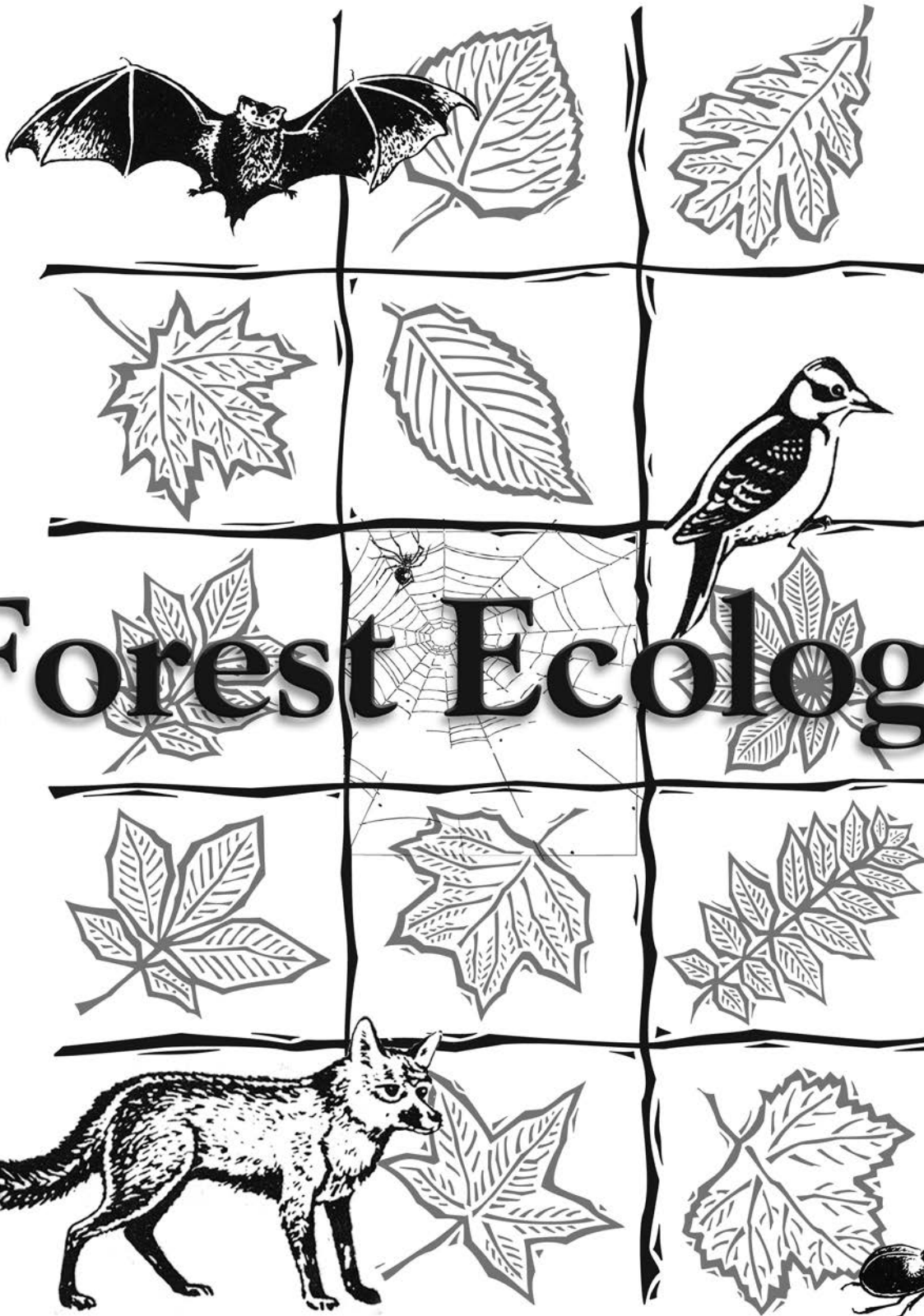




State of Illinois
Illinois Department of Natural Resources

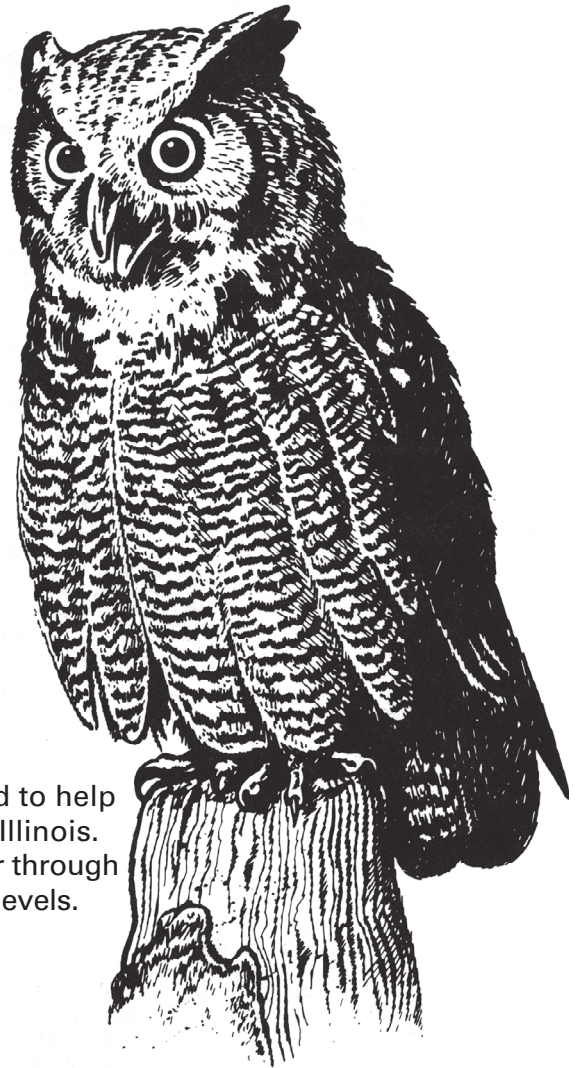


Forest Ecology



Illinois
Department of
Natural
Resources

Forest Ecology



The exercises and activities included in this guide are designed to help teachers familiarize their students with the forest resources of Illinois. Although the materials are best suited for students in grades four through eight, most of the activities can be easily adapted to other grade levels.

Next Generation Science Standards: 4-LS1-1, 5-LS2-1, MS-LS2-1
Illinois Social Science Standards: SS.G.2.6-8.LC

Note to Teachers

Students will need to record their answers to the questions and activities on a separate sheet of paper or in another format. Some of the pages are suitable for copying. Teachers in Illinois have permission to copy the pages for use with students in the classroom. They may not be used in any other manner or converted in any way without the written permission of the Illinois Department of Natural Resources. Help us conserve paper by allowing multiple students to use this resource.

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Scientific Names

A scientific name is the official name for each organism. It is assigned after careful research and is made up of two parts: the genus name (written first) and the species name. The name is always in Latin because when the naming process began, nearly all scientists understood the Latin language. The scientific name should be underlined

or italicized. Often, it tells you something about the organism or someone who studied it. Listed below are the common names of all the organisms mentioned in Forest Ecology. It is your task to find the most current scientific name for each one. You can use field guides, the Internet or other resources to help you.

Acadian flycatcher _____

ambush bug _____

American basswood _____

American elm _____

American hornbeam _____

artist's fungus _____

baldcypress _____

Baltimore oriole _____

barred owl _____

black carpenter ant _____

black cherry _____

black locust _____

black maple _____

black oak _____

black willow _____

black-capped chickadee _____

blue cohosh _____

blue jay _____

bobcat _____

boxelder _____

brown thrasher _____

bulbous cress _____

bumblebee _____

bur oak _____

burying beetle _____

carrion beetle _____

cicada _____

columbine _____

common adder's-tongue fern _____

common garter snake _____

common kingsnake _____

common persimmon _____

Cooper's hawk _____

corn _____

domestic dog _____

downy woodpecker _____

Dutchman's-breeches _____

earthworm _____

eastern box turtle _____

eastern chipmunk _____

eastern cottonwood _____

eastern gray squirrel _____

eastern hophornbeam _____

eastern mole _____

eastern redbud _____

eastern redcedar _____

eastern screech-owl _____

eastern towhee _____

elm sawfly _____

fence lizard _____

firepink _____

flower fly _____

forget-me-not _____

fox sparrow _____

goldenseal _____

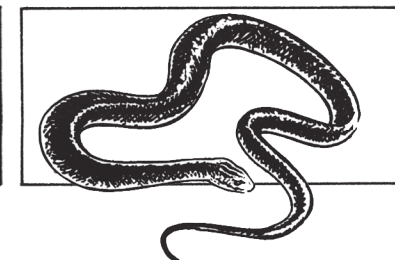
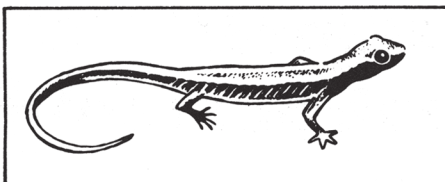
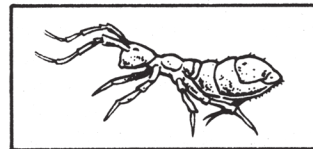
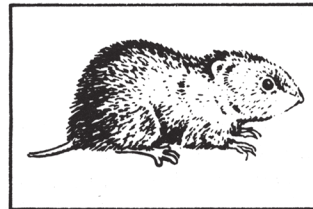
gray fox _____

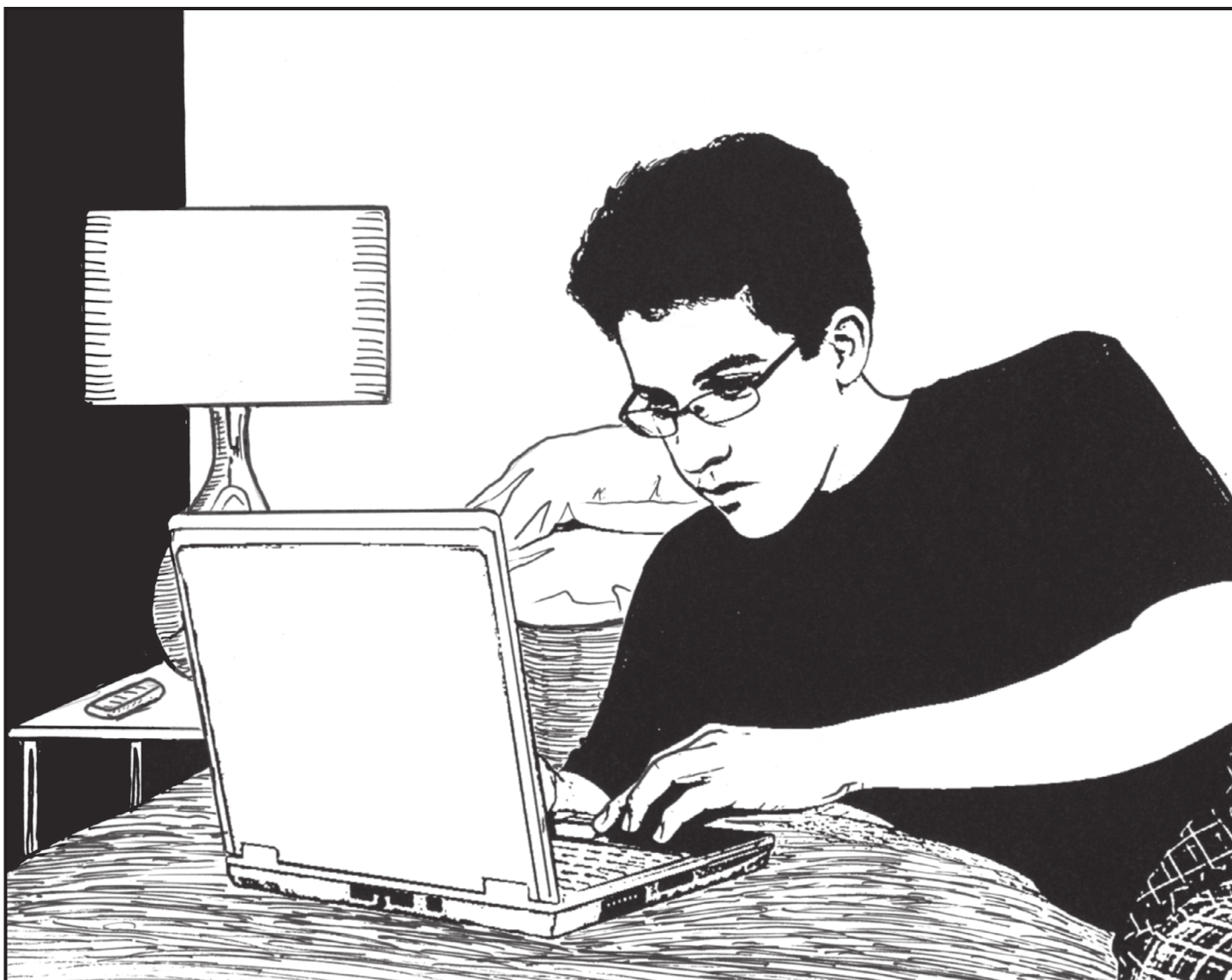
gray ratsnake _____
gray treefrog _____
great horned owl _____
green dragon _____
green heron _____
ground skink _____
hackberry _____
hairy woodpecker _____
harbinger-of-spring _____
hen-of-the-woods fungus _____
hermit flower beetle _____
honey bee _____
honeylocust _____
hooded warbler _____
horned passalus beetle _____
horse-nettle _____
house cat _____
imperial moth caterpillar _____
indigo bunting _____
Jack-in-the-pulpit _____
Kentucky coffeetree _____
long-tailed weasel _____
luna moth _____
marbled salamander _____
masked shrew _____
northern cardinal _____
northern red oak _____
Ohio buckeye _____
orchard oriole _____
Osage-orange _____
ostrich plume moss _____
oyster mushroom _____
pawpaw _____
pecan _____

pignut hickory _____
pin oak _____
prairie crabapple _____
protococcus _____
puffball _____
quaking aspen _____
raccoon _____
racer _____
rattlesnake fern _____
red admiral butterfly _____
red maple _____
red mulberry _____
redbelly snake _____
red-headed woodpecker _____
red-shouldered hawk _____
river birch _____
roughleaf dogwood _____
sandbar willow _____
searcher beetle _____
shadbush _____
shagbark hickory _____
silky fork moss _____
silver maple _____
silver-haired bat _____
slippery elm _____
small carpenter bee _____
smooth sumac _____
snapping turtle _____
southern flying squirrel _____
southern short-tailed shrew _____
soybean _____
spotted touch-me-not _____
springtail _____
star moss _____

starry Solomon's-seal _____
 striped skunk _____
 sugar maple _____
 swamp white oak _____
 sweet cicely _____
 sweetgum _____
 sycamore _____
 tamarack _____
 tick trefoil _____
 tiger salamander _____
 tiger swallowtail butterfly _____
 triangle spider _____
 twayblade orchid _____
 underwing moth _____
 viceroy butterfly _____
 Virginia opossum _____
 whip-poor-will _____
 white ash _____

white oak _____
 white violet _____
 white-footed mouse _____
 white-lipped land snail _____
 white-tailed deer _____
 wild plum _____
 wild strawberry _____
 wild turkey _____
 wood ear fungus _____
 wood frog _____
 woodland vole _____
 yellow dog-tooth violet _____
 yellow morel _____
 yellow wood sorrel _____
 yellow-billed cuckoo _____
 yellow-throated vireo _____
 zebra swallowtail butterfly _____





Jim's Journal

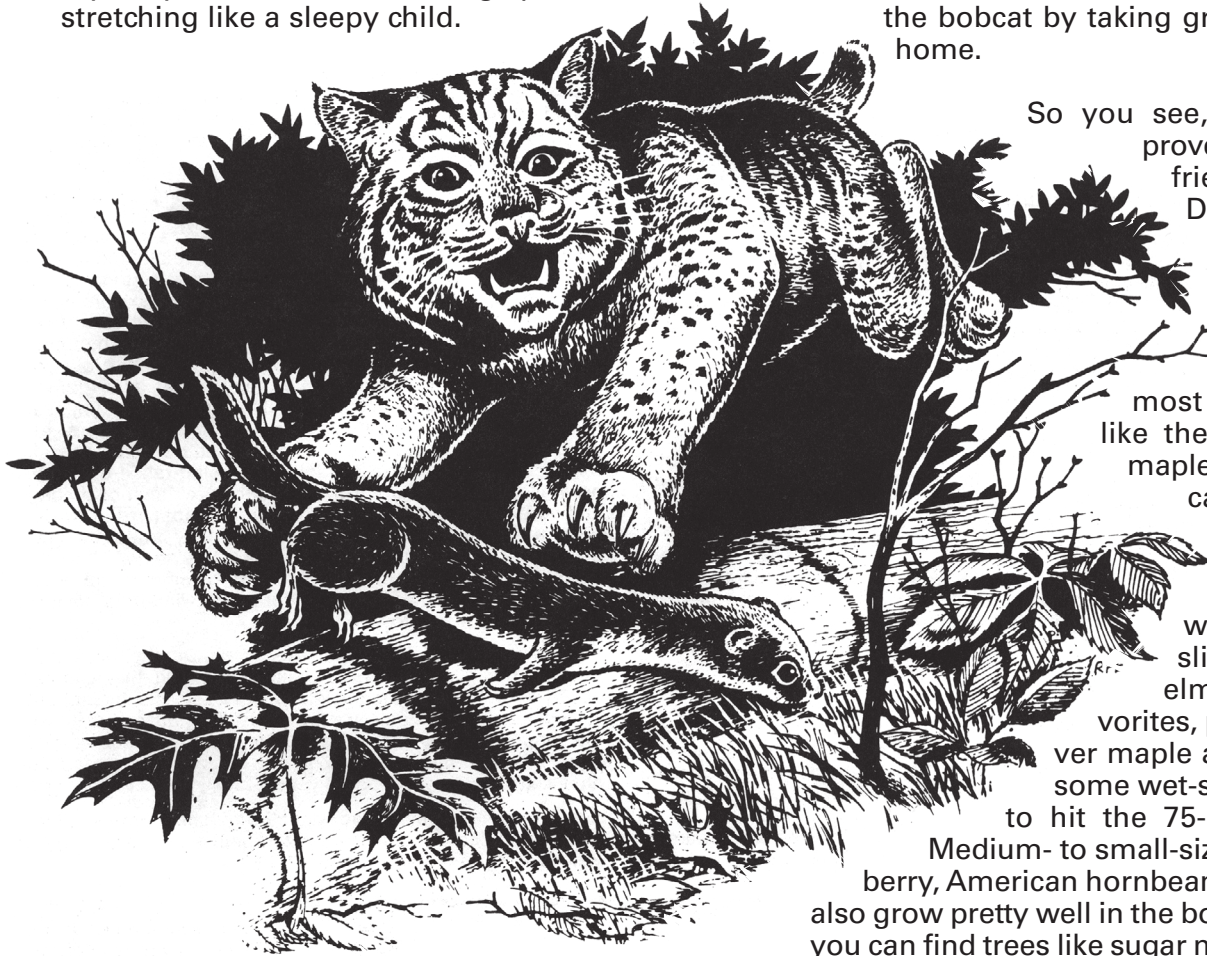
Dear Journal,

You are not going to believe it! I finally got to see one, and it was FANTASTIC. You know how all last month, I heard them yowling, meowing and squalling through the night. I read about them and figured a pair must be mating, probably right here in our woods. For weeks now, I've been searching for signs of them. The claw marks on the big oak on the edge of the clearing were my first real clue. I guess they scratch on trees like our cat scratches on the sofa. Anyway, the last three days in March, it rained night and day without stopping. The first night of April was clear, and I went to bed pretty early. Deep in the night, unbelievable shrill screams sent me running to the front porch. It sounded like the biggest cat fight in the world. Standing there, listening to the screams, hissing and moans, I came up with the theory that a strange female had wandered into the territory of

the female who was making a home in our woods. The heavy rains must have washed away the urine our female had left as scent posts all around her territory, posts that meant to all strangers, especially other females, THIS IS MY PLACE-LEAVE ME ALONE. As I jumped back under the covers, I thought about our female. I knew she was probably pregnant, and I fell asleep hoping she would not be hurt or killed that night.

Four days later I found tracks by the creek. Right by the tracks were some fresh droppings. I bent down and picked apart the remains of what the big animal must have eaten the day before. There were teeth of several mice, some bits of rabbit fur and part of the foot of a bird. Every day since then, I have thought of nothing except getting a glimpse of the animal that left them.

I had been in the forest since I got home from school, and the sun was starting to fall. I have always been afraid of the forest at night. To beat the darkness, I decided to take a short cut across the clearing. At the edge of the clearing I stopped for a second to look at the old oak. There were new claw marks but no time to spare studying them. As I turned from the woods to strike out across the clearing I saw a dark heap beneath a bush no more than 20 yards from me. It couldn't be, I thought and kept on. Then it moved, and I dropped flat on my belly. It was! It was standing up and stretching like a sleepy child.



Unaware of me and the sleepy heap beneath the bush, a long-tailed weasel came loping across the clearing. The bobcat crouched and froze. The weasel paused for a second and lifted its head to search the area. No motion detected - it continued with a slow gait, but when it was about 10 feet from the bush, it saw the big cat. Quicker than a flash, it turned and ran, but the bobcat was faster. With just three leaps the bobcat had the weasel by the neck. In a few seconds the squirming weasel was still, and the bobcat proceeded to eat it, hind quarters first. For a second, I felt sorry for the weasel, but then I remembered the time I watched a weasel devour a rabbit. It's just the way animals get their food, and there's no waste or cruelty about it. When the big cat was through, it sat quietly and washed itself. Then a loud

motherly call pierced the woods, "Jim, where are you?" Instinctively, I lifted my head to answer, and the bobcat saw me. Before I could help myself, I stood up and thought about running, but it was too late — the bobcat beat me to it.

First trotting, and then leaping seven to 10 feet at a time, it crossed the clearing and disappeared into the woods. It was dark by then and you know what, Journal, I wasn't scared of the night woods for the first time in my life. Yes, I was trembling but from excitement, not fear, and as I raced along, I imitated the bobcat by taking great leaps all the way home.

So you see, Journal, the forest proves again to be the best friend I have. Mom and Dad say we are lucky to own so much forest land, just over 300 acres. On our land we have trees that are among the most common in Illinois, like the oaks, hickories and maples. Along the river you can find some pretty large trees, like sycamore, sweet-gum, eastern cottonwood, black willow, slippery and American elm and one of my favorites, pecan. River birch, silver maple and boxelder are also some wet-soil trees that manage to hit the 75-100 foot high mark.

Medium- to small-sized trees like red mulberry, American hornbeam and sandbar willow also grow pretty well in the bottomland. On upland, you can find trees like sugar maple, American basswood, eastern redbud and pawpaw, a tree that grows in thickets. Along the ravines, honeylocust is pretty common and on the slopes white oak, pignut hickory and red maple seem to take over the forest. At the northern edge of our property, we have some pretty steep slopes and ridges where you can find bur oak, eastern hophornbeam and shadbush. Quite a bit of our property borders farm land. Fence rows that separate the forest from the fields have Osage-orange, black cherry, common persimmon and prairie crabapple trees. Once in a while, especially around an opening in the forest, you can find eastern redcedar. Eastern redcedar is one of the few native conifers of Illinois. A coniferous tree does not shed all of its leaves every fall like the deciduous trees. Coniferous trees usually have leaves that look more like needles. The great majority of Illinois' trees are deciduous, but you can find coniferous

trees, such as tamarack in northeastern Illinois and baldcypress in southern Illinois.

We also have 40 acres of white oak just south of the house. In 1821, my mother's great-great-grandfather was one of the first settlers to stake a claim in the Illinois country. The story is that when he saw that 40 acres of white oak, he fell in love with the big trees and decided to build his cabin right beside them. Do you know, Journal, that when my great-great-grandpa first saw those oaks, some of the trees were already 200 years old? Well, his cabin is gone now, our house stands in its place, but many of those old trees are still alive and well, even though they are more than 350 years old.

Illinois was very different when my great-great-grandpa settled here. There was a great deal of forest in Illinois, just over 14 million acres. But when my grandfather was born in

1901, just 4 million acres of forest were left. Today, about 4.3 million acres of forest exist in Illinois.

Sometimes when I'm out in the woods I wonder how more than 10 million acres of forest could have disappeared from our state. I know all that forest didn't really disappear. The land it stood on is just used for different things now. Most of it is used for farming. When the settlers moved into Illinois, they saw how the soil beneath the forest grew big, healthy trees and decided the same soil would grow good crops. They cleared forests to make crop land, and the clearing has never stopped. Even fence rows of timber between the fields are taken out. The new highway north of here took a bunch of timber and so did the new shopping mall on the outskirts of town. Even at school, forest was lost when they put in the new playing field. So you see, Journal, every time something

new needs to be built, there's a chance for losing more forest. I just hope there's always enough forest for wildlife to have a home and for people to enjoy.

We get a lot of enjoyment from our forest. During the winter, my sister and I cross-country ski in it and during the warmer weather, we hike. Some of my favorite time spent is with a pair of binoculars. I write down and draw my observations in my sketchbook.

9:30 a.m. I've found a red-shouldered hawk nest. Three downy young are standing up in the nest, flapping their wings, screaming and watching the sky. They must be hungry, but there is no sign of an adult.

9:45 a.m. The adult hawk arrived at the nest and dropped the body of a mouse. The young hawks didn't even touch the mouse, and the adult took off.

9:55 a.m. The adult returned with a snake in its talons. The big hawk tore the snake and the mouse into tiny bits. The young hawks are now taking the bits of food from her bill. The biggest one keeps crowding the other two out. I hope they can all get enough food!

10:20 a.m. All is well. All three ate until their crops were bulging out, and they turned away from the



9:30 A.M.

9:55 A.M.



10:20 A.M.



GRAY TREEFROG

grows on old logs. In the bottomland especially, you can find ferns, like common adder's-tongue and rattlesnake fern. My mother is a wildflower expert and every year, sometimes as early as February, she has me out in the woods to catch the blooming of harbinger-of-spring, usually the first wildflower to bloom. In March we look for the blossoms of yellow dog-tooth violet and blue cohosh. From April to June you can see all kinds of blooming flowers like sweet cicely, white violet, Jack-in-the-pulpit, firepink, columbine and green dragon.

We need to take good care of our forests and the plants and animals in them. One of the ways we take care of our forests is by preventing fire. We are very careful with any type of burning we do. Did you know Journal, nine out of 10 forest fires are set carelessly by people and that thousands of acres of forest burn in Illinois each year?

We also care for our forest by not grazing it with cows. If you let cows graze in a forest, they eat the young trees. Plus, the cows beat down the wildflowers, fungi, mosses and even the soil. As a result, the packed soil can't hold water very well and pretty soon, the soil of the forest is running down and filling up some stream or river. Of course, we

adult and stood peacefully on the edge of the nest. The adult gobbled down the last bits of food and flew away.

I've spied on so many of the forest creatures. I've watched a male gray treefrog singing with its vocal pouch puffed out big like a trumpet. One early June morning, I watched a snapping turtle crawl from the water into the forest where she dug a hole and laid her soft-shelled eggs. Once, I saw a viceroy caterpillar loop along the limb of an eastern cottonwood and when I touched it, it stopped and imitated a twig. I've gotten to see a monarch butterfly bust loose of its green jewel-like chrysalis. I guess one of the best times was when I spied a cicada nymph scrambling up the trunk of a dogwood. It positioned itself on a branch and was still until its shell cracked open. A winged adult crawled out and flew away. Do you realize Journal, that cicada nymph had been in the soil growing and changing for 17 years before it climbed that dogwood and flew off as an adult?

Trees and animals aren't the only things in the forest. There are lots of fungi like yellow morel, wood ear fungus and hen-of-the-woods. You can find different varieties of moss like silky fork moss that grows on hillsides and ostrich plume moss that



GREEN DRAGON

BLUE COHOSH

HARBINGER-OF-SPRING

GOLDENSEAL

have cows, but we keep them in a pasture where they belong. Some insects can also harm a forest, and we work with our forester to keep those insects under control.

Probably the most important way we protect our forest is by not overcutting it. We select some of the mature trees to harvest every year but we leave back a good supply of trees as growing stock. The type of harvesting we practice is called selective harvesting. We harvest our forest in this way to guarantee that there will be more trees to harvest later and so that there will always be plenty of trees, to provide food and shelter for forest animals. Some of the wood we harvest we use ourselves to build the things we need like the new porch on our house. The rest of the wood we sell to the mill. Our wood is eventually used all over the country to build homes, schools and furniture.

Another way we manage our forest is by practicing timber stand improvement. We improve the quality of our timber by removing some of the trees that are taking up too much space or are crooked, diseased or damaged. By taking out those trees it leaves more sunlight, soil, water and nutrient elements for the healthy, well-formed trees. My Dad says that timber stand improvement produces a better crop of trees in the forest just like hoeing produces a better crop of vegetables in the garden. It sure provides plenty of fire wood.

We pay special attention to our 40 acres of white oak trees. Since we want that stand to look just the way it did when my great-great-great-grandfather first saw it, we don't allow any cutting of those trees. That way, the old stand of oak will always be a living record of Illinois' natural heritage. I guess a harvest in the stand would bring in a lot of money, but my parents say we'll never harvest it. You see, since we harvest the rest of our forest, we can afford to never touch the oaks. That's what good forest management is all about – making the most of the forests we have – so that we can have more of all of the things forests provide, like a natural habitat for plants and animals, opportunities to hunt, picnic, camp and study nature, and lumber to build and make the forest products we use so much in everyday life.

One time my parents had a long talk with me about how someday I'd be in charge of managing our forest. I could tell from the way they spoke that they were a bit nervous about whether I'd take good care of the white oaks and green dragons. I tried to reassure them that I would. I know that journals are supposed to be secret, but one day I think I'll let them read this journal. Then they'll know for sure that I will always take care of the forest not only for the sake of the oaks, green dragons, turkeys, deer, bobcats and red-shouldered hawks – but for the sake of us all. Good night, Journal.

Thinking Further

1. Jim writes in his journal about the different reasons why forests have been and continue to be cleared. Name some of the reasons. Can you think of some other reasons why forests are cleared? Jim writes that every time something needs to be built, more forest is lost. What does Jim say his hope for the future of forests is?
2. Jim writes that his family is careful not to overcut their forest. What is this type of forest harvesting practice? Describe the practice of timber stand improvement. Can you name at least 10 things that might be made from the wood that comes from Jim's forest?
3. Jim writes that because his family carefully manages their forest, they are able to set aside some of it as a nature preserve and harvest other parts of it. In addition, Jim writes that because of their good management, their forest will continue to provide food and shelter for forest animals. What does Jim mean when he says that the goal of forest management is to make the most of the forests we have?

Spinning a Food Web

Plants are the producers of food energy in the forest ecosystem. Animals known as herbivores get food energy by eating plant parts, mainly the fruits, seeds, buds, leaves, bark and petals. Other animals known as omnivores get food energy by eating plant parts and other animals. Still other animals obtain food energy by eating only animals. Those predator animals are carnivores. If you were a spider and could spin a strand of silk from all of the animals in the forest to all of the plant parts and animals they eat, you would have a food web.

Step 1. A forest ecosystem is drawn for you on pages 10 and 11 of this booklet. For the largest plants, the parts that animals most often eat, such as the buds, seeds, fruits, bark and leaves, are drawn large and highlighted by a circle. Most of the plants and animals are not drawn to scale.

Step 2. Study the Diet Chart. The chart tells you what types of plant and animal materials each animal normally eats.

Step 3. Look at the forest ecosystem and select an animal. Now read the diet of that animal and draw a line to every plant or animal that animal might possibly eat. For example, the diet of the great horned owl includes all animals except the large mammals and birds of prey. By checking the Diet Chart, you can see which animals are not commonly in the great horned owl's diet. Therefore, the correct move is to draw a line from the

great horned owl to all of the animals in the forest ecosystem except for the large mammals and birds of prey. To complete the spinning of your

food web, take each of the animals in the ecosystem and draw a line to each plant part or animal it might possibly eat.

Diet Chart

■ Small Mammals

1. eastern chipmunk – seeds and fruits
2. eastern gray squirrel – buds, seeds, fruits and fungi
3. southern flying squirrel – seeds, fruits, buds and insects
4. white-footed mouse – seeds, buds, fruits and insects
5. woodland vole – the roots of plants
6. southern short-tailed shrew – earthworms, snails and insects
7. silver-haired bat – insects

■ Medium-sized Mammals

8. raccoon – fruits, seeds, insects, snails, earthworms, amphibians, reptiles, fishes, small mammals and small birds

■ Large Mammals

9. gray fox – fruits, seeds, small mammals, small birds and insects
10. bobcat – small mammals, birds and insects
11. white-tailed deer – flowers, bark, buds, fruits and seeds of plants

■ Small Birds

12. eastern towhee – seeds, fruits and insects
13. Acadian flycatcher – fruits, seeds and insects
14. yellow-billed cuckoo – fruits, seeds and insects, especially caterpillars
15. black-capped chickadee – fruits, seeds and insects
16. red-headed woodpecker – fruits, seeds and insects, especially ants
17. whip-poor-will – insects
18. hooded warbler – insects,

especially beetles, ants and caterpillars

19. yellow-throated vireo – insects and spiders
20. orchard oriole – fruits and insects, especially caterpillars
21. fox sparrow – fruits, seeds and insects, especially beetles

■ Large Birds of Prey

22. barred owl – small birds, small mammals, reptiles, amphibians, fishes and insects
23. eastern screech-owl – small birds, small mammals, reptiles, amphibians and insects
24. great horned owl – all types of animals except the largest mammals and large birds of prey
25. red-shouldered hawk – small birds, small mammals, reptiles, amphibians and insects
26. Cooper's hawk – small birds, small mammals, reptiles, amphibians and insects

■ Amphibians

27. marbled salamander – snails, worms, insects and spiders
28. gray treefrog – insects
29. wood frog – snails

■ Reptiles

30. eastern box turtle – fungi, fruits, seeds, insects, snails and spiders
31. fence lizard – insects, especially ants
32. ground skink – insect larvae
33. racer – small mammals, small birds, amphibians, reptiles and insects
34. common kingsnake – small birds, small mammals, small snakes and insects

35. common garter snake – amphibians, earthworms and young birds

■ Insects

36. zebra swallowtail caterpillar – tree leaves
37. tiger swallowtail caterpillar – tree leaves
38. viceroy caterpillar – tree leaves
39. red admiral butterfly – flower nectar
40. tiger swallowtail butterfly – flower nectar
41. imperial moth caterpillar – tree leaves
42. underwing moth – tree leaves
43. searcher beetle – caterpillars
44. hermit flower beetle – flower pollen
45. hermit flower beetle larvae – decaying wood
46. horned passalus beetle (adult and larvae) – decaying wood
47. honey bee – flower pollen and nectar
48. bumblebee – flower pollen
49. small carpenter bee – flower pollen
50. black carpenter ants – insects
51. elm sawfly – tree leaves
52. flower fly – flower pollen
53. carrion beetle – dead plant and animal matter

■ Spiders

54. triangle spider – small insects

■ Worms (Annelids)

55. earthworm – dead plant and animal materials

■ Snails (Mollusks)

56. white-lipped land snail – dead plant material
57. land snail – plant leaves



A FOREST IS A HOME ADDRESS FOR:

SMALL MAMMALS

1. eastern chipmunk
2. eastern gray squirrel
3. southern flying squirrel
4. white-footed mouse
5. woodland vole
6. southern short-tailed shrew
7. silver-haired bat

MEDIUM-SIZED MAMMALS

8. raccoon

LARGE MAMMALS

9. gray fox
10. bobcat
11. white-tailed deer

SMALL BIRDS

12. eastern towhee
13. Acadian flycatcher
14. yellow-billed cuckoo
15. black-capped chickadee
16. red-headed woodpecker
17. whip-poor-will
18. hooded warbler
19. yellow-throated vireo
20. orchard oriole

21. fox sparrow

LARGE BIRDS OF PREY

22. barred owl
23. eastern screech-owl
24. great horned owl
25. red-shouldered hawk
26. Cooper's hawk

AMPHIBIANS

27. marbled salamander
28. gray treefrog
29. wood frog

REPTILES

30. eastern box turtle
31. fence lizard
32. ground skink
33. racer
34. common kingsnake
35. common garter snake

INSECTS

36. zebra swallowtail caterpillar
37. tiger swallowtail caterpillar
38. viceroy caterpillar
39. red admiral butterfly
40. tiger swallowtail butterfly



- 41. imperial moth caterpillar
- 42. underwing moth
- 43. searcher beetle
- 44. hermit flower beetle
- 45. hermit flower beetle larvae
- 46. horned passalus beetle (adult and larvae)
- 47. honey bee
- 48. bumblebee
- 49. small carpenter bee
- 50. black carpenter ant
- 51. elm sawfly
- 52. flower fly
- 53. carrion beetle
- SPIDERS**
- 54. triangle spider
- WORMS (ANNELIDS)**
- 55. earthworm
- SNAILS (MOLLUSKS)**
- 56. white-lipped land snail
- 57. land snail
- PLANTS**
- 58. slippery elm tree
- 59. slippery elm buds, fruit and flower
- 60. slippery elm leaf
- 61. slippery elm bark
- 62. boxelder tree
- 63. boxelder twig, fruit and flower
- 64. boxelder leaf
- 65. boxelder bark
- 66. northern red oak tree
- 67. northern red oak buds and fruit
- 68. northern red oak leaf
- 69. northern red oak bark
- 70. hackberry tree
- 71. hackberry buds, fruit and flower
- 72. hackberry leaf
- 73. hackberry bark
- 74. river birch tree
- 75. river birch buds, fruit and flower
- 76. river birch leaf
- 77. river birch bark
- 78. smooth sumac tree
- 79. smooth sumac buds and fruit
- 80. smooth sumac leaf
- 81. smooth sumac bark
- 82. roughleaf dogwood shrub
- 83. roughleaf dogwood flower
- 84. roughleaf dogwood fruit and leaf
- 85. forget-me-not
- 86. starry Solomon's-seal
- 87. Dutchman's-breeches
- 88. wild strawberry
- 89. yellow wood sorrel
- 90. horse-nettle
- 91. wood ear fungus
- 92. oyster mushroom
- 93. artist's fungus

Plant Reproduction in the Forest

To understand how trees and other plants pass on life from one generation to another, study the five stages of the reproductive cycle.

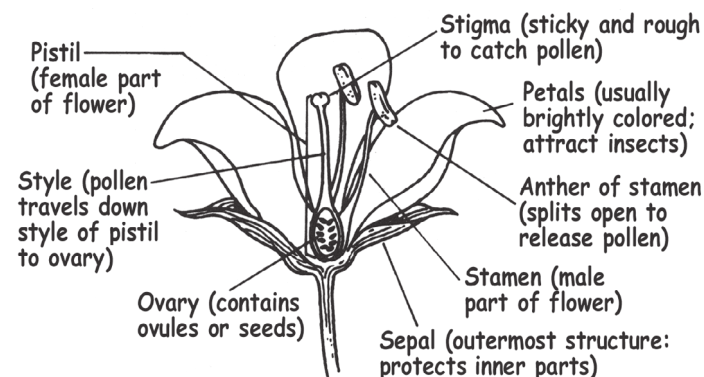
Flowering

Usually in the spring, plants bear flowers. A complete flower contains four main parts: sepals; petals; pistil; and stamens. Sepals are the outermost circle of leaves that protect the inner parts of the flower. Petals are located inside the sepals. The pistil is in the center and is the female part of the flower. A stigma is at the top of the pistil. A slender stalk called the style runs from the stigma to the base of the pistil where the ovary is located. The ovary contains undeveloped ovules (or seeds). Stamens are the male parts of the flower. At the top of the stamen is the anther, packed with pollen.

Flowers of different plant species are not alike. Some flowers have both stamens and pistils while others have just one or the other. A flower that has only stamens is called a staminate (male) flower. A flower that has only pistils is called a pistillate (female) flower. Plants are different, too. Some plant species have both pistillate and staminate flowers on the same plant. Some species have pistillate flowers on certain plants and staminate flowers on others. Flowers differ greatly in size, shape, color and how they are displayed.

Pollination and Fertilization

Pollination is the transfer of pollen from the stamen to the pistil. Pollen can be carried by wind or insects. Flowers that depend on insects to carry their pollen are bright and showy and/or have nectar. When an insect visits this flower, the sticky, moist pollen of the anther will rub off onto the insect. When that insect visits the pistil of the same or a different flower, the pollen is rubbed off onto the sticky, rough surface of the stigma. The stamen and anthers of wind-pollinated plants are large and send out huge amounts of



dry, light pollen that catches the breeze and collects on the stigma of pistillate flowers. Once pollen is caught by the stigma, it travels down the style to the ovary where it fertilizes the ovules (seeds).

Fruits and seeds

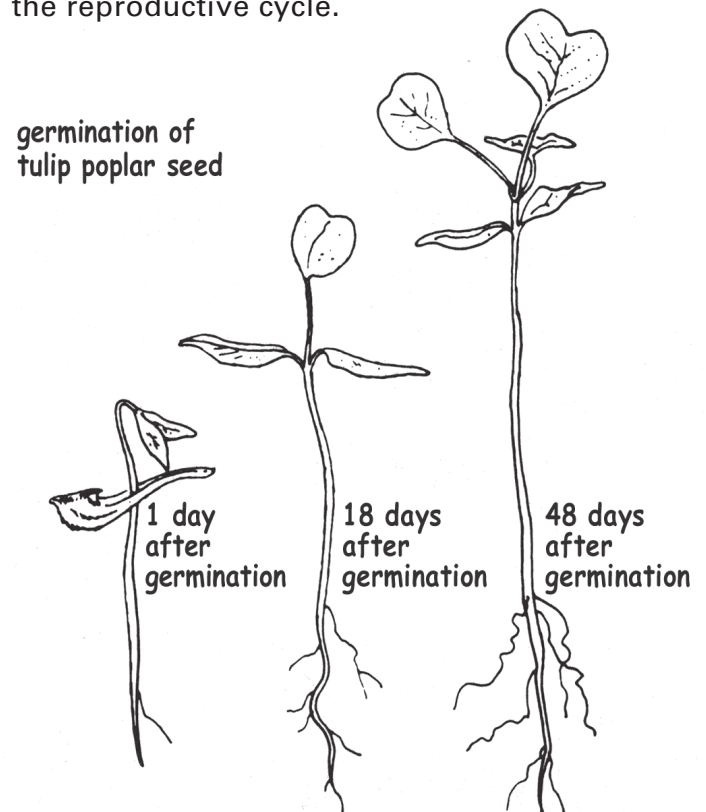
Following fertilization, the ovary and the ovules (seeds) begin to grow. The ovary grows into a fruit, and the ovules develop into mature seeds. The fruit (varies in shape, size, color and texture in different plants) serves as a carrying case for the seeds' journey to the soil.

Seed Movement

How do seeds travel from parent plants to the soil? Some seeds fall to the ground inside their fruit and are either eaten by animals, left to rot or carried away by water. Other seeds are carried by the wind, while still others stick to the fur of animals or the clothing of humans.

Germination

Most seeds do not start to grow as soon as they hit soil. Instead, they lay in rest (dormancy) for a while. At the end of dormancy, the seed takes in water and starts to grow rapidly. The seed coat pops open, and a root runs downward into the soil while a shoot pushes upward to catch the sunlight. This process of germination completes the reproductive cycle.

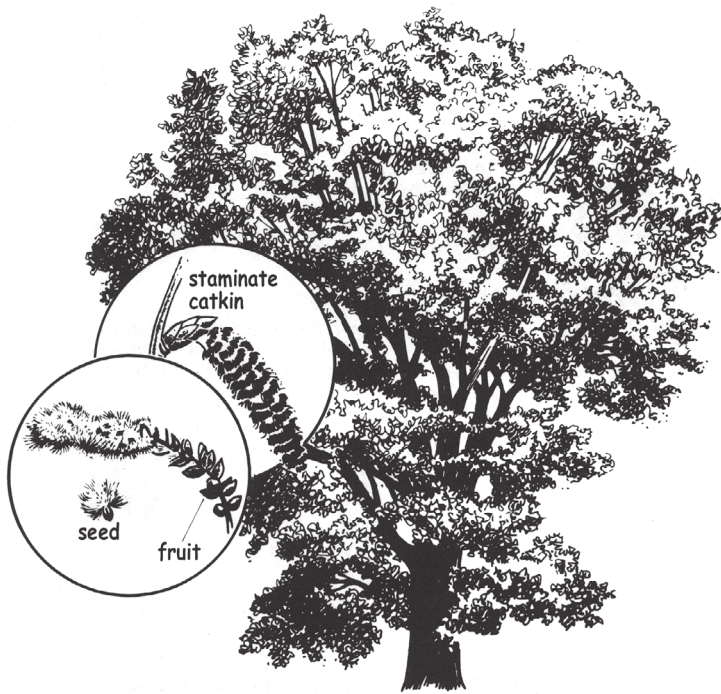


Thinking Further

1. Name and describe the four main parts of a flower.
2. Explain the process of fertilization.
3. Explain the process of germination.

Fitting Together Plant Reproductive Cycles

In this exercise you will fit together the reproductive cycle of two forest plants: eastern cottonwood and spring beauty. There are five sentences describing the reproductive cycle of each plant. The five sentences are not in the proper order. Number them in proper order.



Eastern cottonwood is a large tree growing up to 100 feet tall.

- _____ The staminate and pistillate flowers of eastern cottonwood develop on separate trees. The staminate flowers are thick red catkins, while the pistillate flowers are narrower, green-yellow catkins.

- _____ By May, the pistillate flowers have matured into long strings of green-brown capsule fruits that hold tiny seeds.
- _____ Wind carries pollen from staminate to pistillate flowers, where the seeds are fertilized.
- _____ The seeds of eastern cottonwood must arrive at moist soil along a stream bank within a few hours after leaving the tree.
- _____ During spring and summer, the fruits split open, and the seeds (each with a cottony, white sail) catch the wind and travel from the parent tree.



Spring beauty is a common woodland wildflower that grows to about six inches tall.

- _____ The seeds of spring beauty germinate in spring.
- _____ By May, each capsule fruit has matured and holds three to six flat seeds.
- _____ The white or pink flowers of spring beauty bloom by the first week in March. Each flower has both a stamen and a pistil.
- _____ When the fruits are very ripe, they split open, and the seeds fall to the soil.
- _____ Shortly after the flowers bloom, insects carry pollen from one flower to another, and the seeds are fertilized.

How Seeds Move in the Forest

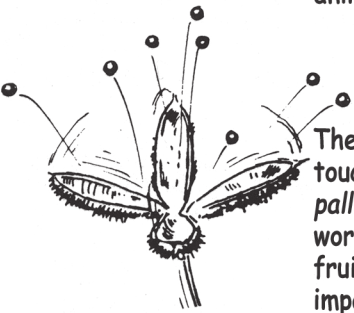
The forest is never still. Even in the fall when the trees are losing their leaves, parts of the forest are on the move. Seeds are traveling from parent plants to new locations where they may someday grow into plants. A seed ripens inside the fruit of a plant. The structure of a fruit and its seed determines how the seed will travel through the forest. In some cases, the fruit matures, splits open and releases its seed. When that happens, the seed has to do its own traveling. In other cases, the fruit leaves the plant,

and it carries the seed with it. When that happens, the fruit is a carrying case for the seed. Below is a chart listing nine different types of fruits and seeds and the nine different ways each is moved through the forest. Study the list and then examine the fruits and seeds drawn below the chart. After you have looked at the makeup of the fruits and seeds and studied the description of each, write down how you think each of the fruits and seeds is moved from its parent plant to a new location in the forest.

1. winged fruits – carried by wind
2. fruits with plumes (cottony, feathery, fibers attached to fruit) – carried by wind
3. fruits with spines or barbs (catch in the fur of animals or the clothes of people) – carried by animals, including humans
4. corky fruits (have air spaces enabling them to float) – carried by water
5. tiny seeds – carried by wind
6. tiny seeds with arils (seeds so small they can be carried by insects; have arils, extra bits of tissue that insects eat) – carried by insects
7. fleshy fruits (berries, pomes, drupes) – eaten by animals and passed out in feces or left to rot and seeds enter the soil
8. nuts – buried in ground by animals
9. explosive fruits – fruits burst open and seeds shoot out



The fruit of swamp white oak is an acorn. Acorns are borne in pairs and serve as food for animals. _____



The scientific name of spotted touch-me-not is *Impatiens pallida*, (*impatiens* is the Latin word for impatient). The mature fruit of this wildflower is so impatient that it bursts open at the slightest touch. _____

The capsule fruit of yellow dog-tooth violet splits open to spill many tiny seeds. The seeds have an aril that insects eat. _____



The fruit of tick trefoil is a legume (a bean-like fruit bearing a seed pod). Each legume carries about three seeds and is covered with very sticky, hooked hairs. _____



The capsule fruit of twayblade orchid splits open to release many, very tiny seeds. _____



The juicy, red berries of smooth sumac each contain a single, brown seed. The berries hang on the tree well into winter and are eaten by animals that can climb or fly. _____



The capsule fruits of quaking aspen are grouped in clusters. The small seeds held in each fruit have cottony hairs attached to them. _____

The light, spherical fruit of sycamore can float for a long distance. Each fruit contains many small seeds that need damp soil for germination. _____



The fruits of black maple each bear one seed, are borne in pairs and have thin, light wings. _____

Forest Shelters

Below are animals and shelters found in a forest ecosystem. A shelter is any place or thing that protects an animal from harsh weather and/or attack. Study the shelter requirements of the animals below. Then draw a line from the animal to its shelter.

burying beetle

The burying beetle uses the forest soil as shelter and for preserving its food. When a small mammal or bird dies, the beetle buries the body by digging the soil from below. The female beetle lays her eggs near the buried food and when the larvae hatch, they eat the dead animal.

luna moth caterpillar

The luna moth caterpillar makes its own shelter using silk produced by a gland near its upper lip. Hanging from a twig, the caterpillar spits out silk while shaking its head back and forth in a zigzag motion. In a short time, the caterpillar spins a tough, waterproof, two-layered case of silk that is firmly tied to the twig. In this cocoon, the caterpillar (now known as a pupa) will undergo metamorphosis, or changes in its physical makeup. The pupa spends the winter in the cocoon and in May or June, emerges as a luna moth.

silver-haired bat

The silver-haired bat commonly takes shelter beneath the loose bark of trees. In such a shelter, the young bats (usually two) cling to the body of the female bat until they are about three weeks old and ready to fly by themselves.

gray fox

The gray fox may make its den in the base of a hollow tree. During spring or summer, three to five

naked and nearly blind kits are born in the den. The rest of the year, the den is used as a resting place, usually during daylight hours.

hairy woodpecker

It takes one to three weeks for a pair of hairy woodpeckers to chisel out a nest cavity in the side of a tree. If the tree is dead or has rotten heartwood, the work takes less time. The opening of the cavity is 1-1 1/2 inches wide, and the cavity may be as deep as 15 inches. Sometimes the male excavates a shallower hole near the nesting tree as a sleeping spot.

Baltimore oriole

The female Baltimore oriole builds a swinging nest high in a tree. First, she hangs long strands of dried plant stalks, yarn or hair over twigs. Next, she loops and weaves the strands together into a strong basket. Hanging on the nest with her head down, she chatters or sings as she weaves.

fence lizard

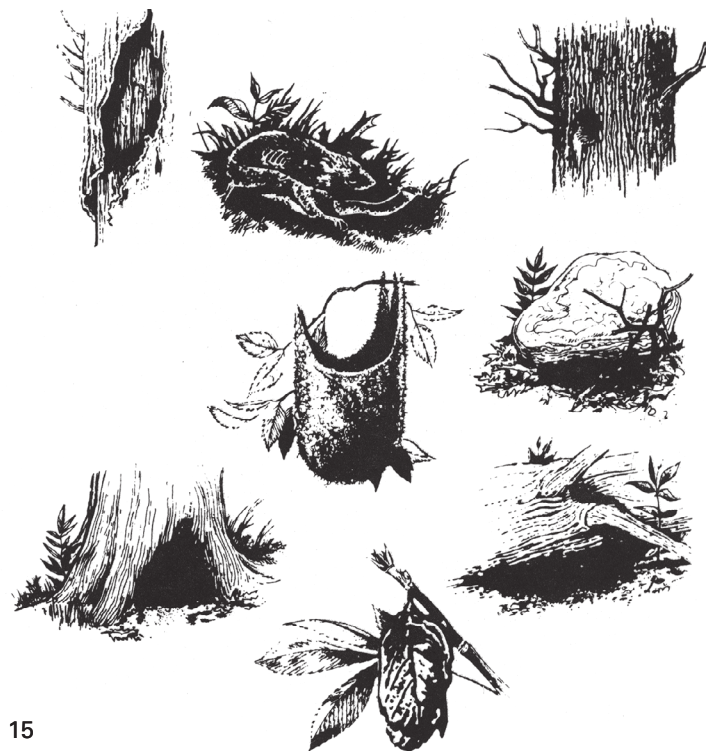
When not basking in the sun, the fence lizard seeks shelter under a fallen and decaying log. Such a log is often used by the female lizard in summer as a place to deposit her long, soft-shelled eggs.

racer

The racer is often found under a rock, especially when it is time to shed its skin or when the weather is cold. In early summer, the female racer lays 10 to 15 white eggs under a rock.

Thinking Further

1. In your own words, explain how the forest ecosystem is one big shelter protecting many smaller shelters.



Tracking the Mammals of the Forest

The mammals of the forest are not easily seen. One of the best ways to tell if a mammal has been around is to find its tracks. Below you will see illustrations of the feet of 10 mammals. On the right, 10 sets of tracks (some showing both running and walking gaits) are drawn just as they appear when they are imprinted on the forest floor. Carefully

study the feet of each mammal and then match each mammal to the set of tracks you think its feet would make. Special Note: The house cat and dog are not native mammals of the forest; however, they are included in this exercise so that you will be able to tell their tracks from the native mammals.

Mammals

<p>white-tailed deer</p> <p>footprint of running deer showing spread toes and imprint of dew-claws</p> <p>2 1/2" - 3"</p>	<p>Virginia opossum</p> <p>right front foot</p> <p>right hind foot</p>
<p>striped skunk</p> <p>front foot</p> <p>hind foot</p> <p>1 3/4"</p> <p>diagonal arrangement of tracks</p> <p>2 3/4"</p>	<p>gray squirrel</p> <p>front feet side by side when running</p> <p>1 1/2"</p> <p>2 1/2"</p> <p>front foot</p> <p>hind foot</p>
<p>raccoon</p> <p>left front foot</p> <p>left hind foot</p> <p>2 1/2"</p> <p>4"</p>	<p>eastern chipmunk</p> <p>prints of front feet always back of hind prints</p> <p>5/8"</p> <p>1 3/8"</p>
<p>gray fox</p> <p>front foot</p> <p>hind foot</p> <p>2 1/4"</p> <p>1 3/4"</p> <p>stride about 11" with tracks in a straight line</p>	<p>bobcat</p> <p>note dip in front of pad</p> <p>claws do not show in tracks</p> <p>front foot</p> <p>hind foot</p> <p>2"</p> <p>1 3/4"</p> <p>footprints not as round as those of house cat and much larger; walking stride to 13"; trotting stride to 16"</p>
<p>dog</p> <p>front foot</p> <p>hind foot</p> <p>foot rounder, pads larger than gray fox; tracks staggered, not in straight line</p>	<p>house cat</p> <p>front foot</p> <p>hind foot</p> <p>1 1/4"</p> <p>1"</p>

Tracks

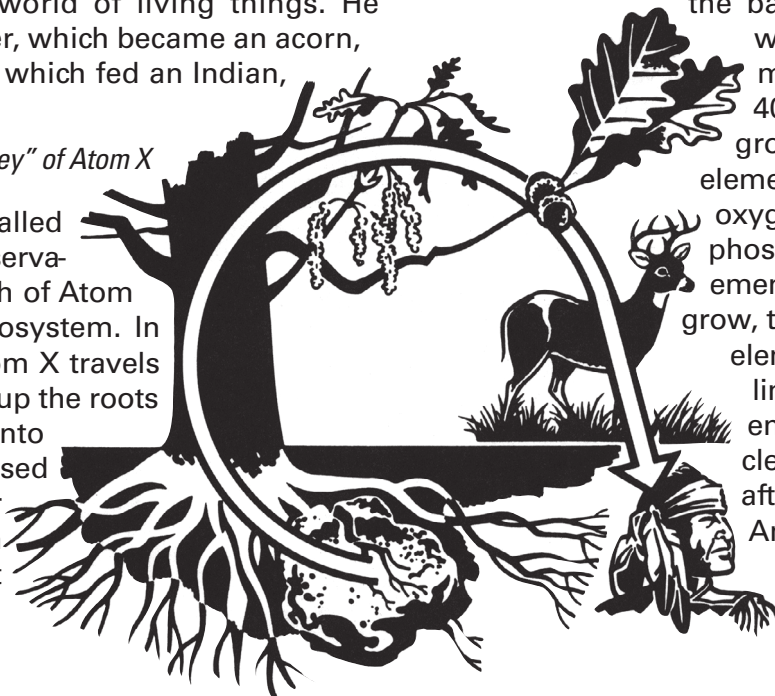
<p>walking</p> <p>15-20"</p> <p>running</p>	<p>walking</p> <p>1-5 ft"</p> <p>running</p>	<p>12"</p>
<p>7"</p> <p>above - walking</p> <p>below - running</p>	<p>11"</p> <p>11"</p>	<p>8-14"</p> <p>16-20"</p> <p>r.h.</p> <p>l.h.</p> <p>l.f.</p> <p>r.f.</p>

Nutrient Element Cycling

"Time, to an atom locked in a rock, does not pass. The break came when a bur oak root nosed down a crack and began prying and sucking. In the flash of a century, the rock decayed, and X was pulled out and up into the world of living things. He helped to build a flower, which became an acorn, which fattened a deer, which fed an Indian, all in a single year."

— Aldo Leopold, "Odyssey" of Atom X

Aldo Leopold, often called the grandfather of conservation, described the path of Atom X through a forest ecosystem. In Leopold's passage, Atom X travels from a rock to the soil, up the roots of a bur oak tree and into its flower. Atom X is used to help ripen the flower into an acorn; the acorn is eaten by a deer that



in turn is eaten by a Native American. What is Atom X and where will it go from the Native American?

Atom X is part of an element. Elements are one of the basic units of matter from which all things on earth are made. Organisms need 30-40 elements for normal growth. The most important elements are carbon, hydrogen, oxygen, nitrogen, sulfur and phosphorus. Because these elements help plants and animals grow, they are known as nutrient elements and since there is a limited supply of nutrient elements, they must be recycled. Atom X will be recycled after it leaves the Native American.

Fitting Together an Oxygen Cycle



Oxygen is vital to the development of all living things. Twenty-one percent of the atmosphere is composed of oxygen.

The forest scene above has all of the parts necessary to illustrate the oxygen cycle on land. Match the parts of the forest scene to the explanations of the oxygen cycle.

1. Read the explanations and place the letter of each explanation (A, B or C) beside the part of the forest scene it describes.
2. Label the parts of the forest with common names. See "Explanations" for names.
3. Start at the first explanation (the atmosphere) and read all the explanations. Notice that each time that oxygen is transferred from one part

of the forest scene to another, the sentence describing the movement is underlined. Each time you see an underlined sentence, draw an arrow from the part of the cycle oxygen is leaving to the part it is arriving at. Remember, every part of the forest that takes in oxygen also releases it back into the atmosphere.

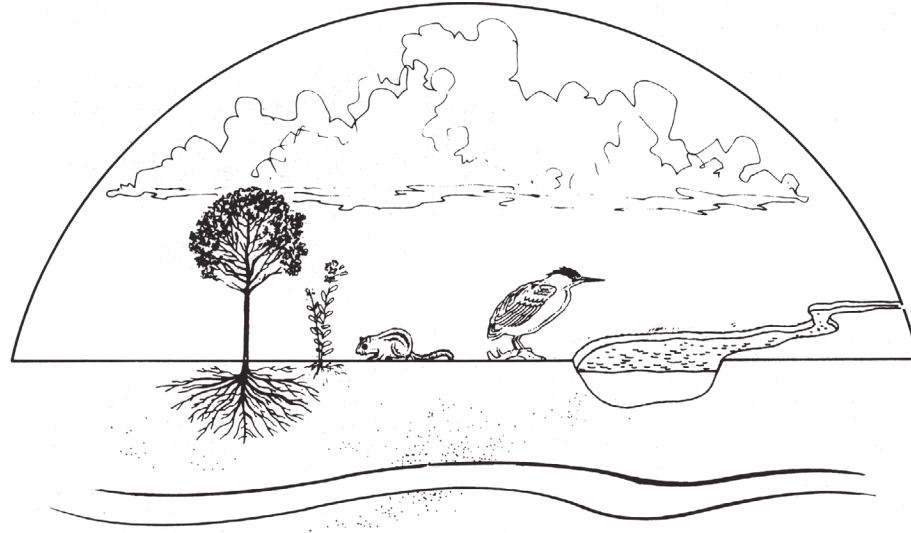
Explanations

- A. The air, or atmosphere, serves as the holding tank for oxygen.
- B. Green plants, such as the pawpaw, a small tree with a broad crown, and the mayap-

ple, a large wildflower, take in oxygen from the atmosphere and use it in the process of respiration. Green plants release oxygen back into the atmosphere as they conduct photosynthesis. In fact, green plants are responsible for manufacturing most of the oxygen in the atmosphere.

C. Animals such as the silver-haired bat, a dark, small bat up to 4 ½ inches long, and the white-footed mouse, a brown mouse with white undersides and feet, also take in oxygen from the atmosphere. As they respire, they release oxygen back into the atmosphere.

Fitting Together a Water Cycle



Water is the source of the element hydrogen.
Water also carries the other nutrient elements through the forest ecosystem.

The forest scene drawn above has all the parts necessary to illustrate the water cycle of the forest. Use the same directions you followed to put together the oxygen cycle. Remember, each time you see an underlined sentence, water is moving from one part of the water cycle to another. You should show that movement by drawing an arrow from the part water is leaving to the part where it is arriving.

Explanations

- Water is stored in clouds in the atmosphere. From those clouds, water falls as rain to the forest soil.
- Water in the soil is absorbed by the roots of plants, such as eastern hophornbeam, a small tree up to 35 feet tall, and bulbous cress, a wildflower up to 18 inches tall. The water carries all of the nutrients the plants need for development. The plants use water during photosynthesis and release water back into the atmosphere during respiration.
- Some of the rainfall from the atmosphere runs into streams that feed lakes, rivers and eventually the ocean. During the process of evaporation, water vapor returns to the atmosphere from those bodies of water.
- Some of the rainfall from the atmosphere penetrates through the forest soil to deep groundwater

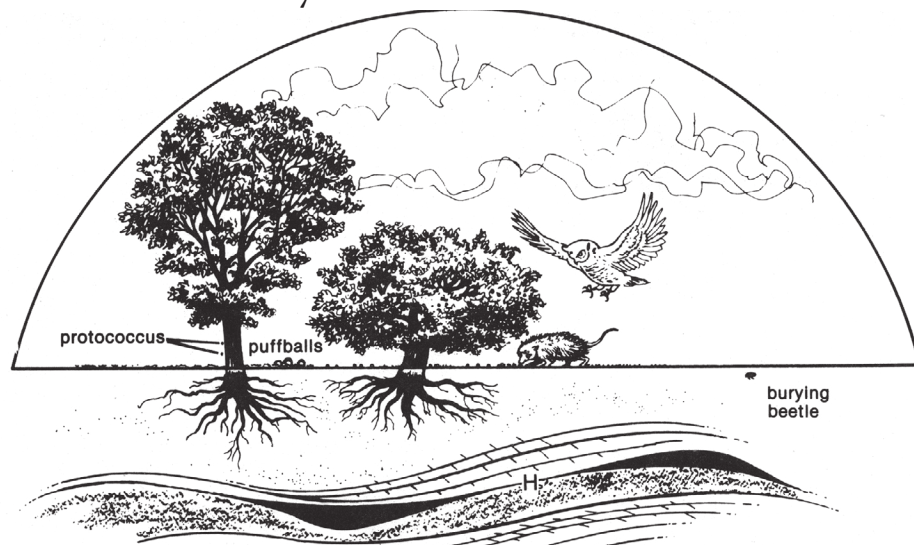
reserves. These reserves feed springs, seeps and lakes.

- Some of the rainfall from the atmosphere hits the soil and returns to the atmosphere almost immediately during the process of evaporation.
- Animals take in water from bodies of water or by eating plant tissues, fruits or seeds. In this scene, an eastern chipmunk, a small mammal, is eating the flat, smooth fruit of bulbous cress and a green heron, a blue-green colored bird, is drinking water from the stream. When animals, such as the eastern chipmunk and the green heron respire, water is returned to the atmosphere in the form of water vapor from their body.

Thinking Further

- A great amount of oxygen is taken out of the atmosphere when fossil fuels, such as coal, oil and gas, are burned to produce energy. We depend on green plants conducting photosynthesis to restore the oxygen supply in the atmosphere. Can the removal of large areas of trees and other plants affect the production of oxygen? If yes, explain how? What does your answer mean for people, for plants, for animals?
- Explain how the water cycle is affected when forests are entirely stripped of trees and other plants.

Fitting Together a Carbon Cycle



Forty-nine percent of the dry weight of living organisms is carbon.

The forest scene drawn above has all of the parts necessary to illustrate the carbon cycle on land. Use the same instructions you followed to fit together the oxygen and water cycles.

Explanations

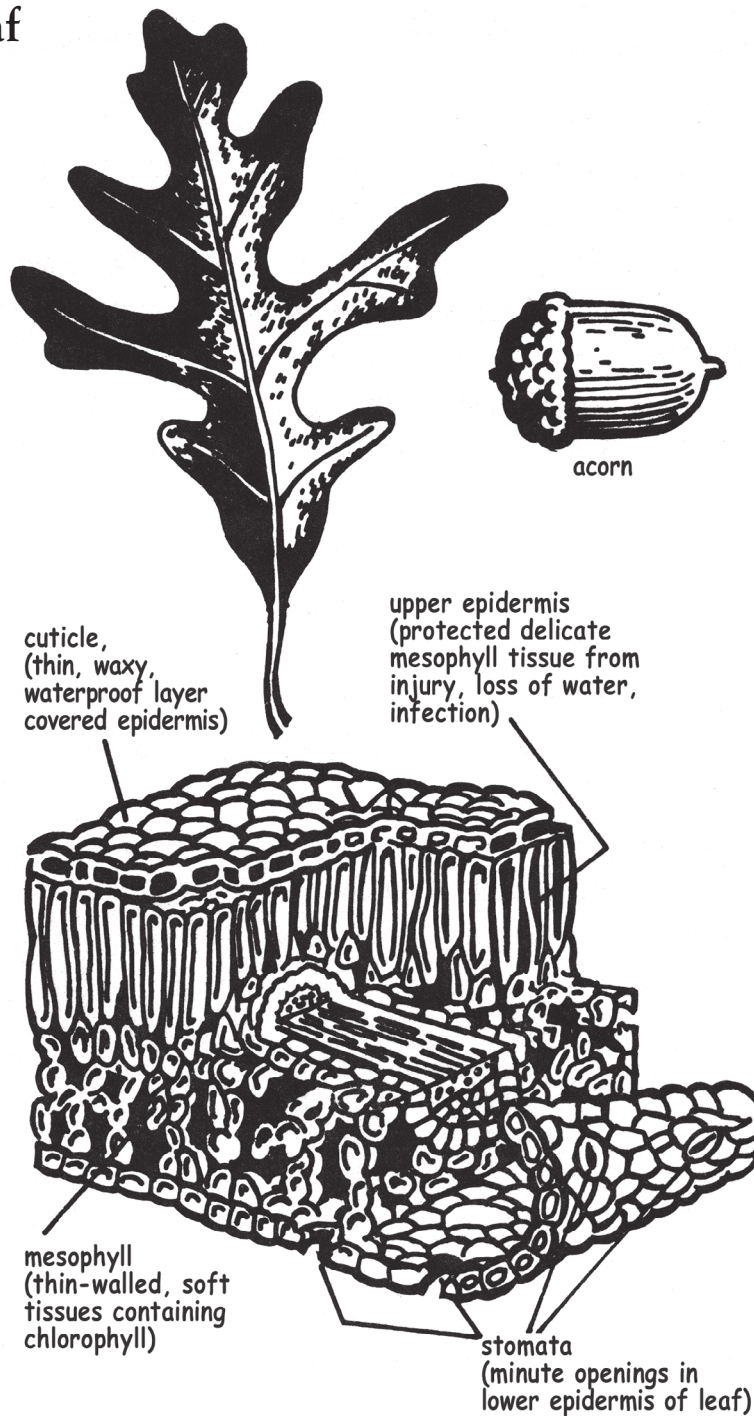
- A. The atmosphere of the earth stores carbon in the form of carbon dioxide (CO_2).
- B. The pecan, a large tree up to 150 feet tall, is taking in CO_2 from the atmosphere through its leaves. In those leaves, CO_2 is used in the process of photosynthesis. When the pecan respire, CO_2 and water vapor are released as waste products into the atmosphere through its leaves and into the soil through its roots.
- C. The leaves of red mulberry, a medium-sized tree up to 50 feet tall, also take in CO_2 from the atmosphere to use in photosynthesis. Like the pecan, the red mulberry releases CO_2 to the atmosphere when it respire. The red, juicy berries of red mulberry are eaten by many animals. In this scene, a Virginia opossum is feasting on the berries. Carbon compounds are being transferred from the red mulberry to the opossum.
- D. The Virginia opossum, like all animals, also respire in order to release energy inside the cells of its body. As it respire, CO_2 is released to the atmosphere. The opossum is eaten by foxes, coyotes, large owls and other predators. In this scene, the opossum is about to be killed and eaten by a great horned owl. Carbon compounds will transfer from the opossum to the great horned owl.
- E. The great horned owl respire to gain the use of energy stored in its body. As it does so, CO_2 is sent into the atmosphere.
- F. In this scene, there are three decomposers. The protococcus is a bacterium growing on the bark of the pecan tree. The protococcus is feeding on the tissues of the tree, and carbon compounds are moving from the pecan to the protococcus. The puffball's mycelium is feeding on the fallen leaves and limbs of the trees, and carbon compounds are moving from the leaves and limbs to the mycelium. The burying beetle is an insect living in the soil. When the great horned owl dies, the burying beetle will feed on its body, and carbon compounds will be transferred from the owl's body to the beetle. The decomposers play a very important role in the carbon cycle because they receive carbon from every organism. When the decomposers undergo respiration, they release more CO_2 back into the atmosphere than do larger plants and animals.
- G. When decomposers die and decay into the soil, carbon compounds will be transferred to the soil. Remember, the roots of the pecan and red mulberry are already releasing CO_2 into the soil. Some of the CO_2 is released from the soil to the atmosphere, but most of it goes downward.
- H. After many thousands of years, bits of animals and plants in the soil form reserves of peat, coal, oil and carbonate rocks deep below the ground's surface. These reserves store the majority of the earth's total carbon.

Thinking Further

1. Forests take in more CO₂ from the atmosphere than any other ecosystem. This transformation of CO₂ to wood is very important because it helps

prevent a build up of CO₂ in the atmosphere. Such a build up is a real danger as we continue to burn larger and larger amounts of coal, oil and natural gas (fossil fuels that release CO₂ into the atmosphere). In your own words, explain how forests help control the amount of CO₂ in

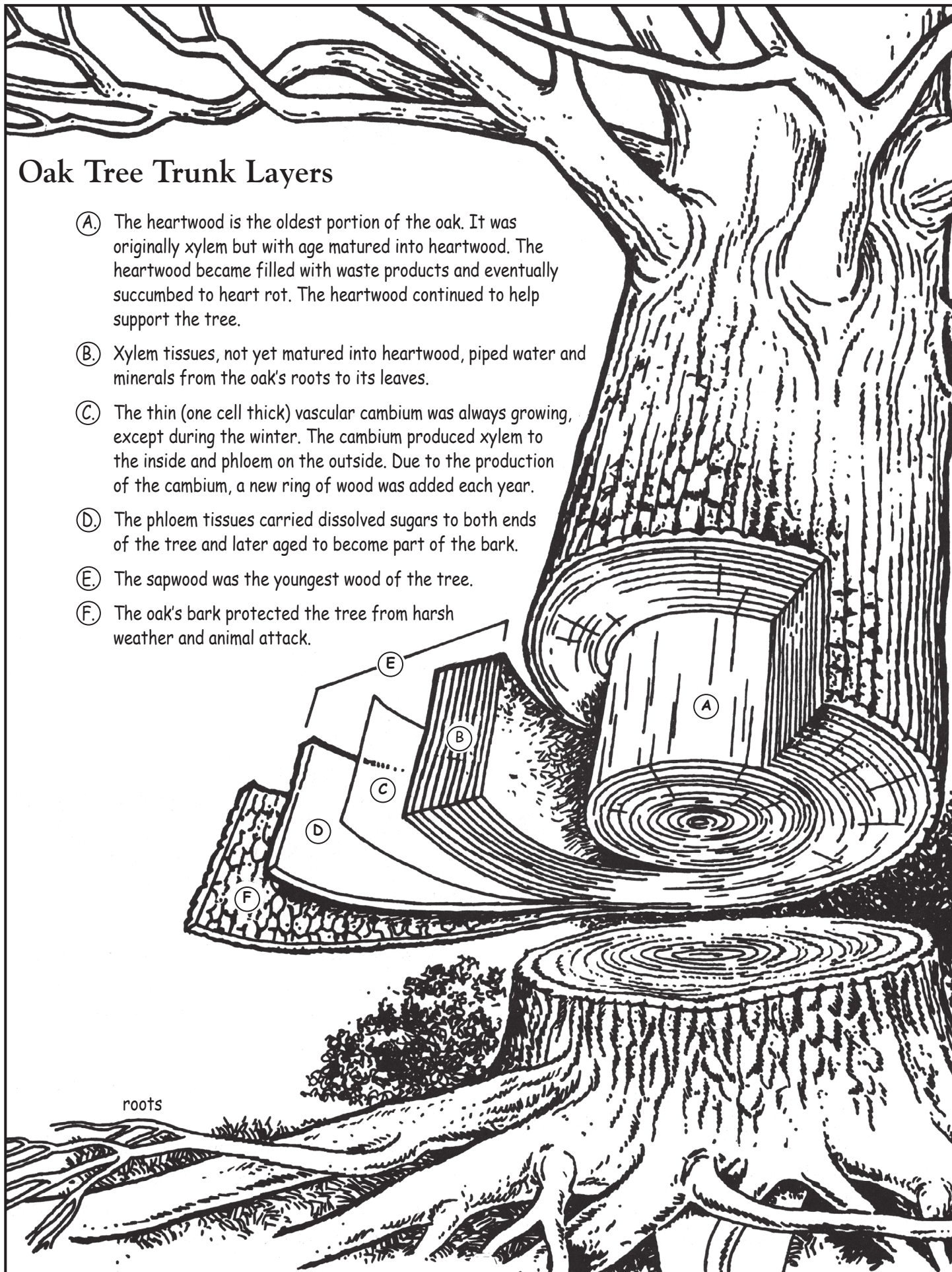
Oak Tree Leaf and Fruit



The main job of the oak's leaves is to make food. Carbon dioxide entered the underside of the leaves through the stomata. Chlorophyll in these cells changed the sunshine, carbon dioxide and water to glucose or food molecules through the process of photosynthesis.

Oak Tree Trunk Layers

- (A) The heartwood is the oldest portion of the oak. It was originally xylem but with age matured into heartwood. The heartwood became filled with waste products and eventually succumbed to heart rot. The heartwood continued to help support the tree.
- (B) Xylem tissues, not yet matured into heartwood, piped water and minerals from the oak's roots to its leaves.
- (C) The thin (one cell thick) vascular cambium was always growing, except during the winter. The cambium produced xylem to the inside and phloem on the outside. Due to the production of the cambium, a new ring of wood was added each year.
- (D) The phloem tissues carried dissolved sugars to both ends of the tree and later aged to become part of the bark.
- (E) The sapwood was the youngest wood of the tree.
- (F) The oak's bark protected the tree from harsh weather and animal attack.



A Southern Flying Squirrel's Life to Live Game

Life History

The southern flying squirrel, *Glaucomys volans*, may be common in much of Illinois' mature forests. Since the flying squirrel is active only at night, an accurate count of its numbers in Illinois has been impossible to make. The flying squirrel is protected by Illinois law, and it is illegal to harm or capture individual squirrels.

The flying squirrel has a "gliding" membrane on each side of its body. The squirrel uses these thin folds of skin to glide from limb to limb. The flying squirrel does not fly. Though it may glide downward 150 feet or more, most of its glides are between 20 and 30 feet in length.

The female flying squirrel gives birth to one to six young during March to early April. She may produce a second litter in late summer. At birth, the young are naked, pink and have their eyes and ears shut. The female flying squirrel has complete responsibility for taking care of the young, and she defends them and the territory around her nest tree. The male flying squirrel does not defend his home territory.

Though nuts, seeds, fruits, berries and mushrooms make up most of the flying squirrel's diet, it also feeds on animals such as moths, beetles, insects, insect larvae, bird eggs and nestlings and meat from the carcasses of dead animals. The flying squirrel is preyed upon by native animals such as weasels, raccoons, owls, hawks, bobcats and tree-climbing snakes. A nonnative predator of the flying squirrel is the house cat.

The flying squirrel is active all year, but it may stay in its nest for several days to avoid bad weather during the winter. In winter, several flying squirrels may share one nest, presumably for warmth.

The flying squirrel is a valuable member of the forest community. By feeding on tree buds, it stimulates better tree growth and by eating wood-burrowing insects, it aids in controlling these sometimes harmful forms. The flying squirrel helps the forest continue to survive by planting nuts and seeds. By serving as food for other forest dwellers, it is an important link in

the food chain. Even in death, the flying squirrel serves life by adding its body to the soil as rich organic material.

Instructions for Playing

1. This game can be played by 1-10 players.
2. Each player should begin the game with a player token, a nine-lives pass, a glide pass and a score sheet.
3. Before beginning the game, one player should read aloud the life history of the southern flying squirrel.
4. To begin the game, each player should spin the spinner, and the person with the lowest number is entitled to go first. The rest of the players should take their turns in clockwise order after the first player.
5. After a player spins the spinner, s/he should move the designated number of spaces. If for any reason, the player does not want to land on a certain space, s/he can use the glide pass to land on any other space on the board. However, once a player uses the glide pass, it is no longer valid. **GLIDE PASS CAN BE USED BY ONE PLAYER ONLY ONE TIME DURING A GAME.** If at the end of the game, a player still has her or his unused glide pass, s/he may turn it in for 20 points.
6. If a player lands on a CATEGORY space, the space will be marked with a number and a capital C. The player should read what is written on the space and decide which category the space refers to.

CATEGORIES

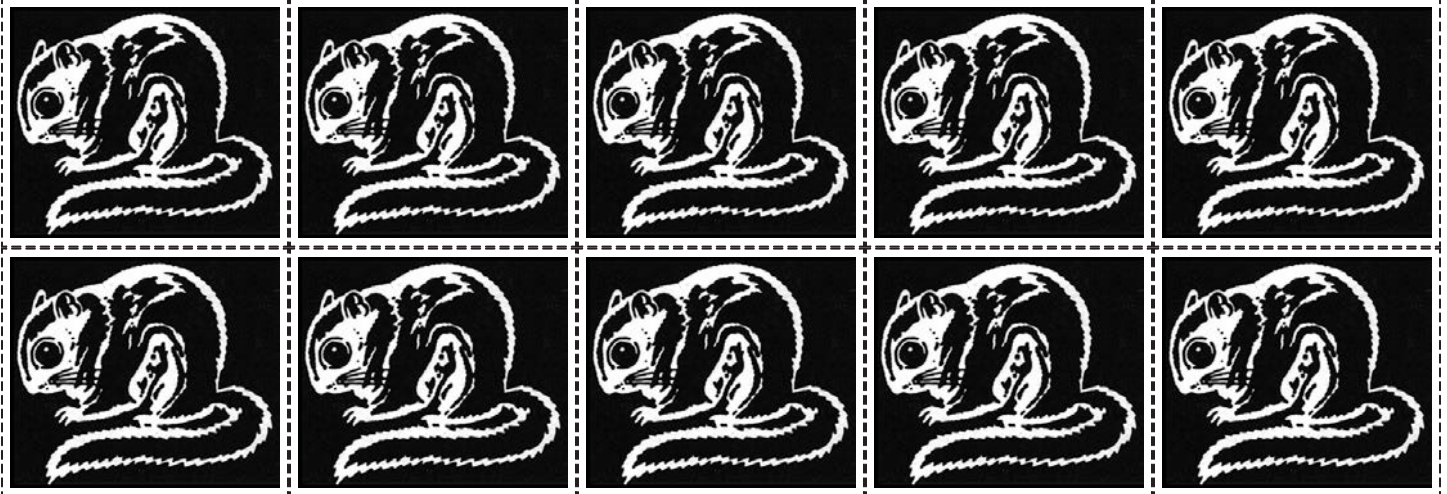
Natural Predator	Young
Unnatural Disturbances/ Predator	Territory/Home Range
Food Gathering	Travel
Nest	Physical Appearance
Habitat	

Each of the categories represents important parts of the flying squirrel's life history. If a space seems to refer to more than one category, the player should decide what the main

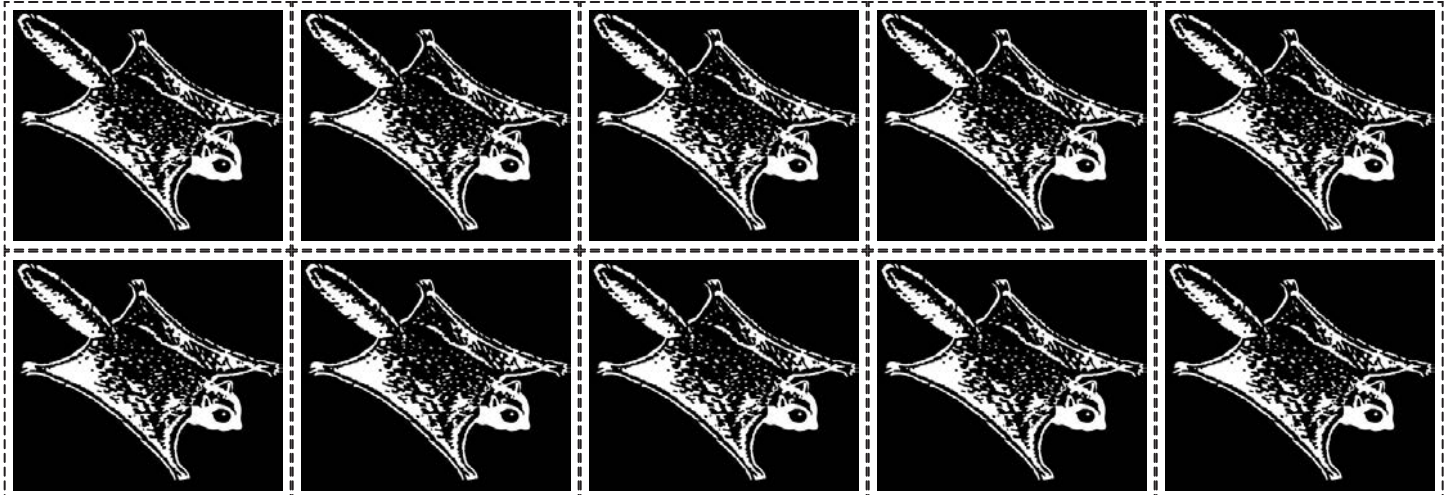
Correct Scorecard Answers

1. **Category:** Natural Predator
 2. **Category:** Food Gathering
 3. **Question:** No
 4. **Situation:** False
 5. **Category:** Young
 6. **Category:** Travel
 7. **Question:** the presence of a gliding membrane on each side of its body
 8. **VALUE BONUS:** by feeding on tree buds, probably stimulates better tree growth; is beautiful and harmless (See also #30.)
 9. **Category:** Habitat
 10. **Category:** Unnatural Disturbance/Predator
 11. **Question:** No
 12. **Category:** Nest
 13. **Situation:** False
 14. **Question:** True
 15. **Question:** 20 to 30 feet
 16. **Situation:** False
 17. **Category:** Travel
 18. **Category:** Physical Appearance
 19. **Category:** Natural Predator
 20. **Question:** moths, beetles, insects, insect larvae, bird eggs and nestlings
 21. **Category:** Habitat
 22. **Category:** Unnatural Disturbance/Predator
 23. **Question:** weasel, raccoon, hawks, bobcat
 24. **Situation:** True
 25. **Category:** Nest
 26. **Question:** naked, pink and with eyes and ears shut
 27. **Category:** Young
 28. **Category:** Territory
 29. **Question:** True
 30. **VALUE BONUS:** part of the food chain; eats harmful insects; plants nuts and seeds; returns body waste to the soil (See also #8.)
 31. **Category:** Food Gathering
 32. **Category:** Physical Appearance
- theme of the space is. After a player decides which category the space refers to, s/he should write down the category on her or his score sheet opposite the number of the space. A correct answer for a CATEGORY space is worth 5 points.
7. If a player lands on a QUESTION space, the space will be marked with a number and a capital Q. The player should write the answer to the question by the number of the space on her or his score card. A correct answer for a QUESTION space is worth 10 points.
 8. If a player lands on a VALUE BONUS space, he or she must write down one value of the southern flying squirrel on the score card next to the space with the same number. A correct answer for a VALUE BONUS space is worth 10 points.
 9. If a player lands on a SITUATION space, the space will be marked with a number and a capital S. The player must decide if the drawn situation represents a true or false situation in the flying squirrel's life. The player should write "true" or "false" next to the space with the same number on her or his scorecard. A correct answer is worth 5 points.
 10. If a player lands on a space where her or his squirrel is killed, s/he may avoid the death by playing her or his nine-lives pass. If the nine-lives pass is played, the player may stay in the game but is still responsible for playing that space in the appropriate manner. If a player lands on a space where her or his squirrel is killed and s/he has already played the nine-lives pass, the player must drop out of the game. However, that player can tally her or his scorecard at the end of the game and is eligible to win. Remember, like the GLIDE pass, THE NINE-LIVES PASS CAN BE USED BY EACH PLAYER ONLY ONCE DURING THE GAME. If at the end of the game a player still has her or his unused NINE-LIVES PASS, s/he may turn it in for 10 points.
 11. After each player has crossed the finish line, a judge or a panel of the players must review the score sheets for the correct answers. The player with the highest point total wins the game.

Player Tokens



Glide Passes



Nine-Lives Passes

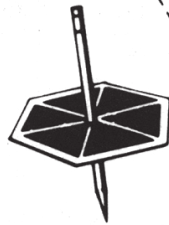


Scorecard

- 1. C. _____
- 2. C. _____
- 3. Q. _____
- 4. S. _____
- 5. C. _____
- 6. C. _____
- 7. Q. _____
- 8. V.B. _____
- 9. C. _____
- 10. C. _____
- 11. Q. _____
- 12. C. _____
- 13. S. _____
- 14. Q. _____
- 15. Q. _____
- 16. S. _____

- 17. C. _____
- 18. C. _____
- 19. C. _____
- 20. Q. _____
- 21. C. _____
- 22. C. _____
- 23. Q. _____
- 24. S. _____
- 25. C. _____
- 26. Q. _____
- 27. C. _____
- 28. C. _____
- 29. Q. _____
- 30. V.B. _____
- 31. C. _____
- 32. C. _____

Spinner



Spin using a pencil.



2. C.

Fall is near, and it is time to begin storing and burying nuts. To bury a nut in the ground, you scrape away dirt with your front feet, press the nut down with your nose and then cover the nut with dirt.

1. C.

It is early April, and you are a female flying squirrel returning to your nest after foraging for food. You find the nest is empty. A tree-climbing snake has preyed upon your young.

3. Q.

Do flying squirrels hibernate during the winter?



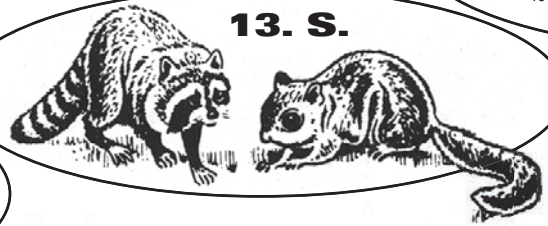
SOUTHERN FLYING SQUIRREL'S LIFE TO LIVE

Game Board

12

You build your den in the old woodpecker. Even though the opening is only a few inches in diameter, you bring in twigs, feathers and bits of leaves to line it.

13. S.

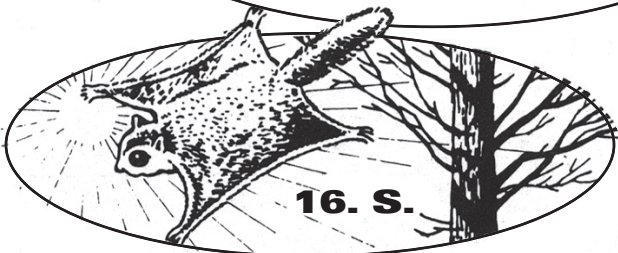


14. Q.

Since flying squirrels are active only at night, biologists do not know exactly how many flying squirrels there are in Illinois. True or False.

15. Q.

How far do flying squirrels normally glide?



16. S.

17. C.

You leap off a perch, spreading your four legs at right angles to your body and stretching your gliding membranes until they catch the force of the air. Using your tail to do most of the steering you turn at a 90-degree angle to avoid a branch. Ready to land, you brake with your tail and touch down on your hind feet. You then scurry to the top of the tree where you launch off again.

18. C.

You have survived the winter, and it is now March. By the end of summer the fur on your head, neck and rump will be wearing thin. Fortunately, your fur will begin to molt in September or early October. By November, you will have traded in your old coat for a new one.

19. C.

There is a full moon. You know this night is risky for travel. You lift off your perch and glide through the air. Sharp talons pierce your back, and a great horned owl silently carries your body away.

23. Q.

In addition to tree-climbing snakes and owls, name a native animal that preys upon flying squirrels.

22. C.

It is daytime, and you are sleeping in the cavity of a tree. A gloved hand reaches in and jerks you out of your nest. You are so startled, you die of shock. The person who wanted you as a pet walks away empty-handed.

21. C.

You seem to prefer a home that is heavily wooded but not so heavily wooded as to prevent gliding, and you favor forests that contain plenty of old dead trees and rotten snags well-drilled with woodpecker holes and cavities.

20. Q.

Name one animal food taken by the flying squirrel.

CATEGORIES: Food Gathering; Habitat; Natural Predator; Travel; Unnatural Disturbance/Predator; and Young.

5. C.

It is your second week of life as a flying squirrel. Since you were born, you have nearly doubled your weight and are almost completely covered with hair. Your eyes will remain closed for another two weeks. It will be four weeks before you begin to forage for your own food.

4. S.



2. C.

Abandoned nest cavity of a downy woodpecker opening in the side of the tree is only one inch of shredded bark, lichens, moss, and leaves to line your new home.

11. Q.

Is it legal to shoot, trap or capture a flying squirrel in Illinois?

6. C.

When not gliding, you run along tree branches and leap from limb to limb. To search for food on the ground, you run and hop across the forest floor. Since you are not a fast runner, you must be careful to guard against predators.

7. Q.

What physical characteristic distinguishes the flying squirrel from other squirrels?

8. VALUE BONUS

9. C.

You are sometimes seen in an attic, under the eave of a roof or around a birdhouse.

24. S.



10. C.

A domestic cat has pounced at you. You run for the nearest cover. Too late! With one big swat, the cat scoops you up and bites your neck. You are dead.

25. C.

Winter is approaching. You move from your cool nest in the cavity of a hollow limb at the top of a white oak tree to a cavity deep in the tree trunk. The nest is protected from wind and snow and is warmer. Five other flying squirrels are sharing the nest with you.

26. Q.

Describe a flying squirrel at birth.

32. C.

The "gliding" membrane on each side of your body is a loose fold of skin running from your wrist to your ankle. The glossy fur on the back and sides of your body is gray, while the underparts are pure white. From the tip of your tail to your head, you are 8 5/8 to 9 3/4 inches long.

27. C.

You are a female flying squirrel. Lightning has just struck your nest tree, and the nest is now exposed. Two of your young are dead. You must move the surviving two to a new nest. One by one, you carry the young squirrels by biting their belly skin while they curl their feet and tail around your neck.

31. C.

Various nuts, fruits and berries are stock items on your menu. During the winter, you nibble on the buds of trees. In spring, you eat sugar maple blossoms and the bark of many hardwood trees.

28. C.

You are a female flying squirrel, and you defend your nest tree and the area around it, about one acre. Another female flying squirrel enters your territory. You stare at the intruder and stomp your feet. When she does not turn back, you lunge, strike her face and jump on her back. A struggle follows, and the other squirrel scurries away.

30. VALUE BONUS

29. Q.

Unlike the female flying squirrel, the male flying squirrel does not defend a territory.

True or False.

Forest Sleuthwork

This exercise requires you to become a spy of the forest and will take you to the four locations, or layers, of the forest.

Location One: The Forest Floor

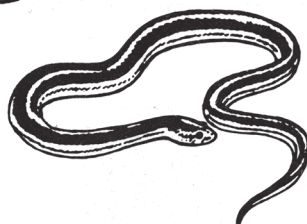
Briefing: It is your mission at Location One to scour the forest floor for signs of plant and animal life.

Strategy:

- A. Pick up a handful of forest litter. List three items you see and feel in the litter. Dig with your fingers into the litter on the forest floor. What is the grainy, dark-colored substance beneath the litter?
- B. Use a hoe or other tool to lift rocks for you to look under. Do not use your hands. Do you see any plant roots running through the soil beneath the rocks? Are there any insects or other animals? If so, can you name them? If you do not know their names, write down a description of them or draw them. Do you see any burrows or tunnels beneath the rocks? Are there animals in the burrows? Are the burrows that you see large enough to be used by the redbelly snake, the tiger salamander or the



The tiger salamander is large for a salamander at 7-8 $\frac{1}{4}$ inches in length.



The redbelly snake is small, only 8-10 inches in length.



The springtail is only about $\frac{1}{4}$ -inch long.

springtail?

- C. Locate a fallen and decaying log. Check the bark first. Are there any types of fungi, such as artist's fungus, growing on the bark? Is there



- D. Peel off a small section of bark and examine the wood of the log. Do you see any tunnels, cocoons or spider webs? Is the wood decayed enough so that animals could place their nest, young or eggs in it? If so, is the wood of your log big enough to hold the nest of the masked

The female masked shrew (about 3 $\frac{1}{2}$ inches long) gives birth to five young each April in a ball-shaped nest.



The stout-bodied gray ratsnake (about 48 inches long) lays about 12 large eggs in decaying wood.

shrew or the eggs of the gray ratsnake?

- E. If you can, roll the log over. Can you see any clue of plant or animal life in the area where the log was laying? If so write down your observations.

Each of the animals drawn below lives at least part of its life under a decaying log. Which of the following animals would be about the right size to live beneath the log you have overturned? The hermit flower beetle, the white footed mouse, the gray treefrog? Be sure to carefully roll the log back over

The 1 $\frac{1}{4}$ -inch long hermit flower beetle is one of Illinois' largest beetles.



The white-footed mouse is about 5-7 inches from head to tail.



The gray treefrog is 1 $\frac{1}{4}$ to 2 inches long.





The $3\frac{3}{4}$ - to 5-inch long woodland vole makes a small opening in the ground's surface and constructs a branching network of underground tunnels.



The eastern mole measures $5\frac{1}{2}$ to 8 inches long. Using its spadelike hands, the mole moves with a "swimming" or "breaststroke" motion through its tunnels near the ground's surface. When the mole is home, it plugs all openings to its tunnels so mice and shrews cannot move in and use its runways.

into its original position.

F. Crisscross the forest until you find a mound of dirt that opens into an underground tunnel. Do you know which animal the tunnel is used by? Is the tunnel the right size for the eastern mole or the woodland vole?

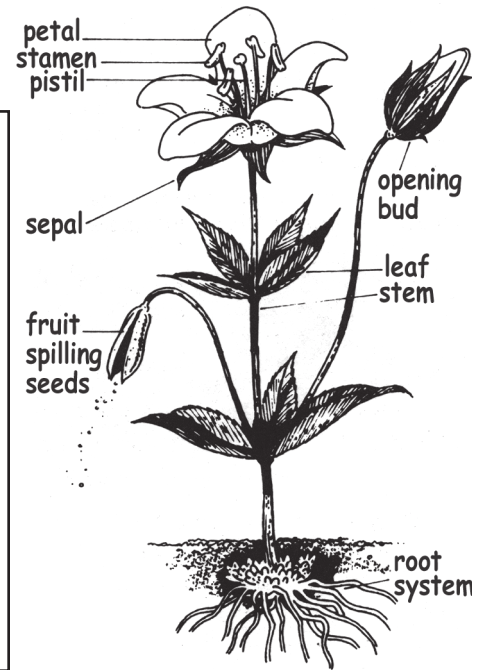
G. Look for mammal tracks. The forest floor is like a roadway for animals, especially mammals. Can you find any of the tracks illustrated on page 16 of this booklet? If so, which ones?

Location Two: The Herb Layer

Briefing: As you walk through the forest, the small plants growing at your feet are the herbs. Herbs are green plants with soft, nonwoody tissues. Most of the herbs in the forest are wildflowers. It is your mission to study the wildflowers and to uncover any insect activity.

Strategy:

- Locate a wildflower. How tall is the plant you have found? What colors are the plant? Smell the plant, especially the flower or blossom, if it has one. Does the plant have a scent? If so, describe the scent.
- Study the construction of the wildflower. Look at the drawing of a complete plant. Though the plant you have found may be different in some ways, you can use the drawing as a guide as you answer the following questions about your plant. Does the plant have a stem? Touch the stem gently. Is it smooth or covered with small hairs? Is the stem fatter or thinner than a pencil? Does your plant have leaves? Can you see any buds on your plant? Do you see any seeds or fruits? If so, draw and de-



Draw the seed and fruit here.

scribe them.

- If your plant has a flower, you should investigate it thoroughly. How many flowers are on the plant? Does your flower have petals, sepals, a pistil or a stamen? Describe the flower of your plant in great detail and then

Plant drawing

draw your flower in the box provided.

- Your wildflower is a good place to look for insects. Insects carry out the very important task

of pollination. Do you see any insects on the plant you are studying? If so, name, describe and/or draw the insect(s).

- E. In order to search for more insects, move on from your plant and inspect as many different herbs in the forest as you can. Be sure to describe, name and/or draw the insects you see.

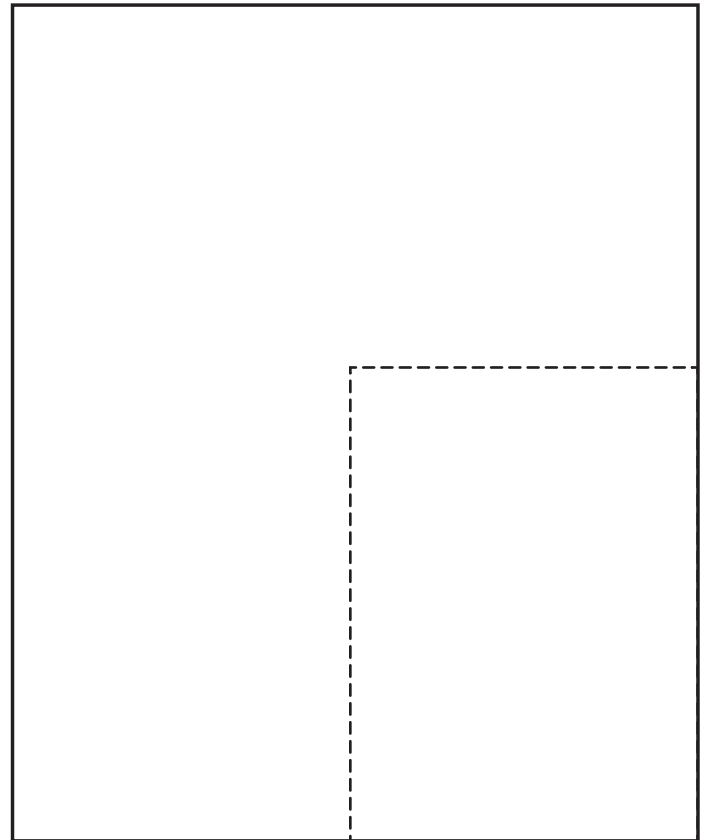
as many shrubs and understory trees as you can for signs of birds. On page 31 are some signs and birds you may find. If you see any of these signs or birds, write your observations

Location Three: Shrub and Understory

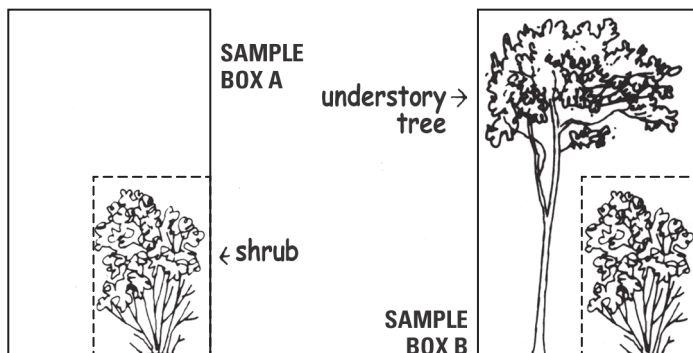
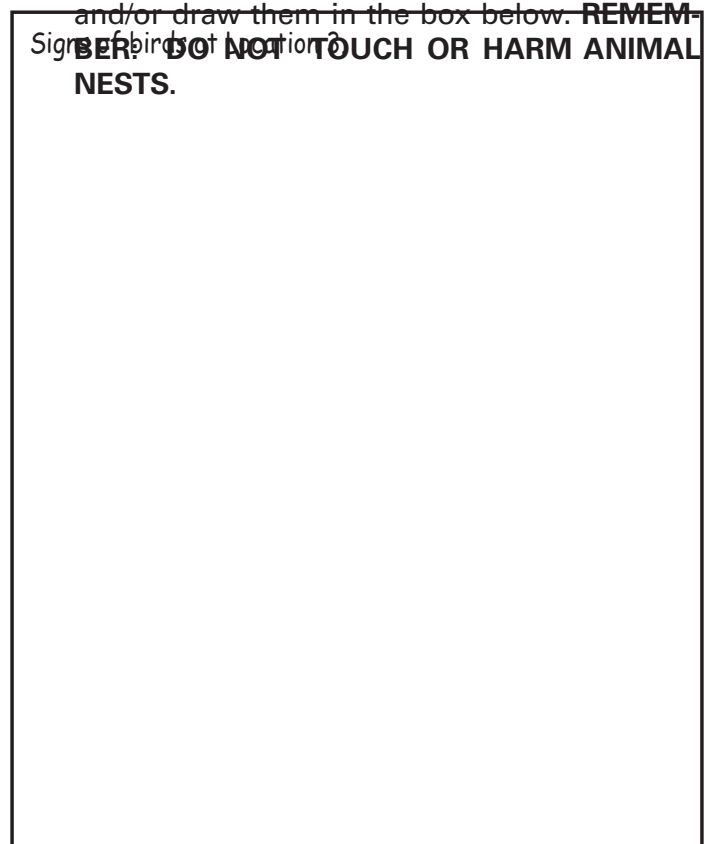
Briefing: It is your mission at Location Three to investigate the sizes of the shrubs and understory trees and to discover any bird activity.

Strategy:

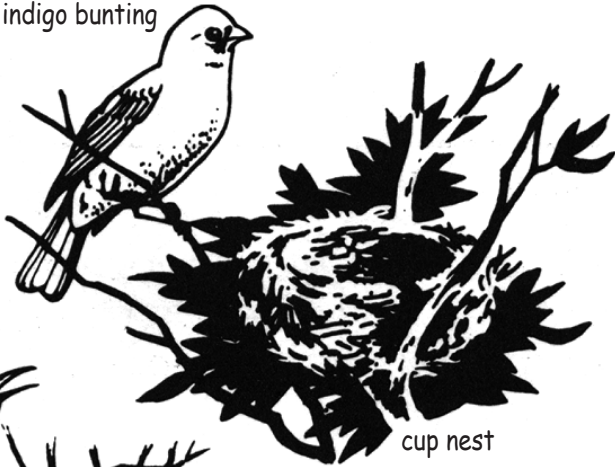
- A. Locate a shrub. A shrub is a small woody plant that has several stems rising from the ground at the same spot. Some shrubs are small trees that eventually may grow into large trees. How tall is the shrub? Name or describe the shrub (include details on leaves, branches, buds and fruits). How wide is the shrub?
- B. Draw the shrub. When you are done, the box should look something like SAMPLE BOX A.
- C. Shrubs are only one part of Location Three. Trees that are smaller than the largest trees are called the understory trees. Together, the understory trees and shrubs make up Location Three in the forest. Locate an understory tree. How tall is the understory tree?
- D. Now go back to strategy B. Draw the understory tree in the same box that you drew the shrub. Draw the tree in the space to the left of and above the dotted lines. When you are done, the box should look something like SAMPLE BOX B.
- E. The branches of shrubs and understory trees in Location Three provide cover and nesting spots for many birds. One by one, investigate



and/or draw them in the box below. **REMEMBER! DO NOT TOUCH OR HARM ANIMAL NESTS.**

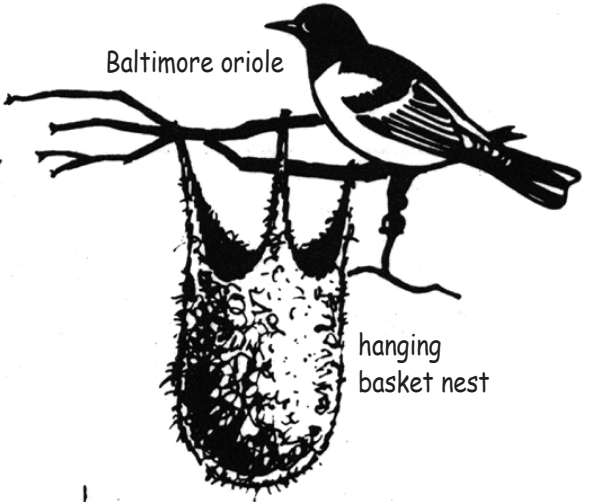


indigo bunting



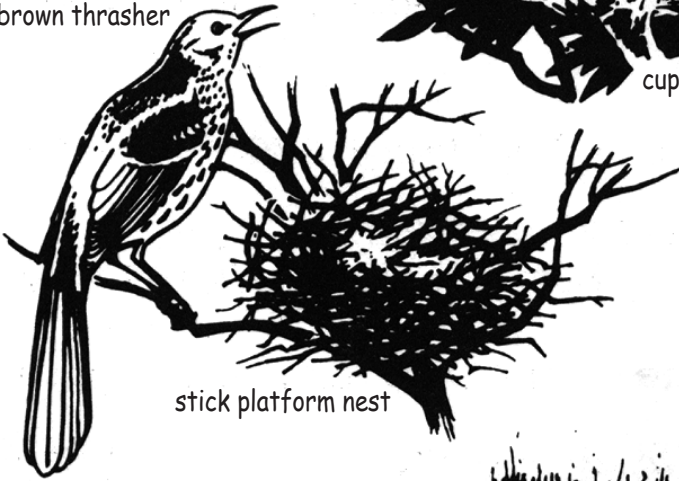
cup nest

Baltimore oriole



hanging basket nest

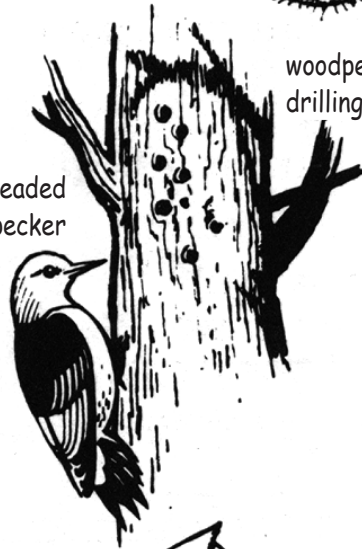
brown thrasher



stick platform nest

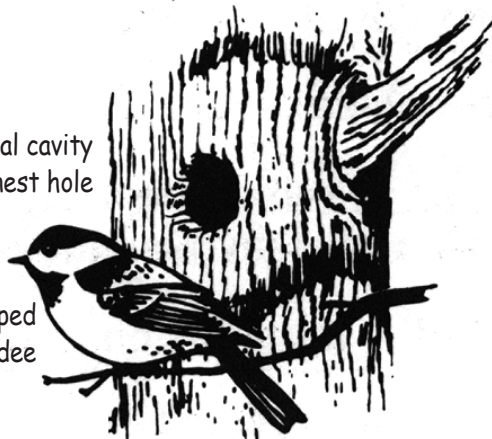
woodpecker drilling holes

red-headed woodpecker



natural cavity nest hole

black-capped chickadee



blue jay



feathers

northern cardinal



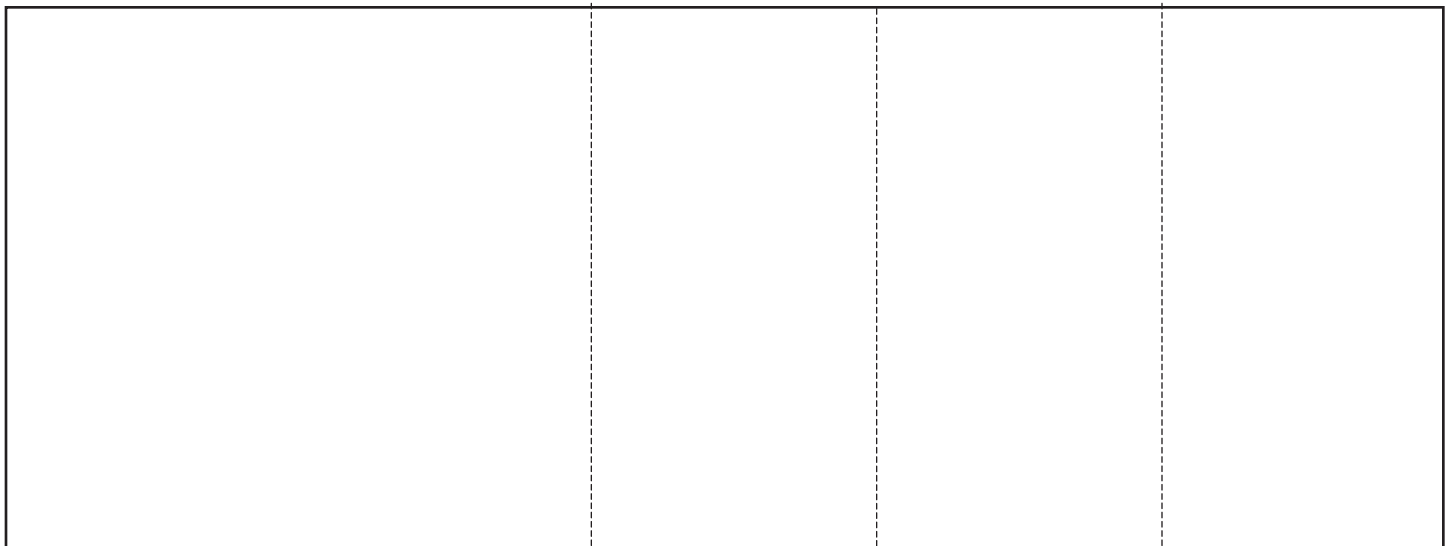
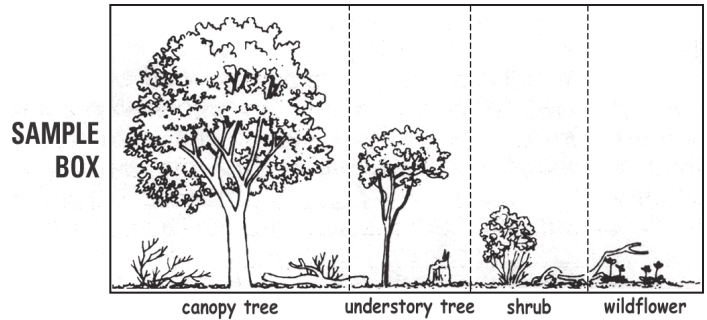
bird droppings

Location Four: Canopy Layer

Briefing: It is your mission at Location Four to investigate the branches, leaves and bark of the canopy trees.

Strategy:

- A. Select a deciduous canopy tree that has leaves. A canopy tree is one of the largest trees in the forest. Its leaves and branches form a protective umbrella over the lower layers of the forest. How tall is the canopy tree you have chosen? How wide is its crown of branches? In the box below, draw the wildflower you studied at LOCATION 2, the shrub



canopy tree

understory tree

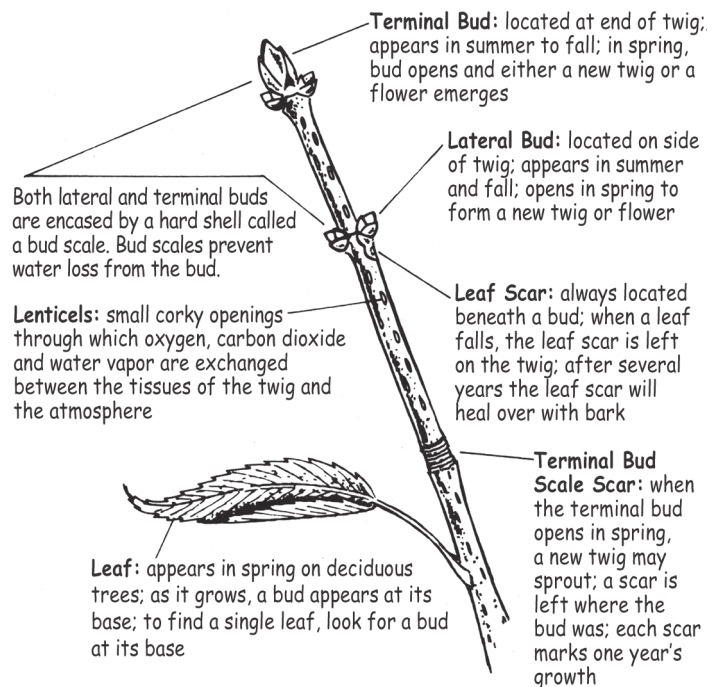
shrub

wildflower

and the understory tree you investigated at LOCATION 3 and finally, the canopy tree you have selected for study at this location. Be sure to draw at the base of those plants what you investigated at LOCATION 1. When you are finished your box should look something like the Sample Box.

- B. Find a twig on your canopy tree. Break it off as close to the main limb as possible. Use the illustration below to help you answer the following questions about your twig.

Start at the outermost end of your twig. Is there a bud? If so, what is that bud called? Is there a leaf or a flower growing out of the end of the twig? Look on the side of the twig. Do you see any buds? If so, what are those buds called? Do you see any leaf scars on the twig? If so, how many? When the leaves fall off the twig in autumn, what mark will they leave behind on the twig? Can you find a terminal bud scale scar on your twig? If so, how many?



*Special note on buds: Some buds open and grow into new twigs. Inside these buds are much shortened stems and tiny leaves, a whole new twig ready to grow. Other buds grow into flowers. Inside these buds are tiny flowers.

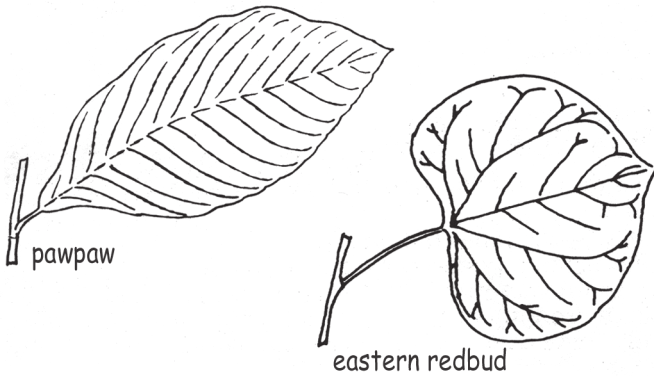
C. Find a leaf. Listed and drawn below are three major types of **SIMPLE LEAVES** and three major types of **COMPOUND LEAVES**. Simple leaves, such as those of pawpaw, appear on the twig singly. Compound leaves are different from simple leaves because they are made up of many leaflets that are arranged in pairs opposite each other. Carefully study the leaf types below and then answer the following questions about the leaf you have found. After you answer the questions, draw your leaf in the box provided. Is your leaf a simple or compound leaf? If it is simple, is it a simple-smooth leaf, a simple-lobed leaf or a simple-toothed leaf? If your leaf is a compound leaf, is it a pinnately compound leaf, a palmately compound leaf or a doubly pinnately compound leaf?

D. Take a piece of white paper and press it against the bark of your canopy tree. While continuing to press the paper against the bark, rub a crayon over the paper so that the bark makes an impression on the paper.

Draw your leaf in this box.

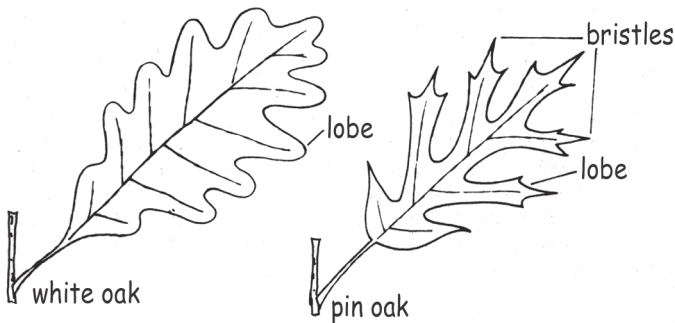
SIMPLE LEAF TYPE ONE

Simple-smooth: The edges of these leaves are smooth.



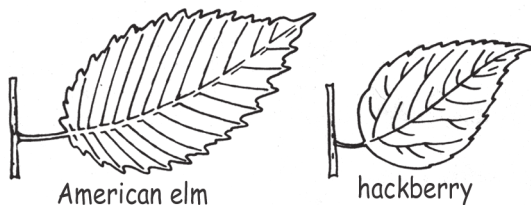
SIMPLE LEAF TYPE TWO

Simple-lobed: The edges of these leaves are cut deeply to form lobes.



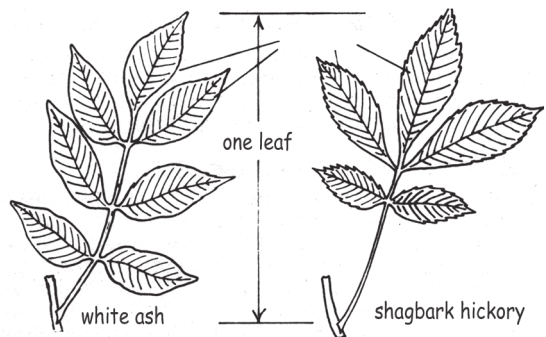
SIMPLE LEAF TYPE THREE

Simple-toothed: The edges of these simple leaves appear to have small teeth.



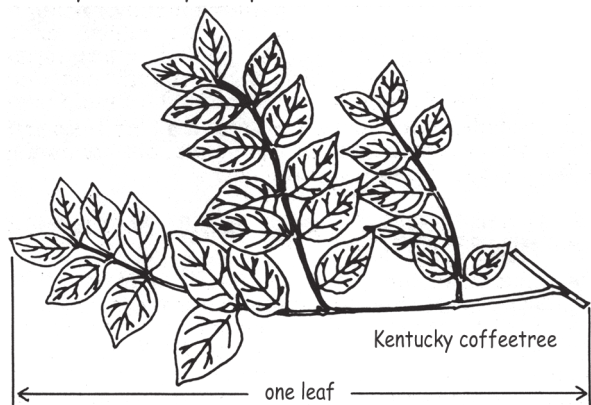
COMPOUND LEAF TYPE ONE

Pinnately Compound: These leaves are made up of many leaflets that appear opposite each other on the twig.



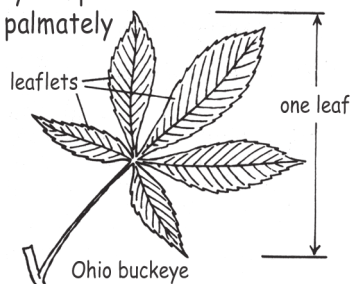
COMPOUND LEAF TYPE TWO

Doubly Pinnately Compound



COMPOUND LEAF TYPE THREE

Palmately Compound: Pinnately compound leaflets appear in pairs while palmately compound leaflets grow out from a central point.





Forest Management – Making the Most of Our Forests

This forest collage shows many of the different things that forests provide for plants, animals and humans. Study the collage carefully and on a separate piece of paper, make a list of all the things you see that forests provide.

The Need for Forests is Great

Your completed list demonstrates what is called **MULTIPLE USE** of forests. In Illinois, forests are used for multiple reasons. Plants and animals depend on forests for natural habitats, and people use forests for recreation, hunting, nature study and the production of lumber. When Illinois was first settled by pioneers in the early 1800s, the state's 14 million acres of forests provided a vast habitat for plants and animals and a wonderful abundance of forest for people to use. In modern day Illinois, however, the state's supply of forests has shrunk by 10 million acres to just 4.3 million acres. Because of the shortage of forest as habitat, many forest plants and animals are fighting for survival. The growing human population in Illinois needs more forest products than ever before. The need for forests by plants, animals and humans is great, yet the supply of forests is shrinking.

Forest Management Can Help Make the Most of Our Forests

Good forest management can help make the most of the forests we have. Forests have one great advantage: they are a renewable natural resource, meaning that forests can renew themselves by growing new trees. With good forest management, we can help forests grow bigger and healthier trees, and we can even replant trees in areas that have been cleared. Forest management is the job of foresters and biologists working for state, federal, county, local and private organizations.

Three Principles of Forest Management

PRESERVE – Forest management often involves setting aside some of our forests as forest preserves. These areas provide plant and animal habitat, as well as opportunities for people to study nature, hike, camp and participate in other outdoor recreation. Some of these areas provide an opportunity to hunt and fish. Since many of these areas have been preserved in the same condition they were in at the time when settlers first came to Illinois, they are living museums of our natural heritage.



PROTECT – An important part of forest management is protection. Forest managers work to protect forests from the destruction that fire, harmful insects and grazing can cause. It also means protecting forests from being cleared away unless absolutely necessary. When protected from harm, forests can better provide all of the things they are needed for.

PRODUCE – Since we all need forest products, it is important to manage some forests to produce a good crop of timber. Even though a forest will grow trees without any assistance from people, a forest manager can help it grow straighter, healthier and better-formed trees by removing some of the trees that are taking up too much space and sunlight (known as “wolf” trees) and some of the trees that are diseased, crooked or damaged. This practice provides more sunlight, soil, water and nutrient elements for the healthy, straight and well-formed trees. Of course, not all

of the “wolf” trees or damaged trees are removed. Many are left to provide food and shelter for forest animals. The practice of removing some trees to help more valuable trees grow is called Timber Stand Improvement (TSI). TSI is wise forest management because it helps produce better, faster-growing trees.

Another way to help a forest produce more timber is by not overcutting it. An overcut forest is one in which all of the mature trees usable for lumber have been cut. An overcut forest provides poor habitat for plants and animals, and it takes many, many years for an overcut forest to grow mature trees that can be harvested. The best way to manage a forest is to select some of the mature trees to harvest but leave many others behind as growing stock. The growing stock can then be harvested every few years as more trees mature. This type of harvesting is called Selection Harvesting. A forest that is harvested in this way can produce timber for all the years it is a forest. Plus, it will continue to provide habitat for plants and animals.

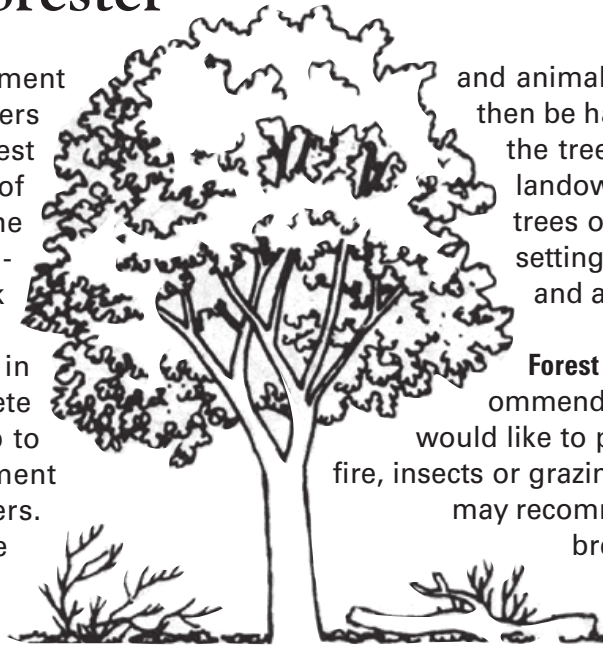


Thinking Further

1. What is meant by the “multiple use” of forests?
2. What are the three principles of forest management?
3. Why is Timber Stand Improvement wise forest management?
4. Why is it better to Selection Harvest a forest than to overcut it?

Working as a Forester

Recommending forest management plans for private forest landowners is a very important part of forest management and the chief job of a forester. Since 95 percent of the land in Illinois is owned by private landowners, foresters work closely with landowners to help them manage their woodlands in the best way possible. To complete this exercise, it will be your job to recommend a forest management plan for five Illinois landowners. These are all people who have contacted you as a forester because they need advice or assistance concerning their existing or potential woodland. You should recommend to each landowner one of the five forest management plans featured on this page. The choices are Selection Harvest Plan, Timber Stand Improvement Plan, Forest Protection Plan, Forest Preservation Plan and Tree Farm Plan.



and animals. More trees in the forest can then be harvested every several years as the trees mature. This plan allows the landowner to market part of his or her trees on a regular basis while not upsetting the forest ecosystem of plants and animals.

Forest Protection Plan: A forester recommends this plan when a landowner would like to protect his or her forest against fire, insects or grazing. For fire protection, foresters may recommend putting in fire breaks. Fire breaks are narrow strips of land that have been cleared of vegetation down to the soil.

These breaks stop a spreading fire and also give firefighters access to the fire. For insect control, foresters sometimes recommend the use of pesticides. For control against grazing, the advice of a forester is simple. **DO NOT GRAZE CATTLE ON WOODLANDS.** Cattle kill wildflowers, fungi and young trees growing from the forest floor. Cattle also pack down the soil so that the soil can no longer hold water, leading to serious problems with soil erosion.

Forest Preservation Plan: A forester recommends this plan when a landowner wants to preserve his or her forest as a natural area, nature preserve, state, county or local park, a forest preserve or a conservation district. Foresters consult with many other people when preparing this plan. The forester usually consults a natural heritage biologist about the plant and animal species living on the property. In addition, the forester talks to different state, county or local officials about registering the property as a protected area to prevent trespassing and damaging impacts.

Tree Farm Planting Plan: A forester recommends this plan when a landowner would like to plant trees on an area that is not presently forest. The forester visits the location and reviews the soil type and drainage patterns. If the location is suitable for raising trees, the forester prepares a plan for the landowner that recommends which species to plant and how to plant and care for seedlings.

Selection Harvest Plan: A forester recommends this plan when a landowner has a forest with mature trees that are ready to be harvested. This plan calls for the cutting of some of the mature trees but recommends that a good supply of trees be left in the forest as reserve growing stock and to provide habitat for plants

Timber Stand Improvement Plans: A forester prepares this plan when a landowner would like to improve the quality of his or her woodland. The goal of this plan is to help the forest produce healthier, better-formed trees that could someday be harvested and sent to market. Timber Stand Improvement (TSI) calls for the girdling of trees that are taking up too much room (known as "wolf" trees) or diseased, crooked or damaged trees. Girdling is done by cutting a ring around the trunk of the tree. The girdled trees die and are left to decay naturally in the forest. The unwanted trees are no longer able to steal sunlight, water and nutrient elements from healthy, well-formed trees. Of course, not all of the "wolf" trees or diseased, crooked or damaged trees are girdled. Many "wolf" trees are left because hawks and owls perch and nest in their highest branches. "Wolf" trees that are producing fruits and seeds are also left so animals can find food. Some of the diseased, crooked or damaged trees are left because they have natural cavities where animals find shelter. TSI is not a harvest but is more like a maintenance operation. TSI does for the forest the same thing hoeing does for a garden. TSI is wise forest management because it helps trees produce more good timber per acre while not



harming the natural habitat for plants and animals.

Landowners

Mr. Boone owns 40 acres of forest, mostly stocked with white oak trees. When he contacted you, he said "I've got all this forest that's not doing me any good. I'm paying high taxes on the land, and I need to make some money from it. I think I'll just bulldoze the whole thing and plant some corn." Several days later you inventory Mr. Boone's forest and find that the mature trees, if harvested, could produce 28,000 board feet of timber worth thousands of dollars on the veneer market. In addition, you find a very good supply of younger trees that could be left in the forest as growing stock. That growing stock could be harvested later on the sustained yield basis to provide money for Mr. Boone and his family for many years to come. You show your findings to Mr. Boone and explain that he could manage his forest as a crop just as a farmer manages a field of corn or soybeans. You point out to Mr. Boone that he could harvest his forest to make money and still have it as a place to watch wildlife, camp, picnic and hunt. After Mr. Boone agrees to your advice you prepare a _____ Plan.



Mr. Olson owns a 200-acre forest. When he contacted you, he said "Our forest has been in our family for 150 years. My ancestors were some of the first settlers to come to these parts. We've always harvested most of our forest, but there's one 55-acre tract of white oak we've left untouched. That stand has some of the biggest, most majestic oaks you've ever seen. Some of those trees are probably five times as old as I am. That stand has many birds and mammals living in it, and the forest floor is just carpeted with beautiful wildflowers. I'd like to make sure this stand is kept the way it's always been. It's a record of what Illinois was made of before humans showed up. Can you help me get it set up to preserve this stand as an example of our natural heritage?" To help you out in this case, you call in a natural heritage biologist, and the two of you take a walk with Mr. Olson through his stand of white oaks. The natural heritage biologist points out that the stand is unique because the trees are more than 300 years old. Knowing that Mr. Olson wants to preserve the stand, you recommend a _____ Plan.



Mrs. Smith owns a large farm. On this farm, there is a mixture of pasture and crop land. When Mrs. Smith called you she said "I love trees so much, but we just

don't have many on our property. I'd like to start a tree farm somewhere on my land. I know it will take several years for the trees to grow large, but I'm a pretty young person and besides, my children will certainly be able to enjoy them. I figure it could be an investment too. Someday, we could harvest some of those trees. We've got five people in our family, and I'd like to plant four acres of seedlings for each of us. Could you give me some advice on where, how and when to plant?" Upon inspection of Mrs. Smith's property, you find a 20-acre abandoned pasture near the house with the right soil conditions for raising hardwood species such as white oak, northern red oak and black walnut. Mrs. Smith agrees that the pasture would be a good place to begin planting. Knowing that Mrs. Smith will need detailed and accurate information about tree planting, you recommend a _____ Plan.



Ms. Adams owns a 50-acre tract of oak, maple and hickory forest. When she contacted you, she said, "I have this lovely woodland, and I don't know what to do with it. I don't want to harvest it now, but I'd like to harvest it later when my children are ready to go to college to help pay for their tuition. Is there anything I can do to help my woodland produce the best crop of trees it can?" During a visit to Ms. Adams' forest, you find a good supply of well-formed healthy trees. However, there are a lot of diseased, damaged, crooked and wolf trees stealing sunlight, water, space and nutrient elements from the healthy well-formed trees. Without those problem trees, Ms. Adams' forest would produce a better crop of trees. Since Ms. Adams wants to improve her forest, you decide _____ to _____ recommend a _____ Plan.



Mr. Jones owns a 55-acre forest stocked with oak, hickory and maple species. When Mr. Jones called you he said "My woodland appears to be in bad shape. It used to be that I could go into my woodland and find many new trees sprouting up. I used to be able to find mushrooms and beautiful wildflowers in the spring. I walk through the woods now, and it's practically bare except for the larger trees. To make matters worse, the soil in my woods is all packed down, and when it rains, the water just washes down the slopes of the forest into the creek, carrying what looks like half of the soil with it. What is the matter with my woods and what can I do to protect it?" When you inspect Mr. Jones' property, you find that he is grazing cattle in the forest. Since Mr. Jones wants to protect his forest, you recommend a _____ Plan.

Preparing a Timber Stand Improvement Plan

In the previous exercise, you worked as a forester and recommended a forest management plan for five landowners. For one of those landowners, you recommended a Timber Stand Improvement (TSI) Plan. It is your job in this exercise to continue working as a forester and to complete the details of the TSI Plan. On pages 40 and 41, a sample plot of forest is drawn. The sample plot is from the forest owned by the landowner for whom you prepared the TSI Plan on page 37. To complete the details of the TSI Plan you should study the drawing and description of each of the trees in the sample plot. A blank TSI Plan is provided for you. Before you begin to work, review the description of a TSI Plan on page 36 and the situation of the landowner on page 37, and study carefully the RULES OF THUMB FOR A TSI PLAN listed below.

RULES OF THUMB FOR A TSI PLAN

Introduction: The following items are the rules a forester follows when deciding which trees to remove and which trees to leave in a forest as part of a TSI Plan. Some of the rules have exceptions. The exceptions are just as important as the rules and should be considered carefully. Trees that are marked to be removed are usually not actually cut and removed from the forest. In most cases, the trees are girdled and left to decay naturally.

As you work to prepare your plan, keep in mind that the goal of TSI is to help the forest grow bigger, healthier and better-formed trees by removing some of the “wolf” trees and crooked, diseased or damaged trees. The good forester always leaves some of those trees to provide food and natural cavities or shelter for forest animals.

1. Leave all healthy, native understory trees and shrubs. They are not competing with the larger trees for sunlight and are an important part of the forest ecosystem.
2. Leave the young, healthy and well-formed canopy trees. These trees will continue to grow and are providing food and shelter for animals.
3. Leave the mature, healthy and well-formed canopy trees. These trees can be harvested later and in the meantime, are providing food and shelter for animals.
4. Leave the dead trees. These trees provide good natural cavities for animals, and they are not taking sunlight, water or nutrient elements from live trees.
5. Remove crooked trees. They will never be useful as saw timber, and they take up too much space. **Exception:** Leave a poorly formed tree if it is a valuable species, such as black walnut. Though the tree will not produce good timber it will put out seed for new generations of its species in the forest.
6. Remove trees that have been badly damaged by lightning, disease, insects or fire. These trees will never be valuable as saw timber and are taking sunlight, water and nutrient elements from well-formed trees. **Exception:** Leave some damaged trees if they are providing food or cavities for animals.
7. Remove trees that are gutted by fungi. Because these trees are usually rotten inside they are often said to have “heart rot.” Again, these trees are stealing valuable sunlight, water and nutrient elements from well-formed trees. **Exception:** Leave some trees with “heart rot” if they are providing cavities for animals.
8. Remove “wolf” trees. “Wolf” trees have an exceptionally wide crown of branches. “Wolf” trees sometimes take up five times the space a well-formed tree requires. “Wolf” trees retard the growth of other trees by shading them too heavily. **Exception:** Leave some “wolf” trees to provide nuts and other fruits for wildlife. Also, leave some “wolf” trees since hawks and squirrels nest and perch in their highest branches and since owls, woodpeckers and chickadees use cavities in their trunks and lower branches.
9. Remove less desirable trees that do not produce quality timber if they are shading more valuable trees. For example, in some forests, black locust is a less desirable species. **Exception:** Leave a less desirable tree if it is a good wildlife food producer. Red mulberry is an example of a less desirable species in terms of poor timber quality, but foresters usually leave it since its berries provide good food for animals.

Timber Stand Improvement Plan

Prepared by _____

Name of Landowner _____

Goal of Plan (what this plan will do for the forest)

Details of Plan

The 20 trees in the sample plot are listed below. In the space beside each tree, write the species of the tree, and either REMOVE or LEAVE. Then use the rest of the space to explain your reasoning. Use this sample as a guide.

Tree #99 White Oak: REMOVE. Tree is crooked, does not have cavities for animals and is stealing sunlight, water and nutrient elements from the well-formed trees.

TREE #1: _____

TREE #2: _____

TREE #3: _____

TREE #4: _____

TREE #5: _____

TREE #6: _____

TREE #7: _____

TREE #8: _____

TREE #9: _____

TREE #10: _____

TREE #11: _____

TREE #12: _____

TREE #13: _____

TREE #14: _____

TREE #15: _____

TREE #16: _____

TREE #17: _____

TREE #18: _____

TREE #19: _____

TREE #20: _____



Tree Description

1. **Tree #1 white oak:** This tree was hit and badly damaged by lightning.
2. **Tree #2 black walnut:** Though this tree has poor form, it is the only black walnut tree in the forest.
3. **Tree #3 northern red oak:** This tree is diseased and has little value as a wildlife cavity tree.
4. **Tree #4 American hornbeam:** This tree is a healthy under-story tree.
5. **Tree #5 black oak:** This wolf tree provides shelter for the squirrels and hawks that nest in its mass of branches. Other animals nest in its cavities.
6. **Tree #6 eastern hophornbeam:** This tree is a healthy under-story tree.
7. **Tree #7 northern red oak:** This tree is crooked.
8. **Tree #8 shagbark hickory:** This mature canopy tree is healthy and well formed.



9. **Tree #9 white oak:** This dead tree is a home for animals and does not interfere with living trees.
10. **Tree #10 northern red oak:** This young canopy tree would grow faster if it was not shaded by Tree #11.
11. **Tree #11 white oak:** This wolf tree has few dens for animals.
12. **Tree #12 white oak:** This young canopy tree would grow faster if not shaded by Tree #11.
13. **Tree #13 white oak:** This mature canopy tree is healthy and well formed.
14. **Tree #14 eastern redbud:** This plant is a healthy shrub.
15. **Tree #15 white oak:** This wolf tree is a good producer of acorns and does not interfere with the growth of other trees.
16. **Tree #16 shagbark hickory:** This tree is damaged by fungi but has a natural den at its base and cavities in its trunk and branches.
17. **Tree #17 black oak:** This tree is gutted by heart rot and is heavily shading Tree #18. This tree does not have as many cavities as Tree #16.
18. **Tree #18 black cherry:** This healthy tree would grow faster if not shaded by Tree #17.
19. **Tree #19 wild plum:** This plant is a healthy understory tree.
20. **Tree #20 black locust:** This tree is an undesirable species that has little value as a wildlife food producer. This tree is competing with Tree #18.

Land-Use Planning

Introduction: *(Read aloud by one student to the class.)*

“Carefully planning the use of the land in Illinois is very important because there is only so much land to go around. Every time something new needs to be built, the question arises as to where to put it. For example, when the people of a town decide to build a new school, should they build it on natural land such as forest, wetland or prairie or on land that is used as crop land? The decision is never easy and a planning commission is usually formed to settle the question. In making a decision, the commission considers the interests of everyone who may be affected by the decision. For example, if crop land is involved, the commission listens to farmers who are usually reluctant to lose crop land. If natural land is involved, the commission listens to outdoors people (including hikers, campers, hunters and naturalists) who usually do not wish to lose acres of forest, wetland or prairie. The commission also considers the needs of plants and animals that depend on natural lands as places to find shelter and food and to reproduce and raise their young. No matter what kind of land is being considered for use, the commission studies the position of the business people who usually want the new development to be built near roads and business areas.

This exercise is a class project that involves land-use planning. As a class we are asked to act as a planning commission for Illini Town, Illinois. As a planning commission, we will plan the location of a new airport for Illini Town. Since the land-use planning process involves many steps, our class should follow Steps 1-7 before we recommend the placement of a new airport for Illini Town.”

STEP ONE: FORMING A PLANNING COMMISSION
(This step should be read aloud to the class by another student.)

“To form a PLANNING COMMISSION, we as a class, should elect one student to the position of PLANNING CHAIRPERSON. The PLANNING CHAIRPERSON is responsible for making sure STEPS 2-7 are followed correctly. Once a PLANNING CHAIRPERSON is chosen, the CHAIRPERSON should divide our class into five groups. The CHAIRPERSON should then assign the students in each of those groups to represent the five special-interest groups that make up the PLANNING COMMISSION. Those groups are: FARMERS, TREE FARMERS,

PLANTS/ANIMALS, BUSINESS PEOPLE, OUTDOORS PEOPLE. Each student in those five groups should make a name tag that says which group he or she belongs to. Each student should pin that name tag on his or her shirt.” *(After a CHAIRPERSON and the five special-interest groups have been formed the Planning Commission will be complete, and the class can move to STEP TWO.)*

STEP TWO: APPOINTING SPECIAL-INTEREST GROUP SPOKESPERSON *(Read aloud by CHAIRPERSON.)*

“It is my first duty as PLANNING CHAIRPERSON to appoint a spokesperson for each of the special-interest groups.” (Chairman should appoint five spokespersons and class should move to STEP THREE.)

STEP THREE: LOOKING AT THE NEEDS OF THE SPECIAL-INTEREST GROUPS *(Read aloud by PLANNING CHAIRPERSON.)*

“It is time for our class as the PLANNING COMMISSION for ILLINITOWN, to look at the needs of the special-interest groups. I ask now that the spokesperson for each group make a presentation to the Commission on the special interests of her or his group.”

FARMERS: *(Read aloud by Spokesperson for FARMERS.)*

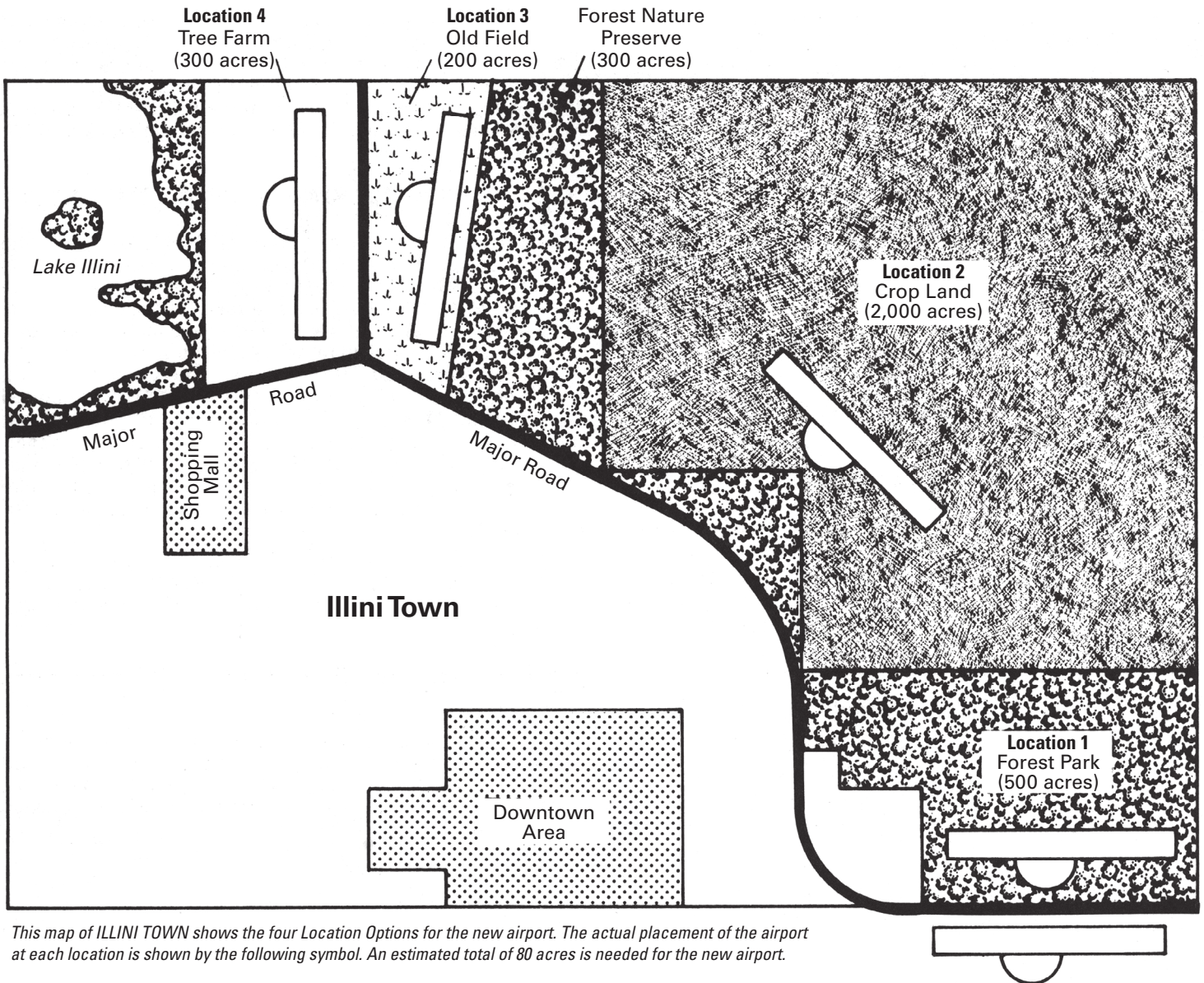
“The FARMERS do not want the airport to be built on or near crop land. If it is built on crop land, we will lose more of the land that supplies us all with food. If it is built near crop land, there will be more traffic, noise and air pollution, vandalism and littering on boundaries of the crop land.”

BUSINESS PEOPLE: *(Read by Spokesperson for BUSINESS PEOPLE.)*

“We want the airport to be built near a major road. We also want the airport to be near either the downtown area or the shopping mall. We feel the airport should be built on land that can be purchased for the lowest price. We want what is best for the businesses and the overall economy of ILLINITOWN.”

OUTDOORS PEOPLE: *(Read by Spokesperson for OUTDOORS PEOPLE.)*

“We are a group made up of everyone who enjoys natural land. We are hunters, fishermen, wildlife photographers and naturalists who enjoy



This map of ILLINI TOWN shows the four Location Options for the new airport. The actual placement of the airport at each location is shown by the following symbol. An estimated total of 80 acres is needed for the new airport.

natural areas as places to simply watch and study nature. We do not want the airport to be built in or near a natural land area. We feel that the airport would take up too much natural land, and we don't have much natural land to spare."

TREE FARMERS: (Read by Spokesperson for TREE FARMERS.)

"The TREE FARMERS do not want the airport to be built on forest land that is harvested to produce the wood we all depend upon. If the airport is built in a tree farm, there will be fewer trees for plants and animals and fewer trees to harvest to make lumber to build houses, schools and furniture."

PLANTS/ANIMALS: (Read by Spokesperson for PLANTS/ANIMALS.)

"We represent a group that cannot tell us what they want, but we know that plants and animals need a natural place to live. Therefore, we do not

want the airport to be built in or near a natural habitat. The construction, traffic and air and noise pollution of an airport might destroy the habitat for plants and drive many animals from their natural homes."

(After the Spokesperson for each group has presented the interests of his or her group, the class should move to STEP FOUR.)

STEP FOUR: STUDYING THE LOCATION OPTIONS (Read aloud by PLANNING CHAIRPERSON.)

"Now that the Commission has heard the needs of the five special-interest groups, it is time to study the four Location Options for the new airport. I will read a description of each location as well as the advantages and disadvantages of placing the airport at that location. As I read the description of each location, each member of the Commission should

look at the location on the map of ILLINITOWN.

LOCATION ONE is a 500-acre forest park. This land would sell for \$2,500 per acre. The forest park is a natural habitat for many forest plants and animals. The forest park is open to many forms of outdoor recreation including camping, hiking and nature study. The forest park is also open to hunting. Advantage: The airport would be close to a major road and to the downtown area. Disadvantage: Placement of the airport in the forest park would ruin the natural habitat for plants and animals in some parts of the park and harm the natural habitat in other parts. Placement of the airport here would also limit the use of the forest park by outdoors people.

LOCATION TWO is a 2,000-acre tract of crop land. An acre of LOCATION TWO would sell for \$4,000. LOCATION TWO is farmed and produces part of the food supply for ILLINITOWN and the state of Illinois. Advantage: No natural land would have to be cleared if the airport is built in LOCATION TWO. Disadvantage: A new major road would have to be built to connect the new airport with the existing major road. Crop land would be lost and less food would be produced.

LOCATION THREE is an old field that borders directly onto a Forest Nature Preserve. The old field is abandoned and would sell at a rate of \$1,500 per acre. The Forest Nature Preserve is a unique forest since it has oak, hickory and walnut trees that are several hundred years old. The Forest Nature Preserve is used by outdoors people as a place to hike and study nature. The Forest Nature Preserve is closed to hunting and camping. The Forest Nature Preserve provides an excellent home for plants and animals. Advantage: The land could be purchased for the lowest price. The airport would be near a major road and close to the shopping mall. Disadvantage: The construction, increase in traffic, noise and air pollution, vandalism and littering could disturb the forest ecosystem within the Nature Preserve.

LOCATION FOUR is a 300-acre tree farm. An acre of the tree farm would sell for \$4,000 per acre. The tree farm produces a large amount of oak and walnut lumber each year for use by the townspeople and by people from all over the state. The tree farm is closed to hunting and fishing, but all other forms of outdoor recreation such as hiking, camping and nature study are allowed. The

tree farm provides a good forest habitat for many plants and animals. Advantage: The airport would be near a major road and close to the shopping mall. Disadvantage: Approximately half of the tree farm (150 acres) would have to be cleared to make room for the airport, a road and proper runway clearance. The natural habitat for plants and animals would be harmed, and the opportunities provided for outdoors people would be cut in half. The tree farm would produce only half or less of the amount of lumber it produces now."

(After the four Location Options have been reviewed, the class should move to STEP FIVE.)

STEP FIVE: PREPARING RECOMMENDATIONS *(Read aloud by PLANNING CHAIRPERSON.)*

"As PLANNING CHAIRPERSON, I now ask that each special-interest group meet and prepare a RECOMMENDATION FORM for the placement of the airport. The Spokesperson of each group is in charge of making sure that the members of his or her group discuss the four location options thoroughly before a RECOMMENDATION FORM is drawn up."

(The five special-interest groups should meet by themselves to discuss the location options and prepare a RECOMMENDATION FORM. Once all of the RECOMMENDATION FORMS have been turned in, the class should move to STEP SIX.)

STEP SIX: STUDYING THE RECOMMENDATION FORMS *(Read aloud by CHAIRPERSON.)*

"The PLANNING COMMISSION must study the RECOMMENDATION FORMS submitted by the special-interest groups. I would like the spokesperson for each group to present the RECOMMENDATION FORM of his or her group to the Commission."

(The Spokesperson for each group should stand before the class and orally present the RECOMMENDATION FORM of his or her group to the class. The Spokesperson should explain how his or her own group feels about the placement of the airport at each of the location options. At the end of the presentation, the Spokesperson should explain to the class which location-option his or her group chose as the site for the new airport and why. After all of the RECOMMENDATION FORMS have been prepared, the class should move to STEP SEVEN.)

STEP SEVEN: MAKING A FINAL DECISION. (*Read aloud by CHAIRPERSON.*)

“The PLANNING COMMISSION has heard the recommendations of the special-interest groups, and must make a final recommendation. I ask now for all of the students to take off their name tags. They should no longer think of themselves as members of a special-interest group but rather as individual members of the PLANNING COMMISSION. We will now vote on the RECOMMENDATION FORMS

submitted by the special-interest groups. You should vote for your own preference. The RECOMMENDATION FORM that receives the most votes will become the final recommendation of this Commission for the placement of a new airport for ILLINITOWN.”

(After the vote has been taken and one RECOMMENDATION FORM has been chosen, the CHAIRPERSON should announce the choice to the class and circle the location on the map.)

Recommendation Form

1. Name of town:

2. Type of project being planned:

3. Reasons why project should be built:

4. Total acreage project will require:

5. Name of special interest group preparing this recommendation:

6. The special concerns of this group concerning the project: (*List here what your group wants in relation to the placement of the new airport. You may wish to review your group’s statement in STEP 3.*)

7. Evaluation of location options: (*Write a description of each location, including the type of land, total acres and what the land is currently used for. Then list the advantages and disadvantages of placing the airport at each location.*)

LOCATION 1: Description:

Advantage: _____

Disadvantage: _____

LOCATION 2: Description:

Advantage: _____

Disadvantage: _____

LOCATION 3: Description:

Advantage: _____

Disadvantage: _____

LOCATION 4: Description:

Advantage: _____

Disadvantage: _____

8. Final recommendation: (*Write here the final recommendation of your group for the placement of the airport. Be sure to state why this location is the best choice.*)



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