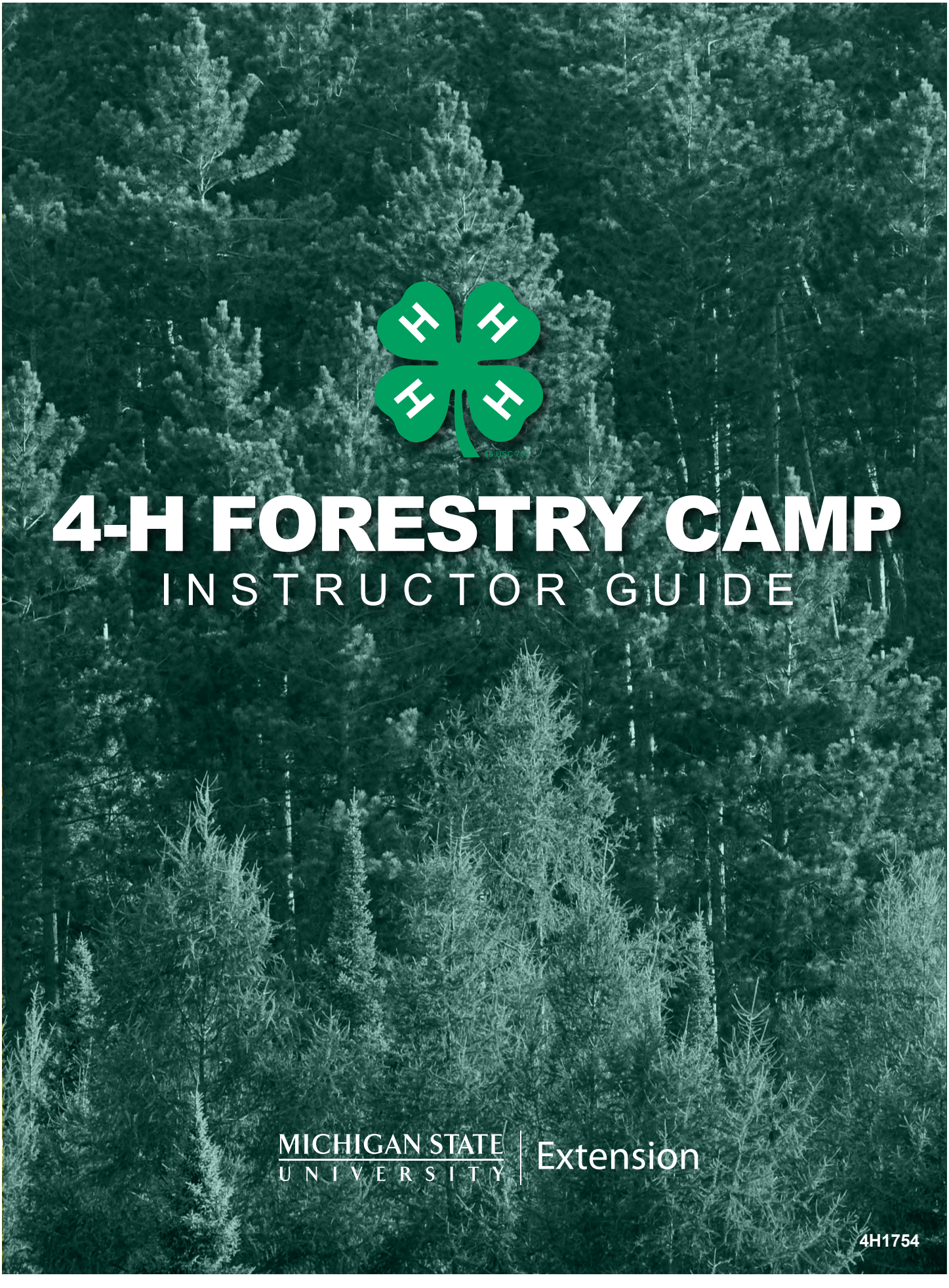


4-H FORESTRY CAMP

INSTRUCTOR GUIDE

MICHIGAN STATE UNIVERSITY | Extension

4H1754

ACKNOWLEDGMENTS

This product would not have been possible without Michigan State University (MSU) Extension educators Tracy D'Augustino, Dorothy Munn and Sara Keinath, and the MSU 4-H Science Team members, who proposed the idea and continue to provide coordination and support for the program.

This curriculum was created by Julie Crick, MSU Extension educator.

It was edited by Patricia Adams, MSU Extension editor, and designed by Howard Davy, ANR Communications & Marketing graphic artist.

It is dedicated to the children who will work in the forest industry. May you find the path that makes you whole.

CONTENTS

INTRODUCTION

The 4-H Forestry Camp is designed to provide youth participants with a concise illustration of the science behind forest management decisions as well as to expose them to career opportunities related to Michigan's forests. 4-H Forestry Camp is a great way to connect science with the environment and to dispel some misconceptions about the forest management activities that occur on private, state and federal lands across Michigan.

The camp can serve as a first step toward sending Michigan 4-H participants to the National 4-H Forestry Invitational held annually in West Virginia. The invitational allows teams of three to four 4-H participants from different states to compete in a variety of forestry-related activities, combining teamwork, knowledge and skills in an enjoyable competition. The cost to attend the invitational is covered almost entirely by a national scholarship, allowing any team of dedicated participants and their leader to attend without economic constraint. Participants range in age from 15 to 19; if you know of an eligible 4-H participant who would be interested in pursuing this opportunity, please contact Michigan State University (MSU) Extension's 4-H environmental outdoor education educator.

ABOUT MICHIGAN'S FORESTS

Forests are ecologically and economically important to Michigan. Ecologically, our forests are important to water quality, wildlife habitat and quality of life. Economically, our forests are an essential part of the timber management industry as well as recreational tourism. To best support all of these functions of forests, active management is required.

Through time, active forest management creates a mosaic of forests in various stages of **succession** (changing over time). Across the **landscape** (the entire forest), this mosaic serves as habitat to the greatest number of wildlife, as each patch in the mosaic offers different food, shelter and hunting opportunities.

Prior to European settlement of the Great Lake's Region, Native Americans were actively managing the forest. They cleared areas to raise crops and actively set ground fires to suppress the underbrush from the forest. This encouraged desired plants and trees to grow while allowing game animals to be more easily hunted. Wind and lightning also created important disturbance events within the forest landscape, adding to the diversity of habitats provided across the landscape.

The arrival of Europeans to Michigan brought a shift from local management to the first large scale use of the forest resources for export. The Europeans found forests ripe to support the growth of the nation. The forests looked somewhat like what we see today, but the trees were much larger and forests covered nearly the entire state. Today, forests cover a little more than half of Michigan, due to the buildup of urban and agricultural areas.

The first European settlers harvested the large **stands** (areas of trees) of white pine for construction material to build nearby major cities and towns. Sawmills, shipyards and railroads popped up all over Michigan, so that wood could be quickly and easily processed and transported to the growing cities.

Hemlock was a valuable tree because it contained a chemical used to tan hides for leather. Mining created a demand for hardwood trees, which became fuel to heat the furnaces used in smelting metallic ores.

Around the year 1900, people began to realize the forests would not last forever. Areas where trees once stood were purchased by settlers for use as farmland, and later abandoned when the low productivity of the sites failed to successfully produce crops. The ownership of the abandoned farmland returned to the State of Michigan. The Civilian Conservation Corps began planting trees on the newly acquired state land in the 1930s to help forests return to the Michigan landscape.

Most of Michigan's forests are in the northern two-thirds of the state. According to the Michigan Department of Natural Resources, in Michigan, the growth of trees in the forest far exceeds the amount of wood we harvest for various products, supporting the $21 billion dollar industry that provides more than 99,000 jobs. This is based on analysis using 2015 *Impact Analysis for Planning* data (Leefers, 2017). The focus is on more than wood: foresters and loggers actively manage for wildlife and recreation as well as wood production. Today, this type of management is called **sustainable forestry**.

REFERENCES:

Leefers, L. A. (2017, December). *Statewide report: Forest products industries' economic contributions to Michigan's econo my – 2019 update.* Lansing: Michigan Department of Natural Resources.

GENERAL OVERVIEW OF THE PROGRAM

Each group of participants evaluates the forest for timber production, recreation and wildlife potential, and then discusses how forest management could help or hinder the forest's potential for each. To accomplish this, participants are guided through basic data collection as if they are foresters gathering information needed to make decisions.

In the process of collecting data, participants learn tree identification, game and nongame wildlife habitat elements, forest health, stand structure and forest succession. They are also introduced to forest management concepts, tools and their proper use.

Participants will:

- Explore forestry-related careers.
- Learn hands-on basic tree identification.
- Evaluate the site for wildlife habitats.
- Engage in activities to evaluate the forest stand structure and forest succession.
- Use a prism and tree scale stick to collect forest measurements.
- Calculate the amount of board feet of timber for a stand.
- Determine the appropriate forest management activities to meet their team's goal and use the data they collected to explain their decisions.
- Explore forestry-related products.

As instructors, or hosts, you have been provided lesson plans, many with reference material. The reference material provides general information on activities while relating the data collected to a variety of sustainable forest management activities. This allows participants to gain a better understanding of forestry practices and to take a more in-depth look at scientific concepts in which forestry decisions are rooted. You may or may not choose to print off pages of reference material for participants.

In addition, participants have the opportunity to explore both forestry-related careers and products, sharing their favorite in each to the rest of the group. They also learn about the shortage of forest industry professionals in Michigan.

The 4-H Forestry Camp contains a variety of engaging hands-on activities that reinforce the scientific concepts and skills needed in forestry careers. Lesson plans for these activities are included in this guide. There is also the opportunity for each coordinator to personalize the program by adding activities with favorite local topics, speakers or field trips.

Pair up with a professional forester

If you know little about forestry, don't worry, the program is designed to be delivered with the help of a professional forester. You may choose to work with a local forester with whom you are familiar, or seek a professional forester from one of several networks that can assist with the delivery of the program. If you are looking for a forester, please contact your local Conservation District, the local MSU Extension office, the Michigan Department of Natural Resources (DNR), the Michigan Forest Association or the U.S. Forest Service to locate a forester willing to help. Contacting a forester should be one of the first things you do, as he or she will need to dedicate at least two days to the camp. Inviting different foresters to help with each day of the camp is not recommended.

SAFETY CONCERNS

When taking young people into the forest, you should be aware of a few general safety concerns, which are captured in the following bulleted list. Please contact the land manager of the site on which the camp will be hosted to ask about safety concerns specific to the property.

- Use flags or markers to denote the boundaries of the forested area within which the participants will be working. Instruct them to remain within the boundaries while collecting data.
- Identify poisonous plants growing in the area; instruct participants to keep away from the plants. Poisonous plants in the forest could include poison ivy and poison hemlock. Both plants produce a topical oil that can cause a rash when the oil comes into contact with human skin. To identify poison ivy, look for "leaves of three." Poison hemlock is a large plant with an umbel flower structure similar to a giant Queen Anne's lace. Both plants have several look-alike plants. Scout the area with someone who can identify both plants to ensure their presence or absence.
- Ensure that all adults on site have a list of participants with allergies to bee or wasp stings as well as any other health ailments that could have an impact on their experience in the forest.
- Have a flexible, alternative plan for participants in case of high winds. During times of high winds, twigs, branches and sometimes even entire trees may fall. This is especially true in areas with standing dead ash trees. The National Weather Service (*weather.gov*) offers a weather graph to monitor such conditions. Look for the graph, titled "Hourly Weather Forecast" on the bottom right side of your a local forecast page. Also, be aware of forecasted severe weather. Take appropriate cover from wind, rain and lightning when necessary.
- Look up! When scouting a potential forested area for the camp, look into the canopy of the trees to search for dead trees or branches that may be hung up in the tops of trees. These branches or trees have the potential to fall to the ground even in calm wind situations. Avoid areas where dead branches or trees pose a danger.

- Most professional foresters wear a hard hat when working in the forest. Hard hats are required for youth and adults participating in the camp. They are fairly inexpensive, and you can buy them at the local home improvement store. You can also use hard hats in place of a nametag by placing a piece of masking tape across the front just above the bill and writing the name there. Participants can decorate hard hats using stickers or permanent markers, which makes for a great opening activity.
- Be aware of water features within or near the area in which young people will participate. Some of the habitat identification may occur near water features. Have appropriate adult supervisors present to monitor the group.

WHAT YOU'LL NEED TO HOST THE CAMP

Note that forestry equipment in kits is provided across the state; you will not need to purchase this equipment. Contact the MSU Extension 4-H Forestry Camp coordinator to learn the location of the kits. Worksheets and resources for all activities are provided in this guide.

To host the camp, you will need the following:

■ A forested location with amenities

- The ideal location is a forest or woodlot adjacent to restrooms and a shelter in case of rain.
- If possible, the forest or woodlot should contain two different stands of trees and a water feature.

■ Staffing

- Professional forester(s) – one for each 6 to 10 participants
  - You should share all lessons and the agenda with the forester(s).
  - The foresters' role is to bring forestry to life for the participants by sharing stories and acquired skills used in forestry. They teach youth how to use the tools and why each piece of data is important for a management plan.
    - Assure them that they will be paired with a youth development person to help manage the participants and make suggestions to keep everyone engaged.
    - If you do not have a forester in mind, please contact one of the professional forester networks in Michigan:
      - Conservation Districts (located in every Michigan county) may have a forester on staff or may have a list of local foresters.
      - The Michigan DNR and the U.S. Forest Service may be able to locate a forester to help.
      - The Michigan Forest Association is a network of forestry professionals and people interested in forestry who may be able to help.
      - MSU Extension's 4-H environmental outdoor education educator or MSU Extension natural resources educator can provide assistance in locating a forester.
- 4-H Youth Development personnel – one for each group to pair with the forester
  - Their role is to work with the forester to help suggest ways to keep the whole group engaged. 4-H personnel can also deal with behavior issues if needed. Remember foresters are experts in forestry, not in youth.
  - A person in 4-H Youth Development may also serve as the camp coordinator (see next bullet).
- Camp Coordinator
  - Beyond coordinating the camp logistics, staff and registration, the camp coordinator should be on site to handle openings, closing and group activities. This person should also be available in case of emergencies or in case of inclement weather, to make weather decisions.

Forestry equipment

(Equipment kits are available.)

- Clinometer (used for measuring the height of a tree; 2 included in equipment kit)
- Tree scale stick (12 included in equipment kit)
- Diameter tape (12 included in equipment kit)
- Forester prism, basal area factor of 10, or pennies (2 prisms included in equipment kit)
- Flagging ribbon (several rolls in equipment kit)
- Compasses (19 are included in equipment kit)
- Canopy cover tubes (need to make, instructions included)
- Maps with soil data (optional) (forester should be able to generate for the chosen site)
- Hard hats (required – each camp host must purchase)
- Soil profile sampler (optional) (You may be able to borrow one from your local MSU Extension office.)
- "Soil Nutrients and pH" worksheet (2 included in equipment kit)
- "Soil Texture" worksheet (2 included in equipment kit)
- 4-H Forestry Camp Stencil (see "T-Shirt Bleaching" lesson plan)

The following equipment is not necessary for the program, but it may be useful in demonstration. Ask the assisting forester to bring one or more of the following to show participants:

- Relascope (used primarily for measuring the height of a tree)
- Densiometer (used for measuring canopy cover; the canopy cover tubes are a very basic example)
- Increment borer (used to take a core sample of the tree to measure age)
- Older logging tools, such as a two-handed saw, log hooks or other tools

General equipment

- Worksheets for each group (printed)
- Calculator (2 to 3)
- Additional resource documents as necessary (printed)
- Hard hat for each participant (optional)
- Tables, one per group (optional)
- Clipboards (a few for each group)
- Pencils (one for each participant)
- First-aid kit
- Water coolers
  (Participants bring their own water bottles.)
- Coolers (or refrigerators) and ice for lunch storage
  (Participants bring their own lunch.)
- Field magiscope or dissecting scopes with petri dishes or slides (optional)
- Earplugs (for each participant for use during field trips or demonstrations)

Canopy cover tubes (densiometers)

- Empty cardboard toilet paper tubes (one for each group)
- Dental floss (6 inches per group)
- Paper clips (one for each group)
- Scotch tape

Optional activities

The following are optional activities that may be included to help enhance the experience. You may choose to include one or more, or not any at all. Feel free to personalize or adjust any of the activities to fit the equipment and area within which you are hosting the camp.

Log roll race

A member of a team races to roll a log across the field and back, tag the next team member, and he or she repeats till all members have gone.

- Logs (one for each team)
- Log hooks (one for each team)

Log cutting or simulation

If a two-person saw and logs are available, teams can race to cut real logs. A simulation option is to have them race to cut a pool noodle with a hacksaw blade.

- Hacksaw blade (one per team) (Wrap tape around each end for a handle.)
- Pool noodle (one per team)
- Table or something to lay the noodle or log across to cut

Axe throwing

Teams take turns throwing the axe into the target and race to see who can hit the target the most.

- Cardboard or plastic costume axes (one per team)
- Hula hoops or other targets to lay on the ground or hang (one per team)

River exploration (if opportunity available)

- Macro kit (optional)
- Dip nets
- Magiscopes or field dissecting scopes

Hard hat decorating

Participants will use the hard hats throughout camp as a safety precaution. Have participants leave the hats with the camp host each evening. When camp is completed, allow participants to take their hard hats home.

- One assembled hard hat per participant
- Masking tape (stick on hat above bill for use as a participant name tag)
- Markers
- Stickers (optional)

AGENDA

The following is a general layout of an agenda for the camp. You may substitute or shuffle activities according to your preference. Although the program may be delivered in two days, three or four days will provide participants a more in-depth experience.

4-H FORESTRY CAMP STAFF SAMPLE 4-DAY AGENDA WITH PARTICIPANTS DIVIDED INTO TWO GROUPS

When: _____

Date: _____

Location: _____

Time: _____

Registration through MSU ANR Events Management

4-H FORESTRY CAMP STAFF AGENDA

Monday	Activity/materials	Who
8:45–9:00 a.m.	Participants arrive • Lunches stored in refrigerator or coolers • Medical concerns – noted for staff • Parent signs in child and leaves emergency call number	Camp coordinator
9:00 a.m.	Introduction – • Restroom locations • Staff Introductions • Youth introductions • Set ground rules. Reference 4-H Code of Conduct (if necessary)	4-H Youth Development personnel and/or camp coordinator
9:40 a.m.	Place name on front of hard hats and decorate using permanent markers, masking tape. Or, have participants make a tree cookie nametag (lesson provided).	Camp coordinator
9:50 a.m.	Break children into 2 groups. Go over tree identification as one group (reinforce in the field). Prior to camp the forester(s) should choose two routes that are equal in length that offer different forest types for discussion.	All staff decide

10:00 a.m.	Group 1 – Tree Identification Tour, Trail 1 Target 5 key tree types in the area Collect leaves for T-shirt bleaching Refer to the following lesson plans and supplemental information: • Tree Identification • Forest Succession • Forest Health	Forester 1
	Group 2 – Tree Identification Tour, Trail 2 Target 5 key tree types in the area (oak, red maple, aspen, birch, white pine) Collect leaves for T-shirt bleaching Refer to the following lesson plans and supplemental information: • Tree Identification • Forest Succession • Forest Health	Forester 2
10:45 a.m.	Compass training Lesson Plan: Compass and Pacing	4-H Youth Development personnel or camp coordinator or forester
11:20 a.m.	Pacing – 66 feet Lesson Plan: Compass and Pacing	4-H Youth Development personnel or camp coordinator or forester
11:35 a.m.	T-shirt bleaching Lesson Plan: T-Shirt Bleaching	
Noon	Clean-up and **lunch** at tables – Decide which forester is with which group if there is a preference.	All staff
12:45 p.m.	Game of preference	4-H Youth Development personnel or camp coordinator
12:55 p.m.	Gather children to go out into the forest with each group visiting a different trail. Forester can continue with the same group, or the foresters can switch groups based on preference.	
1:00 p.m.	Group 2 – Tree Identification Tour, Trail 1 Target 5 key tree types in the area (oak, red maple, aspen, black cherry, white pine) Collect leaves for T-shirt bleaching Refer to the following lesson plans and supplemental information: • Tree Identification • Forest Succession • Forest Health	Forester 2
	Group 1 – Tree Identification Tour, Trail 2 Target 5 key tree types in the area (oak, red maple, aspen, black cherry, white pine) Collect leaves for T-shirt bleaching Refer to the following lesson plans and supplemental information: • Tree Identification • Forest Succession • Forest Health	Forester 1
1:45 p.m.	Your job – forester – discuss how a forester handles different landowner goals of timber production, recreation and wildlife habitat for both game and nongame wildlife habitat	Foresters and 4-H Youth Development personnel

1:55 p.m.	Instruction and general practice using forestry tools
	May have to explain a second time once you are in the field.
	Refer to the following lesson plans and supplemental information:
	• Lesson Plan: Forest Measurements for Timber Production
	  ○ Worksheet: Timber Plot Tally Sheet
	  ○ Reference Material: Measuring Basal Area With a Prism
	  ○ Lesson Plan: Canopy Cover (can be constructed prior to camp or with the participants)
	• Lesson Plan: Forest Measurements for Recreation and Wildlife
	  ○ Instructions: How to Use a Diameter Tape
	  ○ Instructions: How to Measure the Height of a Tree Using a Clinometer
	  ○ Worksheet: Recreation and Wildlife Plot Tally Sheet
	• Lesson plan: Wildlife Habitat Evaluation
	Optional
	• Lesson Plan: Relating Soils to the Forest
	  ○ Worksheet: Soil Nutrients and pH
	  ○ Worksheet: Soil Texture
		Forester(s)

2:15 p.m.	Collect data from two points –
	Group 1 will focus on:
	• Lesson Plan: Forest Measurements for Timber Production
	  ○ Two points in Stand 1
	Group 2 will focus on:
	• Lesson Plan: Forest Measurement for Recreation and Wildlife
	  ○ Two points in Stand 2
	Refer to lesson plans and supplemental information listed above	

3:15 p.m.	Game	
3:45 p.m.	Wrap–up What is one thing you learned today? Reference Tree ID, forest health, forest measurement, wildlife habitat, recreation in the forest	4-H Youth Development personnel and/or camp coordinator
4:00 p.m.	Dismiss participants Parents sign out participants	

Tuesday	Activity/materials	Who
8:45 – 9:00 a.m.	Participants arrive • Lunches stored in refrigerator or coolers • Medical concerns – noted for staff • Parent signs in child and leaves emergency call number	Camp coordinator
9:00 a.m.	Start the day by reflecting on the previous day's activities. Next, begin talking about the different careers that are available in forestry. If possible, have the forester share their story at this time. Lesson Plan: Exploring Forestry Careers (if forester shares their story)	4-H Youth Development personnel in conjunction with forester
9:20 a.m.	Data Collection overview – good to repeat a second day to reinforce how and why to use	Forester(s)
9:30 a.m.	Group 1 will focus on: • Lesson Plan: Forest Measurement for Recreation and Wildlife ○ Two points in Stand 1	Forester 1
	Group 2 will focus on: • Lesson Plan: Forest Measurements for Timber Production ○ Two points in Stand 2 See above for lesson plans and supplemental information for reference.	Forester 2
10:40 a.m.	Forestry-related professional of choice • Lesson Plan: Exploring Forestry Careers	Forestry-related professional (invited guest or one of the foresters)
11:30 a.m.	Game	4-H Youth Development personnel and/or camp coordinator
12:10 p.m.	Clean-up/lunch	All staff
1:00 p.m.	Discuss difference in stand data collected for each forest management goal. Participants should focus on how management recommendations would differ for the same stand of trees depending on the management goal. Lesson Plan: Final Presentation	
2:15 p.m.	If time allows, hike to other forest types and discuss how it is either different or like the types in which data was collected.	Youth
2:30 p.m.	Guest speaker on forestry-related topic of choice Lesson Plan: Exploring Forestry Careers	Invited guest
3:45 p.m.	Wrap–up What is one thing you learned today? About Tree ID, forest health, forest measurement	4-H Youth Development personnel and/or camp coordinator
4:00 p.m.	Dismiss participants Parents sign out participants	

Wednesday	Activity/materials	Who
8:45–9:00 a.m.	Participants arrive • Lunches stored in refrigerator or coolers • Medical concerns noted for staff • Parent signs in child and leaves emergency contact number	Camp coordinator
9:00 a.m.	Start the day off by reflecting on the previous day's activities.	4-H Youth Development personnel and/or camp coordinator
9:15 a.m.	Lesson Plan: Exploring Forestry Products	
9:40 a.m.	Hike to other forest types in the area, collect data loosely, discuss management of each	Forester(s)
11:00 a.m.	Forestry-related guest speaker Lesson Plan: Exploring Forestry Careers	Guest speaker of choice
11:45 a.m.	Lunch Game/activity for after lunch	
12:30 p.m.	Board bus and depart for Hartwick Pines (example field trip destination)	4-H Youth Development personnel and/or camp coordinator
1:00 p.m.	Arrive Hartwick Pines Visitor Center	
1:05 p.m.	Guided tour of logging museum	Field trip host
2:05 p.m.	Tour Old Growth Forest trail and visitor center	Forester
3:15 p.m.	Board buses to leave	
3:45 p.m.	Wrap–up What is one thing you learned today?	4-H Youth Development personnel and/or camp coordinator
4:00 p.m.	Dismiss participants Parents sign out participants	

Thursday	Activity/materials	Who
8:45–9:00 a.m.	Participants arrive • Lunches stored in refrigerator or coolers • Medical concerns noted for staff • Parent signs in child and leaves emergency number	Camp coordinator
9:00 a.m.	Start the day off by reflecting on the previous day's activities. Assemble, use the bathroom (if necessary), provide instructions for behavior	4-H Youth Development personnel and/or camp coordinator
9:10 a.m.	Depart for CCC Museum (example field trip destination)	
9:30 a.m.	Tour CCC Museum	Historian
10:10 a.m.	Depart museum for sawmill	
10:30 a.m.	Sawmill Tour Hear from DNR Regional Forest Marketing and Utilization Specialist (any DNR representative will fit here) (if possible) Lesson Plan: Exploring Forestry Careers	DNR representative, DNR foresters
11:30 a.m.	Depart sawmill	
noon	Lunch – somewhere with a bathroom and tables	
12:30 p.m.	Depart lunch for active timber harvest	DNR foresters
1:00 p.m.	Arrive active timber harvest Watch machines work Talk to logger/operators for career perspective	
3:00 p.m.	Depart timber harvest for Gahagan Nature Preserve (example field trip destination)	
3:30 p.m.	Return to camp location Deliver and collect completed evaluations Pass out Certificates of Completion (graduation ceremony)	4-H Youth Development personnel and/or camp coordinator
3:45 p.m.	Wrap–up What is one thing you learned this week?	4-H Youth Development personnel and/or camp coordinator
4:00 p.m.	Dismiss participants Parents sign out participants – informally gather feedback from parents if possible	

LESSON PLAN:

TREE COOKIE NAMETAGS

This activity is optional because hats may are also used as nametags.

WHEN: Beginning of 4-H Forestry Camp

TIME: 30 minutes

AGES: 10–15

OBJECTIVES:

Participants will:

- Be able to identify the layers of a cross section of a tree.
- Be able to determine the age of a tree (or branch of the tree), drought years, disease and fire exposure.
- Make a unique nametag for their camp experience.

MATERIALS:

- ❏ Tree cookies (cross section of a maple, oak or alder limb or trunk about 1/3 inches thick and 3 inches across) with a hole drilled in at one end (one per participant)
- ❏ Cotton string that breaks easily (in case it catches anything) for threading the cookies
- ❏ Beads
- ❏ Puffy paint or permanent markers
- ❏ Sample tree cookies from a variety of hardwood and softwood trees, and trees that experienced different environmental factors

BACKGROUND INFORMATION:

To make the tree cookie nametags, use a hardwood such as maple or oak. Softwood trees such as cedar, fir or hemlock have larger capillaries making them more difficult to write on. It's best to cure or dry the branches before cutting them into cookies to avoid cracking and to ensure cookies will be free of sap.

PROCEDURE:

Before the meeting:

1. Set out the tree cookies, string and markers or paint.
2. You may want to include a few different types of hardwood trees (maple or oak) used for the tree cookies; consider including a few softwoods to demonstrate the difficulty of writing on them.

During the meeting:

1. Show several tree cookies to participants. Ask them what they think they are. Pass some around and let them feel the tree cookies. Ask participants to touch them and describe how they feel.
2. See if you can get participants to guess the types of trees that the cookies came from.
3. Read aloud or paraphrase the following:

- *What can we determine about this tree by looking at this tree cookie?* (Allow various answers then continue asking the following questions and allowing time for answers. Read below for explanations to possible answers.)
- *One of the things we can tell is the age of the tree. Look at the rings. How do they look? Is there a pattern?* (They are in circles that start in the middle of the cookie and get larger toward the edge. Each year a tree is alive, it adds a ring of light and dark wood. That means each ring represents one year of the tree's life.)
- *What does that tell us about the tree?* (Counting the rings tells us how old the tree was when it was cut down.)
- *Can anyone guess how old the tree was when it was cut?* (Have a few participants count the rings and report out to the group. Answers may differ by 5 years due to the difficulty in reading the rings. Announce the number as the average or count the rings as a group.)
- *Do you think the tree experienced unique environmental conditions such as disease, limited access to water or exposure to fire? How can you tell?* (Rings that were formed in drought years are narrower than those formed in a year with adequate moisture. Patterns of a few narrow rings followed by wider rings signify a drought situation. If the rings are consistently wider near the middle and gradually become more and more narrow, this signifies that the tree started in full sun, and gradually received less sun as the forest grew up around the tree. Fire can scar the bark and the living tissue that produce the ring. If the rings are dark and scarred in one area, the tree likely survived a fire.)

4. Have participants design and assemble their individual tree cookie nametags. First, have them use the markers or paint to write their name on the tree cookie. Next, thread the string through the hole at the top of the tree cookie. Beads can be used to decorate the string. Finally, tie the string to a length that allows the nametag to hang around the participant's neck and rest on their chest.

ALIGNMENT TO SCIENCE AND ENGINEERING PRACTICES:

TREE COOKIE NAMETAGS

HOW DOES 4-H INCREASE SCIENCE LITERACY?

Nationally and in Michigan, 4-H has long enjoyed a reputation for engaging young people in positive, experiential (hands-on), and nonformal activities that are inquiry based. The activities in the *4-H Forestry Camp Instructor Guide (4H1754)* can be used to enhance classroom science education. The activities are aligned with the eight Science and Engineering Practices from *A Framework for K-12 Science Education* (National Research Council, 2012, p. 42). The activities in the instructor guide were evaluated for their alignment with the Science and Engineering Practices by MSU Extension Educator Tracy D'Augustino in 2019.

TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants answer questions by observing the tree cookie.	3
Developing and using models		
Planning and carrying out investigations	Participants make observations about the tree cookie.	3
Analyzing and interpreting data	Participants use their observations to answer questions about the tree.	3
Using mathematics and computational thinking		
Constructing explanations and designing solutions	Participants explain what they think happened to the tree.	3
Engaging in argument from evidence	Participants explain their reasoning using their observations.	3
Obtaining, evaluating, and communicating information	Participants share what we can determine about the tree from the tree cookie.	3

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

T-SHIRT BLEACHING

(This lesson plan is optional.)

WHEN: Anytime

TIME: 30 minutes to set up; around 30 minutes for activity

AGES: 12–15 years

OBJECTIVES:

Participants will:

- Be able to identify a variety of flora from the forest.
- Be able to describe key characteristics of the forest ecosystem.
- Explain about how forests benefit humans and the planet.
- Explore the beauty of the individual shapes and textures of the forest.
- Create their own wearable art using simple items from the forest floor.

MATERIALS:

- ❑ Twigs, small branches, leaves, fern fronds, seed pods other items
- ❑ T-shirts made of natural fibers (one per participant) (cotton, linen or rayon – polyester is colorfast and may not release the dyes) The darker the shirt, the better the contrast between bleached and unbleached areas.
- ❑ Old clothes or aprons (one per participant)
- ❑ Latex, vinyl or nitrile gloves (one pair per participant)
- ❑ Safety glasses (one pair per participant)
- ❑ Garbage bags, flattened cardboard boxes or newsprint
- ❑ Cardboard
- ❑ Scissors
- ❑ Tweezers (optional)
- ❑ Plant press (optional)
- ❑ Bleach-and-water mixture (about 50/50)
- ❑ Plastic spray bottle with adjustable nozzle
- ❑ Paper towels
- ❑ At least two sinks, buckets or tubs, each ¾ full of clean, cold water
- ❑ Clothesline
- ❑ Clothespins
- ❑ 4-H Forestry Camp Stencil (optional, to use on back of shirt)

BACKGROUND INFORMATION:

This activity allows participants to create a wearable piece of art that features shapes from the forest. It allows participants to gain a different perspective of the shapes as they appear independent of the source plant. Participants identify the source of the shapes they are using and communicate that to others in the future when wearing their shirt.

PROCEDURE:

Before the meeting:

1. Gather all of your materials except natural items from the forest floor.

During the meeting:

1. Encourage participants to gather twigs, small branches, leaves, fern fronds, seed pods and other items from the forest floor that have interesting shapes and edges. (Discourage them from damaging living organisms, and instead, look to the abundant debris scattered across the forest floor.) These will be used for design stencils.
2. Ask participants to choose a partner and share information with each other about their items. explaining how the items connect to the forest. Help participants if they need assistance in identifying the source of the items they collected.
3. Participants should wear old clothes or aprons to protect their clothing from bleach. Caution them to be careful to avoid getting bleach on their clothes.
4. Caution participants to use protective gloves to protect their hands from bleach and safety glasses to protect eyes from bleach spray and fumes.
5. Instruct them to bleach the T-shirts using the directions on the next page.

1. Lay garbage bag, flattened cardboard boxes or newsprint on a flat surface. This will protect the work surface from the bleach and from overspray.

2. Lay the T-shirt flat on the covered work surface, with the front of the shirt facing up.

3. Place a piece of cardboard inside the shirt to prevent bleach from soaking through the front and bleaching the back of the shirt.

4. Smooth all wrinkles from the shirt.

5. Arrange items for design on top of the shirt. Encourage playing with the arrangement of nature's stencils to create an interesting design. If desired, use scissors to cut stems and use tweezers to position delicate items.

6. Attempt to press items flat onto the fabric of the shirt so the shapes are better defined when you spray the bleach. If a plant press is available, items can be pressed for 24 hours to flatten them.

7. Use the spray bottle to apply the 50/50 bleach-and-water mixture. Explain to participants that the act of removing color from a fabric is called **discharging**. Adjust the nozzle to a fine mist for a more delicate and uniform effect. Start by gently spraying a very light application of the bleach-and-water mixture all around the edges of the items you've placed on the shirt. Allow the bleach to sit for 2 to 10 minutes, until you reach the desired color change. (Trust your eyes to tell you when to stop the **discharge** process. If you let it sit too long, you may risk burning holes in the fabric. Remember: Wet fabric appears darker than when it is dry.) Blot any mishaps immediately with a paper towel.

8. For a greater variety of values and depth in the design, after the first spray, lift a few of the design items from the shirt (or add a few new items), and spray again where you'd like further color discharge.

9. The bleached area may present a series of unexpected colors during the discharge process. If it reaches a color you especially like, blot that area with a paper towel to try to soak up extra bleach and stop the discharge process in that area.

10. Carefully remove and safely discard the bleach-soaked items used for the design. If desired, turn the shirt over and repeat the procedure or use the 4-H Forestry Camp stencil.

11. When finished bleaching, remove the cardboard from inside the shirt. Dip the shirt into the first bucket of water to stop the bleaching process. **Repeat** – dip the shirt for a second rinse in the second bucket. Add additional buckets if desired.

12. Hang shirt to dry. Participants should launder in cold water at home before wearing.

Photos by Sara Keinath, MSU Extension

Example of materials collected from the forest laid out on a colored T-shirt before bleach is sprayed on the shirt.

After T-shirts are sprayed with bleach, they must be rinsed to prevent the bleach from harming the fabric.

The end results of the T-shirt bleaching activity. After rinsing, hang the T-shirts on a clothesline to dry. Youth participants should wash their shirts in cold water at home before wearing.

ALIGNMENT TO SCIENCE AND ENGINEERING PRACTICES:

T-SHIRT BLEACHING

HOW DOES 4-H INCREASE SCIENCE LITERACY?

Nationally and in Michigan, 4-H has long enjoyed a reputation for engaging young people in positive, experiential (hands-on), and nonformal activities that are inquiry based. The activities in the *4-H Forestry Camp Instructor Guide (4H1754)* can be used to enhance classroom science education. The activities are aligned with the eight Science and Engineering Practices from *A Framework for K-12 Science Education* (National Research Council, 2012, p. 42). The activities in the instructor guide were evaluated for their alignment with the Science and Engineering Practices by MSU Extension Educator Tracy D'Augustino in 2019.

TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems		
Developing and using models		
Planning and carrying out investigations	Participants collect items connected to the forest.	1
Analyzing and interpreting data	Participants determine how the items are connected to the forest.	2
Using mathematics and computational thinking		
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants discuss with a partner the items they collected, explaining how they are connected to the forest.	2
Obtaining, evaluating, and communicating information		

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

FOREST SUCCESSION

(A forester is recommended for this activity.)

WHEN: Forest Succession may be done as its own activity or as part of the forest health, tree identification or wildlife habitat evaluation activities.

TIME: 30 minutes

AGES: 10–15

OBJECTIVES:

Participants will:

- Be able to identify key vegetation for two forest successional stages.
- Be able to describe how the forest structure changes over time.
- Be able to identify key wildlife for at least one forest successional stage.
- Be able to explain how the amount of sunlight reaching the forest floor changes with forest succession.

MATERIALS:

- ❏ "Vertical Structure of a Forest" graphic (on page 24)
- ❏ "Succession of Vegetative Communities" graphic (included on page 26)
- ❏ "Preferred Forest Successional Stages Used by Selected Wildlife Species" table (on page 27)
- ❏ "Stand Description" (current structure and current stand condition for each stand) sections of the "Forest Stand Data Sheet" (on page 28)

Participants do not need to take notes; rather, this is an observational lesson that takes place in the forest.

BACKGROUND INFORMATION:

Forest succession is the changing of the vegetation in a forest over time. Vegetation changes because shrubs and trees compete for resources – mainly sunlight and moisture.

Trees need these things to grow:

- Water
- Nutrients
- Sunlight
- Space

Shade intolerant trees (Trees that like full sun)

Foresters refer to trees that require full sunlight to grow as shade intolerant because they cannot grow properly under the shade of another tree. These trees require full sun to reach their full growth.

Shade tolerant trees (Trees that like shade)

Trees that can grow in the shade of another tree are called **shade tolerant**, because shade doesn't stop them from growing properly. These trees require less sunlight to reach their full growth.

Other factors that affect succession:

- Soil type and characteristics
- Insects
- Diseases
- Animals
- Fire
- Weather
- Humans
- Forest structure

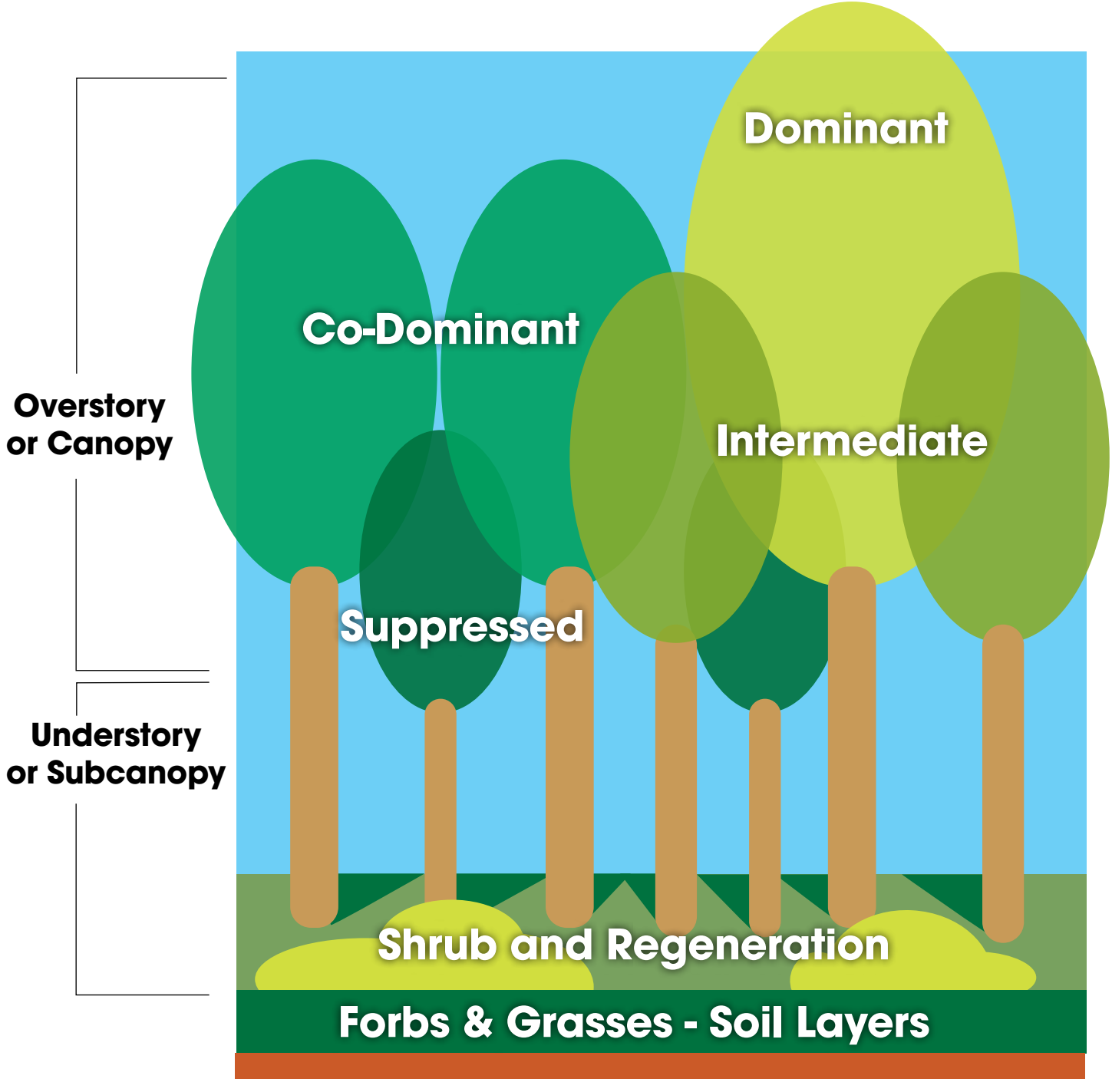
As a forest progresses through successional stages, it also undergoes changes to its vertical and horizontal structure. **Vertical structure** refers to the arrangements of plants, branches and trees from the forest floor to the tops of the trees (down to up). **Horizontal structure** refers to the arrangements of the plants, branches and trees that are growing next to one another (side to side).

Both vertical and horizontal structure are important to wildlife habitat. Vertical structure can determine how much cover is present for animals to use to hide from predators or to be sheltered from winter snow. Horizontal structure can determine how hard it is for a deer to walk through the forest, or how easy it is for a squirrel to travel from tree to tree. Forest structure can also determine the type and number of plants and trees that grow on the forest floor. A crowded vertical and horizontal structure means less sunlight reaches the forest floor, resulting in fewer plants and less food for wildlife. A more open structure allows more sunlight to reach the forest floor and increases the type and number of plants that can be food for wildlife. More sunlight also allows more young trees to grow from seed, meaning that the forest is able to grow future generations of trees.

A drawing of vertical forest structure follows on page 24. The terms define the position of each tree within the canopy. A **dominant** tree is a tree with a **crown** (branches) that reaches over and above the other trees and receives sunlight on at least three sides. **Co-dominant** trees have crowns below the dominant trees and are all similar in size. **Intermediate** trees have their crowns in the lower canopy. They will quickly grow into the place of a dominant or co-dominant tree that has been removed or died. **Suppressed** trees have their crown below the main forest canopy and grow more slowly than normal. Suppressed trees are usually stressed due to competition, or lack of space, sunlight, nutrients, or lack of some or all of these.

GRAPHIC:

VERTICAL STRUCTURE OF A FOREST



Cook, William. (2001). *Michigan Forests Forever Teachers Guide*. Michigan State University Extension.

PROCEDURE:

Before the meeting:

1. Scout the area with the forester to determine the stages of succession of the forest stands that will be focused on during discussion.
2. Have the forester point out which species of trees are part of the early successional stage of the forest as well as those species that will be present in the late successional stages. (Try to use the five species decided upon from the Tree Identification lesson on page 35.)
3. If possible, locate nearby examples of early successional stages, late successional stages or both to provide visual examples of each.

During the meeting:

1. Ask participants to brainstorm what they think is forest succession. Ensure you discuss these ideas from the Background Information section:
    - Forest succession – change in vegetation over time
    - Things trees need to grow
    - Shade tolerant and intolerant tree species
    - Vertical and horizontal structure
2. Refer participants to the visual representation, using the graphic "Succession of Vegetative Communities" that is on page 26.
3 Lead participants on a hike through the stands of forest targeted for data collection. As you walk through the forest:
    - Ask participants to identify the forest structure relating it to the stage of succession.
    - Ask participants to work with a partner to identify the species of trees that are part of the early successional stages of the forest, as well as the species of trees that will occupy the site in the late successional stages.
    - Ask participants to talk to a partner about the wildlife they think are using the forest, connecting them to the structure and species of trees present throughout successional stages.
    - Ask participants to discuss how management can shift the successional stage of the forest forward or backward depending on the type of management used on the site. (Shifting the stage will also change the wildlife on the site.)

(An optional activity would be to have participants complete the "Stand Description" [current structure and current stand condition for each stand] sections of the "Forest Stand Data Sheet" worksheet for each stand.)

WRAP-UP:

Ask participants how they can determine the successional stage of a forest. If you are in the forest, have them explain to you the stage of the surrounding forest and the reasons why they think it is in that stage. When learners justify their answers, it increases learning and ownership of the information.

REFERENCES:

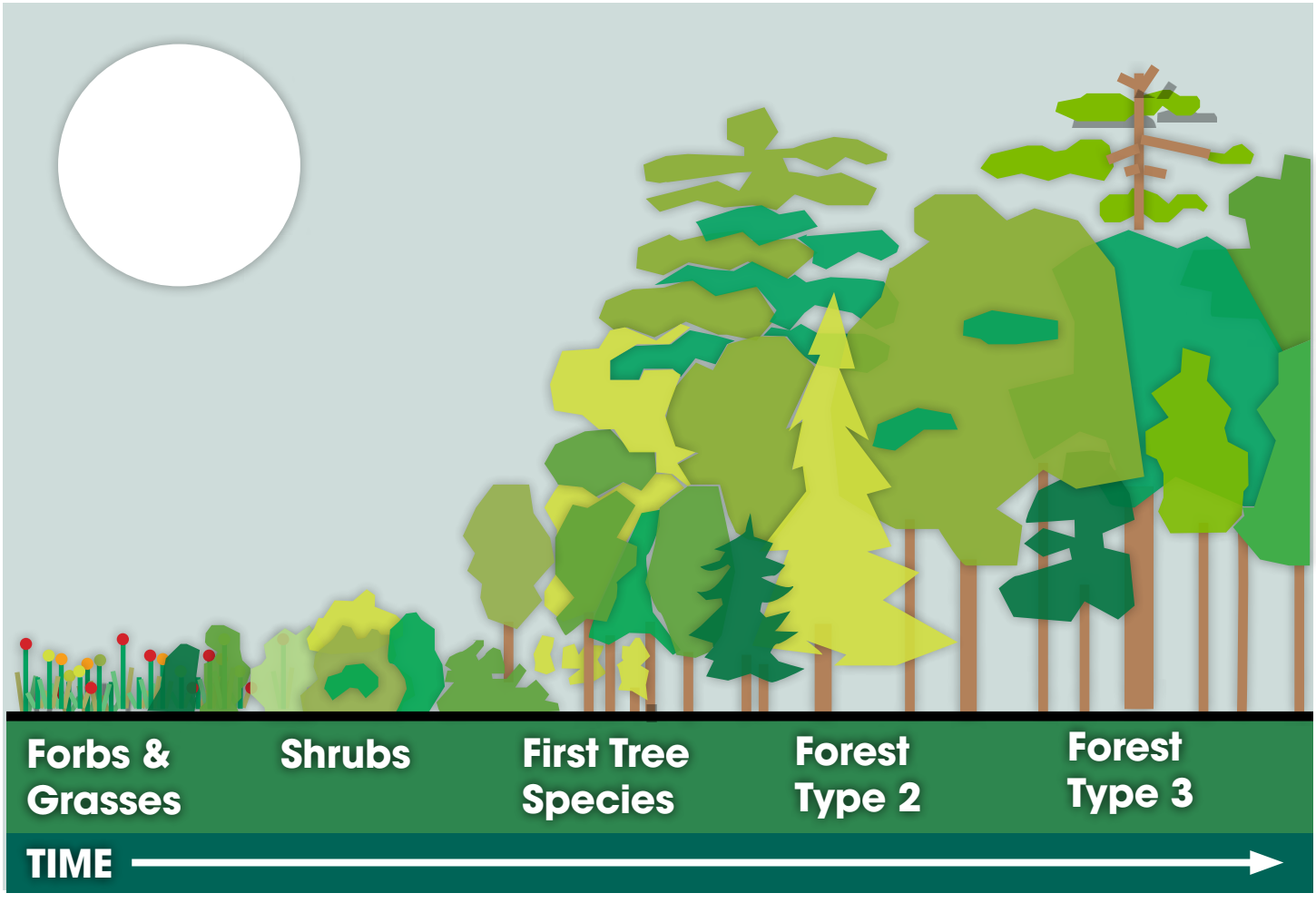
Chambers, R., (n.d.). *Preferred forest successional stages used by selected wildlife species* [table]. University Park: Pennsylvania State University, College of Agricultural Sciences.

Cook, William. (2001). *Michigan Forests Forever Teachers Guide.* Michigan State University Extension.

National Audubon Society. (2017, February 6). Why some birds' names have changed. *Audubon.* https://www.audubon.org/news/why-some-birds-names-have-changed

GRAPHIC:

SUCCESSION OF VEGETATIVE COMMUNITIES



This illustration can be used to help participants conceptualize forest succession over time. Try to incorporate real world, local examples of the types of forests that represent each stage, if possible.
Cook, William. (2001). *Michigan Forests Forever Teachers Guide*. Michigan State University Extension.

TABLE:
PREFERRED FOREST SUCCESSIONAL STAGES USED BY SELECTED WILDLIFE SPECIES

Each stage of forest succession provides habitat for several species of wildlife. The table following lists some Michigan wildlife species that use each stage of succession.

Species	Grass and Forbs	Shrubs and Saplings	Pole Stage	Mature Forest
Amphibians				
American toad	X	X	X	X
Grey tree frog		X	X	X
Red-back salamander			X	X
Slimy salamander			X	X
Red-spotted newt			X	X
Wood frog		X	X	X
Reptiles				
Eastern box turtle	X	X	X	X
Eastern garter snake	X	X	X	X
Northern redbelly snake			X	X
Smooth green snake	X	X		
Wood turtle	X	X	X	X
Black rat snake	X	X	X	X
Birds				
American woodcock	X	X		
Black-capped chickadee		X	X	X
Chipping sparrow	X	X		
Eastern meadowlark	X			
Grasshopper sparrow	X			
Great-horned owl	X			X
Ovenbird				X
Pileated woodpecker				X
Red-eyed vireo			X	X
Red-tailed hawk	X			X
Ruffed grouse	X	X		X
Rufous-sided towhee*		X		
Song sparrow		X		
Wild turkey	X			X
Mammals				
Black bear				X
Cottontail rabbit	X	X		
Gray squirrel				X
Meadow vole	X			
Red fox	X			X
White-tailed deer	X	X		X

Table used with permission. Rae Chambers, the Pennsylvania State University, College of Agricultural Sciences.

*Note: Because of new findings, the rufous-sided towhee has been split into two distinct species: the spotted towhee in the West and the eastern towhee in the East (National Audubon Society, 2017).

WORKSHEET:

FOREST STAND DATA SHEET

Fill out a separate document for each forest stand. This worksheet is optional.

Stand # _____ **# of Acres** _____

Common tree species:

_____

_____

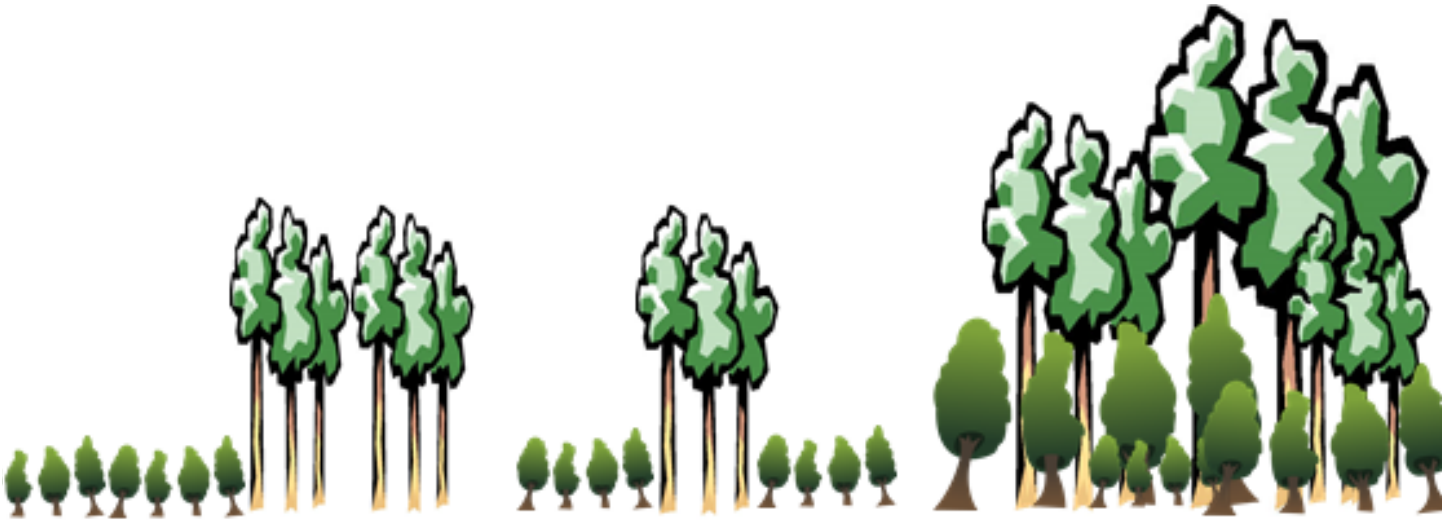
_____

Dominant tree species:

_____

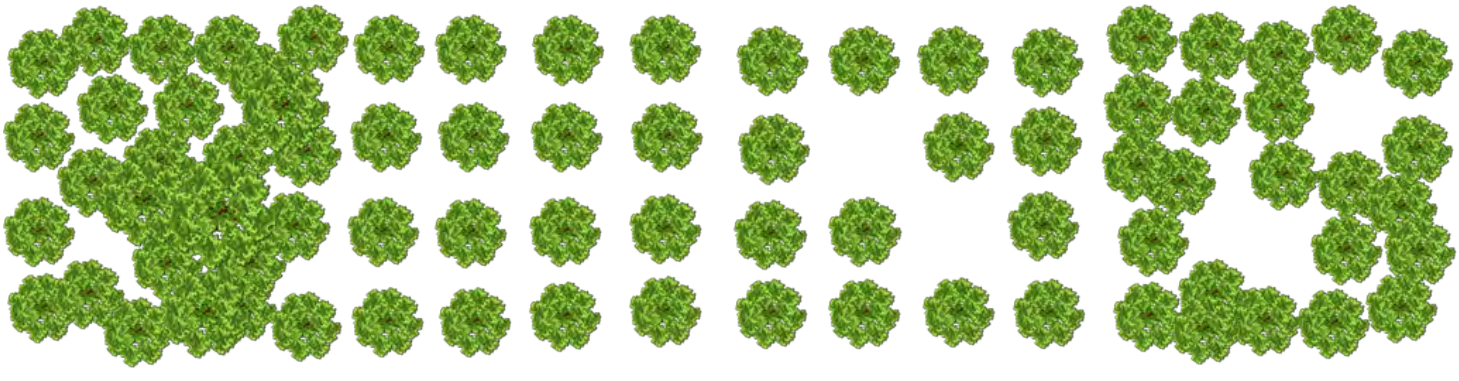
Stand description

Current Structure:



☐ One-canopy layer ☐ Two-canopy layer ☐ Multi-layer

Current Stand Condition:



☐ Wild stand ☐ Evenly spaced openings ☐ Evenly spaced with openings ☐ Variable density

ALIGNMENT TO SCIENCE AND ENGINEERING PRACTICES:

FOREST SUCCESSION

HOW DOES 4-H INCREASE SCIENCE LITERACY?

Nationally and in Michigan, 4-H has long enjoyed a reputation for engaging young people in positive, experiential (hands-on), and nonformal activities that are inquiry based. The activities in the *4-H Forestry Camp Instructor Guide (4H1754)* can be used to enhance classroom science education. The activities are aligned with the eight Science and Engineering Practices from *A Framework for K-12 Science Education* (National Research Council, 2012, p. 42). The activities in the instructor guide were evaluated for their alignment with the Science and Engineering Practices by MSU Extension Educator Tracy D'Augustino in 2019.

TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants discuss ways to change succession to manage the forest.	3d
Developing and using models	Participants use succession models to explain their answers.	2–3
Planning and carrying out investigations		
Analyzing and interpreting data	Participants make observations about the forest and interpret their observations in relationship to forest succession.	3
Using mathematics and computational thinking		
Constructing explanations and designing solutions	Participants use forest models to explain forest success.	2–3
Engaging in argument from evidence	Participants use their observations to justify the identified stage of forest succession for the forest they are visiting.	3
Obtaining, evaluating, and communicating information		

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

FOREST HEALTH

(A forester is recommended for this activity.)

WHEN: Forest Health can be done as its own activity or as part of the forest succession, tree identification and wildlife habitat evaluation activities.

TIME: 30 minutes

AGES: 10–15

OBJECTIVES:

Participants will:

- Describe a threat to forest health.
- Explain how forest health can be improved using forest management.
- Explain the difference between native and invasive threats to forest health.

MATERIALS:

- ❏ Forest Health Issues. Michigan Forests Forever Teachers Guide (information for the instructor) (*https://mff.forest.mtu.edu/Environment/ForestHealth.htm*)
- ❏ "Tree Species Longevity" graph (on page 32)
- ❏ Forest Health Highlights Report, Michigan Department of Natural Resources (Click on the report.) (*https://www.michigan.gov/dnr/0,4570,7-350-79136_79237_81077---,00.html*) (information for the instructor)
- ❏ "Forest Health Concerns" worksheet (on page 33) (optional)

BACKGROUND INFORMATION:

A variety of insects, diseases and pathogens can be active at any given time in a forest. Some, such as pollinators or decomposers can be beneficial to the forest. Some play a role in killing off stressed or diseased trees, strengthening the forest as a whole. Native and naturalized pests can negatively impact forest health, but the damage is usually temporary and rarely fatal because native predatory pests and other factors work within the forest ecosystem to keep them in check.

Non-native invasive pests and diseases can negatively affect forest health in a relatively short amount of time, because they have no predators to keep their populations in check. The emerald ash borer is one example; it effectively eliminated nearly all of the ash trees in the Lower Peninsula within a 15- to 20-year period.

Other threats to forest health include invasive plants, which can limit sunlight and space available for **regeneration** (growth of new trees). Overabundance of animal populations, such as the white-tailed-deer, can also limit tree regeneration by their browsing on the new growth.

Forest health is defined by how well the forest ecosystem is functioning. In a healthy forest, trees have enough space to obtain the water, nutrients and sunlight they need. New trees are continuously growing as older trees become weak and die. In a healthy forest, the natural cycle of life is happening continuously all over.

When foresters select the type of management to perform, they consider the health of the current forest, and the things that will ensure the forest is healthy after the management occurs. Some of the things foresters think about when judging the health of a forest follow.

Trees compete for resources

In a healthy forest, trees compete for resources (water, light and nutrients). Too many trees growing in an area may result in not enough resources to keep every tree healthy. Foresters call this **overcrowding**. They usually recommend thinning the trees in the forest to be sure the remaining trees can get the resources they need to remain healthy and reach their full growth potential.

Trees have a life span

All trees species have a life span. Scientific research tells us how long each tree species lives is based on the growing conditions. Trees can live longer if they grow in soil rich with nutrients and have adequate sunlight. They live shorter lives if they grow in nutrient poor soils with little light. When foresters consider management activities, they always consider the age of the trees and their potential for additional growth. If the trees in a forest are near the end of their life span, foresters usually recommend cutting down the trees to make room for new trees to grow. (See "Trees Species Longevity" graph on page 32.)

All forests have insects and tree diseases

Every forest has a population of insects or diseases that can damage or kill trees. In a healthy forest, those populations are low because of other animals or organisms. If a forest has many trees with insects or disease, foresters usually recommend cutting the infected trees out of the forest. Doing so will reduce the presence of the insects or diseases, and will increase the overall health of the forest.

Environmental Conditions

Environmental conditions are important factors in forest health.

Drought

Drought can stress trees, making them open to attack by insects or infection by disease. Foresters use forest management to counteract drought conditions only in situations where many trees are beginning to die. When many trees of one species begin to die in a forest, it is

called **tree decline**. Tree decline means that particular species of tree has lived its expected span for the growing conditions present. Drought conditions can begin the process of tree decline, as it weakens the tree, allowing insects and disease to continue to decrease the health of the tree until it dies.

Windthrow or storm damage

Sometimes a storm with high winds comes through an area and knocks down some or all the trees. **Windthrow** refers to the uprooting and overthrowing of trees by the wind. While windthrow and other storm damage does drastically change the habitat in an area, it also resets the cycle of forest succession and allows new trees to grow. In some cases, the damaged trees may be salvaged for timber production or left onsite to increase wildlife habitat opportunities.

PROCEDURE:

Before the meeting:

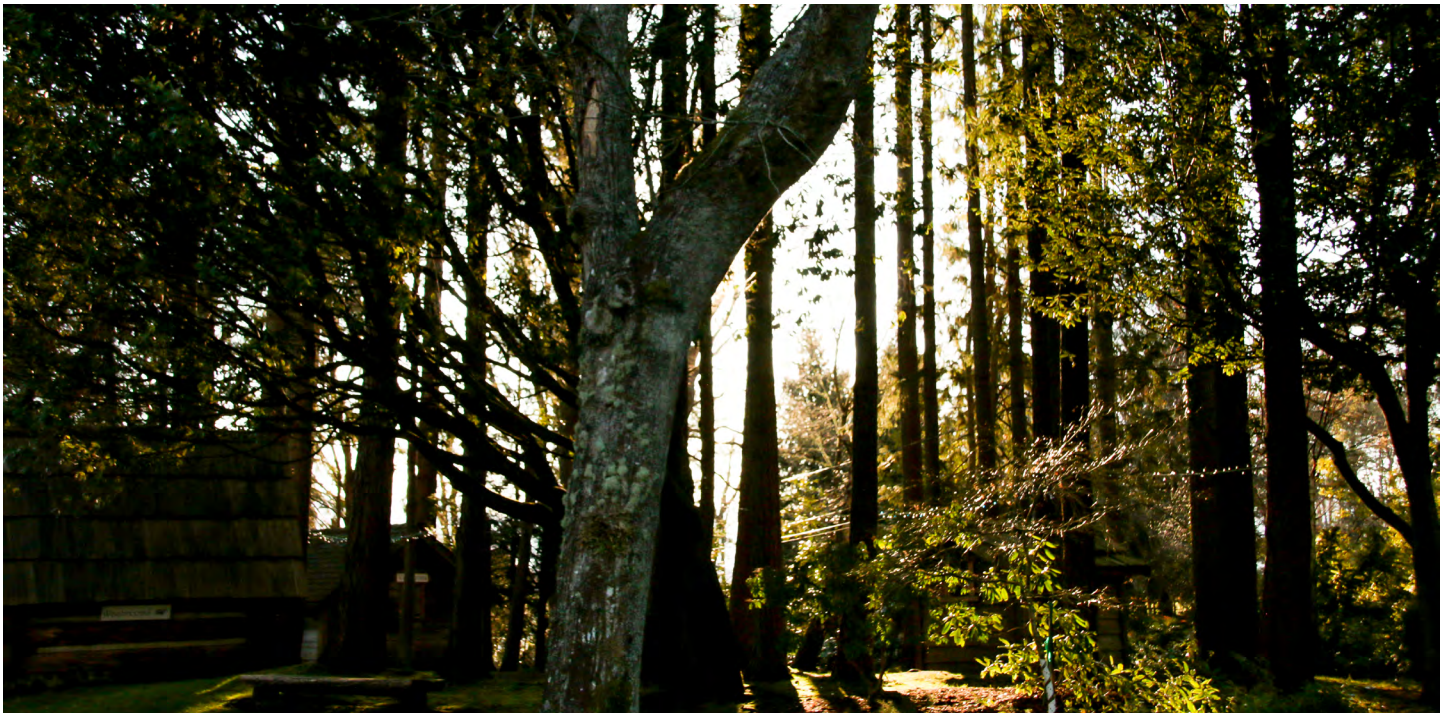
1. Walk the forest with a forester to identify any major threats to forest health.
2. Use flagging to mark examples of forest health concerns. Note native and naturalized pests and diseases that work within the forest ecosystem and affect the health of individual trees, especially when another stressor, such as drought, is present. Participants should understand that there are always insects and diseases in the forest that are not necessarily threats to the health of the forest ecosystem.

During the meeting:

1. While in the forest, ask participants what they think can have an impact on the health of the forest.
2. Ask participants if they think pests and diseases are a normal part of forest life. If participants struggle with this idea, ask them if there are pests or diseases that are normal in our lives. (Participants should come up with ideas such as the common cold and mosquitos.) Explain that pests and diseases are a natural part of forest life. Some can be good for a forest, while others can be bad.
3. Show participants examples of nonthreatening pests and diseases as well as those that can potentially harm forest health. While exploring the forest, have the forester lead a discussion to differentiate between the two types of threats to forest health using the specific examples available. Discuss the life cycles of a few pests or diseases in relation to individual tree health so that participants understand how the pest or disease affects the tree's natural processes.
4. Ask participants how they think the transferring of a pest or disease from one tree to another depends on the density and spacing of the individuals of a particular species of tree.
5. In the discussion, include how forest management activities can help mitigate forest health concerns before, during or after a major threat to forest health occurs.
6. Optional: Have participants complete the "Forest Health Concerns" worksheet for each stand.

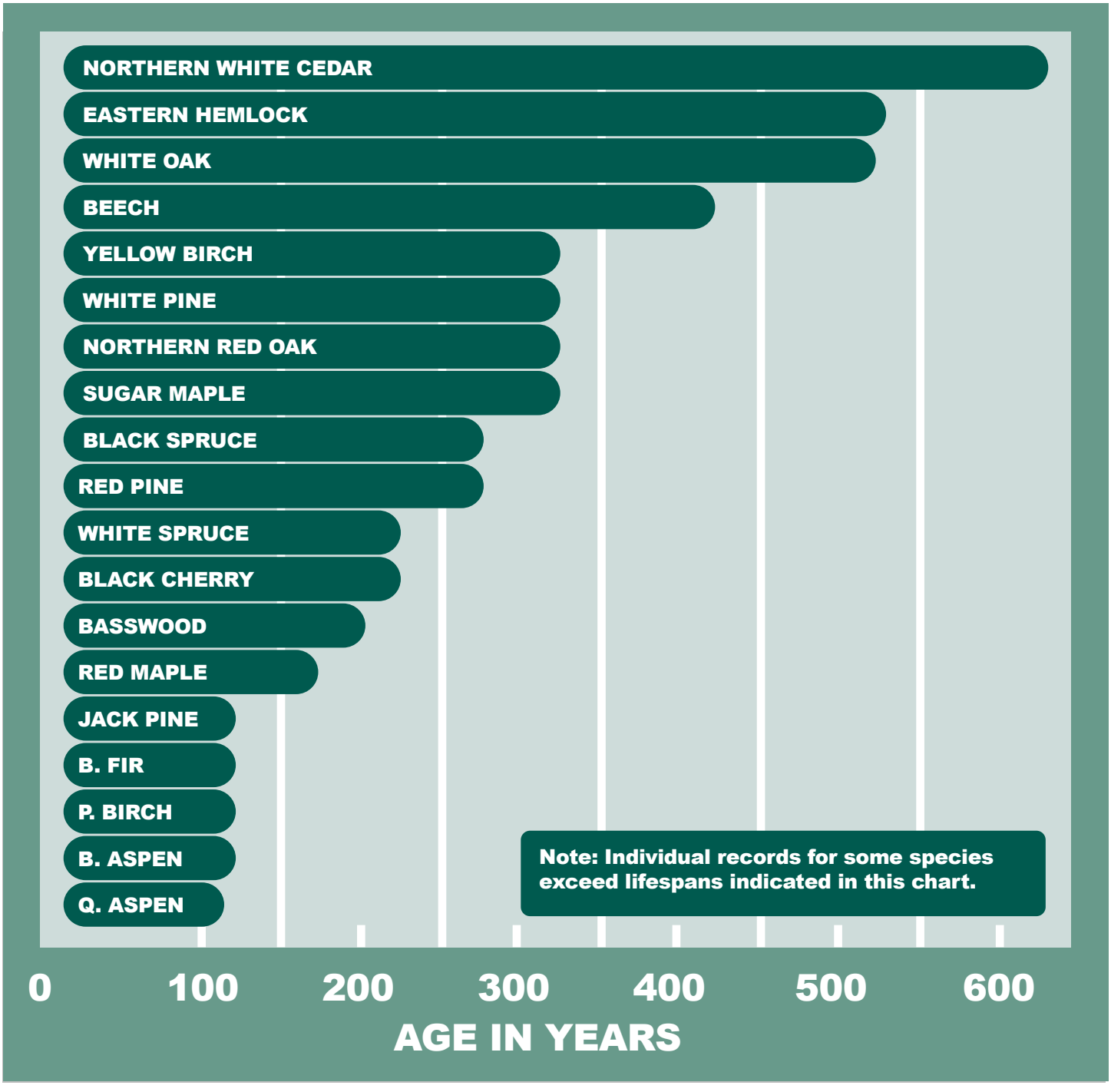
WRAP-UP:

Ask participants which pests or diseases they found. Ask them how they recognized the threat to forest or tree health and how they think the forest management plan should be adjusted for these threats.



GRAPH:

TREE SPECIES LONGEVITY



Cook, William. (2001). *Michigan Forests Forever Teachers Guide*. Michigan State University Extension. https://mff.forest.mtu.edu/TreeBasics/Descriptors.htm#Tree%20Age

WORKSHEET:

FOREST HEALTH CONCERNS

_____ Insects:

What kind? _____

_____

_____

Evidence _____

_____

_____

_____ Disease:

What kind? _____

_____

Evidence _____

_____

_____ Invasive Species:

What kind? _____

Evidence _____

Important Notes:

 |

FOREST HEALTH

HOW DOES 4-H INCREASE SCIENCE LITERACY?

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TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants identify threats to forest health including specific pests and diseases.	1–2
Developing and using models		
Planning and carrying out investigations		
Analyzing and interpreting data	Participants make observations about the health of the forest with the forester.	3
Using mathematics and computational thinking	Participants discuss and explain why density and spacing can have an impact on the rate a disease or pest may spread.	4
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants use their observations to explain the overall health of the forest.	Wrap-Up
Obtaining, evaluating, and communicating information	Participants discuss potential changes to the forest management plan based on the identified threats to the forest.	Wrap-Up

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

TREE IDENTIFICATION

(A forester is recommended for this activity.)

WHEN: Beginning and throughout camp

TIME: 30 minutes initially – This should be incorporated with other lessons and revisited throughout camp.

AGES: 10–15

OBJECTIVES:
Participants will:

- Identify the species (or family) of trees present in each stand of forest being used for the camp.
- Be able to match some trees species with the habitat in which they grow. For example, the presence of Northern White Cedar indicates a wet site; Northern pin oak indicates a dry site.

MATERIALS:

❏ Leaves and twigs from five of the most common tree species at the camp location

❏ Identification materials:

- Forest Basics: Tree Identification Information. *Michigan Forests Forever:* http://uptreeid.com/
- *Forests of Michigan*, *2014*, USDA: https://www.fs.fed.us/nrs/pubs/ru/ru_fs35.pdf
- *How a Tree Grows*, Michigan Department of Conservation (now the DNR). Presented by Michigan Department of Natural Resources, Project Wild: https://www.michigan.gov/dnr/0,4570,7-350-79135_79220_81129-427770--,00.html, http://www.michigan.gov/documents/dnr/HowATreeGrows_382468_7.pdf
- *Keys to Michigan Trees and Keys to Michigan Trees 2.* Presented by the Michigan Department of Natural Resources, Project Wild: https://www.michigan.gov/dnr/0,4570,7-350-79135_79220_81129-427770--,00.html

  https://www.michigan.gov/documents/dnr/KeytoMITrees_382471_7.pdf

  https://www.michigan.gov/documents/dnr/KeytoMITrees2_382470_7.pdf
- Tree Identification Characteristics or What Am I Supposed to Look at? *Michigan Forests Forever Teachers Guide:* https://mff.forest.mtu.edu/TreeBasics/TreeIDchars.htm

BACKGROUND INFORMATION:

Tree identification is important to forest management. The species of trees in a stand will help a forester choose the type of management activities to recommend to regenerate the desired species of trees following a management recommendation. The factors that help a forester make these determinations are the amounts of sunlight, nutrients and water each species of tree needs. Each species of tree has specific needs and grow near other trees that have the same needs. Therefore, trees found growing on a site indicate the site conditions such as dry, wet, sandy soil or loam soil. The species of trees in the forest can also help a forester determine what type of management activities have occurred on the land in the past.

Trees needing full sun, such as oaks, will require that more trees are cut in the forest to allow the next generation of trees access to sunlight. This means that the forest will have to be **clearcut** (all the trees will need to be cut down) or nearly so to stimulate the regeneration and growth of oaks on the site. Other trees that grow in shady conditions, such as maples, will regenerate with less intensive management activities.

PROCEDURE:

Before the meeting:

1. Be sure you or the forester are familiar with the species of trees found on the site. Select no more than five species to have participants identify and learn about. According to research, working memory can hold only five to nine bits of information at a time (Oregon State University, 2019). Since 4-H Forestry Camp introduces youth to other additional information as well, the number of species should be kept to five. Pre-identification may be necessary to ensure all instructors are in agreement about the species found on a site. Tree identification may be done as its own activity or as part of the forest health, forest succession and wildlife habitat evaluation. Choose any or all of the materials listed under "Identification Materials" in the "Materials" list of this lesson. Run off as many per participant that you will need.
2. Survey the area to determine if there are any concerns for plants such as poison sumac, poison ivy, poison oak or others. If they are present, try to have photos of plants so participants know what to avoid.

During the meeting:

1. Ask participants how they would normally identify a species of tree. Then read aloud or paraphrase the following:

The easiest way to identify a tree is usually by its leaves. If the leaves for a particular tree are too high up for you to reach, look around for a smaller tree of the same species. Seeds, nuts and flowers at the base of the tree can also help you identify the tree depending on the time of year. Foresters usually identify trees using the bark, and that takes a lot of practice.

2. Discuss how bark from each species is different. Encourage the participants to try to identify trees first by examining the bark, then by using the leaves to confirm their identification.
3. Have participants collect leaves from identified trees for the T-shirt bleaching activity.
4. Ask the participants if they think all trees are used for the same products. Why or why not? Explain that different tree species are used in different products. The forester can facilitate a discussion of local markets for various types of wood.
5. If possible, include the following information when introducing a tree. They are key characteristics when considering forest succession:
    - Light requirement
    - Growing conditions
    - Forest cohorts (the other species of trees usually found with a particular species)
    - Uses of the wood from different species

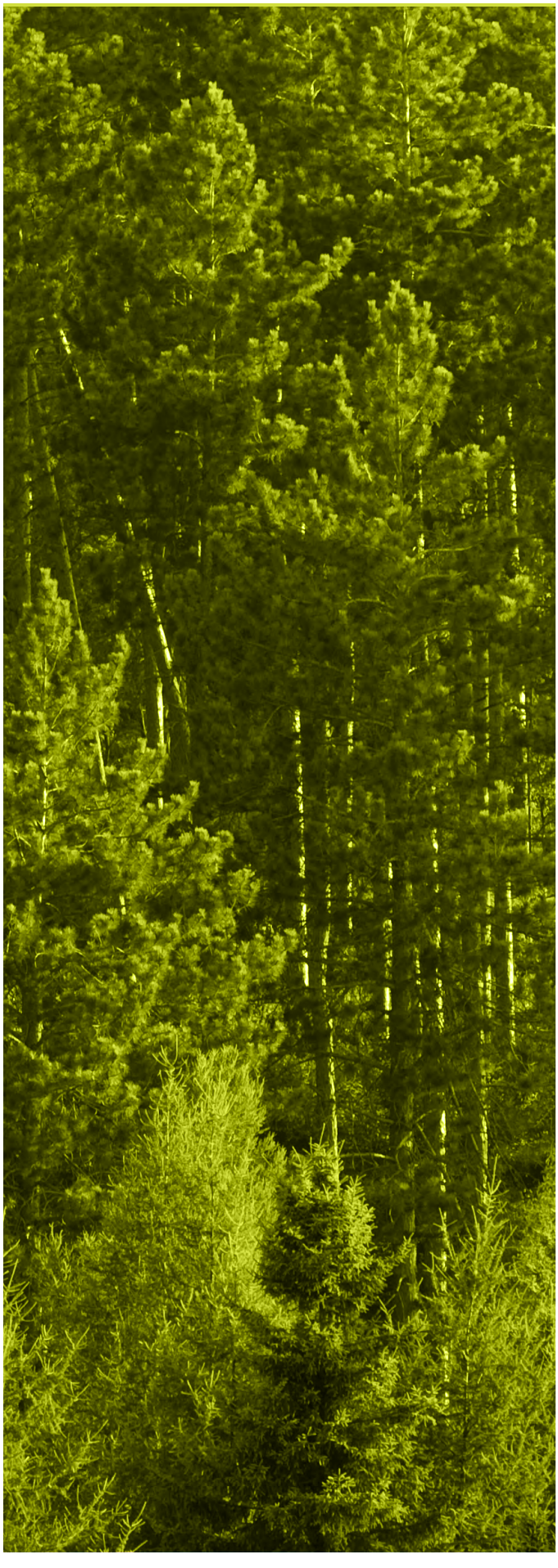
WRAP-UP:

Reiterate that tree identification is a skill that comes easier with practice. Do a quick review by having participants identify trees they learned about. (If in the forest, have them physically touch a tree and share its identity.) Then ask them **how** they knew the identity of the tree. (Asking participants how they know something requires them to articulate their learning and increases the chance they will remember the information.)

Throughout camp, continuously ask participants to identify the five trees as you encounter them.

REFERENCE:

Oregon State University. (2019). *The memory process, in four fantastic nutshells.* Corvallis: Academic Success Center.



ALIGNMENT TO SCIENCE AND ENGINEERING PRACTICES:

TREE IDENTIFICATION

HOW DOES 4-H INCREASE SCIENCE LITERACY?

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TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants brainstorm key features of different species of trees and products produced from them.	1, 4
Developing and using models		
Planning and carrying out investigations		
Analyzing and interpreting data	Participants make observations about different trees and use their observations to identify its species.	2
Using mathematics and computational thinking		
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants identify trees and explain the features they used to explain their answer.	Wrap-Up
Obtaining, evaluating, and communicating information		

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

COMPASS AND PACING

WHEN: Before forest data collection

TIME: 30 minutes

AGES: 10–15

OBJECTIVES:

Participants will:

- Explain how to use a compass.
- Identify components of a map (optional).
- Describe the importance of **pacing**.
- Determine the number of their paces that equals 66 feet.
- Be able to demonstrate **triangulation** and **back bearing** using a compass.

MATERIALS:

- ❏ Large compass display (with moving parts – optional)
- ❏ Compasses (one per participant)
- ❏ Marker (or other easily seen item that participants can use to mark their place on the ground)
- ❏ Map (optional)

BACKGROUND INFORMATION:

Many occupations rely on the use of compasses. Pilots, ship captains, drivers, guides, foresters, surveyors, prospectors, engineers, soldiers and tourists all use maps and compasses to explore and locate places.

Compasses are an important tool, which could become vital to the survival of people who explore or work in the forest. Even in this age of technology, knowing how to use a compass is an important lifesaving skill. Compasses work because of the magnetic composition of our planet. The needle of a compass will always turn toward magnetic north. Because the needle is magnetic, ensure it is not near a metal object (such as a zipper) that could result in a false reading.

Pacing is also an important skill. Pace can be used to determine the distance (feet, yards or miles) you have traveled to know your rough location on a map. Pacing a fixed distance (66 feet) is also important when using many of the forestry tools.

PROCEDURE:

Before the meeting:

1. Study the triangulation activity described on the next page. Use the degrees and distances provided, or make up another set, ensuring that the participants will use their compass and paces to start and end at one location. The number of turns and the distance between can vary as desired and as space allows.

During the meeting – maps:

1. Begin a discussion on maps by asking the following:
   - *What is a map?* Allow participants to respond; then explain that a map is a reduced representation of the earth surface. Show the map as an example.
   - Ask: *Why do we need maps?*
   - Ask: *What information is contained in a map?* (Their answers should include distances, geographical features of the area, direction and constructed features such as roads, buildings, quarries and airports.)
   - *Ask: When would you use a map?* (Answers could include driving around a city, finding a store in a mall or choosing a seat in a stadium.)

During the meeting – compasses:

1. Begin a discussion on compasses by asking the following:
   - *What is a compass?* Allow participants to respond; then explain that a compass is an instrument for determining directions (north, south, east and west).
   - *What careers or jobs do you think you would need a compass to do?*
   - *What is a GPS?* Allow participants to respond; then explain that a GPS uses satellites to determine your position on the planet and can be used instead of a compass; however, a compass should always be carried as a backup. Ask participants why. (Batteries are required and satellite reception, like cell reception, is not always good.)
   - *Why is it important to know how to use a compass?* (It allows you to explore areas without roads and street signs.)
   - *What else should you know when walking in the forest?* (what and where are major landmarks, roads, bodies of water)
2. Pass compasses out, making sure each participant has a compass.
3. Show participants the needle in the shed – "red in the shed." If a large compass display is available, use it to demonstrate.
4. Read aloud or paraphrase the following:

   Set your compass to 0 or 360. Then turn your body until you have the red end of the needle in the "shed."

5. Walk around and make sure participants have their

compasses set with the red end of the needle in the shed. Try having the participants hold the compass level and touching their chest pointing straight out. Remind them that their feet need to be pointing in the same direction as the compass.

6. Begin a discussion of the numbering around the edge. Ask:
   - *Why is the largest number 360?* (There are 360 degrees in a circle and the compass is a circle.) *What number is north?* (360 or 0) (Participants have already dialed this in and should all be facing north.)
   - *What number is south?* (180) *Set your compass to 180, then turn your body until you have the red end of the needle in the "shed."*
   - *What number is east?* (90) *Set your compass to 90, then turn your body until you have the red end of the needle in the "shed."*
   - *What number is west?* (270) *Set your compass to 270 and then turn your body until you have the red end of the needle in the "shed."*

During the meeting – finding your back bearing:

1. Read or paraphrase the following:

   If we walked at a bearing of 90, what number would we need to dial in to get back the same way? (270) *You can find the answer, which is called a **back bearing**, by drawing a straight line across the face to the number directly across from 90 or by adding 180 degrees.*

During the meeting – triangulation:

1. Read or paraphrase the following directions to participants:
   a. *Place your marker on the ground between your feet.*
   b. *Dial your compass to 0 and place the red end of the needle in the shed. Make sure your feet are pointed the same direction as your compass. Follow the line of your compass and look at something in line in the distance such as a tree or rock.*
   c. *Walk 15 steps toward the object – it's important to be consistent in your step size.*
   d. *Next dial your compass to 120 and place the red end of the needle in the shed. Make sure your feet are pointed the same direction as your compass. Follow the line of your compass and look at something in line in the distance such as a tree or rock.*
   e. *Walk 15 steps toward the object – it's important to be consistent in your step size.*
   f. *Finally dial your compass to 240 and place the red end of the needle in the shed. Make sure your feet are pointed the same direction as your compass. Follow the line of your compass and look at something in line in the distance such as a tree or rock.*
   g. *Walk 15 steps toward the object – it's important to be consistent in your step size.*
   h. *Look for your marker. How close did you get to your starting place?*
   i. *Why did you end up at your starting spot?* (because we made a triangle)

2. Continue to read or paraphrase the following:

   ***Triangulation** involves traveling a path using three different directions, that form a triangle, so that you return to your starting point. You will be adding 120 three times. Why is that?* (360 divided by 3 = 120).

   Triangulation can be done with any number of "legs" that divide evenly into 360.

   For example, using 4 legs, add 90 to the starting degree and for 3 more legs, for a total of 4 directions traveled to get back to the starting point.

   For example, for 6 legs, add 60 to the starting degree and for 5 more legs, for a total of 6 directions traveled to get back to the starting point.

During the meeting – pacing

1. Choose a flat, clear walking space for this activity.
2. Use a measuring tape or the logger's tape (included in the kit) to measure off a distance of 66 feet. This is the distance from the tree a person must be to accurately use some of the forestry tools included in the kit.
3. Use flagging to denote the start and end of the 66-foot-long walking path.
4. Instruct participants to walk the 66-foot-long path, counting their steps along the way.
5. Instruct participants to walk the 66-foot path a second time, counting their steps. Ask them to take the average of the two counts to find how many steps make up the 66-foot distance.
6. Instruct participants to remember this number (or write it down) as this will be the number of steps required to pace off 66 feet from the tree to accurately use some of the forestry tools.

WRAP-UP:

Review what was learned by asking these questions:

- *Who uses compasses?*
- *Who uses GPS Units?*
- *Why is it important to know how to use a compass?*
- *What else should you know when walking in the forest?*

(General location and relationship to large landmarks such as highways, lakes and rivers)

ALIGNMENT TO SCIENCE AND ENGINEERING PRACTICES:

COMPASS AND PACING

HOW DOES 4-H INCREASE SCIENCE LITERACY?

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TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants explore what are maps and compasses and why they are important.	During the Meeting – Maps & During the Meeting – Compasses
Developing and using models		
Planning and carrying out investigations		
Analyzing and interpreting data		
Using mathematics and computational thinking	Participants learn and practice how to use a compass, back bearing and variations on triangulation.	During the Meeting Sections on Compasses, Back Bearing &Triangulation
Constructing explanations and designing solutions		
Engaging in argument from evidence		
Obtaining, evaluating, and communicating information	Participants explain the importance of maps and compasses including specific examples.	Wrap-Up

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

FOREST MEASUREMENTS FOR RECREATION AND WILDLIFE

(A forester is strongly recommended for this activity.)

WHEN: Anytime

TIME: One hour

If participants are broken into groups, one group will be involved in this activity while the other group is involved with the "Forest Measurements for Timber Production" activity. Ideally, each group should have at least four participants.

The "Wildlife Habitat Evaluation" activity is conducted at the same time and place as both are measurement related activities.

AGES: 11–15

OBJECTIVES:

Participants will:

- Describe how forest measurements are obtained and calculated.
- Measure the diameter of a tree using a diameter tape.
- Measure the height of a tree using the hypsometer on the tree scale stick.
- Measure the height of a tree using a clinometer.
- Identify the species of each tree measured or counted.
- Determine the recreation and wildlife value of the forest stand.
- Use a canopy cover tube to determine the amount of sunlight reaching the forest floor.
- Use data collected to make management recommendations.

MATERIALS:

- ❏ Ribbon flags to denote boundaries
- ❏ Four diameter tapes (depending on the size of the group), (20 are included in the equipment kit)
- ❏ "How to Use a Diameter Tape" instructions (on page 45)
- ❏ Tree scale stick
- ❏ Clinometer (included in the equipment kit)
- ❏ "How to Measure the Height of a Tree Using a Clinometer" instructions (on page 46)
- ❏ Canopy cover tube (must be constructed, see "Canopy Cover" lesson) (on page 62)
- ❏ "Recreation and Wildlife Plot Tally Sheet" worksheet (2 per group) (on page 44)
- ❏ Canopy cover datasheet (2 per group) (see "Canopy Cover" lesson) (on page 64)
- ❏ "Wildlife Species and Habitat" worksheet (2 per group) (see "Wildlife Habitat Evaluation" lesson on page 48)
- ❏ Pencil (1 per group)
- ❏ Clipboard (1 per group)

BACKGROUND INFORMATION:

Forests may be measured for different values according to the goals of the landowner. In this activity, we measure the size (diameter and height), age and species composition of the forest and discuss how the measurements are related to the recreation and wildlife value of the forest.

The diameter tapes are used to measure the diameter at breast height of each tree within the plot, which measures 66 feet by 66 feet. A plot of this size is equal to 1/10 of an acre. The "Recreation and Wildlife Plot Tally Sheet" organizes the tree diameter into 4-inch-size classes. This creates a way to quantify the visual appeal of the forest for recreation potential. Instructions "How to Use a Diameter Tape" are included on page 45.

The height of the tree is measured using the clinometer. Instructions "How to Measure the Height of a Tree Using a Clinometer" are included on page 46.

The canopy cover relates to the amount of sunlight that penetrates the forest canopy and reaches the forest floor. This is important because it can affect the growth potential of vegetation on the forest floor as well as regeneration of trees in the forest. If more than 50 percent of the canopy is open, sunlight can reach the forest floor increasing the amount (and likely variety) of vegetation and tree regeneration. The vegetation represents the amount of forage, or food for wildlife; while tree regeneration can provide food and habitat for wildlife.

Refer to the "Wildlife Habitat Evaluation" lesson plan for details about wildlife.

PROCEDURE:

Ideally, each group will include at least four participants to perform each of the following roles:

- Identifying the species and measuring the diameter of each tree within the plot
- Measuring the height of each tree within the plot
- Measuring the amount of sunlight penetrating the canopy using the canopy cover tube
- Recording the data

NOTE: Provide instruction on using all the tools, encourage teamwork among the participants, then step back and observe participants, providing direction as appropriate.

Before the meeting:

1. Prior to going out in the field, use ribbon flagging to clearly denote the boundaries of two plots, each measuring 66 feet by 66 feet. This is a 1/10-acre plot. If possible, place each plot in a different stand, or forest type, for comparison.

During the meeting:

1. Ask participants the following questions related to the recreation potential of forests:
    - *What are some examples of recreation people do in a forest?*
    - *How does the type of forest, or the species and size of trees in a forest, affect different recreational activities?*
    - *How do they think the recreational value is determined?* (The number, size and species of trees, snags and the amount of sunlight reaching the forest floor all are used to help determine the recreational and wildlife value of a forest.)

Recreation potential may or may not involve hunting or wildlife viewing. This question relates to game wildlife (hunted wildlife) habitat:

- *What types of wildlife are hunted in Michigan?*

This question relates to nongame (not hunted) wildlife:

- *What are some types of wildlife that we like to view, rather than hunt, in Michigan?*

Use the following discussion questions if discussing wildlife in general, rather than related to recreation.

- *What are some of the wildlife habitat elements we might find in the forest?*
- *What types of wildlife could be supported by a forest? (*Vertebrates [birds, mammals, reptiles, amphibians] and invertebrates)

2. Read aloud or paraphrase the following:

    You will be collecting data to help determine the recreational and wildlife value of two sites today.

3. Instruct participants to take the following measurements for each tree in the plot that is more than 4 inches in diameter: species, diameter and height (not number of logs).
4. Record the measurements on the "Recreation and Wildlife Plot Tally Sheet" in the appropriate species column according to the diameter class and height of the tree.
5. Count and record the number of **snags**, or standing dead trees, greater than 4 inches in diameter.
6. Collect canopy cover measurements at the plot center and at each corner.
7. Read aloud or paraphrase the following*:*

    It is the responsibility of each participant using the tools to be sure the data recorder has correctly heard the measurements provided. To accomplish this, follow these steps:
    a) *Make sure you have the data recorder's attention before providing measurements.*
    b) *Speak loudly and clearly.*
    c) *Ask the data recorder to repeat back the measurement to you. This will decrease frustration and inaccuracy during data collection.*

8. Instruct participants to complete the "Wildlife Species and Habitat" worksheet; recording all sources of food, water, shelter and space within the plot as well as the amount of forested space surrounding the plot. Space is the amount of forested area that is available for wildlife to use as habitat. It can be estimated in acres and represents the area of contiguous, or connected, forest habitat for which wildlife that might use the plot have access. In other words, is the forest in which the plot sits a small isolated woodlot, or is it part of a larger forest that could provide home range habitat for larger wildlife species?
9. Move to the next plot and repeat. Be sure to use a new "Recreation and Wildlife Plot Tally Sheet" to record the trees and a new "Wildlife Species and Habitat" worksheet to guide wildlife habitat discussion points at the second spot.

WRAP-UP:

After the data is collected, assemble students to complete the "Recreation and Wildlife Plot Tally Sheet."

Be sure the "Wildlife Species and Habitat" worksheets are completed for each site.

Compare the data collected within each plot and discuss the differences.

If possible, include soil data collected and relate the soil information to the growth potential of the trees. Soil is also related to the species of trees present; if possible, make that connection as well.

Ask participants the following questions related to the recreation potential of the plots they studied:

- *Based on the data collected is this a good forest for a recreation site?*
- *What type of recreation do you think could be enjoyed on this site?*
- *What do you think would increase the recreation potential of this site?*
- *How do you think forest management activities could help increase the recreation potential of this site?*

Recreation potential may or may not involve hunting or wildlife viewing. Some questions that relate to game wildlife (hunted wildlife) habitat follow:

- *Do you think this forest provides good habitat for game wildlife? Why? Why, not?*
- *What do you think could make this site better for game wildlife?*
- *How do you think forest management activities could help improve the wildlife habitat?*

Some questions that relate to nongame (not hunted) wildlife follow:

- *Do you think this forest provides good habitat for nongame wildlife? Why? Why, not?*
- *What do you think would make this site better for nongame wildlife?*
- *How do you think forest management activities could help improve the wildlife habitat?*

WORKSHEET:

RECREATION AND WILDLIFE PLOT TALLY SHEET
PLOT

Place a mark for every tree you measure according to its species, diameter and height.

Height (feet)	0-20′				21-30′				31-40′				41-50′				51+′			
Diameter (inches)	Oak	Maple	Conifer	Other	Oak	Maple	Conifer	Other	Oak	Maple	Conifer	Other	Oak	Maple	Conifer	Other	Oak	Maple	Conifer	Other
4-8″																				
9-13″																				
14-18″																				
19-23″																				
24+″																				

Total number of “snags” (standing dead trees): _____

How many trees (across all species) are 24+ inches in diameter? _____

How many TOTAL trees do you have in your plot that are 4 inches in diameter or greater? _____

What is the estimated number of trees per acre (total number of all trees x 10)? _____

INSTRUCTIONS:

HOW TO USE A DIAMETER TAPE

Diameter of trees present (DBH)

Foresters measure tree diameter at a standardized height of 4.5 feet above the ground. This is referred to as diameter at breast height (DBH). The height usually avoids the natural swelling from the **tree butt** (the bottom of the tree where the roots start to grow) in addition to being a convenient height. Irregularities in the trunk have necessitated a host of rules about where to measure diameter.

The average diameter of trees in a forest can provide information about the conditions in which trees have grown in the past on the property, and what might occur to individual trees if they are exposed to more sunlight and space. Trees that have been suppressed, or have grown under the canopy of other trees for a long time, can have a small diameter despite being 100 years old. These trees will not likely grow any taller or bigger around, even if they are exposed to full sunlight. Young trees also have a small diameter.

Trees that have been growing as a dominant part of the forest canopy usually have a large diameter because they have been able to get more of the water and nutrients required for growth than the trees below.

Diameter is also used, along with height of the tree, to determine how much lumber can be produced from a tree. The straight portions of the trunk are usually divided into 8- or 16-foot sections that will be sent to a mill. A math equation was developed that can calculate how many boards measuring 12 inches long by 12 inches wide by 1 inch thick may be produced in each 8- or 16-foot section, and ultimately, by a single tree. The lumber produced from a single tree is referred to as **board feet**.

For example, a 17-inch diameter tree that has two 8-foot sections of straight wood in the trunk will contain about 118 board feet. The math has been compiled into charts found on the tree scale stick included in the kits of equipment.

The diameter of a tree may be collected by using a regular measuring tape to measure the circumference (C) of the tree and dividing by pi (~3.14). The mathematical formula is D = C/pi. Foresters used this formula to develop the **diameter tape**, or a measuring tape that is graduated, or marked, at intervals of pi inches to increase the efficiency of their work. Several diameter tapes are included in the kit for use during the camp.

To increase the accuracy of the measurement taken with the diameter tape, follow these guidelines:

- Measure the tree at 4 1/2 feet from the ground on the uphill side. This is referred to as **diameter at breast height**, or **DBH**. If the same tree is to be measured multiple times throughout its life, foresters mark the DBH with paint or a bark scrape so that the repeated measurements will be taken at the same height and truly reflect the increased growth of the tree.

Photo by Julie Crick, Michigan State University Extension

In this photo, the '0' mark, or the beginning of the measurement scale, is closest to the diameter mark of 10.3.

- The tape must be wrapped around the tree keeping it tight, not slack, and not sliding down. Be sure the tape is on a level plane perpendicular to the trunk of the tree prior to taking the measurement.

How to use a diameter tape:

1. Locate DBH; hold the tape perpendicular to the trunk of the tree with the metal hook in one hand.
2. Secure the hook to the tree bark and wrap the tape around the tree. The tape can either be wrapped around the tree by reaching around (hugging) the tree or by physically walking around the tree itself.
3. Take special care to be sure the tape remains at 4 1/2 feet from the ground all the way around the tree without sliding down the trunk at any point.
4. As the tape completes the wrap around the tree, continue wrapping until the graduated lines match up with the '0' mark. Be sure the tape is tight and parallel to the ground, and then take a reading. The line that closely matches the '0' mark is the diameter of the tree. Be sure to line up the diameter mark and the '0' mark for an accurate reading.

INSTRUCTIONS:

HOW TO MEASURE THE HEIGHT OF A TREE USING A CLINOMETER

The clinometer is an instrument used to measure the height of a tree, the percent slope and the degrees of a slope. The instrument is used in forestry operations to determine the number of logs that may be harvested from a tree, or to measure the slope of the land when creating roads or when using cables to harvest trees in rolling topography.

The clinometer provided in the kit includes all three scales, with the height in feet being the middle scale. Percent slope is the left scale and degree of slope is the right scale. The index line is the line that runs through all three scales.

How to use the clinometer to measure the height of a tree:

1. Instruct each participant to use pre-determined paces to be 66 feet from the tree to be measured.
2. Turn to face the tree to be measured; hold the clinometer up to the left eye.
3. Keeping both eyes open, focus on the scale inside the clinometer to line up the index line with the “0” line of the middle scale. This is the scale that will measure the height of the tree in feet.
4. Shift the focus to the tree beyond the clinometer; an optical illusion will allow the index line to be seen outside of the instrument housing. If the index line is not at the base of the tree, tilt the clinometer down until the index line is at the base of the tree. Remember the number on the middle scale (it may be a positive or negative value); it will be added to the second reading to give the full height of the tree
5. Now, tilt the clinometer up toward the top of the tree. Using both eyes, line up the index line with the uppermost branches of the tree. Focus on the middle scale, and read the number under the index line on the middle scale.
6. Add the first number (base of the tree) with the second number (top branches of the tree) to obtain the height of the tree.
7. Report the height of the tree as well as the species and diameter of that tree to the data recorder. If there is a designated data recorder, he or she should record the data on the “Recreation and Wildlife Plot Tally Sheet.”
8. Do this for all other trees over 4 inches DBH within the 1/10 acre plot.

View looking into a clinometer. The numbers measure (from left to right) the degrees of a slope, the height of a tree (in feet) and the percent slope.

Photo credit: Julie Crick, Michigan State University Extension

ALIGNMENT TO SCIENCE AND ENGINEERING PRACTICES:

FOREST MEASUREMENTS FOR RECREATION AND WILDLIFE

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TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants determine the recreational and wildlife value of the forest.	1
Developing and using models		
Planning and carrying out investigations	Participants discuss components of the recreational and wildlife value of the forest, then collect data to evaluate it.	1–9
Analyzing and interpreting data	Participants discuss the data they collect and evaluate how it helps determine the recreational and wildlife value of the forest.	Wrap-Up
Using mathematics and computational thinking	Participants collect tree size and canopy cover data.	3–6
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants use the data collected to discuss and determine the recreational and wildlife value of the two forest sites.	Wrap-Up
Obtaining, evaluating, and communicating information		

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

WILDLIFE HABITAT EVALUATION

WHEN: To be done formally at the same time as the "Forest Measurements for Recreation and Wildlife" lesson; observations can be collected and recorded any time, such as during the data collection for the "Forest Measurements for Timber Production" lesson.

TIME: One hour; throughout camp

AGES: 11–15

OBJECTIVES:

Participants will:

- Identify signs of animals in the forest.
- Describe signs of animals that could be found in the forest.
- Identify wildlife habitat in the forest.
- Explain why animals live in the forest, connecting food, water, shelter and space.
- Identify invertebrate wildlife (insects, spiders, snails and others) within the plot.
- Explain why invertebrates are important.

MATERIALS:

- ❏ Ribbon flags to denote boundaries
- ❏ "Wildlife in the Forest" reference material (on page 51)
- ❏ "Creating Habitat for Michigan Wildlife" reference material (on page 53)
- ❏ "Wildlife Species and Habitat" worksheet (two per group) (on page 50)
- ❏ Clipboard (one per group)
- ❏ Pencil (one per group)

BACKGROUND INFORMATION:

Refer to the "Wildlife in the Forest" and "Creating Habitat for Michigan Wildlife" reference material included on pages 51-53.

When conducting as part of the "Forest Measurements for Recreation and Wildlife" lesson plan, instruct participants to gather to discuss wildlife habitat. Use the "Wildlife Species and Habitat" worksheet to guide the discussion, recording all sources of food, water, shelter and space within the plot as well as the amount of forested space surrounding the plot. Space is the amount of forested area that is available for wildlife to use as habitat.

PROCEDURE:

Before the meeting:

1. Prior to going out in the field, use ribbon flagging to clearly denote the boundaries of two plots, each measuring 66 feet by 66 feet. This is a 1/10-acre plot. If possible, place each plot in a different stand, or forest type, for comparison. (This is a repeat for the preparation for the "Forest Measurements for Recreation and Wildlife" lesson, which is done formally at the same time as this lesson.)
2. Wildlife species and habitat data can be collected anytime throughout the camp. If evidence of wildlife is discovered (scat, nest, hole or other signs), record the evidence and lead participants in a discussion about the habitat, or the food, water, shelter and space available.

During the meeting:

1. Ask participants the following questions related to the wildlife habitat in the forest:
   - *What are some of the wildlife habitat elements we might find in the forest?* (Types of food, water, shelter and space)
   - *What types of wildlife could be supported by a forest*? (vertebrates [Birds, mammals, reptiles, amphibians] and invertebrates)

   Direct the discussion to the invertebrate wildlife found in the plot.
   - *What is an invertebrate?* (wildlife without a backbone, such as insects, spiders and snails)
   - *Why do you think invertebrates are important in the forest?* (break down leaf litter allowing nutrients to return to the soil, food for vertebrates, invertebrate population control and other reasons)
   - *How do they think the wildlife value is determined?* (The variety of wildlife evidence, food, water, shelter and space available help determine the wildlife value of the forest.)
2. Invertebrates (insects, spiders, snails and others) are also important wildlife species, both for their function as well as for food for vertebrate species. Instruct participants to look for and record any invertebrate species encountered.
3. Instruct participants to complete the "Wildlife Species and Habitat" worksheet; recording all sources of food, water, shelter and space within the plot as well as the amount of forested space surrounding the plot. Space is the amount of forested area that is available for wildlife to use as habitat. It can be estimated in acres and represents the area of contiguous, or connected, forest habitat for which wildlife that might use the plot have access. In other words, is the forest in which the plot sits a small isolated woodlot, or is it part of a larger forest that could provide home range habitat for larger wildlife species?

4. Encourage participants to point out evidence of wildlife observed anytime throughout camp. Then ask what wildlife they think it is evidence of, and why do they think that. For example, if scat is found, ask:

   What type of animal do you think left that scat? (Answers might include coyote or other carnivore.) *Why do you think it is a coyote?* (Answers might include because it looks like a dog's and I can see fur in it – so a carnivore.)

5. Lead discussions rather than lecture about habitat specifics. Ask participants to contribute or share relevant information.

6. Try to assign a wildlife recorder for each group. Ask this person to always carry a clipboard, worksheets and pencil and be ready to record when evidence is found. Reminders may be necessary.

WRAP-UP:

Be sure the "Wildlife Species and Habitat" worksheets are completed for the two plots from which forest measurements for recreation and wildlife are collected.

Compare the data collected within each plot and discuss the differences.

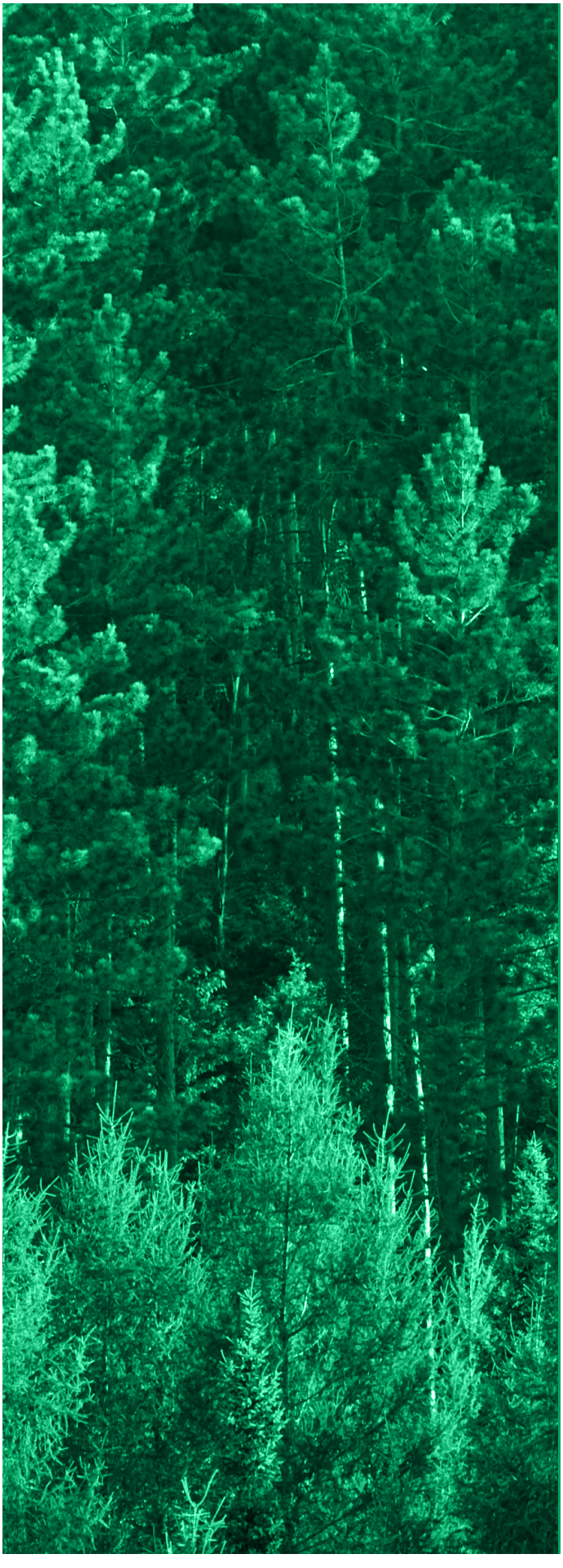
Some of the following discussion points are duplicated in the "Forest Measurements for Recreation and Wildlife" lesson plan.

Use the following discussion questions if discussing wildlife in general, rather than related to recreation.

- *What are some of the wildlife habitat elements found in the first site? In the second site?*
- *How do you think the wildlife habitat is different between the two sites?*
- *What types of wildlife do you think could be supported by the wildlife habitat elements found in each plot?*
- *How do you think forest management could help improve the wildlife habitat at either of these sites?*

Direct the discussion to the invertebrate wildlife found in the plot.

- *What is an invertebrate?* (wildlife without a backbone, such as insects, spiders and snails)
- *Why do you think invertebrates are important in the forest?*
- *Many invertebrates are decomposers. What is the role of decomposers?* (break down leaf litter allowing nutrients to return to the soil, food for vertebrates)



WORKSHEET:

WILDLIFE SPECIES AND HABITAT

(Print off two worksheets.)

What animal species are in or near the plot, based either on direct observation or other indirect signs (shelter, scat, tracks, browse or other feeding)?

Evaluate the plot to determine whether it is suitable habitat for the species you identify.

If no evidence of any species is observed, simply identify habitat elements that exist in the plot.

Species identified: _____

Available food: _____

_____

Available water: _____

_____

_____

Available shelter: _____

_____

_____

Available space: _____

_____

_____

Take a look under or around logs or other decaying debris, and try to collect a sample or two of any invertebrates you encounter. What did you find? What is their role in this ecosystem?

List below:

_____

_____

_____

_____

_____

_____

REFERENCE MATERIAL:

WILDLIFE IN THE FOREST

WHAT IS WILDLIFE?

The word **wildlife** is almost a uniquely North American term. Words with a similar meaning are hard to find in other languages, although the scientific roots can probably be traced to managing the game of kings and queens in Europe. Concern about wildlife in America began in the last half of the 1800s due to changes in habitat available. The widespread and uncontrolled logging that occurred with the arrival of Europeans and continued over the course of a century gave rise to the conservation of both wildlife and timber resources.

Numbers of Michigan Wildlife by Taxonomic Group (species)

Birds	306
Fish	146
Mammals	68
Reptiles	30
Amphibians	25
Total Vertebrates	575

The term **game species** refers to an animal that is either hunted or trapped. Michigan lists 115 animals as game species. **Nongame species** are all the other animals. **Endangered or threatened species** are a special group of nongame species whose populations are low in either Michigan, the United States or both.

The Michigan Natural Features Inventory keeps track of all these species and listings in Michigan. An **extinct species** is one that can no longer be found *anywhere* in the world. If a species is not found in one area any more, but is found in other places in the world, then then it is called an **extirpated species**.

WILDLIFE HABITAT

Habitat refers to places where animals can find food, water and the shelter they need to live and reproduce. Over the last 100 years, as the forests grew back in Michigan, researchers and landowners spent a lot of time learning about wildlife and the kinds of habitat they require to survive. The information they learned is used today to re-create or manage habitat. Because habitat management is largely a matter of managing the vegetation to provide food and shelter, forest management is also wildlife management. When foresters, farmers and others change the vegetation, it directly affects wildlife populations. Many times, wildlife biologists and foresters co-manage public and private lands to benefit as many species of wildlife as possible. This is one of the primary reasons why habitat considerations, at both the stand level and landscape level, are important in forest management.

Every species has a minimum **space** requirement to obtain life's necessities. A large predator such as a wolf needs more space to meet its needs than a field mouse. **Home range** is the area within which an animal will feel comfortable, and in some cases, actively defend. The amount of space and the size of a home range of a particular species will vary with the season (winter vs. summer) and sometimes by gender (especially during breeding). Many species use multiple forest and vegetation types within their home range.

Every living thing needs **food and water**. During the course of a year, the availability and quality of food and water can change dramatically. For example, finding liquid water in the winter can be a challenge. Wildlife, not just birds, will often migrate to find food or water during the winter months. Others might hibernate or undergo other metabolic changes. For example, the white-tailed deer undergoes a metabolic change when it produces different sets of digestive enzymes to be sure it can digest the different types of food available.

Wildlife needs **shelter** for a variety of purposes. Shelter can provide protection from the weather or an escape from predators. Shelter is also needed for performing courtship displays, nesting, rearing young, and roosting or loafing. The male woodcock has fairly specific requirements for its dancing grounds and the performance of its sky dance. Frogs may spend the winter buried in pond muck.

Each fall, the young individuals of many species leave their parents and must find their own suitable habitat including space, shelter, food and water.

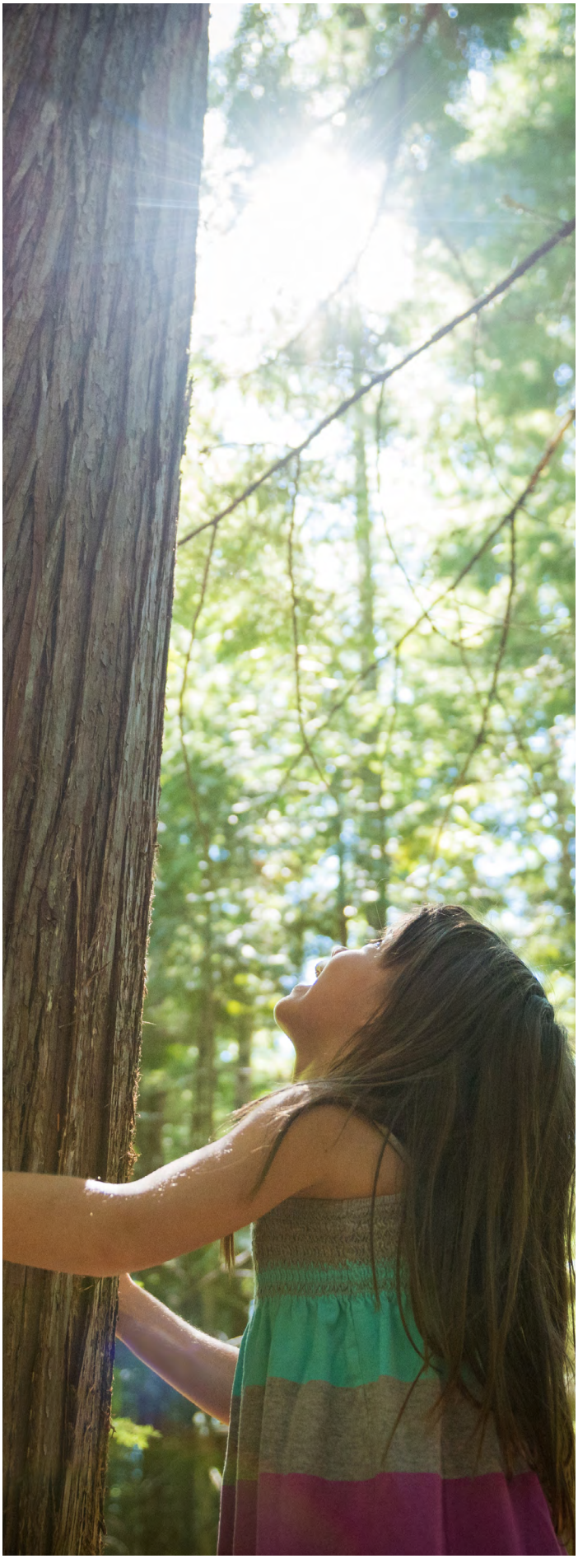
Carrying capacity is the maximum number of individuals of one species the physical and biological resources of an area will support. The carrying capacity varies with the seasons. When most species approach their carrying capacity, mortality (death) rates overtake birthrates and the population declines rather than grows. For some species, this ecological balancing-act is fairly regulated without a lot of growth or decline in population. For other species, a normal boom and bust cycle takes place. Ruffed grouse and snowshoe hare populations are good examples of species exhibiting the boom and bust cycle: both produce numerous offspring, but few survive to adulthood. A few species can maintain high population densities long enough to actually damage their habitat and reduce the carrying capacity. Deer and moose are classic examples of species than can damage their habitat. Humans may very well fall into this category, too.

Producers are organisms (usually plants) that make their own food from basic chemicals generally through the process of photosynthesis.

Consumers are organisms that need to consume other live organisms for food.

Decomposers are organisms that break down dead organisms for food. Decomposers are essential to the food web as they break down the majority of the nutrients so they can used by other organisms in the ecosystem.

"Wildlife in the Forest" is adapted from Cook, William. (2001). *Michigan Forests Forever Teachers Guide*. Michigan State University Extension. (https://mff.forest.mtu.edu/Environment/EcologyWildlife.htm)



REFERENCE MATERIAL:

CREATING HABITAT FOR MICHIGAN WILDLIFE

Much like humans, wildlife have many needs that must be met in order for them to survive. As forest managers, you might be asked to increase the amount of wildlife on a particular property. You can do this by creating the appropriate habitat for the type of wildlife desired by the landowners. Landowners are usually interested in either game species (such as deer and turkeys) or nongame species (such as songbirds, reptiles and amphibians). The decisions that you make about managing a forest may benefit some species, but you must ensure that your actions do not have a major negative impact on others.

When managing a property for specific wildlife goals you must first understand the needs of each wildlife species.

HABITAT NEEDS OF GAME SPECIES

Ruffed grouse (*Bonasa umbellus*)

- The ruffed grouse prefers early successional species (especially aspen).
- They typically thrive when three different age classes of early successional tree species are present.
- Trees from 0 to 5 years are good brood habitat.
- Trees from 6 to 25 years provide cover for nesting, drumming and wintering.
- Trees from 25 to 30 years are a great source of winter food.
- They are benefited by mast-producing (seed-producing) trees and shrubs.
- Ruffed grouse need 10-inch diameter 8-foot-long logs lying on the forest floor for “drumming.” ”Drumming” is used by male grouse to call for mates and establish territory.

Wild turkey (*Meleagris gallopavo*)

- The wild turkey needs 30–50% of its habitat to be mature hardwoods (or mixed hardwoods), required for roosting and nut production. (Wild turkey diet is 90% plants and nuts.)
- They need openings such as grasslands, pastures and idle farm fields where they hunt insects. (The wild turkey diet is 10% insects.)
- They winter in dense stands of conifers.
- Nesting occurs on the ground in forested areas, with nests surrounded by logs, dense bushes or shrubs.
- Turkeys usually remain on the ground until startled when they fly as fast as 50 miles per hour into trees.
- Turkeys roost in different trees each night.

White-tailed deer (*Odocoileus virginianus*)

- Deer need lots of young vegetation, nuts, berries, mushrooms and other foods below 8 feet high so they can reach it.
- Deer get much of the water they need from food; however, creeks, streams and ponds do improve their habitat.
- Deer need cover to bed (sleep), escape predators and survive the winter months. A mix of conifer and hardwood forest types are best.
- Creating lots of edge habitat, where a forest meets an open field, for example, allows for deer to have access to young vegetation and cover.
- Deer are known to eat young trees, thus affecting the regeneration of trees after forest management. A list of trees deer will eat, in the order of preference, follows.

Preferred deer foods

- White cedar
- White pine
- Maples (red and sugar)
- Dogwoods and viburnums
- Sumac

Medium-quality deer foods

- Aspen
- Jack pine
- Oaks (white and black)
- White birch
- Witch hazel

Starvation or low-quality deer foods

- Spruce
- Beech
- Red pine
- Balsam fir
- Tag alder

HABITAT NEEDS OF NONGAME SPECIES

Nongame wildlife species require food, water, space and shelter to live. Providing options for wildlife to meet each of these needs on a property will increase the likelihood the wildlife will at least use, if not live on, the property.

Food

Provide a variety of food options such as nuts, fruits, flowers, grasses and trees.

- Some wildlife will eat these foods directly.
- Some wildlife will rely on the food to attract prey, which can range from grubs and insects to mice and rabbits.

Water

- All animals need water to survive.
- Some wildlife such as frogs and salamanders also need water to breed.
- Fish that live in forested streams rely on the trees to shade the stream to keep the water temperature cooler than if the sun were shining on it all day long.
- Water is also used by some insects for breeding. Insects that hatch from water pollinate flowers and serve as a food source for many types of animals, birds and bats.

Shelter

Provide a variety of options:

- Trees with cavities (or hollowed-out spaces) and snags (standing dead trees)
- For birds that nest in cavities and snags:
  - Leave as many as possible when conducting a timber harvest.
  - Create 1 to 3 snags per acre if none are present naturally.
- Trees and shrubs
- Tall grasses and plants
- Piles of dead branches
- Dead logs on the forest floor (also called downed woody debris)

Space

Every species has a minimum **space** requirement to obtain life's necessities. A large predator such as a wolf needs more space to meet its needs than a field mouse. **Home range** is the area within which an animal will feel comfortable, and in some cases, actively defend. The amount of space and the size of a home range of a particular species will vary with the season (winter vs. summer) and sometimes by gender (especially during breeding). Many species use multiple forest and vegetation types within their home range.

DOWNED WOODY DEBRIS

Downed woody debris refers to large woody material lying on the ground in the form of tree trunks and large limbs on the forest floor. Downed woody debris tends to be more prevalent in mature forests that do not regularly experience fire in the **understory** (beneath the forest canopy). Species that use downed woody debris for habitat include the following:

Snails

- Spike-lip crater

Insects

- Zigzag darner, arrowhead spiketail

Amphibians

- Blue-spotted salamander, spotted salamander, four-toed salamander, western chorus frog, pickerel frog

Reptiles

- Blue racer, northern ring-necked snake, eastern fox snake, eastern hognose snake, smooth green snake, queen snake, eastern massasauga snake, wood turtle, eastern box turtle

Birds

- Ruffed grouse, American woodcock

Mammals

- Pygmy shrew, water shrew, American marten, northern flying squirrel, woodland jumping mouse, southern red-backed vole, woodland vole, southern bog lemming, deer mouse, snowshoe hare

"Creating Habitat for Michigan Wildlife" is adapted from Michigan Department of Natural Resources. (2005). *Michigan's Wildlife Action Plan*, p. 25.

WILDLIFE HABITAT EVALUATION

HOW DOES 4-H INCREASE SCIENCE LITERACY?

Nationally and in Michigan, 4-H has long enjoyed a reputation for engaging young people in positive, experiential (hands-on), and nonformal activities that are inquiry based. The activities in the *4-H Forestry Camp Instructor Guide (4H1754)* can be used to enhance classroom science education. The activities are aligned with the eight Science and Engineering Practices from *A Framework for K-12 Science Education* (National Research Council, 2012, p. 42). The activities in the instructor guide were evaluated for their alignment with the Science and Engineering Practices by MSU Extension Educator Tracy D'Augustino in 2019.

TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants determine the wildlife value of the forest.	1–6
Developing and using models		
Planning and carrying out investigations	Participants discuss components of the wildlife value of the forest, then collect data to evaluate it.	1–6
Analyzing and interpreting data	Participants discuss the data they collect and evaluate how it helps determine the wildlife value of the forest.	Wrap-Up
Using mathematics and computational thinking		
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants use the data collected to discuss and determine the wildlife value of the two forest sites.	Wrap-Up
Obtaining, evaluating, and communicating information		

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

FOREST MEASUREMENTS FOR TIMBER PRODUCTION

(A forester is strongly recommended for this activity.)

WHEN: Anytime

TIME: One hour

If participants are broken into groups, one group can be involved in this activity while the other group is involved with the "Forest Measurements for Wildlife and Recreation" activity. Ideally, each group should include at least four participants.

The "Wildlife Habitat Evaluation" activity is done at the same time as this activity.

AGES: 11–15 years old

OBJECTIVES:

Participants will:

- Explain how forest measurements are obtained and calculated.
- Use a prism to create a representative sample of trees to be measured.
- Use a tree scale stick to measure the diameter of a tree.
- Use a tree scale stick to determine the number of 16-foot logs in a tree.
- Identify the species of tree being measured.
- Use the data to determine the amount of standing timber in the forest.
- Use a canopy cover tube to determine the amount of sunlight reaching the forest floor.
- Use the data collected to make forest management recommendations.

MATERIALS:

- ❏ 4 tree scale sticks (depending on group size) (20 are included in equipment kit)
- ❏ 10 BAF prisms (included in equipment kit)
- ❏ Canopy cover tube (must be constructed, see "Canopy Cover" lesson on page 62)
- ❏ "Timber Plot Tally Sheet" (2 per group) (on page 58)
- ❏ "Canopy Cover Measurements" worksheet (2 per group) (found on page 64 in the "Canopy Cover" lesson)
- ❏ "Measuring Basal Area With a Prism" reference material (on page 60)
- ❏ Pencil (1 per group)
- ❏ Clipboard (1 per group)

BACKGROUND INFORMATION:

Forests can be measured for different values according to the goals of the landowner. In this activity, we will measure the potential timber that can be produced from the trees at the given site. This is referred to as **standing timber** because the tree is still standing.

The board feet of standing timber is calculated by measuring the diameter at breast height (DBH) and the number of 16 foot logs in the tree. Both of these measurements are collected using the tree scale stick. The tree scale stick also has a table that gives the number of board feet for a tree of a given diameter and number of 16-foot logs.

The prism is used to determine which trees are "in" the sample plot. If a tree is deemed "in" the plot, the species, diameter and number of 16-foot logs is measured and recorded on the "Timber Plot Tally Sheet." Each tree that is "in," represents 10 trees per acre in the forest. Specific instructions for using the prism are included in the "Measuring Basal Area With a Prism" reference material.

The canopy cover relates to the amount of sunlight that penetrates the forest canopy and reaches the forest floor. The amount of sunlight determines the growth potential and regeneration of trees in the forest. If very little sunlight reaches the forest floor, there is little space in the canopy for the mature trees to expand their branches, and smaller trees may not grow taller. Regeneration may also be diminished due to the low amount of light available to foster the growth of new seedlings. As the amount of light penetrating the canopy increases, so does the potential for increased growth of all of the trees in the forest.

PROCEDURE:

Ideally, each group will include at least four participants to perform the following roles:

- Denoting which trees are "in" and "out" of the plot using the prism
- For each tree that is "in," identifying the species of the tree as well as measuring the diameter and number of 16-foot logs using the tree scale stick (can have up to four people using a tree scale stick)
- Measuring the amount of sunlight penetrating the canopy using the canopy cover tube
- Recording the data

NOTE: Provide instruction on using all the tools, encourage teamwork among the participants, then step back and observe participants, providing direction as appropriate.

Before the meeting:

1. Find and use ribbon flagging to mark two spots, at least 150 feet apart. Each spot will be the center of a separate plot. If possible, place each plot in a different stand, or forest type, for comparison.

During the meeting:

1. Ask participants to look around them, and ask the following:

   - D*o you think it is a good idea to conduct a timber harvest now? Why? Why not?*
   - *Are there different ways to harvest timber?*
   - *Why are there different ways to harvest timber?*
   - *How might the forest change if a timber harvest is done?*
   - *When we harvest, what species can we expect to regenerate, or grow back, on the site?*

2. If desired, continue asking these additional questions:

   - *What species do you think are the most valuable? Why?*
   - *What product or product do you think the trees will become?*

3. Read aloud or paraphrase the following:

Today you will be collecting data to determine the potential timber value of two forest sites.

4. Instruct participants to hold the prism over the plot center and determine which trees are considered "in."

5. Measure and use the Timber Plot Tally sheet to record the diameter, number of 16-foot logs and species of each "in" tree.

6. Record any standing dead trees that are considered "in."

7. Collect canopy cover measurements at the plot center and at a distance of 66 feet from the plot center in each cardinal direction. Record the measurements on the "Canopy Cover Measurements" worksheet. Record the number of "snags" on the line provided at the bottom of the "Timber Plot Tally Sheet."

8. Read aloud or paraphrase the following:

   It is the responsibility of each participant using the tools to be sure the data recorder has correctly heard the measurements provided. To accomplish this, follow these steps:

   - *Make sure you have the data recorder's attention before providing measurements.*
   - *Speak loudly and clearly.*
   - *Ask the data recorder to repeat back the measurement to you. This will decrease frustration and inaccuracy during data collection.*

9. Move to the next spot and repeat. Be sure to use a new "Timber Plot Tally Sheet" to record the trees in the second plot.

10. After the data is collected, assemble participants to complete the "Timber Plot Tally Sheet." Use the tree scale stick to find the estimated volume of each tree; add up the estimated volumes to find the total. Multiply the volume by 10 to determine the volume per acre for that stand of trees in the forest.

    Add up the number of snags observed. Multiply by 10 to find the number of snags per acre of the forest stand.

11. Use the "Timber Plot Tally Sheet" to determine the number of trees that are more than 24 inches in diameter. Multiply by 10 to find the number of trees that are more than 24 inches per acre for the forest stand. Most trees are considered mature and ready for harvesting when they reach 24 inches in diameter.

12. Repeat these steps to complete the tally sheet for the second plot.

13. Encourage teamwork among the participants. After instruction is given, step back and observe the participants, providing direction as appropriate.

WRAP-UP:

Compare the data collected at each point and briefly discuss the differences.

Incorporate information about the soils present. If possible, include soil data and relate the soil information to the growth potential of the trees. Soil is also related to the species of trees present; if possible, make that connection as well.

Referring to the tree volume and canopy cover data collected, lead participants in a discussion around the following questions:

- *Based on the data collected, do you think it is a good idea to conduct a timber harvest now? Why? Why not?*
- *How do you think the forest will have changed if we choose to harvest in 5 years? 10 years?*
- *When we harvest, what species can we expect to regenerate, or grow back, on the site?*
- *How will the forest change with the type of harvest we recommend?*

Additional discussion points:

- *What is the current market for the species present?*
- *How much money will a timber harvest generate?*
- *What product will the trees become?*

WORKSHEET:

TIMBER PLOT TALLY SHEET
PLOT # _____

After measuring the diameter and (**merchantable***) height of each tree that is deemed "in" the plot, record the volume (in board feet) for each tree from the table on the tree scale stick:

Tree species	Tree diameter	Tree height	Estimated volume

What is the **total estimated volume**? (Add volumes from right column in table.)

_____

Total number of "snags" (standing dead trees): _____

How many trees (across all species) are 24+ inches? _____

What is the total volume of trees 24+ inches? _____

*Merchantable height refers to the length of the usable tree and is measured from a 1-foot stump height to the cutoff (merchantable height) point in the top of the tree. To determine the merchantable height of the tree, estimate the diameter of the upper trunk and use the following as guidelines:

- Pulpwood is measured to a 5-inch diameter.
- Softwood sawlogs are measured to a 7-inch top diameter (minimum 9-inch DBH).
- Hardwood sawlogs are measured to a 9-inch top diameter (minimum 11-inch DBH).
- The cutoff point may also be a fork, or major 'Y' in the tree, above which neither limb is merchantable.

REFERENCE MATERIAL:

MEASURING BASAL AREA WITH A PRISM

Basal area

Basal area is a measure of space taken up by trees growing in a forest. If you cut every tree in the forest off at DBH, and add up the area of the top of each resulting tree stump, you would have the basal area of the forest. It's the area covered by the bases of trees in the forest.

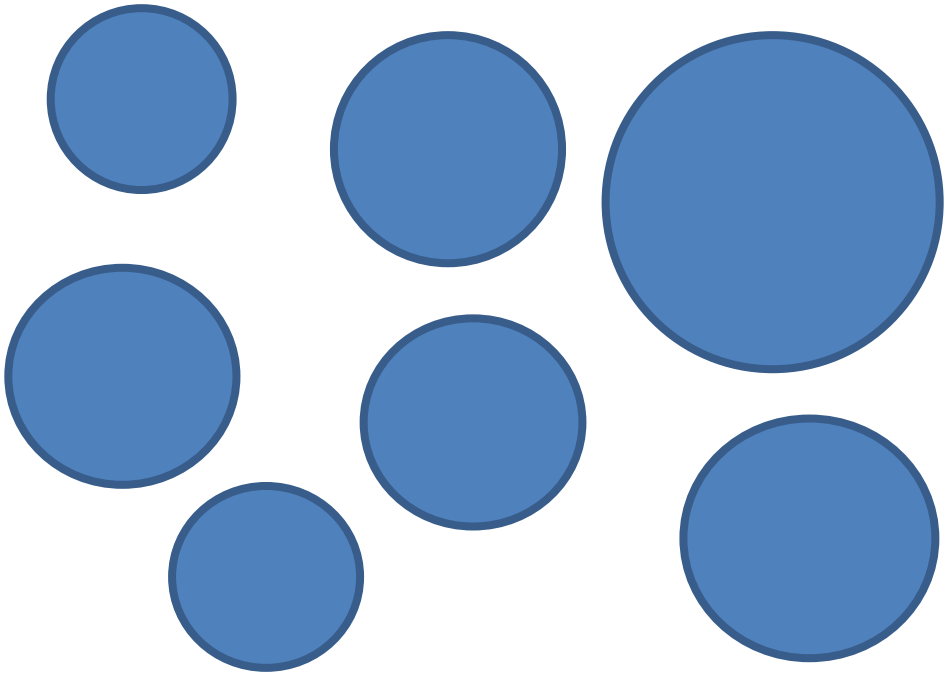
In the United States, we measure basal area in square feet by the acre. Mature stands of trees in Michigan that are fully stocked usually have basal area values between 100 and 200 square feet per acre. Fully stocked describes forest stands in which most of the growing space is occupied but which still have ample room for the development of some trees.

Because we can not cut all of the trees to measure the space taken up by the trunk, we use tools that were developed using complex mathematical calculations. Several tools can help us measure basal area. We will use a tool called a **prism**. We can measure the basal area of several portions of the forest using a prism, and use those measurements to find an average basal area of the forest. This process is called **sampling**, because we use many samples to give us the average.

Each prism has a basal area factor, which means it is calibrated to include trees in a sample that are of representative size of the trees in the greater forest. For example, the prisms included in the equipment kit have a basal area factor of 10, and each tree that is deemed to be "in" the plot by the prism represents 10 square feet of basal area in an acre of that forest.

How to use a prism:

1. Mark a spot on the ground; this is the plot center. Hold the prism over that spot. For accurate use, the prism must remain directly over that spot. Move yourself, not the prism.
2. Arrange yourself so that the prism is at arm's length and at eye level.
3. Look at the trees you are facing and determine if each is "in" or "out" of the plot (see graphic following).
4. As you keep the prism over the plot center, move yourself in a circle around the plot center; continue to view each tree through the prism to determine if each is "in" or "out" of the plot
5. Move slowly enough and communicate clearly to be sure group members can keep track of each tree that is "in." Group members will collect and record measurements from each "in" tree. Be sure to make a mental note of the first tree you measured so that you know where to end.
6. Continue moving around the circle until you return back to the first tree you measure



Cross section of tree trunks from above. The collective area of each cross section of trunk represents "basal area."

FOREST MEASUREMENTS FOR TIMBER PRODUCTION

HOW DOES 4-H INCREASE SCIENCE LITERACY?

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TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants need to determine the potential timber value of the forest.	1–2
Developing and using models		
Planning and carrying out investigations	Participants discuss components of the potential timber value of the forest, then collect data to evaluate it.	1–13
Analyzing and interpreting data	Participants discuss the data they collect and evaluate how it helps determine the potential timber value of the forest.	Wrap-Up
Using mathematics and computational thinking	Participants collect tree size and canopy cover data.	4–9
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants use the data collected to discuss and determine the potential timber value of the two forest sites.	Wrap-Up
Obtaining, evaluating, and communicating information		

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

CANOPY COVER

WHEN: As part of the forest measurements data collection

TIME: 15 minutes (additional 10 to make densiometers)

AGES: 10–15

OBJECTIVES:

Participants will:

- Construct densiometers to use to take measurements of the forest canopy.
- Measure the proportion of the forest floor obscured by vertical forest vegetation.

MATERIALS:

- ❏ Supplies to make densiometers:
  - ❏ Cardboard toilet paper tubes
  - ❏ Dental floss
  - ❏ Scotch tape
  - ❏ Paper clips
- ❏ Compass
- ❏ Clipboards
- ❏ Pencil
- ❏ "Canopy Cover Measurements" worksheet (one copy per participant)

BACKGROUND INFORMATION:

A **densiometer** is an instrument used for taking measurements of **canopy cover**. Canopy cover is an important measurement of how much sunlight breaks through the mature tree canopy and reaches the forest floor to nurture tree regeneration and herbaceous plants that serve as food for wildlife. A professional forester uses a **densiometer** that is made of a concave or convex piece of glass etched with a grid that allows the forester to count the number of squares that are or are not obscured by vegetation. For this exercise, participants will make a cardboard densiometer that will give slightly less accurate but useful data on canopy cover.

When canopy cover is a low percentage (0–39%), foresters refer to it as an **open canopy.** This means a large amount of sunlight reaches the forest floor and many small trees and shrubs can grow to create a dense understory. The small trees are the new growth and the future forest. A dense understory can mean increased food and habitat for wildlife.

Depending on the goals of the property, a forester may recommend cutting trees in a forest with low canopy cover or wait to cut until the existing trees have grown to fill the canopy. The forester may also choose to cut single trees to be sure that selected individual trees can grow healthy and tall. An individual tree may be selected for growth because of its potential to grow into a timber quality tree, to produce a lot of nuts or acorns for wildlife, or because of the color its leaves change to in the fall.

When canopy cover is a moderate percentage (40–69%), there is a small amount of sunlight that reaches the forest floor. Not a lot of trees can grow, resulting in a thin understory. A thin understory can mean that few new trees grow to become the future forest, and there is only a moderate amount of food and habitat for wildlife.

A forester may consider cutting some trees when canopy cover is moderate to allow more sunlight to reach the forest floor. In this case, a single tree selection or gap creation may be the best way to encourage new growth while still allowing the trees around it to continue growing.

When canopy cover is a high percentage (70–100%), foresters refer to it as a **closed canopy.** A closed canopy can result in little to no tree regeneration on the forest floor and insufficient food available for wildlife.

A closed canopy usually means it is time to conduct some sort of forest management, especially if the tree species that the landowner wants to grow to meet his or her objectives on the site requires full sun.

Photo by Julie Crick, Michigan State University Extension

A properly assembled canopy cover tube.

PROCEDURE:

Before the meeting:

1. Gather the materials you will need for the lesson.

During the meeting:

1. Ask participants the following questions:
    - *What is canopy cover?* (The amount of sunlight that reaches the forest floor)
    - *Why is this data important?* (Plants need sunlight to grow.)
    - *What inferences can be made based on the amount of canopy cover?* (The more sunlight the greater the variety of plants and wildlife dependent upon the plants for food and shelter. More sunlight means more regeneration of trees.)
2. Read aloud or paraphrase the following.

Each of you will make a densiometer, an instrument used to measure how much sky is blocked out by plant and tree cover.

3. Hand out the materials needed to make the densiometers as well as the other supplies.
4. Give the following directions for making the densiometer and demonstrate as you do so:
    - Cut off two pieces of dental floss, each about 2.5 inches in length.
    - Tape one piece of dental floss across the middle of the cardboard tube.
    - Tape the second piece of floss across the middle of the tube, perpendicular to the first, so that the intersection of the two pieces of floss creates four right angles.
    - Hang the paper clip from the intersection of the two pieces of floss, taking care to be sure it hangs from both pieces of floss.
    - Test it out by holding it vertically above your head, looking through it to be sure the paperclip is hanging straight down from the intersection of the floss.
5. Walk around and assist participants, making sure everyone has a functioning densiometer.
6. Read aloud or paraphrase the following:

    You will collect data with this instrument at each of five points on each forest measurement plot. One measurement will be taken from the center of the plot; one measurement should also be taken 66 feet from the center of the plot in each cardinal direction (north, south, east and west). A compass may be used to ensure measurements are taken in each cardinal direction.

7. Demonstrate how to use the densiometer by reading aloud or paraphrasing the following:

    First, look up through the densiometer, making sure it is vertical. The paperclip should be directly below the intersection of the crosshairs at the top of the tube.

8. Make sure that each participant is holding the densiometer correctly. Continue to read aloud or paraphrase the following:

    You will notice the tube is divided into four sections. Count the number of sections in which vegetation, twigs or branches cover more than half of the section. Multiply the number of sections counted by 25. This will give you a percent of canopy cover for that point. (For example, if vegetation, twigs or branches cover more than half of three sections, the number recorded would be 75 percent [3 sections x 25 = 75%].)

9. Have each participant record the percent of canopy cover for each point location (center, north, east, south and west) on the "Canopy Cover Measurements" worksheets.

WRAP-UP:

Lead participants in a discussion around the following questions:

- *What was the canopy cover of the site?*
- *What does the data imply about the variety of plants and wildlife on the site?*
- *What does your data tell you about the regenerative ability of your site?*

WORKSHEET:

CANOPY COVER MEASUREMENTS

Group Name:_____

Plot No. _____

Point Location	Center	North	East	South	West
Percent Cover					

Plot No. _____

Point Location	Center	North	East	South	West
Percent Cover					

Plot No. _____

Point Location	Center	North	East	South	West
Percent Cover					

Plot No. _____

Point Location	Center	North	East	South	West
Percent Cover					

Plot No. _____

Point Location	Center	North	East	South	West
Percent Cover					

ALIGNMENT TO SCIENCE AND ENGINEERING PRACTICES:

CANOPY COVER

HOW DOES 4-H INCREASE SCIENCE LITERACY?

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TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants determine the canopy cover of the forest sites.	1–9
Developing and using models	Participants make a model densiometer.	2–5
Planning and carrying out investigations	Participants carry out the data collection.	6–9
Analyzing and interpreting data		
Using mathematics and computational thinking	Participants determine the percent of canopy cover.	8
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants explain how they used the data they collected to determine the canopy cover of the site.	Wrap-Up
Obtaining, evaluating, and communicating information		

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

RELATING SOILS TO THE FOREST

(This is an optional lesson plan, and the level to which it is included, if at all, depends on the level of comfort of the forester or host with soil science.)

WHEN: During field data collection in conjunction with the "Forest Measurements for Timber Production" lesson plan, or as a standalone activity

TIME: 10 minutes to an hour, depending on the activities performed

AGES: 11–15

OBJECTIVES:

Listed in order of simple to more complex

Participants will:

- Explain that soil is made up of three different particles.
- Explain that the ratio of the particles in the soil determines the soil type.
- Determine the type of soil found in the forest; the forester will relate it to the trees present.
- Use a soil test kit to determine the level of primary macronutrients and pH of the soil in the forest (additional kit required).
- Explain the importance of primary macronutrients and pH to tree health.

MATERIALS:

- ❏ "Soil Texture" handout (two per group to share) (in the equipment kit)
- ❏ Soil core sampler (for illustrating soil profile, or layers; sampler is included in the equipment kit)
- ❏ "Soil Nutrients and pH" handout (two per group to share) (in the equipment kit)
- ❏ Jar with a lid (for soil texture analysis)
- ❏ Basic soil testing kit (not included in equipment kit, available at local stores for a reasonable cost)
- ❏ Clipboard (one per group)
- ❏ Pencil (one per group)

BACKGROUND INFORMATION:

Refer to the "Soil Texture" handout in the equipment kit.

- Soils are the foundation of the forest because their texture as well as the moisture and nutrient content determine the variety of trees that can thrive in a given soil type.
- The United States Department of Agriculture has mapped the soils for the entire United States, including a list of suitable tree species for each soil type. The soils and associated trees for any piece of land can be viewed using the "Web Soil Survey" website (type in "web soil survey" to any browser to find the site).
- Soils are made up of different-sized particles; the percentages of each particle in a soil determine its "type." The soil triangle illustrates the soil types according to the percentages of each particle present. The soil texture analysis, as described in the handout, is one way to find the percentages of particles in a soil to determine its type.
- The soil core sampler is available in the equipment kit to illustrate the different soil horizons (layers). Estimate the texture of each layer and discuss its relation to the species of trees growing on each site.

Refer to the "Soil Nutrients and pH" handout in the equipment kit.

- The mineral nutrients found in soil are divided into two groups: macronutrients and micronutrients.
- Trees use large amounts of macronutrients, sometimes depleting them from the soil. Micronutrients are only needed in small amounts and are usually found in sufficient amounts.
- A simple soil test kit, available at any hardware store, will measure the level of nitrogen, phosphorous and potassium, which are macronutrients. The same kit will also measure soil pH.
- The pH of the soil can affect the availability of both micronutrients and macronutrients by changing the form of the nutrient in the soil. Under highly basic or acidic conditions, nutrients will react, or bond together, to form less soluble compounds that make the nutrient absorption by the tree more difficult.
- The "Plant Nutrient Availability Chart" on the "Soil Nutrients and pH" handout illustrates that when a soil is acidic (pH 4.5), some nutrients are readily available to plants while other nutrients are less available.

PROCEDURE:

Before the meeting:

1. Read through the handouts and decide which activities to include in the camp curriculum. Consult with the forester, if possible, to seek input.

   Optional: Create a map of the soils for the camp location using the "Web Soil Survey" website. The forester or local natural resource professional can help with this.

   Optional: Purchase a basic soil test kit.

During the meeting:

1. Ask participants:
    - *Where do you think the soil in the forest came from?* (glaciers initially with slow changes from weather processes and the activity of decomposers)
    - *How do you think soil impacts the forest?* (Water retention, nutrients, pH)

During the meeting – soil texture

1. Soil texture may be estimated using the instructions under "Soil Texture Analysis" on the "Soil Texture" handout. The estimated percentage of sand, silt and clay that settle out in the jar can be applied to the soil texture triangle to determine the type of soil.
2. Another way to estimate soil texture is to follow the instructions below. Read aloud or paraphrase the following*:*

    - *Gather 2 to 3 tablespoons of soil. Remove any rocks or plant debris.*
    - *Dampen the soil using small amounts of water until it is wet, not mud.*
    - *Roll the soil into a ball.*
    - *Does it remain in a ball? If not, then the soil has a high content of sand.*
    - *If it does, press a small amount through your thumb and forefinger to make a ribbon.*
    - *Does it make a ribbon? If not, then it is a sandy soil that contains loam (decomposed plant matter).*
    - *If it does make a ribbon, then the soil contains clay. The longer the ribbon, the higher the clay content.*

The importance of soil texture to tree growth is described in the "Soil Nutrients and pH" that is in the equipment kit.

During the meeting – soil nutrients and pH

1. If a basic soil test kit is purchased, soil nutrients and pH can be quantitatively measured. Instruct participants to follow the directions on the kit and record their results on the handout. If possible, compare the soil nutrients in two different forest types and discuss the differences with the forester.

WRAP-UP:

Discuss and compare results from activities performed.

Ask participants the following questions related to the soil texture information collected:

- *Compare the three basic needs of trees (sunlight, water, nutrients or space) to the soil texture identified.*
- *Do you think the type of soil found here allows the trees to get enough water? Too much water?*

Point out that soils that are higher in sand do not hold water and dry out faster than soils with high clay content. Soils with a high clay content can create pooling of water, which can drown some types of trees.

- *Do you think this type of soil provides a lot of nutrients to the trees? Not enough?*

Sandy soils also tend to have less nutrients available than clay or loamy soils. As the amounts of clay or loam increase, so does the nutrient content.

- *Do you think we can do anything at this site to change the soil present?*

The answer for a forest setting is no. We have to work with the soil on a site, and adjust the species or number of trees accordingly. If we asked the same question about a yard, the answer could be yes, if we choose to invest the time, money or both into depositing new soil or adding fertilizer or mulch to the present soil.

- *Do the two different forest types have the same type of soil? Why do you think that is the case?*

The two forest types may or may not have the same soil type. In most of northern Michigan, the soils were deposited by glaciers that covered the area around 15,000 years ago. This means that one area may have a few different soil types according to how the glacier moved through.

Ask participants the following questions related to the soil nutrients and pH information collected:

- *Is the soil lacking any of the three key nutrients?*
- *At this pH, do you think the tree will have good access to the nutrients it needs to grow?*
- *Do you think we can do anything about the pH of the soil?*

The answer in a forest setting is no. Just as with soil texture, we have to work with the pH of the soil on a site, and adjust the species or number of trees accordingly. Farmers have some ability to change the soil pH, and it requires repeated applications to the field over time. An application to change the forest soil could occur just after the trees are cut down, but repeated applications would be very difficult after the trees begin to grow back.

ALIGNMENT TO SCIENCE AND ENGINEERING PRACTICES:

RELATING SOILS TO THE FOREST

HOW DOES 4-H INCREASE SCIENCE LITERACY?

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TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants discuss the impact soil has on the forest.	During the Meeting 1
Developing and using models		
Planning and carrying out investigations	Participants collect data about the soil in the forest.	During the Meeting – Soil Texture 2
Analyzing and interpreting data	Participants discuss the data they collected.	Wrap-Up
Using mathematics and computational thinking		
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants use the data they collected to identify the soil type in the forest and explain the impact that soil has on the forest.	Wrap-Up
Obtaining, evaluating, and communicating information		

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

EXPLORING FORESTRY PRODUCTS

WHEN: Before "Exploring Forestry Careers" lesson plan

TIME: 10 to 20 minutes

AGES: 10–15

OBJECTIVES:

Participants will:

- Identify various products that come from the forest (including Michigan forests).
- Explain the relevance of forestry products to their own lives.

MATERIALS:

- ❑ A large table or surface to display sample products
- ❑ A large assortment of sample products (or photos of products) supplied by forestry. It might include pencils, furniture, paper, fruit, nuts, maple syrup, cellulose insulation, nail polish, hairspray, parmesan cheese, football helmets, golf balls, baseball bats, tires and wood pellets. Photos of the following can demonstrate the importance of trees to our quality of life: state and national parks, people hiking, houses and buildings, Christmas trees, clean water and clean air. (You can find a list of Michigan wood products in the *Michigan Forests Forever Teachers Guide* at https://mff.forest.mtu.edu/Products/ProductsMI.htm.)
- ❑ Wood disks, tokens or poker chips (Each participant should have as many tokens as there are sample products on display.)
- ❑ Small paper bags or containers (one for each sample forest product)
- ❑ Paper or poster board

BACKGROUND INFORMATION:

Trees are used in many ways to make many different types of products. For some products, such as lumber, the connection to trees is obvious. For others, such as nail polish, the connection is not so easily made. Throughout time, people have used nearly each part of a tree to provide or treat something; modern science has only expanded that list, allowing us to use every part of the tree for products useful to society. The trunk of the tree provides lumber and paper. The bark, resins, cellulose, scraps and even sawdust provide products that range from camera cases to medicines and rugs.

The focus of this activity is to introduce participants to a sampling of the products we use every day to showcase the importance of forest products to our daily lives.

Background on Michigan's forests

Michigan's state forests are sustainably harvested, which means that when trees are cut, a forest management plan is always in place to be sure trees grow back on that land. In fact, the volume of wood that is added to Michigan's forests each year is more than twice the volume of wood that is cut from the forests, ensuring that our forests will last long into the future while still supporting our needs and the forest products industry.

In Michigan, the forest industry is a $21 billion dollar industry that provides more than 99,000 jobs (Leefers, 2017). Some facts about Michigan forests and the products they help create follow:

- There are 14 billion trees in Michigan (Pugh, 2015).
- The state has 20 million acres of forest, covering about 53 percent of the state. That's an increase of a million acres since 1980 (Cook, 2011, Michigan Forest Descriptors: https://mff.forest.mtu.edu/TreeBasics/TreeBasics.htm).
- If all the timber standing in Michigan's forests were laid in adjacent cord piles (which are 4 foot high by 4 foot wide by 8 foot long), it would stretch over 250,000 miles – roughly the distance to the moon! (Cook, 2011, Forest Facts: https://mff.forest.mtu.edu/Facts.htm)
- Each person uses 4.5 pounds of wood and paper products every day; annually, that's equivalent to one 18-inch diameter, 100-foot tall tree.
- A 2,000-square-foot home can contain 16,900 board feet of lumber and up to 10,000 square feet of panel products. That is as much wood as would be in a 3- to 7-acre Michigan forest (Cook, 2011, Forest Facts: https://mff.forest.mtu.edu/Facts.htm).
- The most likely serious threats to Michigan forests are the loss of the forest industry, invasive species, intense browsing by deer and forest ownership **parcelization** (subdividing tracts into smaller and smaller ownerships) (Cook, 2011, Forest Facts: https://mff.forest.mtu.edu/Facts.htm).

PROCEDURE:

Before the meeting:

1. Before participants arrive, set up a table featuring a variety of products (or photos of products) derived from forestry. (See sample list under "Materials.")
2. Place an open small paper bag or container beside each item. (These will be used to collect tokens.)

During the meeting:

1. Read aloud or paraphrase the following:

We are going to take a survey to find the answer to this question: How important are trees and their management to our daily lives? Please hold up your fingers to vote using this method:

- *One finger means "not very important at all."*
- *Two fingers mean "sort of important."*
- *Three fingers mean "really important."*

2. After all have voted, ask a few participants to explain their rating. Discuss: *Why do you think trees and their management are "not very," "sort of" or "really important" to our daily lives?*
3. Give each participant a handful of wood disks or tokens.
4. Ask participants to approach the table and place a wood token in the bag or container beside every item they use that affects their lives regularly.
5. Assign teams of participants to count the tokens and tally the results on paper or poster boards listing the products.
6. Have teams present the data on their sample products. Presentations and discussions should bring up the following questions: *Are any of the products used by every single participant? What percentage of the products shown are used by every participant?*

WRAP-UP:

Discuss: *Who makes possible all the sample products on the table? Who brings the forest to life for us?* (a variety of careers: foresters, loggers, industry professionals)

REFERENCES:

Cook, W. (2001). *Michigan forests forever teachers guide*. East Lansing: Michigan State University Extension.

Leefers, L. A. (2017, December*). Statewide report: Forest products industries' economic contributions to Michigan's economy – 2019 update.* Lansing: Michigan Department of Natural Resources.

Pugh, S. A. (2015). *Forests of Michigan, 2014.* (Resource Update FS-35.) Newtown Square: PA. U.S. Department of Agriculture, Forest Service, Northern Research Station. https://www.fs.fed.us/nrs/pubs/ru/ru_fs35.pdf

RESOURCES:

Hughes, A. J. (2016, February 12). Diverse trees, diverse products support Michigan's forest industry. *Second Wave Upper Peninsula*: http://www.secondwavemedia.com/upper-peninsula/features/dnrdiversetrees21216.aspx

Rawlings, C. (2012, March 20). 24 ways forestry improves our lives. *Forest Business Network.* https://www.forestbusinessnetwork.com/15198/24-ways-forestry-improves-our-lives/

EXPLORING FORESTRY PRODUCTS

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Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems	Participants explore the importance of trees in relationship to products we use.	1–2
Developing and using models		
Planning and carrying out investigations	Students collect data on the products they use in their daily lives.	3–5
Analyzing and interpreting data	Participants discuss the data they collected.	6
Using mathematics and computational thinking	Participants calculate percentages of products used and by what percent of the population.	5–6
Constructing explanations and designing solutions		
Engaging in argument from evidence	Participants determine the value of trees and explain their determination using the data they collected and analyzed.	6
Obtaining, evaluating, and communicating information	Participants discuss the value of forests including both products and careers.	Wrap-Up

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

LESSON PLAN:

EXPLORING FORESTRY CAREERS

WHEN: Any time a speaker talks about their career related to forestry

TIME: 10 to 15 minutes

AGES: 11–15

OBJECTIVES:

Participants will:

- Identify careers in forestry.
- Describe the primary responsibility of at least one career in forestry.

MATERIALS:

- ❏ Index cards
- ❏ Writing utensils (one per participant)

BACKGROUND INFORMATION:

One of the purposes of this camp is to introduce participants to forest-related career possibilities, especially those that may be available in their local area. Michigan's forestry industry supports more than 99,000 jobs in the state (Leefers, 2017). Many are skilled trades that support harvesting, processing or manufacturing sections.

Some facts related to jobs in Michigan's forestry sector follow:

- In Michigan, there are over 800 logging and trucking firms working in the forest products industry.
- There are over 300 **primary manufacturers** of forest products, producing lumber, veneer, paper and engineered boards (oriented strand or particle boards).
- There are over 1,000 **secondary manufacturers** or companies that use products made by primary manufacturers to produce finished products. An example is a cabinet maker (secondary manufacturer) that uses lumber from a sawmill (primary manufacturer).

(Michigan Department of Natural Resources, 2019)

If possible, try to provide moments for participants to interact with professionals working in the Michigan forestry sector.

PROCEDURE:

This is a suggested lesson plan intended to fully engage participants with speakers sharing their forest-related career journeys. The plan may be followed as written or adjusted accordingly depending on the situation and participants.

Before the meeting:

1. Invite a variety of people who work in the forestry field to your camp.

   Optional: If there is time, you might ask participants what they would like to know about a guest speaker's career before they come to camp.
2. Write the sample questions that appear below on index cards.

Sample questions

- How did you discover this job or career?
- What kind of education is needed for your career?
- What does a typical day look like for you? (hours, setting, who you interact with)
- What is the best part of your job?
- What challenges did you have on your career path?
- How long did it take to get where you wanted to be?
- What is the next step for you? Where do you see yourself in 5 years?
- What is your motivation?
- In your opinion, what skills does a person need to be successful in your career?
- What advice do you have for someone interested in forestry as a career path?

During the meeting:

1. Hand out the index cards to participants who want to participate by asking questions.
2. After the speaker has introduced himself or herself, have the participants with the index cards read the questions to the speaker and allow the speaker to answer.
3. Allow others to ask further questions if time allows.

WRAP-UP:

Have each participant write on an index card the most interesting thing about the career covered, or have them draw a picture of the person at work.

REFERENCE:

Leefers, L. A. (2017, December). *Statewide report: Forest products industries' economic contributions to Michigan's economy – 2019 update.* Lansing: Michigan Department of Natural Resources

Michigan Department of Natural Resources. (2019). *Forest products industry.* https://www.michigan.gov/dnr/0,4570,7-350-79136_79237_80943---,00.html

LESSON PLAN:

FINAL PRESENTATION

WHEN: After data collection is complete, before or after any field trips

TIME: Up to 1 hour to prepare, 5 minutes per group to present

AGES: 11–15

OBJECTIVES:

Participants will:

- Create a 5-minute group presentation highlighting something they enjoyed or learned during the camp experience.
- Each deliver a portion of the presentation.
- Use the dry erase board to create a visual component to the presentation.
- Use props, if available, to enhance the presentation.

MATERIALS:

- ❏ Dry erase board (included in the equipment kit)
- ❏ Dry erase markers (included in the equipment kit) Do not use permanent markers.
- ❏ Scrap paper for each group's participants to scratch out ideas
- ❏ Props for each group

BACKGROUND INFORMATION:

Research shows that when youth prepare and deliver a presentation or demonstration, they gain leadership skills. More specifically, youth are more confident and knowledgeable in the subject matter, and reported increased ability in communicating, setting goals and working as part of a team (Silliman, 2009).

The presentation or demonstration can be about anything that reflects upon an experience at camp and is appropriate. For example, a group may wish to demonstrate how forest measurements for recreation and wildlife are collected, including proper use of the tools. Or, a group may wish to celebrate the moment they found the largest tree in the area, and the history of the area that allowed the tree to remain. Because each group will focus on a single stand of trees, encourage the groups to provide a general overview of the forest stand in which they worked in addition to the chosen focus of the presentation.

Whatever the content, the group should be in control of the creation and delivery of the presentation or demonstration.

PROCEDURE:

Before the meeting:

1. Prepare participants for the presentation at the beginning of camp and again after the groups are formed. Soft reminders of the upcoming presentation throughout the camp experience will increase creativity and ease tension for participants afraid to speak to a group.
2. Choose a location that allows each group space to discuss the presentation content as well as a table or surface on which to place the whiteboard.

During the meeting:

1. Provide each group an assortment of dry erase markers.
2. Instruct groups to create speaking parts for each participant as well as a visual using the whiteboard.
3. Provide guidance and assistance as necessary.
4. Encourage groups to practice their presentation at least once prior to delivery.
5. After the given creation time, assemble all of the camp participants to listen to the presentations. You may choose the last moments of camp and invite parents to listen to the presentations. Be sure evaluations are completed prior to the presentations to ensure completion.
6. If necessary, coax the group participants to provide more information. Ask questions to aid participants who may be uncomfortable or struggling.
7. Document the presentations by taking a picture of the white board, the group or both as they are presenting. You might want to capture the presentation on video. Make sure you have photo permissions.

WRAP-UP:

Congratulate groups upon the completion of their presentation.

Further discuss any points that may need clarification.

Finish by passing out certificates of completion for the camp.

REFERENCE:

Silliman, B. (2009). Youth views of experiences and benefits of public speaking. *Journal of Youth Development, 4*(2), 85-94. ISSN: 2325-4009. https://jyd.pitt.edu/ojs/jyd/article/view/266

FINAL PRESENTATION

HOW DOES 4-H INCREASE SCIENCE LITERACY?

Nationally and in Michigan, 4-H has long enjoyed a reputation for engaging young people in positive, experiential (hands-on), and nonformal activities that are inquiry based. The activities in the *4-H Forestry Camp Instructor Guide (4H1754)* can be used to enhance classroom science education. The activities are aligned with the eight Science and Engineering Practices from *A Framework for K-12 Science Education* (National Research Council, 2012, p. 42). The activities in the instructor guide were evaluated for their alignment with the Science and Engineering Practices by MSU Extension Educator Tracy D'Augustino in 2019.

TABLE: HOW THIS LESSON ALIGNS WITH THE SCIENCE AND ENGINEERING PRACTICES (NATIONAL RESEARCH COUNCIL, 2012, P. 42)

Science & Engineering Practice	Action	Activity Step
Asking questions and defining problems		
Developing and using models		
Planning and carrying out investigations		
Analyzing and interpreting data		
Using mathematics and computational thinking		
Constructing explanations and designing solutions		
Engaging in argument from evidence		
Obtaining, evaluating, and communicating information	Throughout the program participants explore many questions and problems connected to the forest. They consider and select a main idea for their presentations, then determine relevant information or data to include and make their presentations.	1–5

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

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Cook, W. (2001). *Michigan forests forever teachers guide*. East Lansing: Michigan State University Extension. https://mff.forest.mtu.edu/Default.htm

Leefers, L. A. (2017, December). *Statewide report: Forest products industries' economic contributions to Michigan's economy -2019 update*. Lansing: Michigan Department of Natural Resources.

Michigan Department of Natural Resources. (2005). *Michigan's wildlife action plan.* p. 25.

Michigan Department of Natural Resources. (2019). *Forest products industry.* https://www.michigan.gov/dnr/0,4570,7-350-79136_79237_80943---,00.html

National Audubon Society. (2017, February 6). Why some birds' names have changed. *Audubon*. https://www.audubon.org/news/why-some-birds-names-have-changed

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press. https://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts

Oregon State University. (2019). *The memory process, in four fantastic nutshells.* Corvallis: Academic Success Center.

Pugh, S. A. (2015). *Forests of Michigan, 2014.* (Resource Update FS-35.) Newtown Square: PA. U.S. Department of Agriculture, Forest Service, Northern Research Station. https://www.fs.fed.us/nrs/pubs/ru/ru_fs35.pdf

Silliman, B. (2009). Youth views of experiences and benefits of public speaking. *Journal of Youth Development, 4*(2), 85-94. ISSN: 2325-4009. https://jyd.pitt.edu/ojs/jyd/article/view/266

RESOURCES

EXPLORING FORESTRY PRODUCTS LESSON

Michigan wood products. *Michigan Forests Forever Teachers Guide* by Bill Cook, Michigan State University Extension. https://mff.forest.mtu.edu/Products/ProductsMI.htm

FOREST HEALTH LESSON

Forest Health Highlights Report. Michigan Department of Natural Resources. (Click on the report.) https://www.michigan.gov/dnr/0,4570,7-350-79136_79237_81077---,00.html

Forest Health Issues. *Michigan Forests Forever Teachers Guide* by Bill Cook, Michigan State University Extension: https://mff.forest.mtu.edu/Environment/ForestHealth.htm

TREE IDENTIFICATION LESSON

Forest Basics: Tree Identification. *Michigan Forests Forever Teachers Guide* by Bill Cook, Michigan State University Extension: http://uptreeid.com/

Forests of Michigan, *2014.* USDA: https://www.fs.fed.us/nrs/pubs/ru/ru_fs35.pdf

How a Tree Grows. Michigan Department of Conservation (now the DNR). Presented by Michigan Department of Natural Resources, Project Wild: https://www.michigan.gov/dnr/0,4570,7-350-79135_79220_81129-427770--,00.html, http://www.michigan.gov/documents/dnr/HowATreeGrows_382468_7.pdf

Keys to Michigan Trees and Keys to Michigan Trees 2. Presented by the Michigan Department of Natural Resources, Project Wild:

https://www.michigan.gov/dnr/0,4570,7-350-79135_79220_81129-427770--,00.html

https://www.michigan.gov/documents/dnr/KeytoMITrees_382471_7.pdf

https://www.michigan.gov/documents/dnr/KeytoMITrees2_382470_7.pdf

Tree Identification Characteristics or What Am I Supposed to Look at? *Michigan Forests Forever Teachers Guide* by Bill Cook, Michigan State University Extension: https://mff.forest.mtu.edu/TreeBasics/TreeIDchars.htm

WILDLIFE HABITAT EVALUATION LESSON

Endangered species: Michigan federally listed threatened, endangered, proposed, and candidate species. U.S. Fish & Wildlife Service (2018, October 10). https://www.fws.gov/midwest/endangered/lists/michigan-spp.html

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