Unscramble the letters below to identify the seed products and write them on the lines.

wasltnu _____

Popular for baking; unique flavor

bnecrierars _____

Grows in bogs; used in holiday baking

carnos _____

Made into flour by American Indians

uconoct _____

Grows in the tropics; seed is big & edible

ureiserbelb _____

Bears love these; they make great muffins!

zetushanl _____

Grows on shrubs; squirrels love them



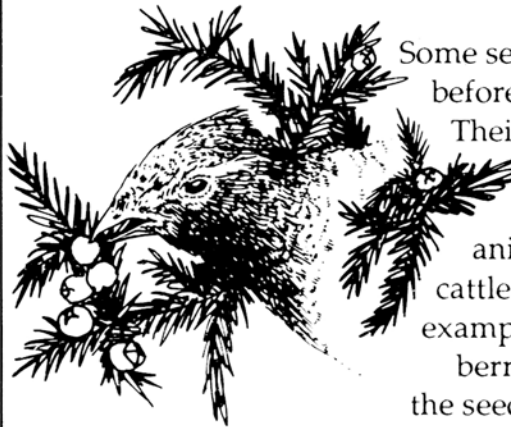
Seeds are scattered in many different ways. Animals eat seed-bearing fruit, and then deposit the seeds on the soil in their scat. Wind carries winged and other light seeds. Sticky seeds often cling to an animal's fur (or your sweater!) and ride along to a new location. Lakes and streams give seeds a "boat ride" to new areas. And, of course, gravity pulls seeds from the trees, giving them a long ride downhill to a new home.

The shaggy, spreading silver maple drops seeds onto the soil in the early summer.

These seeds are already mature, and will start to **germinate**, or grow, shortly after they hit the ground. The

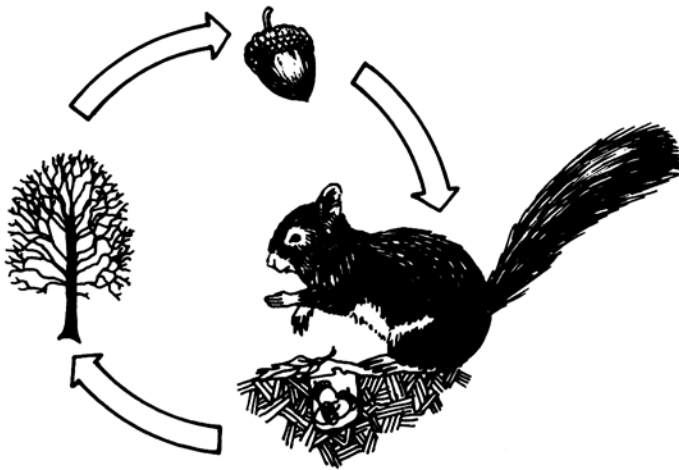


nut-bearing black walnut, on the other hand, drops its seeds in the fall. These seeds are **dormant**, and will not germinate until the spring. Dormant seeds must go through a cold spell before they germinate. In nature, winter provides this cold treatment.



Some seeds must be softened before they will germinate. Their tough seed coat can be softened by the digestive systems of animals such as birds or cattle that eat the seed. For example, grouse eat juniper berries and then disperse the seeds in their droppings.

Seeds from most tree species germinate best on bare mineral soil, which has the moisture that they need. Seeds germinating on leaf **litter** (leaves scattered on the forest floor) often die for lack of water. Their roots cannot penetrate dry litter to reach the moist soil.



A New Beginning Part II

Many trees get their start in life as seeds. But not all! Did you know there are other ways that trees can reproduce?

Stump sprouts develop from the stump of a recently cut tree. They commonly grow from the stumps of deciduous trees such as oak, basswood, and willow.

Root suckers are new shoots that develop from special buds on the roots of a few species of trees. Aspen trees grow from root suckers after the parent tree has been harvested. Root suckers grow very fast.

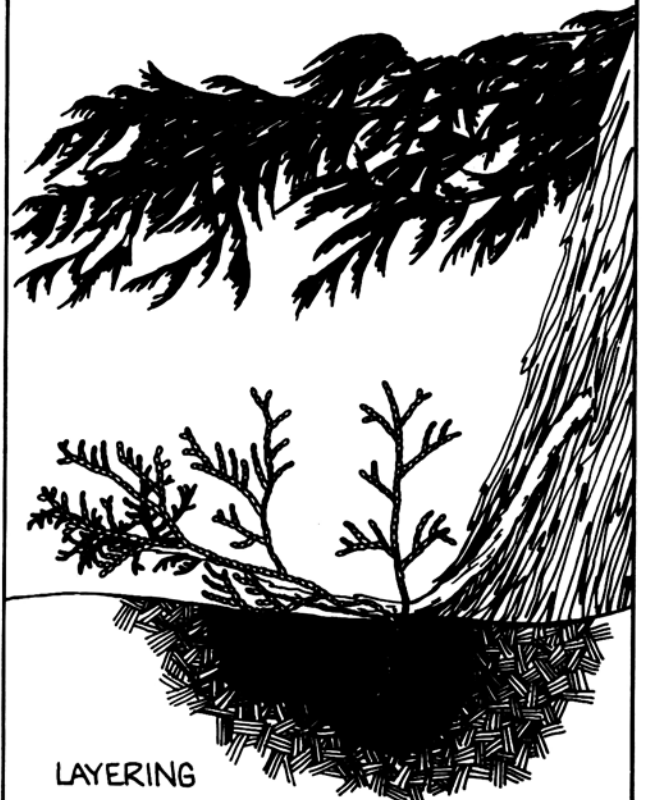
Layering occurs when the branch of a living tree touches the ground, becomes covered by leaf litter or soil, and takes root. A new tree is created at this junction. Northern white cedar is one tree that can reproduce by layering.



STUMP SPROUTS



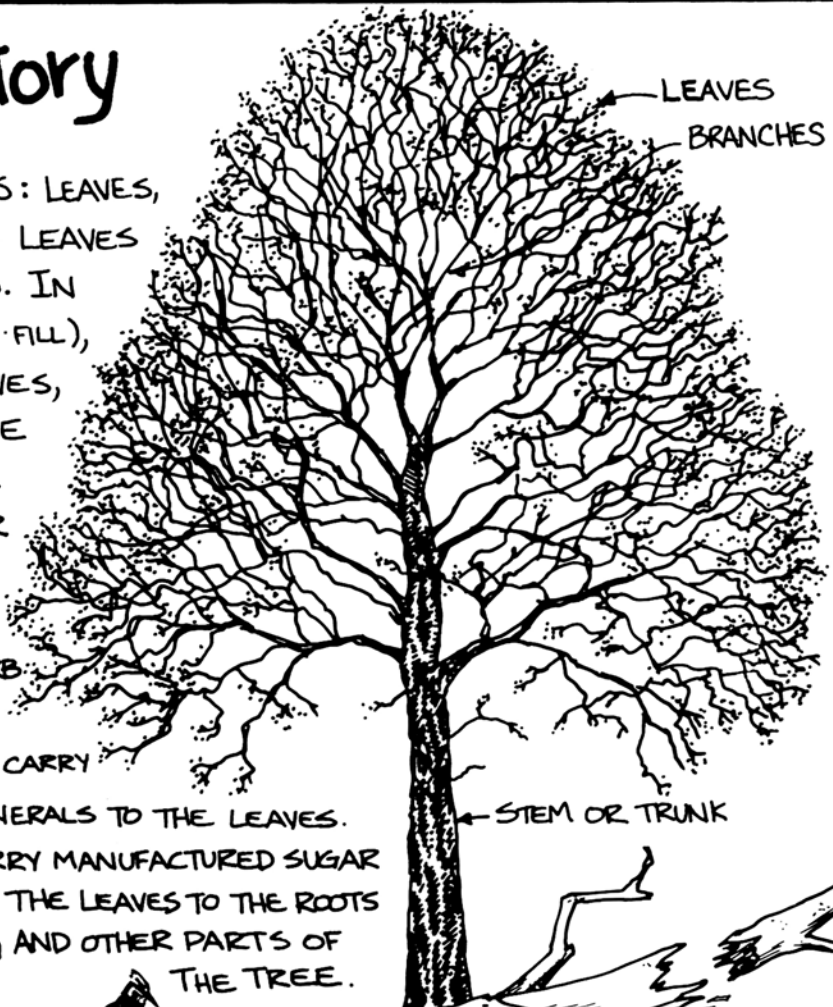
ROOT SUCKERS



LAYERING

The Forest Food Factory

A GROWING TREE HAS FOUR MAIN PARTS: LEAVES, BRANCHES, STEM OR TRUNK, AND ROOTS. LEAVES MAKE FOOD THROUGH PHOTOSYNTHESIS. IN PHOTOSYNTHESIS, CHLOROPHYLL (SAY KLOORO-FILL), A GREEN MOLECULE FOUND IN THE LEAVES, USES SUNLIGHT ENERGY TO REMOVE CARBON DIOXIDE FROM THE AIR. THE CARBON DIOXIDE IS MIXED WITH WATER FROM THE SOIL TO CREATE SUGAR. THE TREE USES THIS SUGAR AS FOOD. THE ROOTS ANCHOR THE TREE AND ABSORB WATER AND MINERALS NEEDED BY THE LEAVES. THE STEM AND BRANCHES ALSO CARRY



WATER AND MINERALS TO THE LEAVES. THEY ALSO CARRY MANUFACTURED SUGAR FROM THE LEAVES TO THE ROOTS AND OTHER PARTS OF THE TREE.






When a Tree Dies...

A TREE THAT DIES BUT REMAINS STANDING PROVIDES BIRDS AND OTHER ANIMALS WITH SHELTER AND FOOD. SUCH TREES, CALLED SNAGS, ARE AN IMPORTANT PART OF THE FOREST. EVENTUALLY, THOUGH, A SNAG WILL FALL OVER, PERHAPS PUSHED BY WIND, OR FINALLY TOPPLED BY GRAVITY ALONE. THEN DECOMPOSERS SUCH AS FUNGI, BACTERIA, AND EARTHWORMS GO TO WORK (SOME DECOMPOSERS START BREAKING DOWN LIVE TREES!). THEY DECAY THE TRUNK AND OTHER TREE PARTS INTO NUTRIENTS. THESE NUTRIENTS ARE RETURNED TO THE SOIL, WHERE OTHER TREES AND PLANTS CAN USE THEM AGAIN. NATURE IS THE ULTIMATE RECYCLER.

Growing . . . Growing . . . Grown!

We have looked at several ways in which a mighty tree starts its life. But how does a tree grow from a tiny shoot into a forest giant?

Trees undergo three different kinds of growth:

-  height
-  diameter
-  root

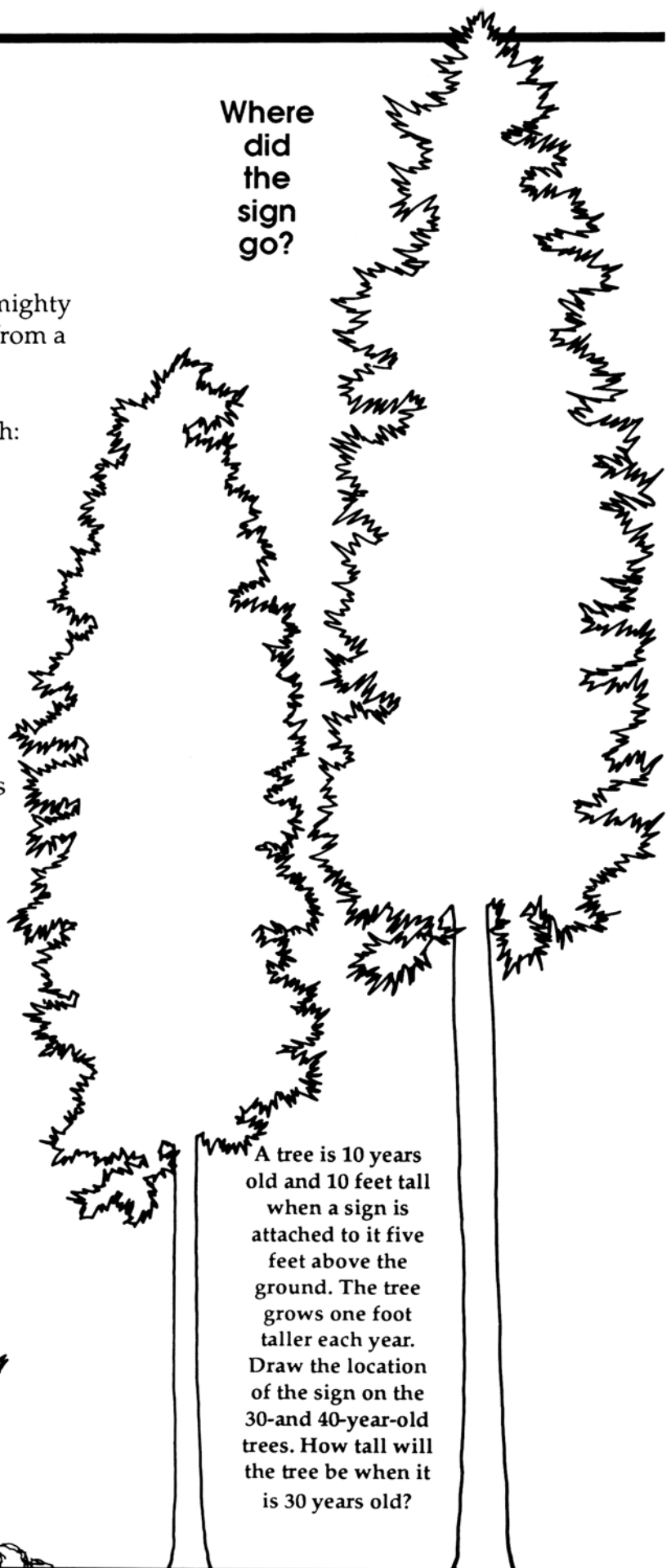
HEIGHT GROWTH

A tree expands in height from the growing points at the end of branches and stems. This means that trees grow from the top up, not from the ground up.

DIAMETER GROWTH

A tree grows not only up, but also out. Just beneath the bark is a thin layer of living cells called the **cambium**. The cambium is like a factory that makes two kinds of products. One, the wood, or **xylem** (zi-lem), is formed on the inside of the cambium layer. The other, called the inner bark, or **phloem** (flow-em), is added on the outside of the tree.

Where
did
the
sign
go?



A tree is 10 years old and 10 feet tall when a sign is attached to it five feet above the ground. The tree grows one foot taller each year. Draw the location of the sign on the 30- and 40-year-old trees. How tall will the tree be when it is 30 years old?

The Heart of the Story

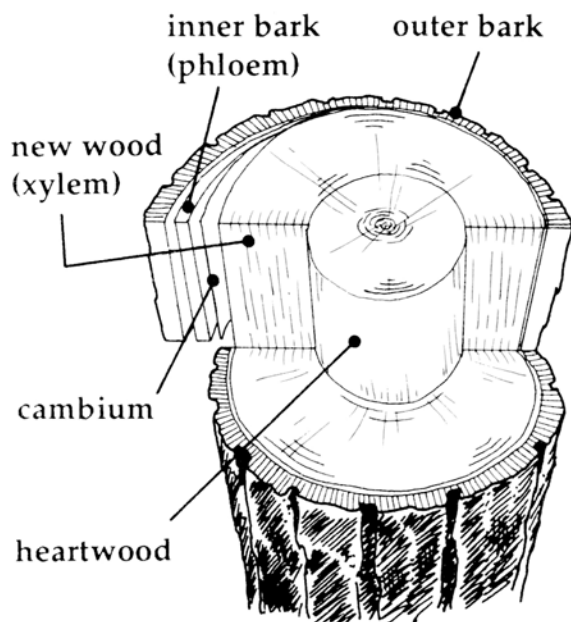
Outer bark is the “skin” of the tree. It protects the tree from injury, serves as a barrier to insects and diseases, and insulates the tree from winter cold and summer heat.

Inner bark (phloem) is a tube through which food travels from the leaves down to the branches, stem, and roots. When phloem cells die, they become part of the outer bark.

New wood (xylem) carries minerals dissolved in water upward from the roots.

A **cambium** cell layer is wrapped around the wood. It makes new bark (phloem) and new wood (xylem) every year.

Heartwood is the backbone of the tree. Heartwood is not living wood. It supports the tree. It also is the place where waste products from the tree collect.



If you hurt the cambium by bumping the tree with a lawn mower or carving your initials into the trunk, you damage the tree’s factory.

ROOT GROWTH

Roots expand in diameter from a cambium layer also. They grow longer from their tips, just like branches and main stems do. The major difference is that roots grow down instead of up.

Diary of a Paper Birch

I am a paper birch. The drawing on the next page shows a cross section of my trunk. Throughout the spring and summer, I add new layers of wood to my trunk. The wood I make in spring (**springwood**) grows very fast, and is lighter colored because the cells are large. The wood I make in the summer (**summerwood**) grows much more slowly, and the wood is dark because the cells are small. Each year’s growth of light and dark wood is called an **annual ring**. Count my dark rings, and you will know my age. If you study my annual rings closely, you can learn my life story.

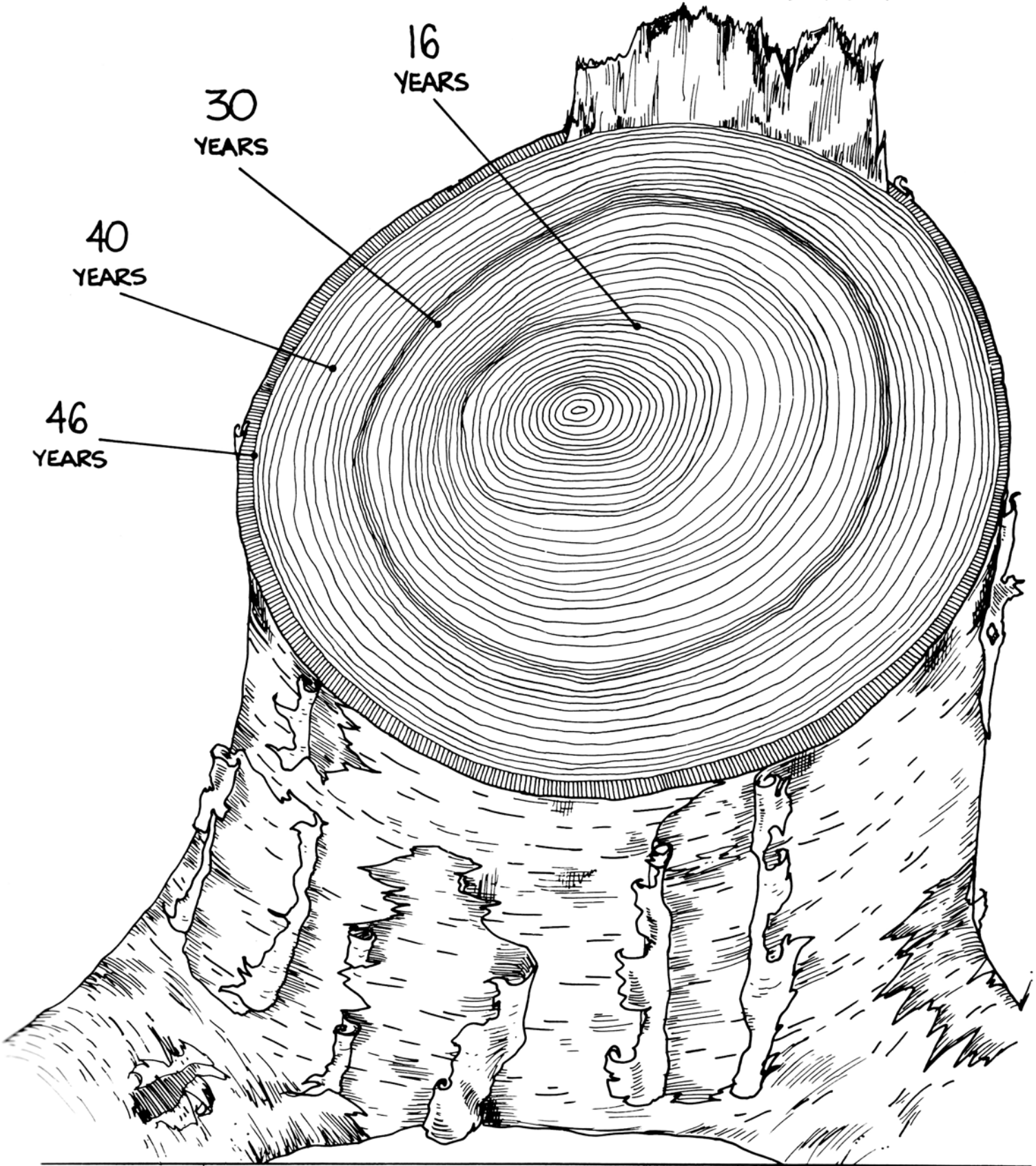
At 16 years of age, I was growing fast. That year I got lots of sunlight and plenty of rain. That year, the trunk of another tree leaned against me, tilting me at an angle. In order to stand upright again, I made my rings wider on the lower side. This extra growth, called **reaction wood**, helped me to balance myself.

When I was 30 years old, a terrible drought hit this forest. It lasted four years. I grew very slowly in those years, so my rings are very narrow. I thought I would soon be food for the decomposers, but I managed to survive.

At age 40, the forest had thinned from the last drought, so I had room to grow again. I didn’t have to compete with so many other trees for sun, water, and nutrients.

Now I am 46, and quite naturally slowing down a bit.
I have enjoyed my life in the forest watching all the
changes.

My scientific name is:
Betula papyrifera



Sugar kept in the leaves causes an increase in the production of certain chemicals that cause bright coloration. At the same time, the production of chlorophyll, which is green, drops.



Yearning to Learn . . . ADDITIONAL ACTIVITIES

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

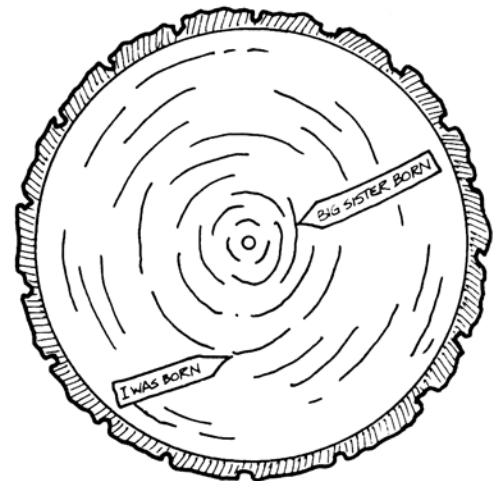
Collect and germinate seeds from a tree in your neighborhood. The kind of seed you should use depends on the time of year.

In the spring you will have the best luck with elm, red maple, or silver maple seeds. Plant these seeds in a pot in regular soil. Cover them with one-quarter of an inch of soil and keep the soil moist. Keep track of how many days it takes for the seeds to germinate. It may take a few weeks, so be patient!

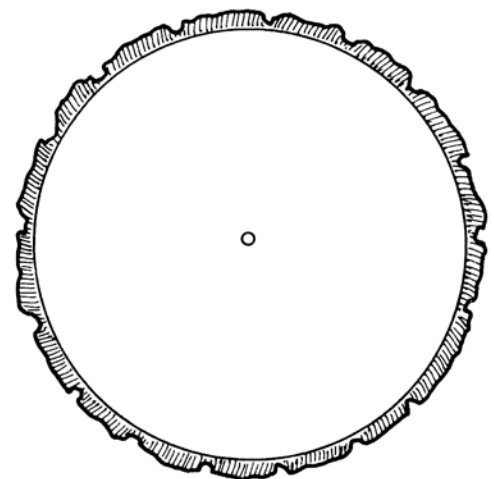
If you collect seeds in the fall, you will have the best results with pine seeds. You can plant seeds from red pine or jack pine as soon as you collect them. White pine seeds will need a pretreatment. To pretreat these seeds, place a moist paper towel on a small plate. Put the seeds on the paper towel and cover them with another moist paper towel. Place this seed "sandwich" on a dish in the refrigerator. Keep the paper towel moist. Change the paper about once a week. After about 60 days, remove the seeds and plant them in a pot one-quarter of an inch deep containing regular soil. Keep the soil moist.

Hunt for seeds in the woods. Collect as many different kinds of seeds as you can find. Where did you find these seeds? Were they on the ground, hanging from a branch, or floating on a lake? Are the seeds heavy? Are they big or small? How do you think they got to where you found them? Which (if any) are seeds that animals might eat?

MAKE A FAMILY TREE!



Obtain a cross section of wood at least two inches in diameter, preferably from a tree that is at least 40 years old. Starting from this year's growth, count back the rings and label (with a small label and glue) the ring that grew the year you were born. Do this for other members of your family, too. Draw your own family ring history here:



Answers



SEED SCRAMBLE:

1. walnuts
2. cranberries
3. acorns
4. coconut
5. blueberries
6. hazelnuts



GROWING . . . GROWING . . . GROWN!

At 30 years the tree is 30 feet tall. The sign is always at five feet since trees grow in height from the top, not the bottom.



QUIZ FOR THE REAL WHIZZES:

1. dormant
2. cambium
3. photosynthesis
4. stem and branches
5. germinates
6. xylem/phloem
7. summerwood
8. roots
9. leaves
10. springwood
11. chlorophyll

Exhibits & Fair Projects

Make a seed collection using at least eight different species grouped according to how the seeds travel. For example, your groups might include seeds distributed by animals, seeds eaten by birds, and seeds that float in the wind. Display your seeds in a box or glue them onto a three-sided display board. Also display each species' seed cut in half, to show the inside.



Prepare a display showing the life and death of a particular tree. Use drawings or models to show how this tree began life as a seed or by suckering, stump sprouting, or layering. Draw or build a model of the tree as a healthy adult, and then as a log on the forest floor. Illustrate what is happening to the log as it is decomposed. Use drawings, pieces of moss, leaves, and other forest matter to construct the display. Use either a three-sided display board or a box for your project.

Make a display based on a cross section of a tree stem. Your cross section should show at least 20 years' growth. Study the growth ring patterns and figure out this tree's "life story"—which years were good and which were tough. Label your cross section with dates, and prepare a short report explaining the annual ring patterns.

CHANGE IN THE FOREST

FOREST SUCCESSION

The Forces of Change

Centuries ago, the Lake States were covered with thick pine forests. Then the settlers came, bringing saws and plows. One by one they cut the towering red and white pines until only stumps and leftover aspen and birch remained. Fires started by passing trains or by the settlers burned through these areas. As farms grew, the pines disappeared. Change came to the forest.

Aspen and birch, a minor part of the original forest, now ruled the areas where pines once reigned. A new cycle of **succession**, the gradual change in the type and amount of plants in an area, had been started by the settlers.

Fire, logging, plowing, and other events sometimes disturb an area of land. When formerly dominant plants and trees are removed, succession begins. New plants take over the area where the old plants once lived.

Mark an "X" by the events that might start succession in a forest:

- | | |
|------------------------------------|---|
| <input type="checkbox"/> tornado | <input type="checkbox"/> logging |
| <input type="checkbox"/> hurricane | <input type="checkbox"/> fire |
| <input type="checkbox"/> floods | <input type="checkbox"/> large numbers of insects |
| <input type="checkbox"/> drought | <input type="checkbox"/> plowing/land clearing |



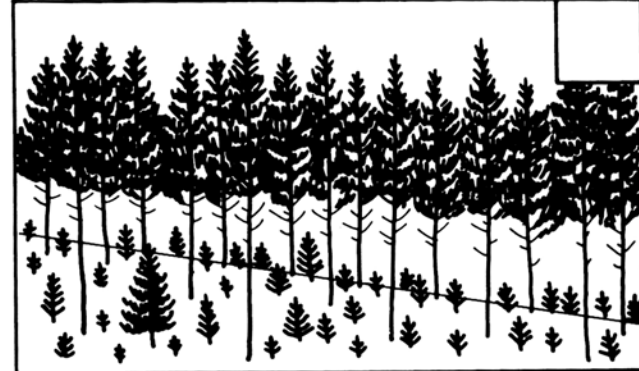


Made In the Shade

When you remove trees, you take away the shade for new trees on the ground. The first new seedlings to grow in this area often like sunlight, but not shade. Aspen, paper birch, and jack pine are some common **shade intolerant plants**, also known as **pioneers**.



Once shade intolerant trees settle into an area, they make a bit of a problem for themselves. Younger pioneer trees can't grow up in the shade of their taller parents. The younger pioneer trees, remember, need lots of sunlight. This means that different tree species will start to take over beneath the parents.



These other tree species are **shade tolerant**—they can grow and reproduce in the shade. Shade tolerant tree species include sugar maple, American basswood, white spruce, and balsam fir. When the pioneers die out, the shade tolerant trees dominate the area.

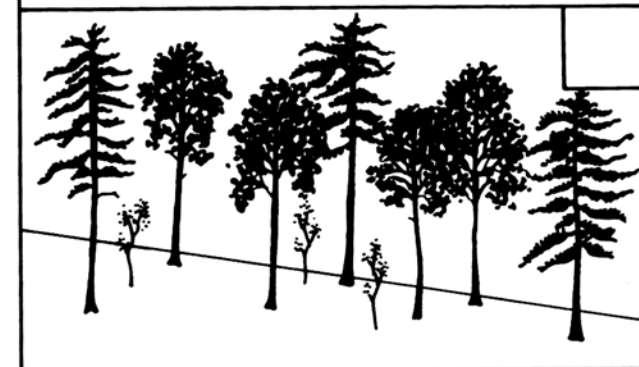
A **climax forest** is a forest in which the overstory trees are the same species as the understory trees. Climax trees remain until fire, harvesting, or another force disturbs the area again.



In the drawings at left, label the correct series of events in the succession. Use a "1" for the first stage, "2" for the second, and so on, until you reach a climax forest.

There's No Place Like Home

Animals are very particular about their surroundings. Every animal has a specific environment, or **habitat**, that it likes the best. This preferred habitat meets that animal's special needs for food, water, shelter, and space.



When a forest changes, the animal species that live there also change. Different stages of succession are ideal habitat for different types of wildlife.

Some animals are **generalists** because they like many types of habitats. The black bear likes berries found in the early successional stages of a forest. Yet the bear also needs mature forests for shelter.

Animals needing a specific habitat to survive are **specialists**. The pine marten, a member of the weasel family, needs older northern pine forests to survive. This type of forest gives the marten many ways to stay warm in the winter. It also gives it places to hide from its predators.

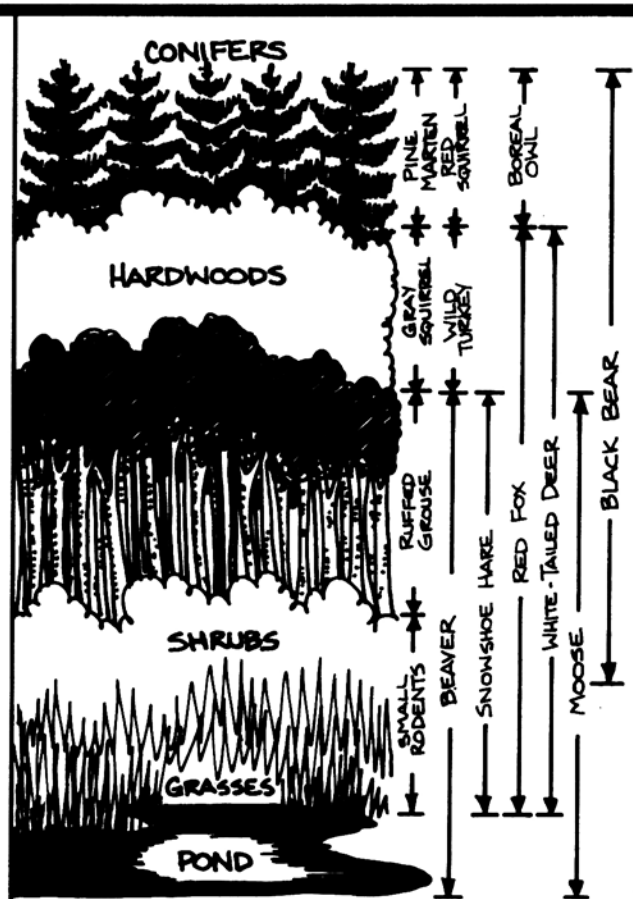
In the Pacific Northwest, the northern spotted owl needs old forests of Douglas fir and western hemlock. The northern spotted owl is a specialist because it survives best in one type of habitat.

When a habitat is changed, either by people or by nature, it can't support the same animals. For example, around 90 percent of the original Pacific Northwest forest has been logged. This loss of habitat has made it difficult for the spotted owl, an endangered species, to survive.

Succession and Products

Forest succession also affects the types of products a forest produces. A forest in the early stages of succession has many shade intolerant trees. These trees—aspens, jack pine, and black walnut—make good wood products. Often foresters will try to slow or stop succession, so that these favored trees can grow.

Other products need a climax forest. Sugar and black maple are needed to make maple syrup. Woodland owners who want to produce syrup will often try to make this successional stage last.



In this picture decide which animals would you call specialists. Why? Which animals would you call generalists? Why?

- pine marten:
- small rodents:
- ruffed grouse:
- gray squirrel:
- beaver:
- wild turkey:
- red squirrel:
- red fox:
- boreal owl:
- snowshoe hare:
- moose:
- black bear:
- white-tailed deer:

Shade Tolerance

🌲 Lake States Trees 🌲

INTOLERANT



- red pine
- jack pine
- tamarack
- black walnut
- paper birch
- eastern cottonwood
- quaking aspen
- black willow
- black ash

INTERMEDIATE



- eastern white pine
- red maple
- oaks
- American elm
- green ash
- white ash

TOLERANT

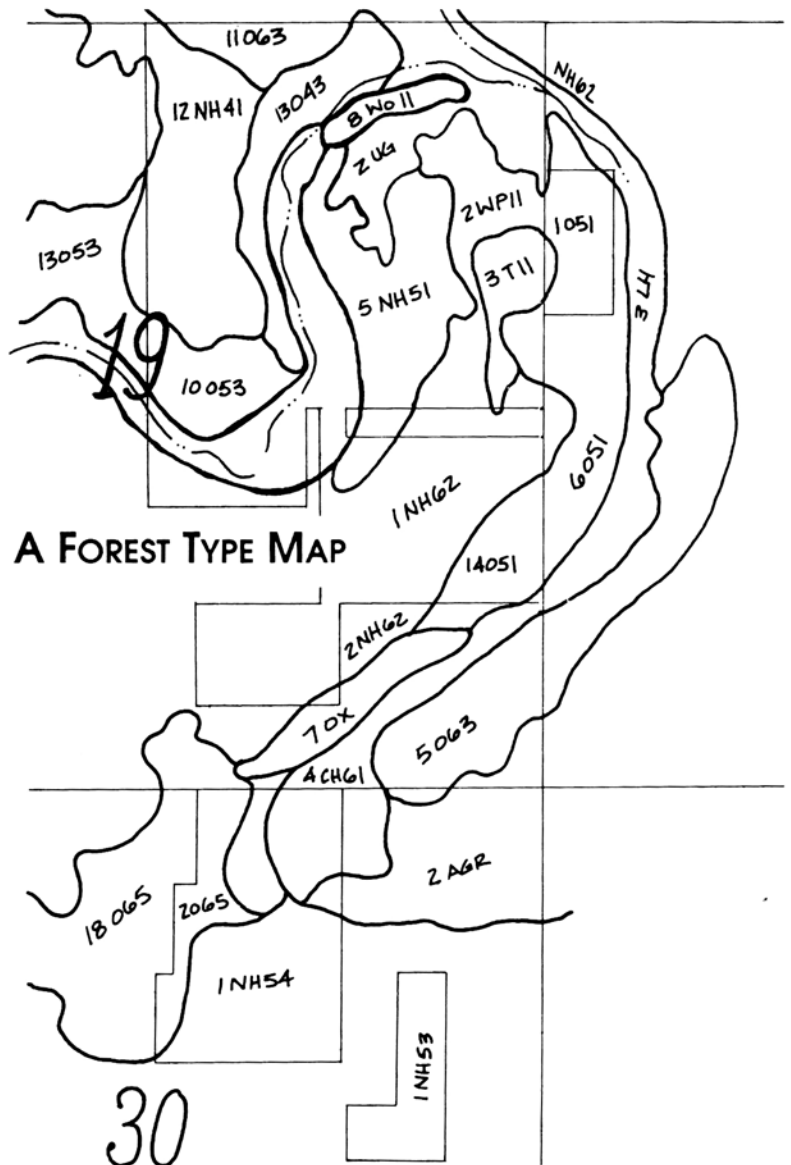


- balsam fir
- white spruce
- black spruce
- sugar maple
- ironwood
- white cedar
- American basswood

Forest Types

Each forest is a special blend of tree species growing together in one community. This collection of tree species is not random. Certain tree species occur together because they need similar soils, water, and light. We call a collection of species that occur together a **forest type**.

Forest types are named for their main tree species. Quaking aspen and paper birch rule an aspen-birch forest type, although other tree species also can be found there. Foresters often map the location of forest types. The map helps them decide how to manage certain areas.



See if you can match each tree species below with the forest type where it would be found. More than one species can match each forest type.

<u>SPECIES NAME</u>	<u>FOREST TYPE</u>
bigtooth aspen	maple-basswood
bur oak	
American elm	oak-hickory
balsam fir	
white birch	spruce-fir
eastern white pine	
northern pin oak	cottonwood-elm-ash
sugar maple	
black spruce	white-red-jack pine
red pine	
American basswood	aspen-birch
eastern cottonwood	

Career Considerations



A **wildlife manager** conducts habitat improvement programs, monitors wildlife populations, and teaches the public about **game** (hunted animals, such as deer and moose) and **nongame** (animals that aren't hunted, such as songbirds) wildlife. You'll have to know a great deal about animals to be a wildlife manager. A good place to start is at a college or university.

Quiz for the Real Whizzes

Fill in the blanks below using the words at the end. Whiz through this!

1. A _____ is an animal that can use many different types of habitat.
2. A collection of tree species that occur together is a _____.
3. _____ plants and trees love shade.
4. A gradual change in the type and amount of trees over a long period of time is called _____.
5. An animal that requires a certain type of habitat is a _____.
6. Invading intolerant plants also are called _____.
7. Plants that do not like shade are called _____.
8. A _____ forest exists when the tree species in the overstory are the same species found in the understory.



forest type	pioneers
climax	intolerant
tolerant	succession
specialist	generalist



Stake out and study an area of forest approximately as big as an average yard (40 feet by 40 feet). This forest can be a community forest within a city park, or you might want to do this activity on a camping trip. Count trees that make up the overstory and identify each.

Determine the forest type from the list of forest types on page 29.

Remember, forest types are named after the tree species that occur most often. If the species you find do not fit into a given type, name your own type using the two most common species in your plot.

Tree Species	# of Trees in Plot

Tree Species	# of Trees in Plot

Forest Type: _____

Leave the Answer to Me . . .

Are you a specialist or a generalist? What type of habitat do you prefer the most?

Tree-vial Pursuit

The male ruffed grouse claims a territory in the spring by jumping up on logs and making a loud drumming sound. He does this by beating his wings back and forth dozens of times every second. Can you move that fast?



Yearning to Learn... ADDITIONAL ACTIVITIES

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave the animal homes unchanged. Have a positive impact on the forest.

Choose one animal that lives in the forests around you. Find out what habitat it requires for food, shelter, and space. "Shelter" can include areas for nesting, sleeping, hibernation, and also escaping from predators or bad weather. Give a short presentation on which stages of forest succession your animal would need to meet these requirements.

Stake out a study area. (see left column).

Exhibits & Fair Projects

Observe succession in your own yard as a long-term project. Isolate, with some type of temporary fencing, a four-foot by four-foot area in your yard. Clear all the plants from this square to expose bare soil. Spade the area and remove any roots you find. Do not water, mow, or fertilize. Observe this area once a month. At each visit note the plants that are growing. Are they weeds, grasses, shrubs, or trees? If tree seedlings appear, try to identify them to the genus level (for example, oak, pine, or aspen).

Photograph or sketch your plot each time you visit it, and record the date. Continue this activity for at least two years. Don't expect a climax forest; that usually takes a few hundred years!

After at least two years, prepare a display using photographs or sketches and the information you gathered to illustrate the different plants that invaded the area over time.

You also could build a model to illustrate the succession you observed—use forest materials, twigs, and other materials that resemble the plants you observed. (This activity is adapted from *Project Learning Tree, Activity Guide for Grades 7-12*, American Forest Institute, 1977.)

Prepare a display that illustrates wildlife found in at least two different forest types. For each forest type, do the following:

- ✓ Photograph or collect pictures of the forest type.
- ✓ Identify the common tree species in the forest type.
- ✓ Identify at least two wildlife species found in that forest type.
- ✓ Include a picture or photograph of the animals mentioned. Mount your photographs or pictures on a three-sided display board or in a box.

Expand on the forest typing activity from page 30. Gather tree species data for at least three distinct forest types in the area. Then map the area. Mount the map on a three-sided display or poster board along with your forest data sheets.

Answers



SUCCESSION DISTURBANCES:

All of these events are capable of starting succession.



SUCCESSION SERIES:

top to bottom: 3; 4; 5; 2; 1



SPECIALIST/GENERALIST QUIZ:

Specialists:

small rodents
ruffed grouse
gray squirrel
wild turkey
pine marten
red squirrel
boreal owl

Generalists:

snowshoe hare
red fox
white-tailed deer
moose
black bear
beaver



FOREST / SPECIES MATCH:

maple-basswood: sugar maple, American basswood
oak-hickory: bur oak, northern pin oak
spruce-fir: balsam fir, black spruce
cottonwood-elm-ash: American elm, eastern cottonwood
white-red-jack pine: eastern white pine, red pine
aspen-birch: bigtooth aspen, white birch



QUIZ FOR THE REAL WHIZZES:

- | | |
|----------------|---------------|
| 1. generalist | 5. specialist |
| 2. forest type | 6. pioneers |
| 3. tolerant | 7. intolerant |
| 4. succession | 8. climax |



Chapter 5

FINDING YOUR WAY

COMPASS AND MAP USE

Orienteering

Orienteering is the art of using a map and compass to position yourself and to find your way through an unfamiliar area. In a sense, it's a way of staying "unlost." Using a compass, a map, and your legs, you can chart your course through the wildest forest thicket.

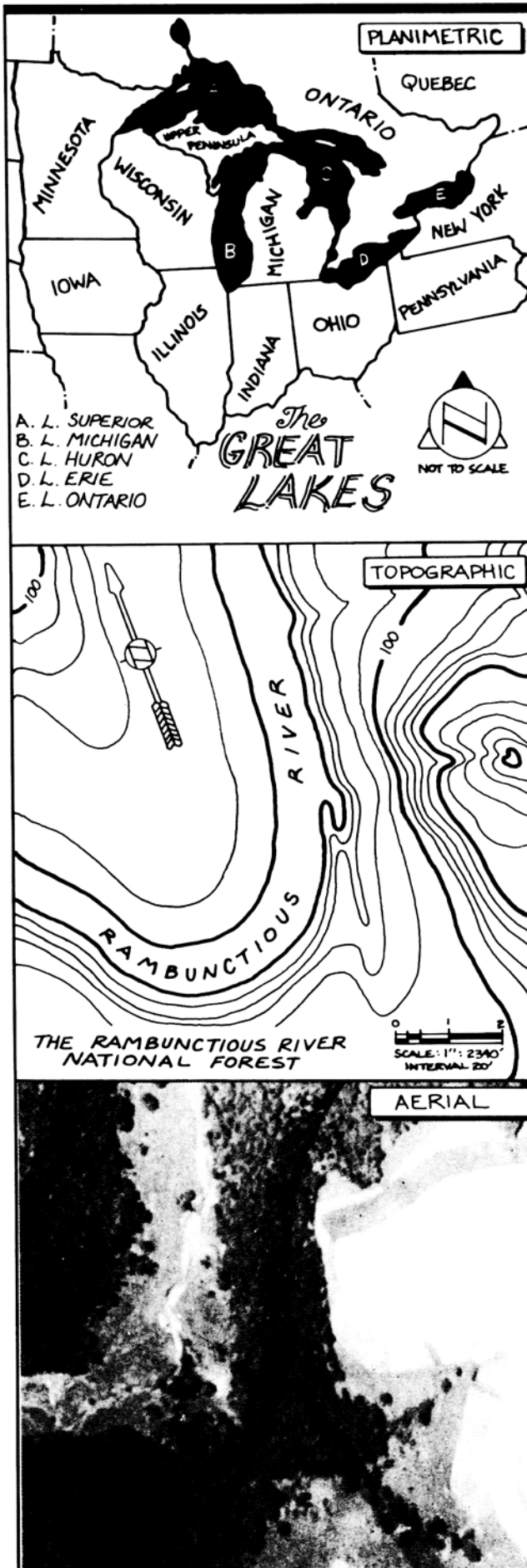
Foresters practice orienteering in their daily work. They rely on their orienteering skills in everyday activities such as inventorying a forest stand or marking a timber sale boundary. Foresters cannot afford to get lost in the woods!

Foresters rely heavily on maps and compasses to help them find their way through the woods. Before you can master orienteering, you have to be able to read a compass and a map.


Maps


A map is a drawing of part of the earth's surface. There are two common types of maps: **topographic** and **planimetric**. A topographic map shows changes in elevation. A planimetric (*plani* means plane, or flat) map does not show how the land gets higher or lower. It is two-dimensional.


Road maps most often are planimetric. An aerial photograph—a picture taken from a plane—shows contour and can be used as a map. Topographic maps or aerial photographs are used in orienteering.




All planimetric and topographic maps share some important features.

 The legend or key explains what the map symbols represent on the ground.

 The north arrow tells which direction is true north on the map.

 The scale tells how much real distance is represented by each unit of measurement on the map. For example, a scale of 1:24,000 means that 1 inch, centimeter, foot, or mile on the map equals 24,000 inches, centimeters, feet, or miles on the ground.

 The title tells what the map represents.

You can order a topographic map of your area from the U.S. Geological Survey. Each state has an index that shows which maps are available.

A book describing maps and indexes can be ordered from:

**U.S. Geological Survey
Federal Center, Distribution Section
Denver, Colorado 80225.**

Your parent, leader, or county extension agent can help you.

Reading a Topographic Map

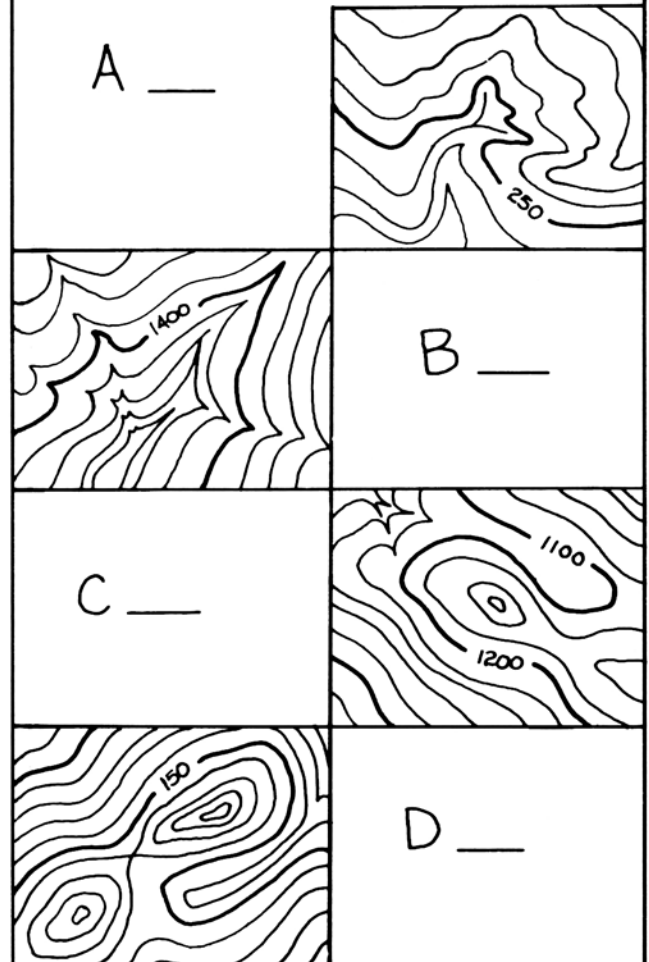
The most obvious way in which topographic maps differ from other maps is that they contain many thin, curved lines that appear to wrap around certain points. These lines, called **contour lines**, connect points of equal elevation. This means that if you were to walk along the ground represented by a contour line, you wouldn't go either uphill or downhill.

A topographic map will tell you if an area is steep or level. Places where the lines are close together are very steep. Where the lines are far apart, the land is relatively flat. The actual elevation is written on every fifth line. In the United States, we measure elevation beginning with 0 feet at sea level.

Contour lines have four important characteristics:

1. All points along the same contour line are at the same elevation.
2. All contour lines eventually connect with themselves.
3. Contour lines never cross each other.
4. Contour lines never split or branch.

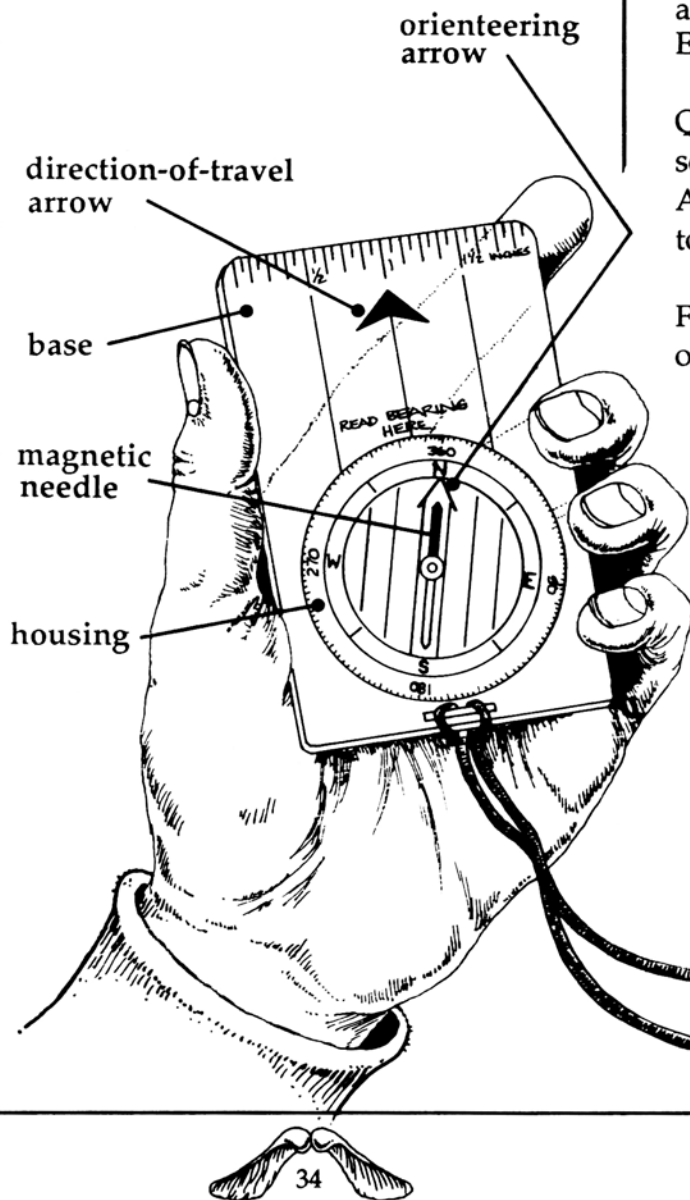
Each drawing below violates a rule of contour lines. Match each rule with the drawing that violates the rule.



To take a bearing:

1. Stand facing a tree or other marker.
2. Hold the compass flat in the palm of your hand near your chest with the direction-of-travel arrow pointing directly at your marker.
3. Turn the compass housing until the painted portion of the **magnetic needle** and the **orienting arrow** point in the same direction.
4. Read the direction at the spot labeled *read bearing here*. This is your bearing.

Note! do not hold your compass near a belt buckle or other metal object since this can skew the reading.



Getting To Know Your Compass

The earth is a gigantic magnet. The north magnetic pole attracts the north end of your compass's magnetic needle.

Compass dials are marked clockwise from 0 to 360 degrees. There are 360 degrees (360°) in a circle.

NORTH is 0 or 360 degrees

EAST is 90 degrees

SOUTH is 180 degrees

WEST is 270 degrees

Each 90-degree section is called a **quadrant**. Think of a pie cut into four equal sections (*quad* means four). Each section is one quadrant.

Quadrants are assigned directions of northeast (NE), southeast (SE), southwest (SW), and northwest (NW). A person traveling at 220 degrees would be traveling to the south and to the west, or southwesterly.

Fill in the correct quadrant readings below. The first one is done for you as an example.

Reading	Quadrant
---------	----------

240°.....	SW
-----------	----

232°	
------------	--

7°.....	
---------	--

316°.....	
-----------	--

90°.....	
----------	--

107°.....	
-----------	--

0°.....	
---------	--

Pacing Yourself

To use a map and compass to find your way in the woods, you need a way of measuring distance. Since it is not practical to use a ruler or tape to measure distance in the woods, your **pace** will serve as a handy measuring device.

HOW TO FIND YOUR PACE

First, find the length of your pace. A pace is the length of your stride while walking (a double step). Your pace may be different from anyone else's pace.

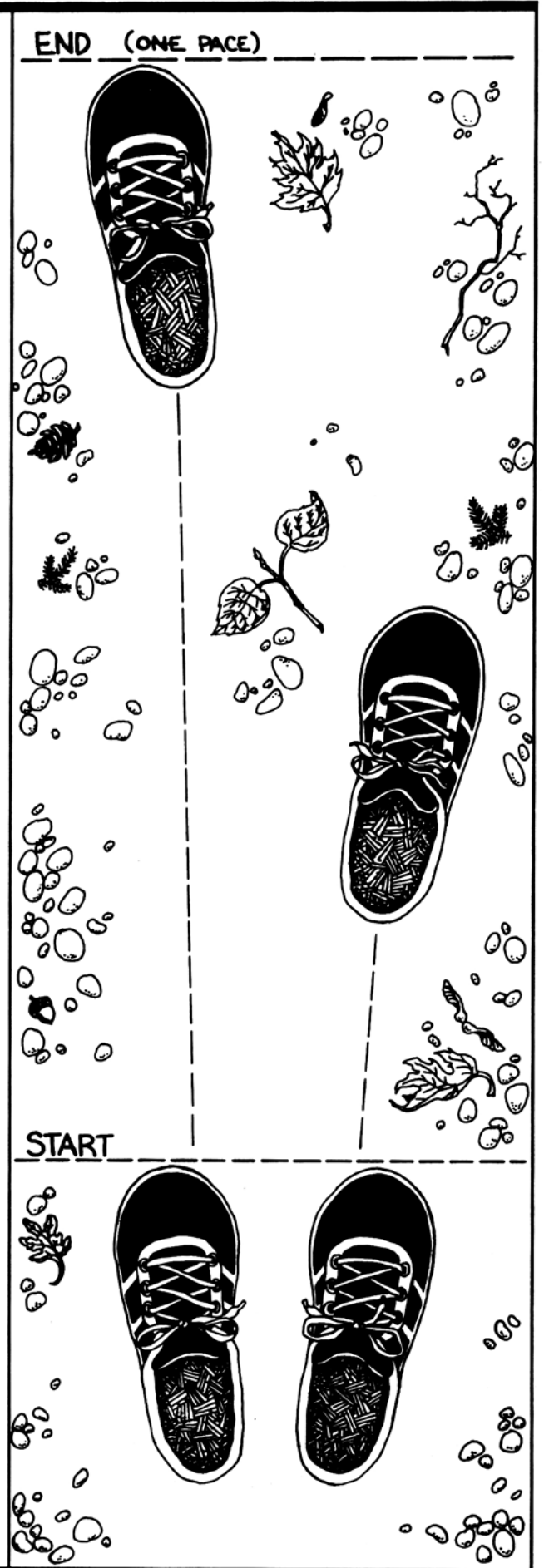
To find your individual pace, measure 100 feet on the ground with a tape measure and mark the beginning and ending point. Starting with your **right** foot, walk from the beginning to the end, counting a pace every time your **left** foot hits the ground. Use a natural walk, not extra large or small steps. Pace the 100-foot distance three times and average your number of paces. Round off the number.

ENTER YOUR PACE HERE: _____

Cruising on Your Own

Cruising is the process of travel through a forest using a map and compass, usually with a goal in mind. Conducting a forest inventory is called **cruising timber**. Using an orienteering compass and a topographic map, follow the instructions below to learn to cruise at your own pace!

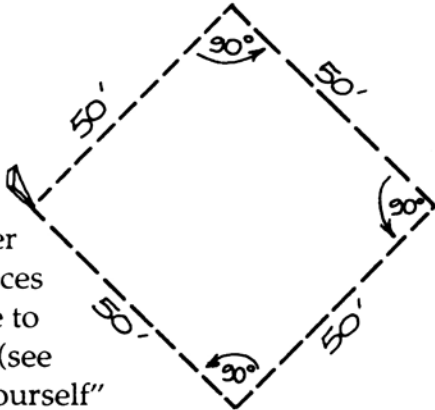
First, find the spot on the map corresponding to where you are standing. Next, find another spot corresponding to where you want to go. Place one edge of the compass along your desired line of travel on the map. Figure out the distance between where



Let's Cruise!

The more you practice using a compass, the more accurate you will become. Here is a fun exercise that will help you sharpen your cruising skills.

Find a spot where there are no fences, trees, or other obstacles for 50 feet. Put a stake in the ground to mark your position.



1. Figure the number of your paces it will take to go 50 feet (see "Pacing Yourself" on p. 35).

2. Set any bearing you wish on your compass, for example 45° .

3. Stand next to your stake and pace 50 feet in the direction of your compass bearing. Be accurate, both in pacing and following the bearing.

4. After 50 feet, stop. Add 90 degrees to the compass bearing, then pace 50 feet in that new direction.

5. Complete the sides of the square by adding 90 degrees each time you have paced 50 feet.


6. If you have been completely accurate, you will have returned to your starting point. How far are you from that point?


When you have successfully completed a 50-foot square, complete a square with 100-foot sides. How far are you from your starting point on this square?


you are and where you want to go, using the map scale. Determine how many paces it will take you to reach this point. For example, if your individual measurement is 20 paces per 100 feet and you want to go 200 feet, you will have to count 40 paces to reach the marker. **Without removing the compass from the map**, turn the compass housing until the orienteering arrow points to north on the map. You've now set the compass for your line of travel.


Holding the compass in your hand, turn it horizontally until the magnetic needle is "framed" by the orienting arrow. The direction-of-travel arrow will point to your desired route. The degree reading is your bearing (direction). Walk in that direction, counting the number of paces you figured you were from your spot. You should end up at the destination you chose on the map!

Compass Points to Remember

 *A compass alone can keep you on a path, but you need a map to know where you want to go. A compass isn't much help without a map.*

 *Decide from a map which direction you want to go.*

 *Find the approximate direction (bearing) in degrees.*

 *Use your compass (as described above) or a protractor to figure out the exact bearing. This will help prevent a 180-degree error.*

Locating Yourself

Surveying is the art of locating points or lines on the earth's surface by measuring angles, directions, and distances. In 1796, Congress passed a law that allowed surveying of the new territories west of the Mississippi River and north of the Ohio River using a rectangular survey system.

Under this system, land is surveyed in a rectangular pattern, with beginning reference lines running north-south (a **base meridian**) and east-west (a **base line**). Every six miles, another line is drawn parallel to the base meridian and the base line. The squares formed by the intersection of these lines are called **townships**. Each township contains 36 square miles. We identify townships by their distance north or south of the base line and east or west of the base meridian. Townships also are given names.

Fill in the name of your township, if you know it:

Each township is divided into 36 squares. Each square is one square mile and is called a **section**. Sections are always numbered in the order shown here. We can further divide sections into quarters and identify them by their location in the section. The northwest quarter of a section would be identified as NW 1/4, the southeast quarter as SE 1/4.

Land managers use this rectangular system in order to establish or survey boundaries and locate themselves. Maps or plat books identify sections, townships, and natural markers, such as lakes, to help land managers know where they are.

Career Considerations

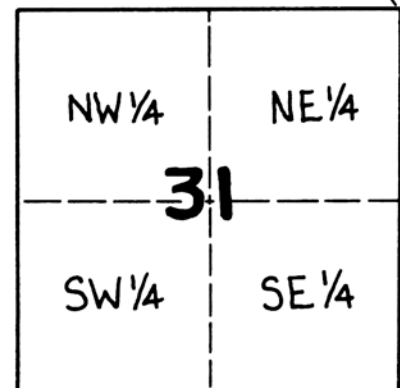


A **forest engineer** designs and constructs roads for timber sales and access. The engineer first surveys the area, using orienteering skills, to determine where a road could be constructed. The forest engineer bases the road layout upon factors such as bluffs, steep hillsides, and stream crossings. The forest engineer then does a formal survey and stakes the location for the new road. A forest engineer always seeks to minimize erosion and damage to the forest.

If you want to be a forest engineer, a good place to start is with a four-year engineering degree from a college or university. Forestry classes help, too!

TOWNSHIP

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



SECTION

Quiz for the Real Whizzes

Fill in the blanks below using the words at the end. Whiz through this!

1. The length of your stride measured in feet is your _____.
2. A _____ map illustrates changes in elevation or contours.
3. _____ is the art of using a map and compass to find your way.
4. The _____ explains what map symbols represent on the ground.
5. Wandering lines on a topographic map that show elevation are called _____.
6. _____ is the direction traveled.
7. A _____ is 1/36th of a township, or one square mile.
8. A _____ map shows detail in flat perspective.
9. _____ is the science of locating points or lines on the surface of the earth.
10. The _____ tells how many units on the ground are represented by each unit of measurement on a map.



planimetric
map legend
bearing
section
pace

map scale
contour lines
surveying
topographic
orienteering

Leave the Answer to Me . . .

The sun rises in the east and sets in the west, and the North Star is part of the Little Dipper's tail. What other clues would you use to find north, south, east, and west without a compass?

Tree-vial Pursuit

People have used compasses for more than a thousand years. Before compasses were invented, only navigators who could tell directions from the movement of the stars and sun could attempt ocean voyages. If they died during a voyage, their ships often were lost at sea!



Yearning to Learn . . . ADDITIONAL ACTIVITIES

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

Build a Christmas tree! You will need a compass, pencil, and graph paper. Assume that your piece of graph paper is a map. Place a dot in the center of the paper. This dot is the start of your map. Using the bearings and distances given on page 39, move from one point to the next, placing dots at each point you locate. Connect the dots to finish the Christmas tree.

Construct your own figures using bearings, distances, and graph paper. You might try something simple, such as a square or a triangle, at first. After you become more skilled, construct a star, a maple leaf, or even an animal. Give the bearings and distances to your friends, and see if they can reconstruct the drawing you have invented.



Make a planimetric map of your backyard or nearby lot on graph paper using your compass and pacing. Use a scale of 1 inch = 20 feet. Indicate the starting point on your map, and then trace the yard or lot boundaries. Be sure to record distances (by pace) and the bearings you followed to map the boundaries.

Exhibits & Fair Projects

Make a planimetric map of a forest, park, or neighborhood. Determine your bearings using your compass, and find distances using your pace. Include the approximate locations of buildings, large trees, roads, sidewalks, pathways, and fences. Draw the map to a consistent scale. Make sure you include bearings and distances of boundaries. Remember to include a title, legend, scale, and north arrow. Some suggestions to help you complete this project:

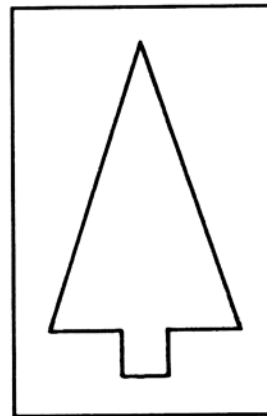
1. Take accurate notes while using the compass and pacing. For example:

Point	Bearing	Distance	Notes
1-2	53°	130'	Crossed stream at 96' from point 1
2-3	86°	75'	Followed fence line for 75'

2. Use a protractor and ruler to transfer distances and bearings from notes to your map.

3. Make a rough copy that includes features such as buildings and streams, then transfer them to the final map.

BUILD A CHRISTMAS TREE!



Bearing	Distance (inches)
270°	0.5
360°	1.0
270°	2.0
31°	5.0
149°	5.0
270°	2.0
180°	1.0
270°	0.5

Answers

CONTOUR LINES QUIZ:

- A = 4
- B = 2
- C = 1
- D = 3

QUADRANT QUIZ:

- 232° = SW
- 7° = NE
- 316° = NW
- 90° = Due east
- 107° = SE
- 0° = Due north

QUIZ FOR THE REAL WHIZZES:

1. pace
2. topographic
3. orienteering
4. map legend
5. contour lines
6. bearing
7. section
8. planimetric
9. surveying
10. map scale

Chapter 6

MEASURING THE FOREST

FOREST INVENTORY BASICS

Taking An Inventory

Standing in a mature jack pine stand, two forest technicians silently inventory the forest. The technicians watch an immature eagle fly overhead, and follow the bird until it is a dot in the sky. They notice a miniature grove of ramshorn orchids on the forest floor, and record the observation in the comments section of the inventory sheet. Using special instruments, the technicians measure and record information about the trees around them.

They also make note of the passing eagle, knowing this information, along with the timber measurements, will be useful to others. The data they gather will help natural resource managers make wise decisions about the best management of the mature stand.

A forest inventory provides land managers with information about:

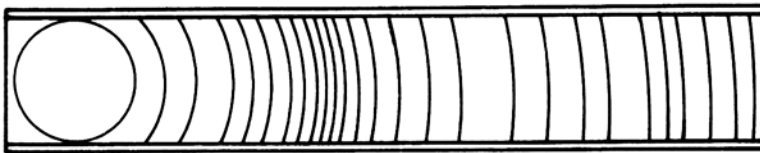
- 🌲 forest type
- 🌲 approximate age and size class of timber
- 🌲 disease or insect pests
- 🌲 timber volume
- 🌲 tree density
- 🌲 tree reproduction
- 🌲 site productivity (site index) based on the age and height of dominant trees
- 🌲 topography
- 🌲 noteworthy features or wildlife



Reading the Rings

Foresters use a tool called an **increment borer** to determine a tree's age. The borer is pressed against a standing tree at 4-1/2 feet above the ground and turned until it drills through to the center of the tree. This action forces a sample of wood, called a **ring core sample**, into the borer. The forester then removes the sample, counts the annual rings, and records the age.

Foresters can get a lot of useful information from a ring core sample. It can tell them how close a tree or stand of trees is to the **rotation age**, the optimum age for harvest. By looking at the width of recent annual rings, a forester also can determine if the tree is growing under satisfactory conditions.



How old do you think this tree is?

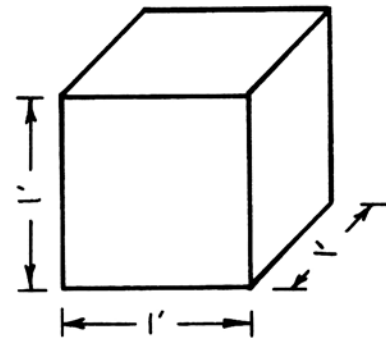
Units of Measurement

Wood volume is the most common information provided by a forest inventory. It is measured in order to arrive at a fair selling price when marketing timber.

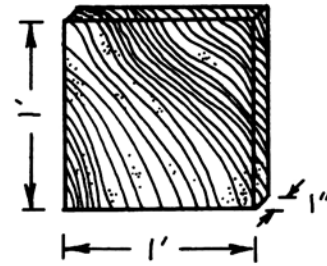
In the United States, we use three different units to measure wood volume: **cubic feet**, **board feet**, and **ords**. Most of the world uses cubic meters. It is becoming more common to measure wood by weight rather than by volume.

A **cubic foot** measures 1 foot by 1 foot by 1 foot. It equals 1,728 cubic inches.

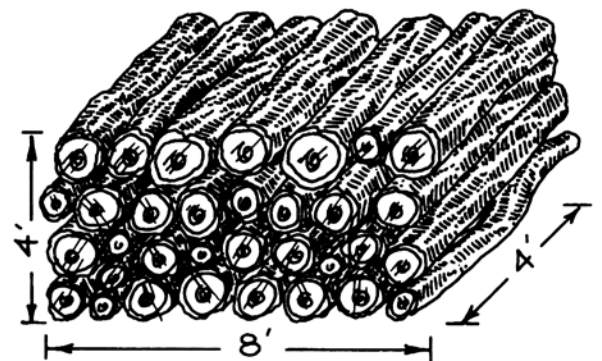
A **board foot** is the volume of a board that is 12 inches wide, 12 inches long, and 1 inch thick. It equals 144 cubic inches.



CUBIC FOOT



BOARD FOOT



CORD



BE SURE
TO MEASURE
DBH FROM THE
UPHILL SIDE!

A **standard cord** is a stack of wood that contains 128 cubic feet of wood, bark, and air (approximately 79 cubic feet of solid wood). The common dimensions of a cord of wood are: 8 feet long, 4 feet wide and 4 feet high. The weight of a specific volume of wood varies depending on the species and moisture content.

The unit used to measure wood depends on the product that is likely to be made from the wood.

Board feet are used when lumber or **veneer** (a thin layer of wood that is peeled from the log) is the most likely product.

Cubic feet or cords are used to measure **pulpwood** (wood used to make paper and paper products) and **fuelwood** (wood used for heating/energy).

Sizing Things Up

To determine a tree's volume, you first need to measure its **diameter** and **merchantable tree height**.

Tree diameter is measured at breast height, defined as 4-1/2 feet above the ground on the uphill side of the tree. We abbreviate this **diameter at breast height** as **DBH**.

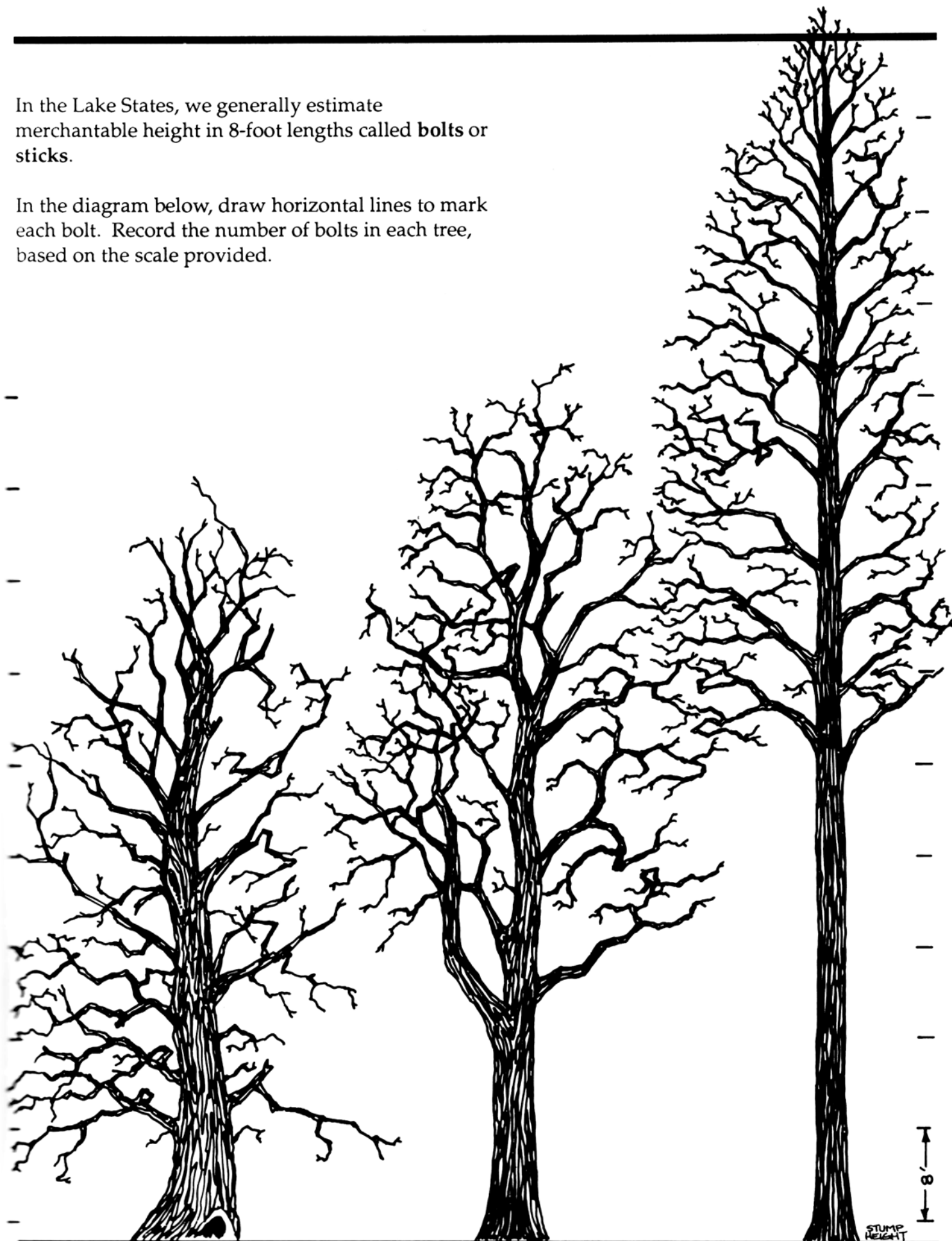
Merchantable tree height is the usable portion of the tree. It is the distance between the presumed stump height and the point where the trunk becomes unusable.

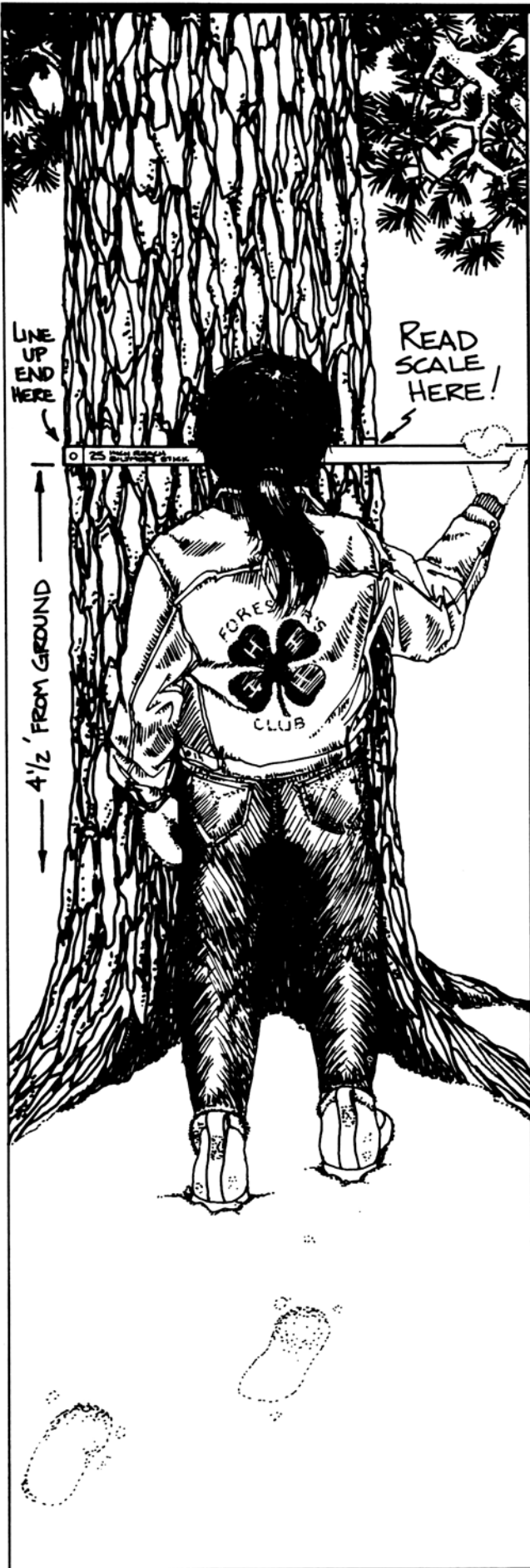
For **hardwoods** (deciduous trees) this is measured from 1 foot above the ground, and for **softwoods** (coniferous trees) from 6 inches above ground.

Merchantable height ends where trunk tapers to a diameter of 4 inches (for pulpwood) or 8 inches (for sawtimber—logs used for products such as veneer), or where a large fork, rot, or another defect limits its use.

In the Lake States, we generally estimate merchantable height in 8-foot lengths called bolts or sticks.

In the diagram below, draw horizontal lines to mark each bolt. Record the number of bolts in each tree, based on the scale provided.





Tools of the Trade

Instruments used to measure diameter are the diameter tape (D-tape) and Biltmore stick. The Biltmore stick also is used to measure tree height. You can make a set of these measuring tools for yourself.

Making and Using a D-tape

You will need:

- 🌲 a cloth measuring tape, available at fabric stores
- 🌲 a black permanent marker

Starting from 0, mark a line on the tape every 3.14 (about 3-1/8) inches. Number the first line "1", the next "2", and so on. Each line corresponds to one inch in diameter when the tape is wrapped around a tree.

After you complete the tape, take it outside and practice measuring the diameter of some trees in your yard or neighborhood. Wrap the tape around a tree 4-1/2 feet above the ground. Be sure to hold the tape horizontally all around the tree. Read the tree's diameter on the tape where the tape crosses the end.

Making and Using a Biltmore Stick

You will need:

- 🌲 two paper ruler strips labeled "For Standing Trees" (see outside back cover)
- 🌲 a yardstick or piece of wood lath
- 🌲 tape or glue

Cut out or copy the two paper ruler strips. Staple or tape them together end-to-end to make one long strip. Then tape or glue the long strip to the lath or yardstick.

To measure tree diameter, hold your Biltmore stick 25 inches from your eye. Press the stick horizontally against a tree trunk, 4-1/2 feet above the ground. Move the stick so the left end lines up with the left edge of the tree.

Without moving your head, look at the right edge of the tree and read the number on the Biltmore stick closest to where your line of sight crosses the stick. Be sure to use the "Diameter of Tree (inches)" scale. This number is the tree diameter in inches.

To measure height with a Biltmore stick, stand 100 feet from the tree you want to measure (measure this distance with a tape or pace it off). Hold the Biltmore stick vertically 25 inches from your eye. Move the stick so the bottom end lines up with the tree's (likely) stump height.

Then, without moving your head, look up the tree and find the point where the tree trunk reaches the minimum acceptable diameter for the product you are measuring (4 inches for pulpwood, 8 inches for timber) or where defects limit its use.

Read the number on the "Height" scale closest to the spot where your line of sight crosses the stick. This is the tree height.

Determining Tree Volume

Once you have measured a tree's height and diameter, you can find the volume of usable wood in that tree. Foresters generally use volume tables to determine the amount of wood per tree. At the end of this unit, you'll find a table for estimating cords.



SIGHT TO LIKELY STUMP HEIGHT

SIGHT TO MAXIMUM USABLE HEIGHT

Let's use this Norway pine as an example.

The measurements were as follows:

DBH: 16 inches

Height (merchantable): 48 feet

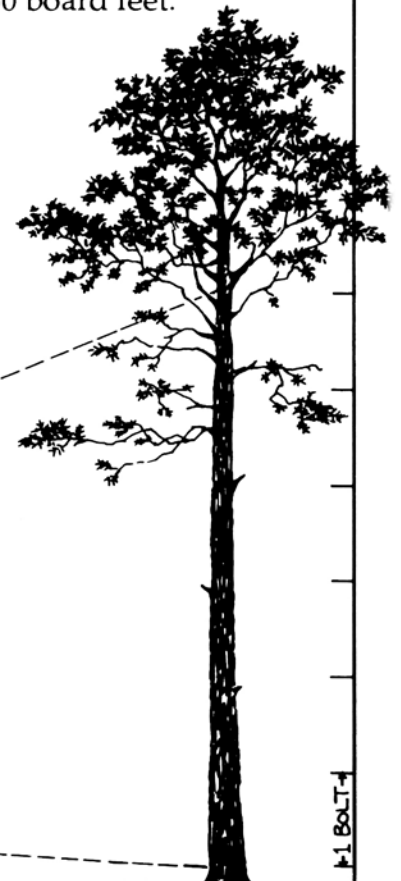
Total # of 8 foot bolts: $(48 \div 8) = 6$

Total cords : 0.46 cords
(cords taken from table on p. 48)

To determine the amount of board feet in a tree, multiply total cords in the tree by 500

Total board feet:
 $0.46 \times 500 = 230$ board feet

This tree contains approximately 0.46 cords of usable wood, and 230 board feet.



BILT-14

Quiz for the Real Whizzes

Fill in the blanks below using the words at the end. Whiz through this!

1. _____ is the abbreviation for diameter at breast height.
2. A _____ measures 1 foot by 1 foot by 1 foot.
3. A _____ is an 8-foot length of a tree.
4. A measurement of certain characteristics of a forest, including timber volume and tree growth rate, is a _____.
5. A _____ contains 128 cubic feet of wood, bark, and air.
6. Cubic feet or cords are used to measure _____.
7. A _____ measures 12 inches by 12 inches by 1 inch.
8. _____ measures the usable length of the tree.



board foot	pulpwood
cord	merchantable height
DBH	bolt
cubic foot	forest inventory

Career Considerations



A **forest technician** inventories forests for federal, state, county, and private groups. You have to really like the outdoors to be a forest technician, because you will spend a lot of time in the forest measuring tree volumes, growth rate, tree age, and site productivity. To be a forest technician, you will need at least a two-year technical degree from a college or vocational technical institute.

Leave the Answer to Me . . .

Why do we make a D-tape by placing an inch mark every 3.14 inches along the tape?

Tree-vial Pursuit

People in the United States use enough firewood each year to build a 100-foot tall wall of wood from New York City to San Francisco.



Yearning to Learn . . . ADDITIONAL ACTIVITIES

In the following activities, remember the basic rules of conservation. Do not damage or destroy the plants and animals you are studying. Leave all animal homes unchanged. Have a positive impact on the forest.

Measure the diameter of several trees using both the Biltmore stick and the D-tape you constructed earlier. Record these measurements for at least six trees.

Do the measurements from the two instruments agree? How close are they?

Tree volume in rough cords to a variable top diameter based on the number of 8-foot bolts in the tree*

DBH (inches)	number of 8-foot bolts									
	1	2	3	4	5	6	7	8	9	10
5	.01	.02	.03							
6	.02	.03	.04	.05	.06					
7		.04	.05	.06	.08	.10	.11			
8		.05	.06	.08	.10	.12	.14	.15	.17	
9		.06	.08	.10	.12	.15	.17	.20	.22	
10		.07	.10	.12	.15	.18	.21	.24	.27	.30
11		.09	.12	.15	.18	.22	.26	.29	.33	.37
12			.14	.18	.22	.26	.31	.35	.39	.44
13			.16	.21	.25	.31	.36	.41	.46	.51
14			.19	.24	.29	.35	.42	.47	.53	.59
15			.22	.27	.34	.41	.48	.54	.61	.68
16			.25	.31	.38	.46	.55	.62	.70	.78
17			.28	.35	.43	.52	.62	.70	.79	.88
18			.31	.40	.49	.59	.69	.78	.88	.98
19			.35	.44	.54	.65	.77	.87	.98	1.10
20			.39	.49	.60	.72	.86	.97	1.09	1.21
21				.54	.66	.80	.94	1.07	1.20	1.34
22				.59	.73	.88	1.03	1.17	1.32	1.47
23				.65	.80	.96	1.13	1.28	1.44	1.61
24				.70	.87	1.04	1.23	1.39	1.57	1.75
25				.76	.94	1.13	1.34	1.51	1.70	1.90
26				.83	1.02	1.22	1.45	1.64	1.84	2.05
27				.89	1.10	1.32	1.56	1.76	1.99	2.21
28				.96	1.18	1.42	1.68	1.90	2.14	2.38
29				1.03	1.26	1.52	1.80	2.04	2.29	2.55
30				1.11	1.35	1.63	1.92	2.18	2.45	2.73

* From Burk, and A. R. Ek. Approximation and extension of the Lake States composite taper and volume tables. University of Minnesota, College of Forestry, Department of Forest Resources Staff Paper Series.

Volume is standard unpeeled cords and includes the stem wood above a one-foot stump to a top diameter inside bark that is the larger of either 4 inches or 50% of the tree DBH. Careful piling of harvested bolts is assumed, equivalent to 79 cubic feet of wood or 92 cubic feet of wood and bark per cord. The standard bolt is assumed to be 8 feet in length. Volumes outside the tabulated range may be estimated by applying the formula to each 8-foot bolt and then summing values to provide tree volume estimates:

Bolt volume = $0.0003 (d^2 + D^2)$ where d = small end inside bark diameter of the bolt in inches; D = large end inside bark diameter of the bolt in inches.





DIAMETER OF TREE (INCHES) | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13

FOR STANDING TREES

To Read Diameters: Hold Stick 25 Inches From Eye Against
To Read Heights: Stand 100 Feet From Tree and Hold Stick

HEIGHT (No. 16 Foot Logs) | 1 | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/2

1/3 | 1/4 | 1/5 | 1/6 | 1/7 | 1/8 | 1/9 | 2/0 | 2/1 | 2/2 | 2/3 | 2/4 | 2/5 | 2/6 | 2/7 | 2/8 | 2/9 | 3/0

e Against Tree At Height of 4 1/2 Feet.
Hold Stick Vertical 25 Inches From Eye.