

The 4-H Science Toolkit Series

Bringing hands-on science education to kids everywhere

The 4-H Science Toolkit Series helps educators show children the fascinating, captivating world of science by providing hands-on activities that can be done simply and inexpensively.

From after school programs to classrooms to special events or 4-H clubs, these activities can be used by anyone who works with children. No special background in science is required and preparation time and supplies are minimal.

But the experiences children will have — from learning about the varieties of ladybugs that live in their backyard, creating a machine to measure wind speed or discovering how to identify constellations in our night sky — can awaken children's curiosity about the wonders of our world and influence their interests in science.

A host of studies, including a 2009 report, "Learning Science in Informal Environments: People, Places, and Pursuits" by the National Research Council, show that there is "mounting evidence that structured, non-school science programs can feed or stimulate the science-specific interests of adults and children, may positively influence academic achievement for students and may expand participants' sense of future science career options."

These Toolkits are one piece of the National 4-H Science, Engineering and Technology (SET) initiative. Recognizing that U.S. youth are falling behind in science and technology, 4-H youth development staff are combining the Cooperative Extension system's well-established outreach system with the cutting-edge research and resources of the nation's land grant universities to bolster science, engineering and technology skills in youth throughout the country using initiatives such as the Toolkits Series.

In New York, these efforts are supported by the New York State 4-H Foundation, a private, not-for-profit corporation focused upon building quality 4-H youth development programs.

The units in this Toolkits Series include:

- **Entomology.** Students will learn about the lives and behaviors of beetles, spiders and bees and ways to measure the health of the environment by observing insects.
- **Astronomy.** Kids will gain an understanding of the sun, stars, moon and planets, while they learn how ancient people used the sky to tell time, chart the seasons and tell stories.
- **Animal Science.** Children will experiment to learn why animals act the way they do, what food and conditions animals need to survive and how humans impact animals.
- **Flight.** Children will build kites, parachutes, boomerangs and flying saucers while they experiment to learn how scientists and engineers keep things in the air.
- **Geospatial Science.** Students will use geographic information systems to find their way around a trail, map features in their community and even uncover treasure.
- **Lost Ladybug Project.** Students will take part in a national survey to help scientists discover the health of our ladybug population.
 - **Climate.** Students will create indoor thunderstorms and rainstorms, learn why snow-fall amounts differ and understand how climate changes affect organisms.

The lessons in this unit were developed by and are connected to departments at Cornell University and offices of Cornell Cooperative Extension throughout New York State. To find out more about resources available through New York State 4-H, check out the NYS 4-H Resource Directory at www.cerp.cornell.edu/4h.

4-H Youth Development is the youth program of Cornell Cooperative Extension



Animal Science

About the 4-H Science Toolkit Series: Animal Science

This series of activities will help children discover a variety of interesting facts about animals and learn of the characteristics we have in common, as well as the ways we are different.

In these six activities, students will use the scientific method to:

During all of these hands-on activities, students will predict what will happen, test their theories, then share their results. They'll be introduced to animal science vocabulary, gain an understanding of animals and our role in caring for domestic animals and discover fascinating facts about how animals and humans are alike.

The lessons in this unit were developed in cooperation with the Cornell University Department of Animal Science.

To find out more about animal science activities, visit the Department of Animal Science Web site at www.ansci.cornell.edu/4H/index.html and to find numerous resources related to animal science, check out the 4-H Resource Directory at www.cerp.cornell.edu/4h.

Animal Science Table of Contents

- So You Think You are Hot?** Explore animal body temperatures and ways animals regulate their temperature.
- Got Immunity?** Learn how animals protect themselves from disease and illness.
- Basic Behavior Instincts:** Learn to read behavioral signals from animals and discover why they behave the way they do in the wild.
- Respiration:** Discover the basic parts of the respiratory system in animals and in humans and learn about respiration rates for different animals.
- Animal Sense-Stations:** Experiment with various activities to help increase understanding about how animals use their senses to survive.
- People Pellets:** Examine animal foods to find out what nutrients are important for animal health and human health.

Animal Science: So You Think You Are Hot?

Activity Series:

Animal Science

Grade: 3-6

Time: 45 min.

Main Idea

Animals respond to changes in their environment.

Motivator

Does every person have the same temperature? What can we do to find out? Do animals have different temperatures than humans?

Pre-Activity Questions

Before you start the activity, ask students:

- Who has ever been asked “do you have a temperature?” What are you really being asked?
- What tool do we use to measure temperature?
- Is your body temperature much higher when you have a fever?
- What is it called when your temperature is too low?
- What is it called when your temperature is too high, but you are not sick?
- What behaviors do mother hens use to keep their young warm? Why do they need to be kept warm?

Activity One

- Forehead thermometer for each participant OR a digital thermometer with protective sleeve OR ear scan thermometer with disposable covers
- Paper and pencil for each participant
- Large poster size paper to record data
- Chart “Staying at right temperature” for each student (included here on last page)

Part 1: Temperature Taking

1. Have the participants work in pairs so that they can read and record each other’s temperature.
2. Distribute the forehead or digital thermometers and explain how to use them OR have everyone prepare their record sheets as you walk to each participant to use the ear scan thermometer to take a reading.

Discussion:

- Who had the highest temperature and who had the lowest? There is a small range of “normal” temperature.
- Record everyone’s data.
- Calculate the average temperature. (Optional: Calculate the mean and mode.)
- Discuss a “fever” and how numerically a fever is not that much higher than “normal.” Tenths of a degree have a large effect.

Supplies

Objectives

- Identify the parameters of body temperature
- Extend understanding of self and animal care

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

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Animal Science: So You Think You Are Hot?

Extended discussion:

Now the discussion will center around maintaining a body temperature since everyone has a range for good health.

- How do animals maintain their body temperature? Most people dress in clothes appropriate to the season (less in summer and more in winter), drink cold water, have hot soup, go swimming, soak in a hot bath, eat more, eat less, sit by a fire or sweat to help maintain their body temperature.
- What do animals do to keep from losing body heat or to keep from getting too hot? (Most animals grow a winter coat and then shed it in the spring.) Do most animals sweat?
- How are we the same or different?
- Use the chart to list ways animals can be protected from temperature extremes.

Now that you have this information, what do you know about caring for an animal in very hot or very cold conditions?

For instance, rabbits and guinea pigs do not cool themselves very well. In extremely hot and humid weather, we need to take some actions to assist rabbits and guinea pigs. We need to recognize the signs of heat prostration in them.

When a goat has a fever you must take care to avoid letting the goat become dehydrated.

Should you make your dog run a lot in the hot sun? Do you know the signs of heat exhaustion in a dog and what to do about that?

Hypothermia is a serious problem in newborn lambs and steps must be taken to assist them. Can anyone share what you do to take care of animals in extreme weather?

Activity Two- Build a Nest

Supplies

- Two "cold cups" (plastic or paper, just make sure they aren't insulated)
- Two round cardboard oatmeal containers, cut so they are about 2 inches taller than cups
- Source of warm water (100 degrees F)
- Two thermometers
- Wood shavings (used for chicken nests)
- Feathers (can buy sterilized at craft stores)
- Hay or straw (be aware of student allergies)

1. You are a mother hen and your job will be to keep your chicks warm. You will receive two cups of warm water. One chick you will leave unprotected. The other you can protect by building a nest.
2. In one oatmeal container, build a nest for your "chick." You may use one material or a combination of materials.
3. Get your "chicks" (cups of warm water) from your instructor. Put one chick in the nest and leave one out. Put a thermometer in each cup and write down the temperature at the start.
4. Take temperature readings every two minutes. How are you doing at keeping your chick warm? How fast is the other chick getting cold?
5. Try to make a better nest. Recycle/reuse materials to improve your first nest and build a new one in that same container. Get two new chicks and start over.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Animal Science: So You Think You Are Hot?

Science Checkup - Questions to ask to evaluate what was learned

- What did you learn about temperature?
- How does your temperature compare to the temperature of other animals?
- What did you learn about caring for animals in the heat?
- Were you surprised that animals may need help from you in very hot weather?
- How would you teach someone else about these ideas?
- Describe a time when you might need the skills/knowledge you learned today.

Extensions

- Participants could compare their own temperature and heart rates with the rates taken after mild exercise such as jumping rope or jumping jacks. Young children may notice that their temperature and heart rate rises with exercise.
- Try incubating eggs. An incubator is regulated to a temperature approximately 5 degrees lower than a female bird's body.

Vocabulary

Temperature - The measure of how much heat is in the body.

Pulse - The number of heartbeats per minute. Count for 15 seconds then multiply by 4.

Respiration rate - The number of breaths taken per minute. Count each breath in and out as one. Count for 15 seconds then multiply by 4.

Hypothermia - When a body has a temperature below the normal range.

Heat prostration - A condition brought on by not being able to cool the body back down to a normal temperature.

Background Resources

- Temperature, respiration and heart rate data found on www.peteducation.com.
- Temperature for sheep, heart rate for guinea pig from Merck Veterinary Manual, <http://www.merckvetmanual.com/mvm/index.jsp>
- Goat information found at <http://www.4-hcurriculum.org> from the Dairy Goat Project Book online, Getting Your Goat. Published: 2006
- Taking Your Goat's Temperature – Article by Dr. Virgil Fleming on Goat World Web site, <http://www.goatworld.com/articles/health/temperature.shtml>
- Sheep and lamb information found on Cornell University Sheep Program Pages, <http://www.sheep.cornell.edu/sheep/index.html>
- Caring for Rabbits During Extreme Weather from Rabbits, Level I, Kansas State University, Kansas 4-H Rabbit Curriculum.
- Guinea Pig Reference: Wikipedia, http://en.wikipedia.org/wiki/Guinea_pig
- Penn State Department of Poultry Science Program, <http://pa4h.poultry.psu.edu>

Animal	Temperature (degrees F)	Average Resting Heart rate beats/minute
Human (child)	97-100	70 (58-104)
Dog	99.5-102.5	115 (60-140) Depends on age and size
Cat	100-102.5	120 (110-140)
Rabbit	102.5	205 (123-304)
Chicken	105	400
Guinea Pig	101-104	280 (260-400)
Goat	102-103	75 (70-80)
Sheep	102.3	75 (70-80)
Cow	101.5	65 (60-70)
Pig	101.5-102.5	110 (100-150) Depends on size

Animal Science:
So You Think You Are Hot?
Staying at right temperature

Animal	How it keeps cool	How it stays warm	Extra care needed when hot	Extra care needed when cold
Human				
Dog				
Cat				
Rabbit				
Chicken				
Goat				
Sheep				
Cow				
Pig				

Animal Science: Got Immunity?

Activity Series:
Animal Science
Grade: 3-6
Time: 45 min.

Main Idea

The spread of disease can be controlled if we understand how transmission happens.

Motivator

We know to wash our hands and take other precautions to avoid catching a cold. But how do animals protect themselves against diseases?

Pre-Activity Questions

Before you start the activity, ask students:

- What makes disease spread through a group of animals?
- What are some things we do to prevent the spread of disease?

Activity

- One disease card per student: One-third of the group should have airborne cards, one-third contact/touch and one-third insect/vector
- Bandanas— at least one per student
- Balls: either tennis, plastic, foam or golf balls - all the same size, three-five per student

Part One:

1. Explain that you will be playing a game about how disease spreads. There are many ways, but in this game participants are going to focus on transmission by contact with the animal (touch), droplets in the air (air) or through insect bites (insect).
2. Divide into two groups. One group will be diseases and the other will be animals.
3. Have each person in the disease group draw one card from the disease pile and keep it a secret.
4. Have the prevention group get together and decide on one tactic to prevent the spread of each mode of disease (i.e. for diseases spread by touch, you could wash your hands). Have the group develop a hand signal for each preventative measure.
5. Have the disease group spread out across the room. Have the animals walk around the diseases until you say stop.
6. When you say stop, the animals must go to the closest disease. One animal per disease.
7. On the count of three, the students with disease cards reveal their cards. At the same time, the animal shows its preventative sign. If the preventative measure is good against that disease, then the animal moves on to the next round. If the preventative measure is not for that disease, then the animal gets sick and sits out the next round.
8. Play until everyone gets sick! Switch animals and diseases.
9. Talk about how an animal could get immunity from the different diseases (immunization, antibodies, etc.).

Objectives

- To learn three modes of disease transmission
- To learn the role of immunization in disease prevention

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Construct
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Animal Science: Got Immunity?

Part Two: The Immunity Challenge

1. Establish boundaries for the play area. There should be sufficient space for students to escape the disease agents. At one end of the playing field, set up the Vet Clinic by placing bandanas in a box. On the sidelines, somewhere mid-field, scatter the balls. The bandanas are the vaccinations, the balls are the antibodies. Select one or two students per 10 players to be diseases.
2. Tell the animals that they must avoid the diseases on their way to the Vet Clinic for vaccination. Vaccinated animals should tie a bandana around their arm. Once an animal has been vaccinated, it can begin to collect antibodies. An animal can collect as many antibodies as it can carry.
3. At the same time, the diseases are trying to tag the animals. Animals who have not been vaccinated and are tagged by a disease must sit out (be quarantined) because they are now contagious. Animals who have been vaccinated can have antibodies knocked away by diseases. Diseases MAY NOT carry antibodies.
4. Once a vaccinated animal has lost all its antibodies, it must return to the Vet Clinic for a booster. A vaccinated animal that gets tagged when it has no antibodies must sit out for a 2-minute penalty.

Science Checkup - Questions to ask to evaluate what was learned

- What does it mean if an animal is immune to a disease?
- What do vaccines protect animals from?

Extensions

- Learn more about the kinds of vaccines that are available to protect your favorite domestic animal by visiting with a veterinarian.
- Simulate a disease outbreak in your town. What would you do and where would you go to learn more?

Vocabulary

Antibody - A blood protein, made by cells of the immune system to fight infection.

Antigen - A substance that when introduced into the body stimulates the production of an antibody.

Disease - An abnormal condition of an animal's body which causes it to function improperly. Rabies is an example of a serious disease that affects animals and humans. If animals are not protected with a vaccination, they can die.

Infection - The damaging growth of an invading organism. In an infection, the infecting organism uses its host to live and multiply. The infecting organism is also called a pathogen.

Immunity - A medical term that describes having sufficient biological defenses to prevent disease or infection.

Pathogen - Typically a microscopic organism or germ. Types of pathogens include bacteria, parasites, fungi, viruses, prions and viroids.

Vaccine - Injection of a live, weakened or killed microbe into a human or animal to stimulate the immune system against the microbe, preventing disease. Vaccinations are also called immunizations.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Animal Science: Got Immunity?

Virus— Ultramicroscopic infectious agents that replicate themselves only within cells of living hosts; many cause disease.

Background Resources

- Veterinary Science Curriculum Package, Teacher's Guide, Cornell Educational Resources Program, Published: 2003. Available from Ohio Curriculum Materials Service, <http://osu-cms.org/>
- PAWSitively Youth: A Guidebook about Dogs for Community Outreach Leaders, Published: 2008 <http://www.nraes.org>
- Scientific explanation of vaccines: <http://en.wikipedia.org/wiki/Vaccine>
- Scientific explanation of antibody: <http://en.wikipedia.org/wiki/Antibody>
- Methods of disease transmission: From the Department of Microbiology, Mount Sinai Hospital, Toronto, Canada, <http://microbiology.mtsinai.on.ca/faq/transmission.shtml>
- University of Nebraska – Preventing the Spread of Diseases <http://www.ianrpubs.unl.edu/epublic/live/g1541/build/g1541.pdf>
- Further lesson plan ideas: Ebola—The Plague Fighters, NOVA Teachers Classroom Activity, 2004, http://www.pbs.org/wgbh/nova/teachers/activities/2304_ebola.html

Animal Science: Basic Behavior Instincts

Activity Series:

Animal Science

Grade: 3-6

Time: 45 min.

Main Idea

Youth will compare basic behavioral instincts found in animals such as fight, flight, pack and herd drive. Youth will learn basic body language of animals and how to read or anticipate different animal behaviors.

Motivator

What are you more likely to do, fight or flee when faced with danger?
What do you think a lion would do?

Pre-Activity Questions

Before you start the activity, ask the students:

- What would be an advantage of herding or flocking together?
- What would be an advantage of a group scattering?
- What is a prey animal and what is a predator?
- Name some differences between wild and domestic animal behaviors.

Activity

- Note cards
- Pack leader and pack follower instructions (shown below), already cut out
- Safe space large enough to move around without obstacles – ideally a gym, playground or large hallway

1. Break into two groups.
2. The first group will act out behavioral signs of dogs as PREDATORS. For example, act aggressive, fearful, relaxed, playful or curious.
3. Second group acts out behavior signs of sheep as PREY. For example, act as if you were flocking/(herding), fearful, playful or relaxed.
4. Play the game Predator vs. Prey using the same rules as Freeze Tag. Modify rules as needed for age and abilities.
5. After the game, choose three students to act as the predator pack. The rest of the class will be sheep.
6. Meet with the predator pack separately from the sheep. Randomly choose a pack leader. Review the pack leader instructions with the group. Encourage the group to develop a strategy to lull the sheep into a comfort zone before hunting. Leave the group to develop behavior signs for each behavior listed on the leader card.
7. Meet with the sheep. Explain that when the predators enter the room, each sheep has the choice of staying scattered or herding with the group. Explain that members of the predator pack will be giving different behavior signs, including one sign for hunting. If they are away from the herd when the pack hunts, they may become dinner.

Supplies

Objectives

- To understand basic animal behavior factors
- To learn to read and interpret body language

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Animal Science: Basic Behavior Instincts

8. To herd, a sheep stomps its foot. Sheep may herd when there are at least two other sheep stomping their feet to herd.
9. Play several rounds. When the hunting sign is given, give the sheep a minute or so to react and then shout “freeze.” All the sheep will stay in place and the predators may each select a “prey” from the sheep farthest from the herd. These three prey will become the new pack of predators. This new pack will need to develop their own behavior signs. The old pack of predators will now become sheep.

PACK LEADER INSTRUCTIONS

You are the leader. You will lead your pack around the classroom (or space) one time each round. Each round, you can display one of the following behavior signs. The rest of the pack **MUST** do the same sign as you. Work with your pack to develop a sign for each of these behaviors:

AGGRESSION: This is hunting mode. When you show this sign, the sheep that are the most scattered will be your prey. You cannot HUNT on the first round.

FEAR: This means you are scared of something.

RELAXING: You are not interested in the sheep at all.

BEING CURIOUS: You are interested in the sheep, but are not sure if the time is right. If more than four sheep begin to herd, you can switch to AGGRESSION and hunt.

PLAY: You are paying attention to your fellow dogs and not to the sheep.

PACK FOLLOWER INSTRUCTIONS

You must follow the behavior of the pack leader. Help the pack leader develop signs for each behavior.

Science Checkup - Questions to ask to evaluate what was learned

- What did you notice about the behavior of the sheep or of the dog pack or pack leader?
- What influences animal behavior?
- Can you describe similar behaviors you have noticed with other animals?

Extensions

- Add a group of guardian animals to the herd of sheep (dogs, llamas, donkeys, etc.) Have this group develop protective behaviors and reactions to the pack.
- Research behavior signs for other types of predators, companion and farm animals.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Animal Science: Basic Behavior Instincts

Vocabulary

Aggression – Actions that lead to a struggle or battle.

Domestic animal – Animals that have been bred/selected to serve humans in some way.

Fight – A struggle or battle.

Flight – To flee quickly.

Instinct – An inherited natural impulse to physically respond to an environmental condition. For instance, this is how a sheep knows what to do when a predator is in their surroundings.

Herd drive – An instinct of animals to stay in groups with other animals of their type.

Pack – A dog's (canine) version of a family. A group of dogs that has a clear leader and has established specific roles for each dog in the family. They work together to supply their pack the basic needs of food, water and shelter.

Pack drive – The instincts dogs have to follow their pack and pack leader.

Play – Actions that are not threatening, but mimic mild forms of aggression, hunting and dominance.

Predator animals – Animals that hunt or prey on other animals for survival.

Prey animals – Animals that are hunted by other animals.

Background Resources

- PAWSitively Youth: A Guidebook about Dogs for Community Outreach Leaders, Published: 2008
<http://www.nraes.org>
- Wonderwise 4-H, Women In Science Learning Series <http://wonderwise.unl.edu>
- Skills for Life – Wiggles and Wags, 4-H Dog Activity Guide Level 1. Published: 2005
- Skills for Life – From Airedales to Zebras, All Systems Go, and The Cutting Edge, 4-H Veterinary Science Activity Guides. Published: 2004
- Freeze Tag Rules can be found on Wikipedia <http://en.wikipedia.org>

Animal Science: Respiration

Activity Series:
Animal Science
Grade: 3-6
Time: 45 min.

Main Idea

Students will explore the basics of the respiratory system and breathing rates in a variety of different types of animals and find out about the parts of the body involved in respiration.

Motivator

Are you full of hot air? Have you ever noticed the changes in your breathing after you've been running around? Did you know that your goldfish breathes five times as fast as you do?

Pre-Activity Questions

Before you start the activity, ask the students:

- What body parts make up the respiratory system?
- Are these the same in all types of animals? Which ones are different?
- Do creatures who live in water have a respiratory system?
- What does respiration do for the body?

Respiration Rates (breaths per minute)

Horse	8-16	Pig	20-40
Cattle	10-30	Dog	10-30
Sheep/Goat	12-20	Cat	15-30
Chicken	15-30	Goldfish	80-90

Activity 1– Build a respiratory system

Have cutouts of the following body parts available in craft foam, felt or colored paper. Label each part:

- Dog:** Mouth and nose/nasal cavity, pharynx and epiglottis, trachea, lungs, diaphragm
- Fish:** Mouth, gill filaments/gills, pharynx, gill openings.
- Bird:** Beak/nostril/mouth, lungs, 5 pairs of air sacs, abdominal muscles

1. Create a respiratory puzzle of comparative anatomy among animals. Explain the body part/s and the function they play in respiration.

Activity 2– Respiratory rate relay

- Large clock with second hand, or stopwatches

1. Have youth partner up and teach participants how to count their number of breaths in 1 minute. One partner can watch the clock 20 seconds, while the other person counts the breaths of the partner watching the clock. Then, multiply the number of breaths by 3 to determine their respiration rate per minute. Switch and count the other person's respiration rate.

Objectives

- Increase understanding of respiration
- Recognize body parts involved in respiration and compare respiration rates of different animals

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Animal Science: Respiration

- Then, have one person from each pair jog in place or jog laps for 2 minutes. Have them watch the clock while their partner counts their breathing for 20 seconds. Switch and have the other person jog, then count their rate. Have youth share their results and explain why their respiration rate goes up with increased physical activity.

Activity 3– Respiration game

Supplies

- Red yarn cut in 1-foot lengths, enough for 1/3 of your group (carbon)
 - Blue yarn cut in 1-foot lengths, enough for 1/3 of your group (oxygen)
 - Masking tape or chalk if outside
- Split the participants into three equal groups. Give each member of one group a piece of red yarn, which represents carbon. Give each member of another group a piece of blue yarn, which represents oxygen.
 - Ask each student with a blue yarn to partner up with one person from the third group, who doesn't have any yarn. Both members should hang onto the blue yarn to become an oxygen molecule (O₂). (Hint: molecular structure of CO₂ is...O-----C-----O)
 - Use tape/chalk and make a large upside down "Y" on the floor/ground so that the top of the "Y" is equal to the sides of the Y" (like three equal pieces of pie). Place the oxygen pairs in one section of the "Y" and the carbons in another.
 - Have the pairs of students representing oxygen molecules pass into the carbon area one at a time and ask them to link with a carbon by grasping the red yarn to become carbon dioxide. Have them stay connected and move into the third section of the "Y," the empty section.
 - When all the conversions have occurred and everyone is linked together as carbon dioxide, repeat the process, asking "how would this change if the animal's physical activity increased?" (They would move faster.) Urge each (oxygen) to go one at a time across into the carbon section and then into the carbon dioxide section. Repeat until everyone has paired with each other at least once.

Science Checkup - Questions to ask to evaluate what was learned

- At higher altitudes, there is lower air pressure. What affect can this have on athletes visiting from lower altitudes? How about animals living at higher altitudes?
- What happens to a person's respiration rate when they exercise? Why do you think this happens?
- Do you think a person with asthma might have a different respiration rate than someone without asthma? Why or why not?

Extensions

- Look into the respiratory process of worms and other animals.
- Research the size of the lung versus function.
- Compare respiration rates across species.
- Learn about other ways carbon dioxide impacts our planet. For example, carbon dioxide is used to carbonate soft drinks.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Animal Science: Respiration

Vocabulary

Carbon – An element found in numerous living and nonliving objects, as well as gases and liquids. It connects with oxygen to form carbon dioxide.

Carbon Dioxide – A colorless gas in the atmosphere, this is the connection of carbon and oxygen and is a waste product of the respiration cycle.

Molecule – The smallest particle of substance that maintains a consistent set of properties. This is the foundation of all objects, gases and liquids.

Oxygen – A key element found in many objects, gases and liquids. Oxygen constitutes roughly 20 percent of the atmosphere, providing fuel for sustaining life. An essential element in the respiration cycle.

Respiration Rate – The number of breaths in one minute.

Respiratory System – In mammals, this system consists of the airways, the lungs and the muscles that initiate movement of air into and from the body. Within the lungs, oxygen and carbon dioxide are exchanged through tissues to and from the blood. The respiratory system causes oxygenation of the blood and allows for the elimination of waste products like carbon dioxide, which are exhaled from the lungs to the mouth.

Background Resources

- Sturkie's Avian Physiology (Fifth Edition) by G. Causey Whittow, Editor
ISBN: 127476059 Published: 1999
- The Normal Animal, Unit 1, 4-H Veterinary Science Guide – University of Nebraska
- PAWSitively Youth: A Guidebook about Dogs for Community Outreach Leaders Published: March 2008 <http://www.nraes.org>
- Diagram of the Respiratory System of a dog – Washington State University College of Veterinary Medicine http://www.vetmed.wsu.edu/cliented/anatomy/dog_resp.aspx
- The Respiratory System of a fish <http://en.wikipedia.org/wiki/Gill>
- Diagram of the Respiratory System of a bird from the University of Illinois <http://chickscope.itg.uiuc.edu/explore/embryology/day15/how.html>
- The Respiratory System of a bird from Eastern Kentucky University <http://people.eku.edu/ritchisong/birdrespiration.html>
- Human Respiration
http://www.righthealth.com/topic/Respiratory_system

Animal Science: Animal Sense Stations

Activity Series:
Animal Science
Grade: 3-6
Time: 45-60 min



Main Idea

Animals have different structures that serve different functions for growth, survival and reproduction.

Motivator

Today you will be asked to solve some mysteries. At each of four stations, you will complete an activity and unravel clues to determine which animal the activity relates to, just like investigators who use clues to solve crimes or figure out what happened at an accident scene.

Pre-Activity Questions

Before you start the activity, ask the students:

- Do you think all animals have the same senses? Do they hear the same, smell the same and see the same?
- What differences have you noticed in animal's eyes? ears? tongues? noses?

Note: This can be done with a large group that is split into smaller groups. Recruit a teen helper to facilitate each station, and give each group about ten minutes per station. OR with a small group, do each activity in succession.

Supplies

Activity 1– Touch

- Box with a hand-sized hole on one side
 - Cloth large enough to cover box
 - Three items, two with similar textures, one different (I used an orange, a golf ball, and a banana)
1. Place your hand through the opening in the covered box.
 2. Using only the most sensitive tips of your fingers, gently brush against the items in the box. There are three.
 3. Think about what the items could be. Do not reveal your guesses until everyone has had a turn.
 4. Once everyone has had a turn, place your hand in the box and touch the items again, using different parts of your hand. Which movements of your hand helped you learn more about the items?

Supplies

Activity 2– Smell

- Film canisters or other small opaque containers (one per student)
- Cotton balls
- Different extracts (almond, banana, peppermint, vanilla, etc.)
- Water

Before the meeting, divide the canisters into groups so that you have at least two for each scent. Use water as the scent

Objective

- To explore animal physiology by using skills of observation and inference.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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with one set of canisters. Code the canisters so you know which ones contain which scent, but students won't know. If you have an odd number of students, make one set of three.

1. Pick a canister from those available at the table. Remove the lid and carefully sniff what's inside. Do not touch what is in the canister.
2. Try to find another student with the same scent. Be sure to check everyone else's scents. There may be more than one match for you!
3. As a group, discuss the different scents. What do you think the scents are? Could one of the scents be something that humans can't smell but animals can?

Activity 3– Hearing

Supplies

- Wire coat hanger with rubber band tied to each corner (one per two students)
- Plastic coat hanger with rubber band tied to each corner (one per two students)

1. Work with a partner. While your partner holds the wire coat hanger by the hook, pick up the end of each rubber band, one end in each hand.
2. Have your partner tap of the straight edge of the hanger, while you hold the rubber ends to your ear. Does it make a difference if you hold the rubber band loosely or stretch it tight? Try this again with the plastic hanger. Why do think the results were different?

Activity 4– Sight

Supplies

- Pirate eye patch (or you can use a large dark plastic spoon)
- Party blower for each student, try to find the ones that don't make noise
- Lightweight plastic fly or picture of a fly on a small wad of paper
- Flower made by turning a paper cup upside down and drawing petals on the bottom
- 10-inch tall thin column made of cardboard, paper or wood, anchored to a base.

Note: You will need to do a little estimating on this station. Read through the activity, try it first with the flower on the ground and fly on top, then with the column with the fly on top, make a mark on the floor with a piece of masking tape and place the flower and column far enough away that it will be a challenge to aim for the fly. Try it yourself before students arrive to make sure you have the appropriate distance.

Animal Science: Animal Sense-Stations

1. Use the pirate patch to cover one eye. Stand at the mark and bend (not lean) so that you can use the party blower to knock the fly off the flower.
2. Try it again with the other eye covered.
3. Try it with both eyes uncovered. Which way was the easiest for you?
4. Use your **least** successful strategy and try to knock the fly off the tall and skinny column. Was it easier or harder than the flower? Why?

Science Checkup—Questions to ask to evaluate what was learned

Bring the group back together. Remind them that each station represented a different animal. List the potential answers on a blackboard or poster (dog, cat, turtle, lizard, fish).

- Have the group pair up and decide which animals best match which stations (there can be multiple answers). Once discussion dies down, bring the group back together and discuss each station. What were the results? Which animals represented which stations and why?

Extensions

- Dogs and scents: Place three similarly scented items in three separate lunch bags (strawberry candle, soap and shampoo for example). Challenge the group to guess what the items are by smelling them. Share that a dog could tell the difference between the items just by scent. OR ... Find two of the exact same heavily-scented items. Hide one in a confined area (a classroom, one section of the playground, etc). Place the other one in a lunch bag. Have the students “scent” the item by sniffing (but not looking into) the bag. Have them use their noses to try and locate the item on the playground or other area.
- Hearing: Have the group sit in a circle and cover their eyes. Make noises in various areas around them and have them point toward the noise. Now have them cover one ear and try it again.

Vocabulary

Senses: The method animals use to detect what is going on in their environment, including seeing, hearing, touching, smelling and tasting.

Physiology: How living bodies function; how organs, tissues, cells and body parts work together.

Background Resources

- PAWSitively Youth: A Guidebook about Dogs for Community Outreach Leaders published March 2008 <http://www.nraes.org>
- Animal Senses by Pamela Hickman Published: 1999
- National 4-H Skills for Life: Pet Series Published: 2001
- Neuroscience for Kids – Washington State University <http://faculty.washington.edu/chudler/neurok.html>

Animal Science: People Pellets

Activity Series:

Animal Science

Grade: 3-6

Time: 45 min

Main Idea

Pelleted pet foods need to meet all of the animal's nutritional requirements.

Motivator

Did you realize that when you feed your pet their pelleted food they are getting almost all of their nutrient requirements in one bite?

Pre-Activity Question

- What would a version of pelleted food look like for people?

Activity

- Samples of various types of pelleted pet food with nutritional label (choose gourmet offerings that contain "people food" like fruits and vegetables).
- Pre-made bingo cards with fruits and vegetables (make your own or use pre-fab)
- Scissors
- Rolling pins (one per group)
- Spoons
- Food service gloves
- Sandwich sized plastic bags that zip closed
- Grains: Pre-measured ½ cup bags of: corn, rice, and oat cereal - will need 2 bags of each grain per group
- Proteins: Bowls of powdered milk, soy nuts or sunflower seeds – will need 2 of each per group
- Energy: Squirt bottles of honey and maple syrup
- Flavors: Raisins and chopped dried apples
- Index cards labeled "Energy" "Protein" "Flavor" and "Grains" (1 per group)
- Ingredient label from a human meal replacement bar or drink

Part 1: Investigate!

1. Have the students work in small teams. Give each team a bingo card, an unopened bag of pet food, and marker.
2. Instruct the teams to read the label of the pet food and seek out the "people food" ingredients. *(Note: You may need to help the students interpret some of the ingredients. Have them focus on the easy ones first.)*

Objectives

- Investigate the ingredients found in pet foods
- Design a nutrition-packed "people pellet."

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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on their bingo card and “x” it with their marker.

4. If the teams do not get bingo with their own bag of food, have the groups rotate stations, leaving the food and marker. Each team will have a chance to use a new bag of food and marker. Continue to rotate until team gets bingo (or you run out of time.)
5. The team that gets the first bingo will be the first to select their ingredients in Part Three.

Part 2: Taste Test!

1. Prepare a trail mix from the cereals listed above. Have the students sample it. **(Be sure to check for food allergies first!)**
2. Now place a small amount of the trail mix in a double plastic bag and let them roll it into powder. Ask the students if they think it will taste the same or different? Will the nutrition have changed? Let a few volunteers sample the powder.
3. Ask the group what would be the benefit in “powderizing” the food?
4. Show the group an energy bar and a pellet of pet food. Ask them what they have in common.

Part 3: Create!

1. Form new teams. Demonstrate the techniques below to make “people pellet.”
2. Give each team one of each card: (protein, energy or grain)
3. Have each team shop for their grains. Each group gets a “free” bag of corn cereal plus whichever they select.
4. Have them “powderize” their cereal by rolling it out in two plastic bags.
5. Now have them shop for their protein, flavor and their energy.
6. Have the students add 2 spoons each of the protein and flavor to their bag with the cereal, zip it closed, and take turns mixing by shaking the bag.
7. Have an adult add the energy ingredient. Use your discretion on how much will be needed to make a dough. Have the students work the ingredients into a pellet shape. If needed, a small amount of water can be added as well.
8. Survey the group for taste testers. Have them taste only one bite and give their opinion on whether they would like to eat it every day for every meal!
9. Review the contents of each pellet and talk about the nutrition. Ask the group how many more ingredients they think they would need for their pellet to really meet all of their nutritional needs. Share a list of ingredients from a meal replacement drink or bar.

Science Checkup - Questions to ask to evaluate what was learned

- What nutrients or ingredients were in the pet food?
- What would be the benefit of making the ingredients into a powder?
- What challenges did the students have with making their pellets?

Extensions

- Have each group use the nutrition labels from their pellet ingredients to make a chart of protein, fat and calories. Have the entire group rate the recipes as high energy, low fat, high protein etc.
- Have each team come up with a name and package label for their product.

Vocabulary

Protein: Any of a large group of nitrogenous organic compounds that are essential constituents of living cells; consist of polymers of amino acids; essential in the diet of animals for growth and for repair of tissues; can be obtained from meat, eggs, milk and legumes.

Carbohydrate: Any of a group of organic compounds that includes sugars, starches, celluloses, and gums and serves as a major energy source in foods.

Fat: Fats are organic compounds that are made up of carbon, hydrogen, and oxygen. They are a source of energy in foods. Fats belong to a group of substances called lipids, and come in liquid or solid form. All fats are combinations of saturated and unsaturated fatty acids.

Nutrients: A *nutrient* is a chemical that an organism needs to live and grow or a substance used in an organism's metabolism which must be taken in from its environment. Essential *nutrients* - proteins, carbohydrates, fats and oils, minerals, vitamins, and water.

Background Resources

- AAFCO (Association of American Feed Control Officials): www.aaeco.org
- Product label ingredient samples: www.kaytee.com/products/animal/small-animals.php?page=0
- "Small Animal Nutrition," by Sandie Agar, published 2001

Astronomy

About the 4-H Science Toolkit Series: Fun with Astronomy

This series of activities focuses on a subject of fascination to both children and adults – astronomy – our Solar System and beyond. Through the activities, children will learn what scientists have discovered about our universe and feel both a sense of awe and connection to our world each time they look at the stars.

All of these adventures call on students to predict what will happen, test their theories, then share their results. They'll be introduced to astronomy vocabulary, make several items they can take home to expand their adventures and come home armed with enough knowledge about the night sky to share with their family.

The lessons in this unit were adapted from "Astronomy – It's Out of this World" 4-H Leader/Member Guide by Brian Rice. This guide is available online at <http://www.ecommons.cornell.edu/handle/1813/3487>.

To find out more about astronomy activities, visit the Cornell Center for Radiophysics & Space Research education and public outreach web site at <http://astro.cornell.edu/outreach/> and to find numerous resources related to astronomy, outdoor exploration and other sciences, check out the 4-H Resource Directory at www.cerp.cornell.edu/4h.

Fun with Astronomy Table of Contents

- Making a Star Chart:** Students will gaze at the night sky, learn to identify constellations and find out how ancient people used stars to chart the seasons and tell stories.
- Mystery Shadows:** Students experiment with light and objects to learn how solar and lunar eclipses happen
- Moon Phases:** Children understand how and why the Moon appears to change shape, or go through phases, each month.
- How Big and How Far?:** Students model the scale sizes and distances of planets and the sun and learn ways to remember the names of the planets in the correct order.
- Constellations in a Can:** Students build their own planetarium to help them learn the constellations.
- Sundials:** Students discover how they can use the sun to tell time.



Fun with Astronomy: Making a Star Chart

Activity Series:
Fun with Astronomy
Grade: 3rd & up
Time: 45-60 minutes

Main Idea

Constellations have fascinated humans throughout history and are fun to identify and teach to others. A star chart can be used to find constellations and objects in the sky.

Motivator

On a really dark night, you can see about 1,000 to 1,500 stars. Trying to tell which is which can be hard, so constellations are used as mnemonics, or memory aids.

Pre-Activity Questions

Before you start the activity, ask the students:

- What experiences have you had observing the sky?
- Will we be able to see every star on the chart? Why? (No. Some won't be bright enough. Some are below the horizon.)
- Why do the constellations we see in the sky change throughout the night and the year? (Because the Earth is orbiting the Sun and rotating.)
- Are all of the stars we see in a constellation at the same distance from Earth? (No)

Activity

- Copies of star chart on cardstock or regular paper pasted to cardboard (See pages 3-4. It is also available at <http://lawrencehallofscience.org/starclock/starwheel.pdf>)
 - Tape or stapler
 - Scissors
 - Optional constellation activity sheets from original guide
1. Cut along the black outer circle of the Star Wheel and along the solid lines of the Star Wheel holder. Remove the interior oval shape on the Star Wheel holder.
 2. On the Star Wheel holder, fold the cardboard along the dashed lines.
 3. Tape or staple along the edges of the holder, forming a pocket.
 4. Place the Star Wheel in the Star Wheel holder (it should be able to move freely.)



Example of a commercial planisphere

Use of the star chart *

- a. Line up today's date with the time you are going to be stargazing. The viewable piece of the star chart is what your sky will look like tonight, when held up to the sky.
- b. Help participants practice using the star chart by first locating constellations you want to find on the star chart's map.
- c. Turn your map so that the horizon that the constellation is closest to is at the bottom. The star positions in the sky should match those on the wheel.

Do extra constellation activities from the original project guide, if desired.

Objective

- Construct a star chart that can be taken home and used to observe the night sky.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

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Fun with Astronomy: Making a Star Chart

* Note: If you live in a city or someplace where there is a lot of light pollution, many of the stars on the chart won't be visible in your night sky. Orion's belt and the Big Dipper (Ursa Major) are some of the easiest constellations to find because people recognize them and they include bright stars.

Science Checkup - Questions to ask to evaluate what was learned

- Make up your own practice questions, using the star chart, and have the students try to figure out the location of certain constellations on specific days and times. For example:
When is Scorpio in the southwestern horizon at 10 p.m.? (Around Aug. 15)
Where is Draco on January 20 at 9 p.m.? (The northern horizon)

Extensions

- Try the supplemental background information and activity sheets that are included in this packet: a mythology crossword, constellation matching game and various activities for finding constellations in the sky.
- Visit NASA Space Place Web site and print the folding fortune teller star finder for the appropriate month: <http://spaceplace.nasa.gov/en/kids/st6starfinder/st6starfinder.shtml>
- Participate in one of the Star Count programs as a citizen science project:
The Great Worldwide Star Count: http://www.windows.ucar.edu/citizen_science/starcount/
Globe @ Night: <http://www.globe.gov/GaN/>
NASA Star Count: <http://www.nasa.gov/audience/foreducators/son/energy/starcount/index.html>
- Check out the Lunar & Planetary Institute Sky Tellers "Stars" and "Polaris" activities:
<http://www.lpi.usra.edu/education/skytellers/stars/>
<http://www.lpi.usra.edu/education/skytellers/polaris/>
- Listen to the Jet Propulsion Laboratory "What's Up" podcasts and vodcasts:
http://www.nasa.gov/multimedia/podcasting/whatsup_index.html
- Check out Google Sky or one of the many other programs on the Web that show the night sky.
- If you have an amateur astronomy club in your area, you may be able to find a mentor for astronomy activities and/or arrange for an opportunity for the group to observe through a telescope.

Vocabulary

Constellation: A group of stars that, when viewed from the Earth, are in an obvious pattern and are usually named for mythological gods, people, animals and objects. Astronomers also divide the sky into 88 regions called constellations that contain these named star patterns.

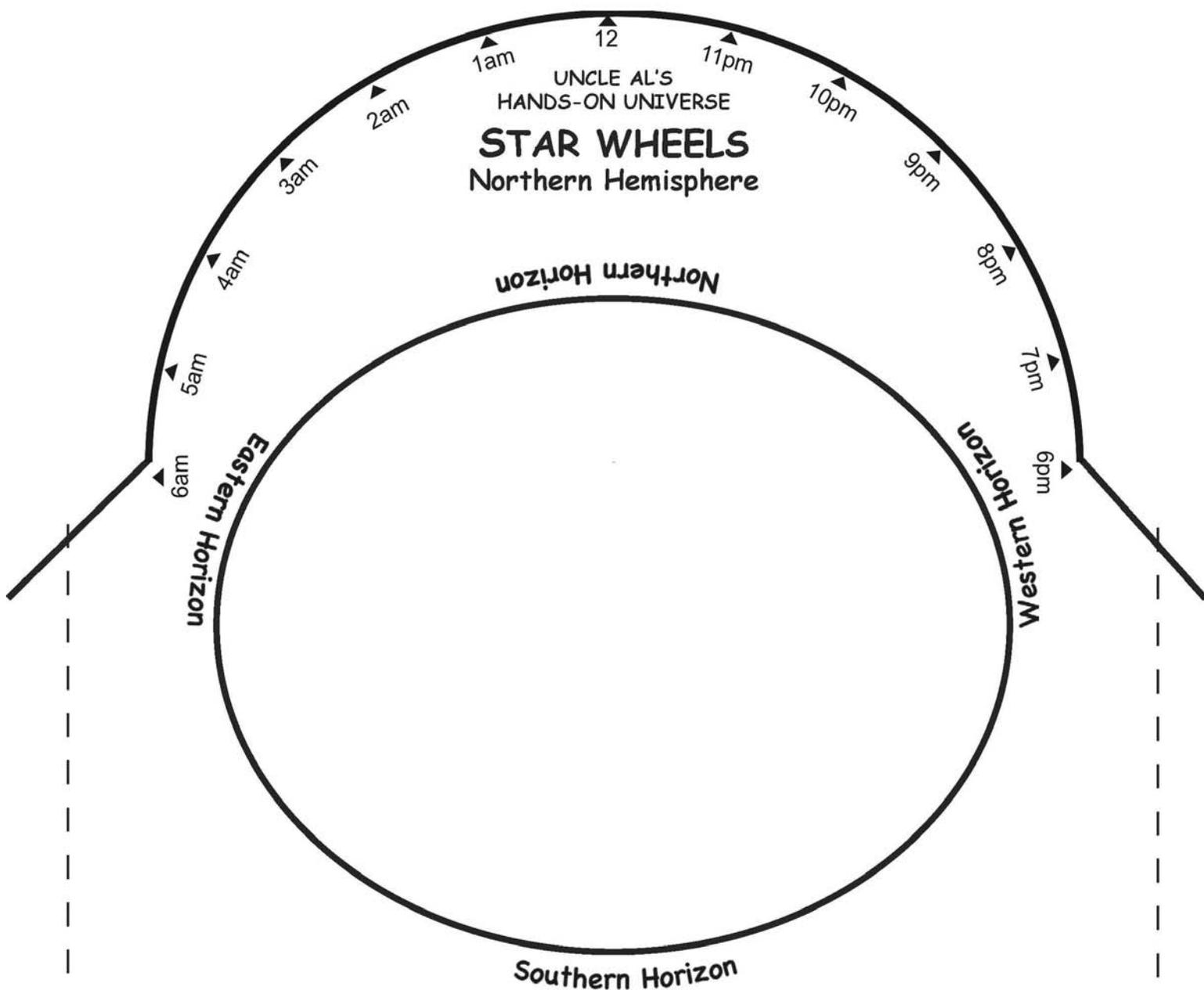
Light year: The distance that light can travel over the course of one year — almost 10 trillion kilometers or more than 5 trillion miles!

Background Resources

- Constellations are imaginary patterns in the sky that poets, farmers and astronomers have named over thousands of years. Many of them were named after ancient gods, creatures and objects in Greek myths. The stars have been tracked and looked at with wonder for thousands of years, and you can follow in this age-old tradition with your own star chart.
- Our modern constellations come from a list of 48 constellations that were described by the Greek astronomer Ptolemy in 150 AD to illustrate stories in Greek mythology. Over the centuries, navigators and celestial mapmakers reworked the system of constellations and expanded the list to include star patterns that can only be observed from the southern hemisphere. They also filled in the gaps between the constellations recognized by the Greeks.
- Astronomers now divide up the sky into 88 distinct regions they call constellations, adopted in 1930 by the International Astronomical Union. The stars that make up a constellation don't have a physical connection with one another and are usually at very different distances from the Earth.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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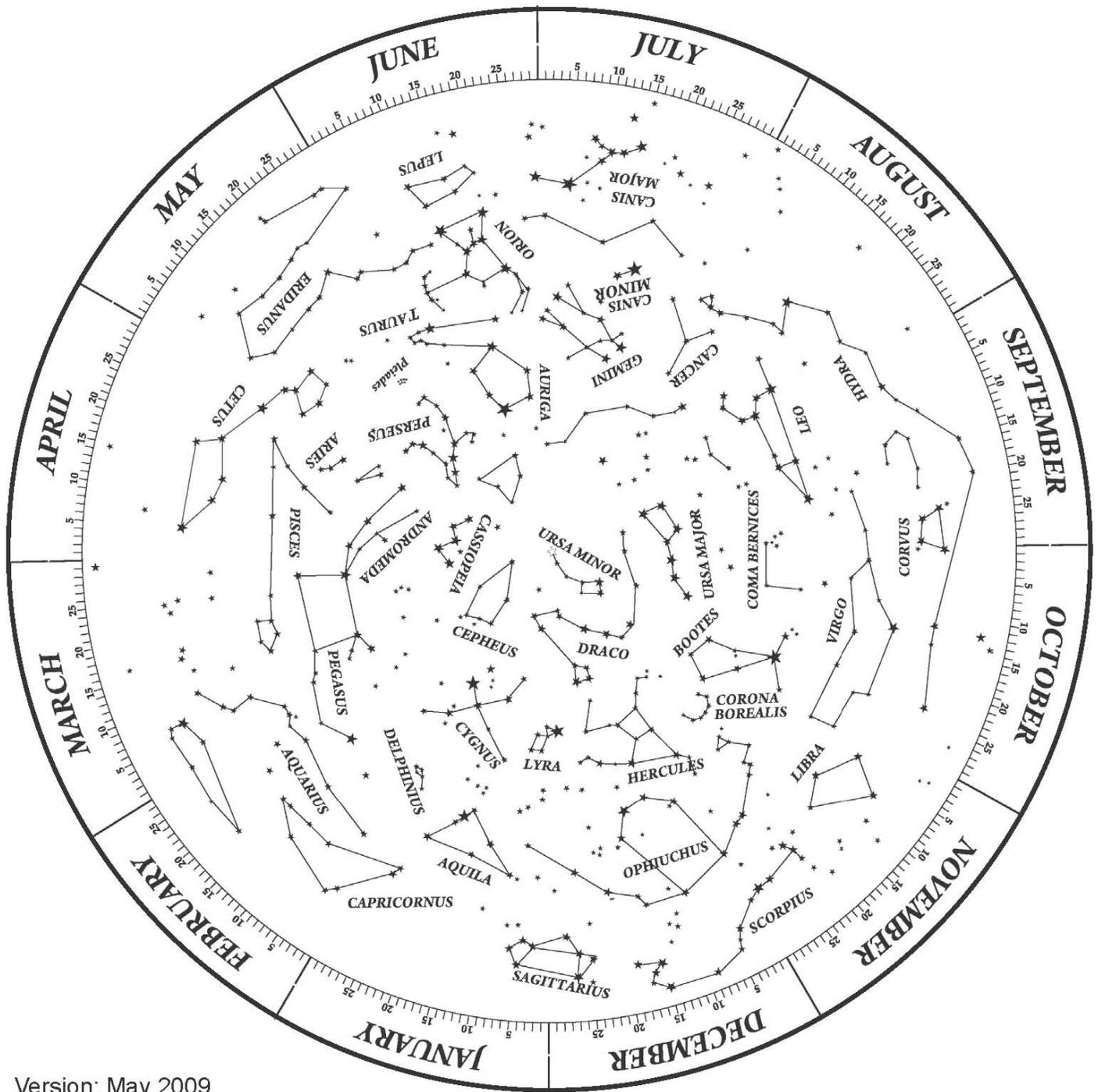


Version: May 2009

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Uncle Al's Star Wheels are based on LHS Sky Challenges created by Budd Wentz and
available through LHS Museum Store
510-642-1016 <http://www.lhs.berkeley.edu/pass/ast110&118&121.html>
Download Uncle Al's Sky Wheels from <http://lhs.berkeley.edu/hou/img/uncleal>

1. Align your date and time, and then look up at the sky.
2. Locate the constellation you want to find on the map.
3. Turn your map so the horizon it is closest to is at the bottom.
4. The star positions in the sky should match those on the wheel.

Instructions for Using Uncle Al's Star Wheels



Version: May 2009

INSTRUCTIONS FOR ASSEMBLING UNCLE AL'S STAR WHEELS

- Step 1: Print out all pages either on heavy cardstock or paste them onto a file folder or any other sturdy piece of cardboard.
- Step 2: Cut along the black outer circle of the Star Wheel and along the solid lines on the Star Wheel Holder. Remove the interior oval shape on the Star Wheel Holder.
- Step 3: On the Star Wheel Holder, fold the cardboard along the dashed lines.
- Step 4: Tape or staple along the edges of the Star Wheel Holder forming a pocket.
- Step 5: Place the Star Wheel in the Star Wheel Holder.

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<http://lhs.berkeley.edu/pass/AST110&111&121.html>
 Download Uncle Al's Sky Wheels from <http://lhs.berkeley.edu/starclock/skywheel.html>
 used by permission for New York 4-H Science Toolkit

Mythology of the Constellations

References: Worksheet 1.3 Constellation Matching
Worksheet 1.4 Mythology Crossword Puzzle



Scorpion

Of the 88 constellations, most were named by the ancient Greeks and Romans. The ancient people made up stories to explain natural occurrences that they did not understand. Many of these stories were related to the forms of the constellations in the skies and are what we now call mythology.

One story told in the constellations is the same story told in the movie *Clash of the Titans*. Using your star chart, find the constellations Andromeda, Perseus, Cassiopeia, Pegasus, and Cepheus. These figures play out part of the story.

In the story, Cassiopeia the queen and her husband Cepheus the king had a very beautiful daughter, Andromeda. They claimed their daughter was more beautiful than the sea nymphs, who were considered the most beautiful



Poseidon

creatures on the earth. Poseidon, the Sea King, became so angry with Cassiopeia and Cepheus' claim that he sent a sea monster to destroy the kingdom unless they sacrificed Andromeda to the sea monster. Meanwhile, Perseus, a brave knight, had been on a quest and had killed the Medusa, which when looked at could turn the viewer to stone. Perseus arrives on his flying horse Pegasus, jumps off, and uses the head of the Medusa to turn the sea monster into stone and thus save Andromeda.

Other stories use fewer constellations but are just as exciting. The tale of Orion and the Scorpion is a simple story.

Orion was a great hunter and claimed that he could defeat any animal. This angered the goddess Juno, and she sent a scorpion to kill Orion. The moon goddess Diana felt sorry for Orion after his death and put him in the stars, along with the Scorpion—but the Scorpion is on the opposite side of the sky where it can never bother Orion again!



Diana

List of the Constellations

Constellations are figures and patterns that are overlaid on the stars to form pictures. These are the 88 constellations recognized by the International Astronomical Union since 1933.

Andromeda	The Princess	★	Leo	Lion
Antlia	Air Pump	★	Leo Minor	Smaller Lion
Apus	Bird of Paradise	★	Lepus	Hare
Aquarius	Water Carrier	★	Libra	Balance (Scale)
Aquila	Eagle	★	Lupus	Wolf
Ara	Altar	★	Lynx	Lynx
Aries	Ram	★	Lyra	Harp (Lyre)
Auriga	Charioteer	★	Mensa	Table Mountain
Boötes	Herdsman	★	Microscopium	Microscope
Caelum	Graver's Tools	★	Monoceros	Unicorn
Camelopardalus	Giraffe	★	Musca	Fly
Cancer	Crab	★	Norma	Square (and Rule)
Canes Venatici	Hunting Dogs	★	Octans	Octant
Canis Major	Greater Dog	★	Ophiuchus	Serpent Holder
Canis Minor	Lesser Dog	★	Orion	Great Hunter
Capricornus	Horned Goat	★	Pavo	Peacock
Carina	Keel	★	Pegasus	Winged Horse
Cassiopeia	Queen (Lady in the Chair)	★	Perseus	Hero, Champion
Centaurus	Centaur	★	Phoenix	Fire Bird
Cepheus	King (Monarch)	★	Pictor	Painter's Easel
Cetus	Sea Monster (Whale)	★	Pisces	Fishes
Chamaeleon	Chameleon	★	Pisces Austrinus	Southern Fish
Circinus	Pair of Compasses	★	Puppis	Stern
Columba	Noah's Dove	★	Pyxis	Mariner's Compass
Coma Berenices	Berenice's Hair	★	Reticulum	Net
Corona Australis	Southern Crown	★	Sagitta	Arrow
Corona Borealis	Northern Crown	★	Sagittarius	Archer
Corvus	Crow	★	Scorpius	Scorpion
Crater	Cup	★	Sculptor	Sculptor's Workshop
Crux	Southern Cross	★	Scutum	Shield
Cygnus	Swan	★	Serpens Caput	Serpent's Head
Delphinus	Dolphin	★	Serpens Cauda	Serpent's Tail
Dorado	Dorado (Fish)	★	Sextans	Sextant
Draco	Dragon	★	Taurus	Bull
Equuleus	Colt, Small Horse	★	Telescopium	Telescope
Eridanus	River Po	★	Triangulum	Triangle
Fornax	Furnace	★	Triangulum	
Gemini	Twins	★	Australe	Southern Triangle
Grus	Crane	★	Tucana	Toucan
Hercules	Hercules	★	Ursa Major	Larger Bear
Horologium	Clock	★	Ursa Minor	Smaller Bear
Hydra	Water Monster	★	Vela	Sails
Hydrus	Water Snake	★	Virgo	Maiden, Virgin
Indus	Indian	★	Volans	Flying Fish
Lacerta	Lizard	★	Vulpecula	Little Fox

Activity: Connecting the Dippers

Reference: Worksheet 1.5 Connecting the Dippers

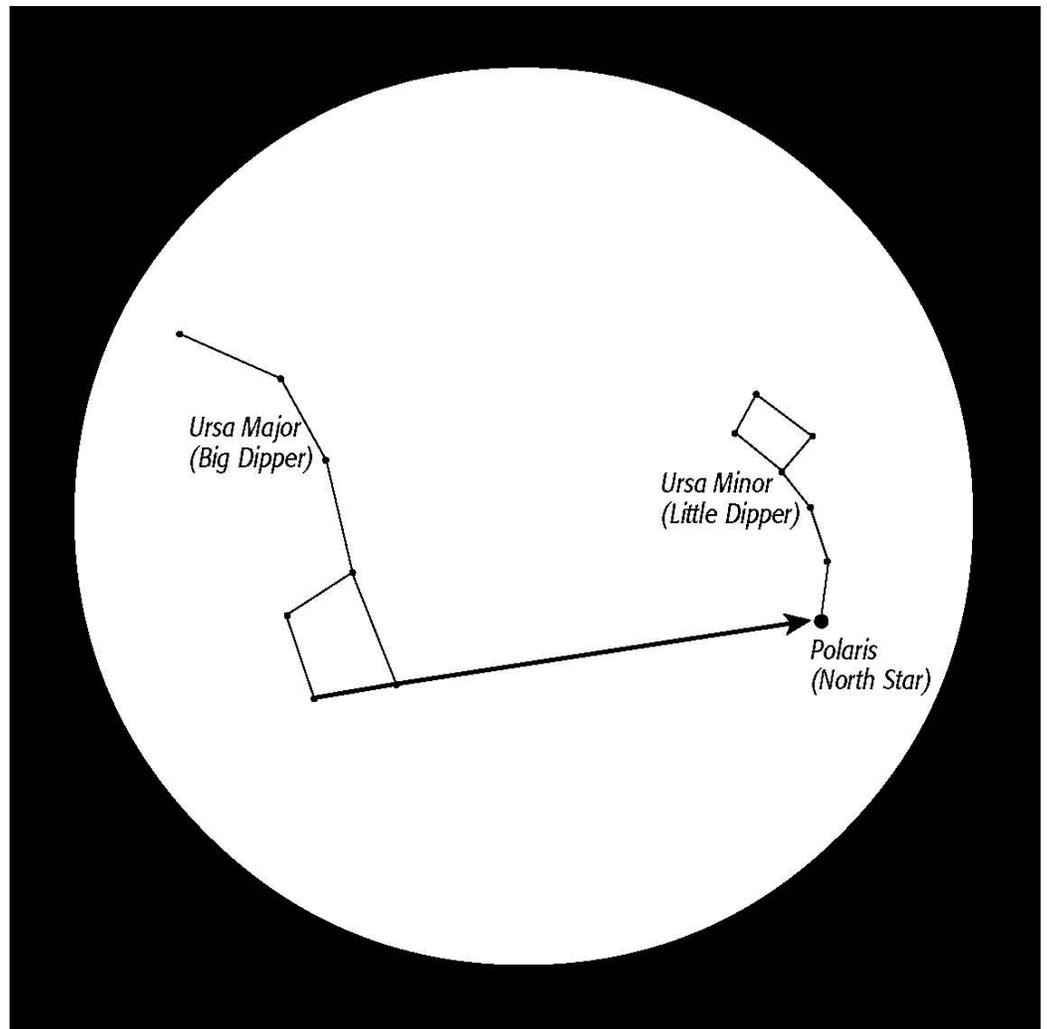
★ Objective

To locate the Little Dipper and the North Star using the Big Dipper

The Big Dipper is the most easily recognizable constellation in the night sky. From the Big Dipper many other constellations can be found. The first and most important to find are the Little Dipper and the North Star.

Procedure

1. While looking at the Big Dipper go to the two stars that make up the end of the bowl. Follow the line that these two stars make until you reach the next bright star. This star is the North Star, "Polaris." Polaris is not the brightest star in the sky, contrary to popular belief.
2. Polaris is the end of the handle of the Little Dipper. The Little Dipper is harder to see, and if there is much light pollution only the last two stars in the bowl will be visible.



Activity: Arcing Along

Reference: Worksheet 1.6 Arcing Along

★ Objective

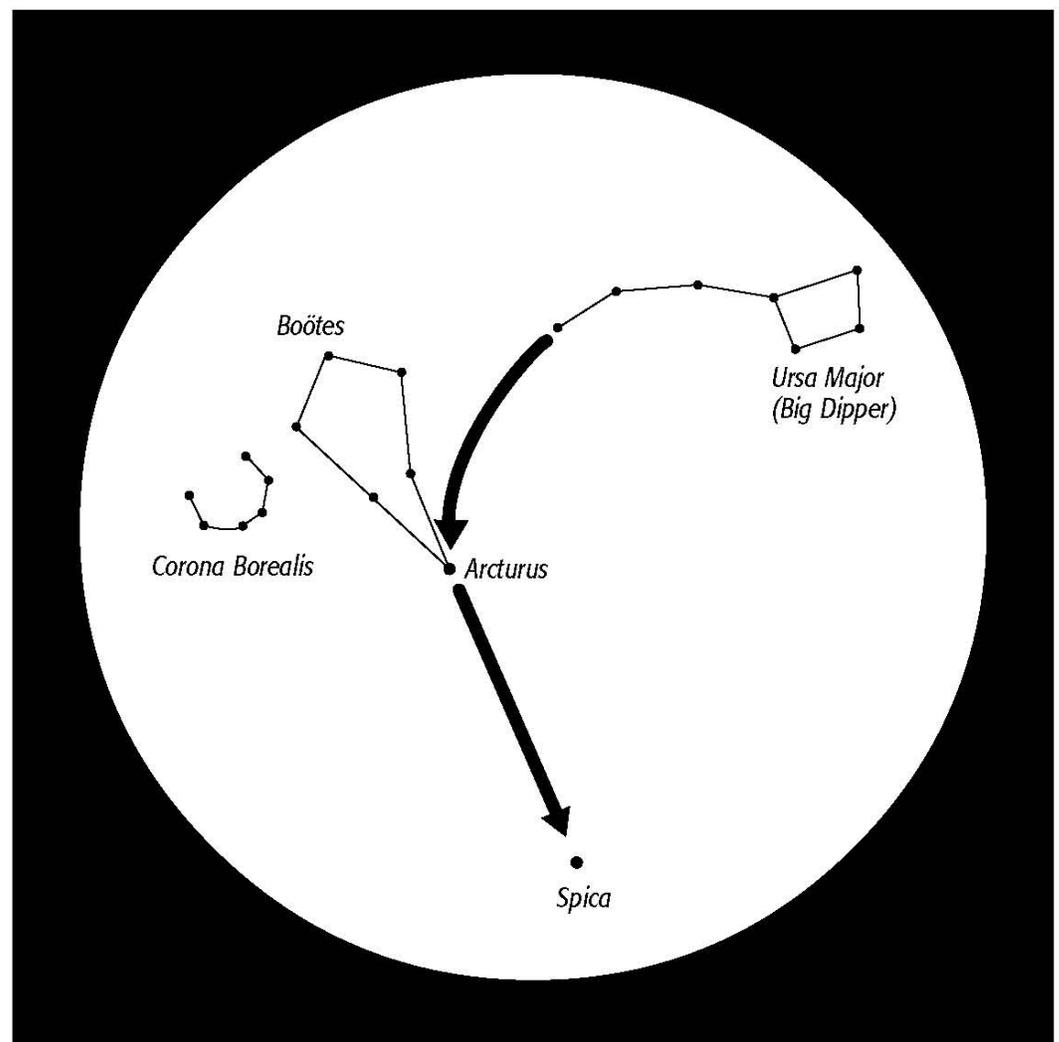
To locate other constellations using the Big Dipper

Again, we will be using the Big Dipper to point us to other constellations in the sky. Following the arc of the handle of the Big Dipper, go about the same distance away as the length of the handle, to the brightest star. This star is called Arcturus and is part of the constellation Boötes, which looks like an ice cream cone.

Procedure

1. To the left of Boötes is a group of stars called Corona Borealis, the Northern Crown, but that looks more like a smile next to Boötes the ice cream cone.
2. From Arcturus, still following the arc of the dipper handle and going one more length is the star Spica.

So remember: From the Big Dipper, arc to Arcturus and speed to Spica.



Activity: Summer Triangle

Reference: Worksheet 1.7 Summer Triangle

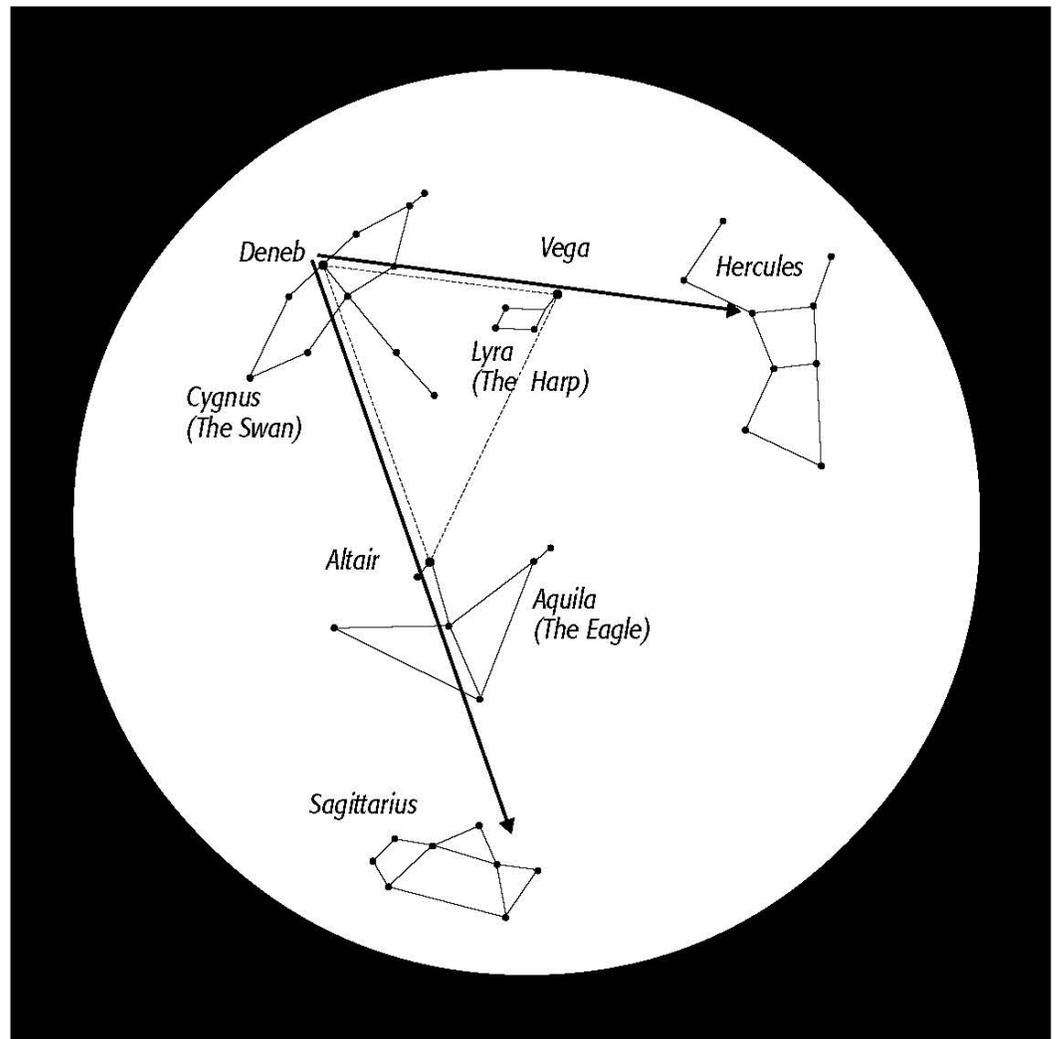
★ Objective

To locate the stars in the Summer Triangle

In the east in early summer and overhead in July and August is a very large constellation called the Summer Triangle. The triangle itself is not an official constellation, but its three corner stars are parts of different constellations.

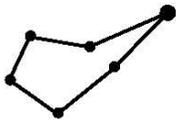
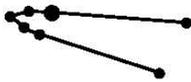
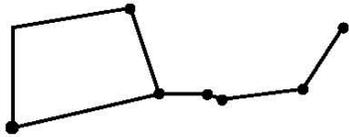
Procedure

1. The brightest star at the top or western side is called Vega, a star in the constellation Lyra the Harp. Going clockwise around the triangle, the next star is Altair, part of Aquila the Eagle. Next would be the star Deneb, part of the constellation Cygnus the Swan, or the Northern Cross.
2. By making a line between the stars of Deneb and Vega and following this line you will come to the constellation Hercules, which looks like a large trapezoid or keystone.
3. A line between Deneb and Altair brings you to the constellation Sagittarius. Sagittarius (the Archer) looks like a teapot and is low on the horizon.

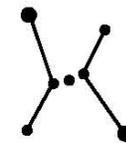
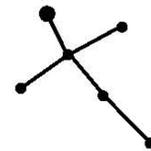
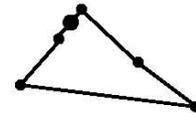
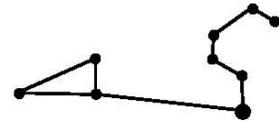


Worksheet 1.3

Constellation Matching

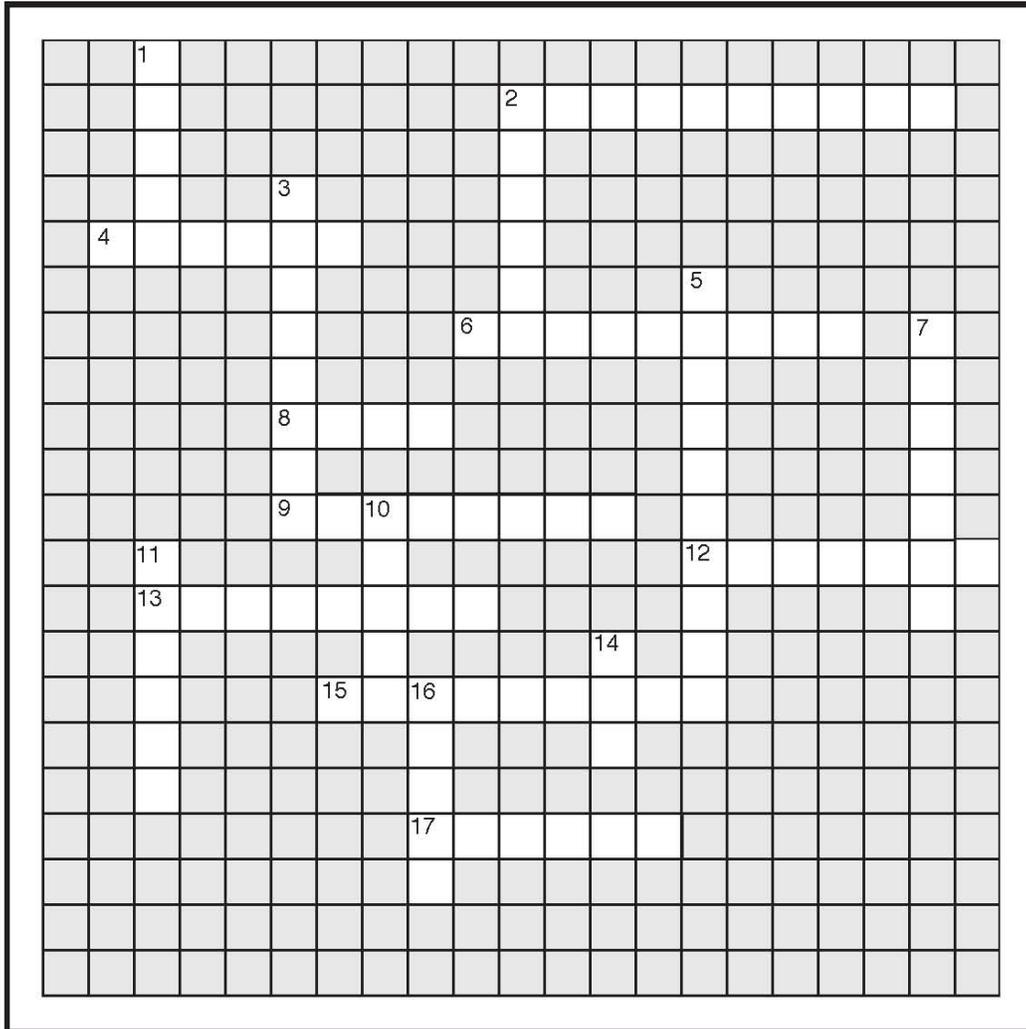


1. Aquila
2. Hercules
3. Corona Borealis
4. Ursa Major
5. Ursa Minor
6. Leo
7. Gemini
8. Boötes
9. Orion
10. Taurus
11. Pleiades
12. Cassiopeia
13. Andromeda
14. Pegasus
15. Cygnus
16. Lyra



Worksheet 1.4

Mythology Crossword Puzzle



Clues

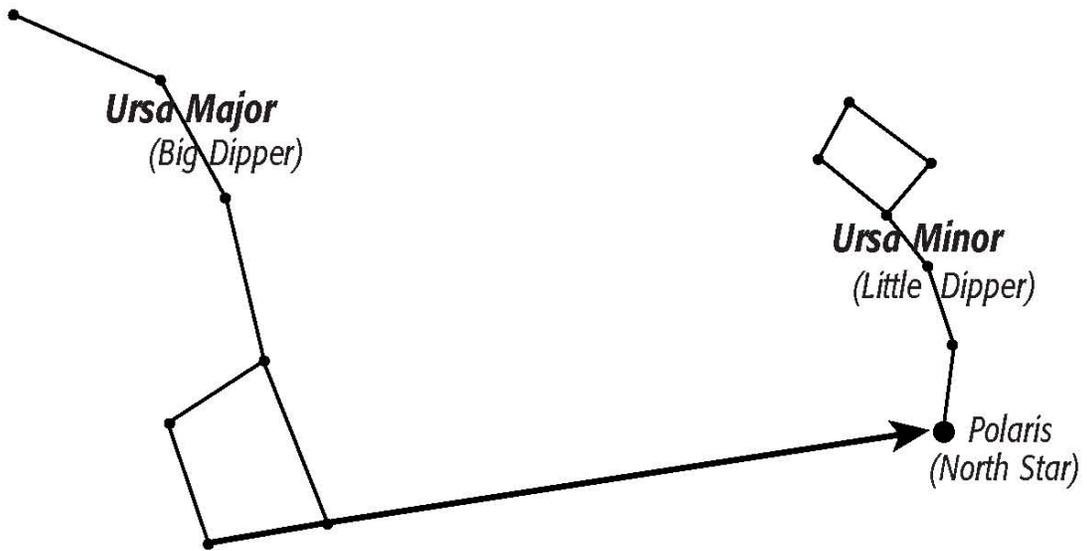
Across

- 2 The Little Dog
- 4 The Shepherd
- 6 The Big Bear
- 8 The Harp
- 9 Killed Orion
- 12 Killed Medusa
- 13 The Water Bearer
- 15 Beautiful Princess Saved by Perseus
- 17 The Swan or The Northern Cross

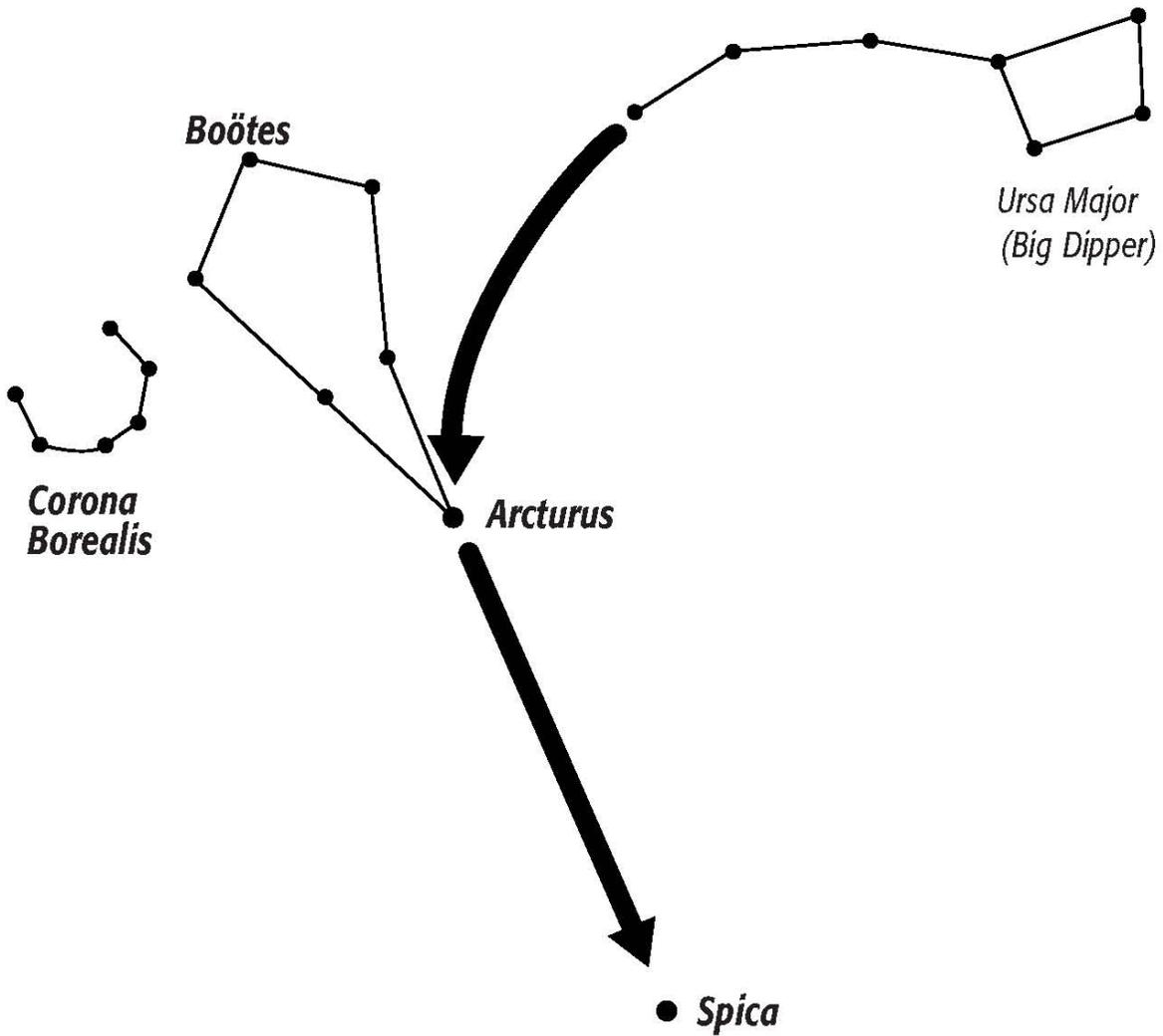
Down

- 1 The Maiden
- 2 The Crab
- 3 Greek Hero or Son of Zeus
- 5 Queen of Gods
- 7 Mythical Winged Horse
- 10 The Great Hunter
- 11 Animal Attacking Orion, or The Bull
- 14 King of the Animals
- 16 The Dragon

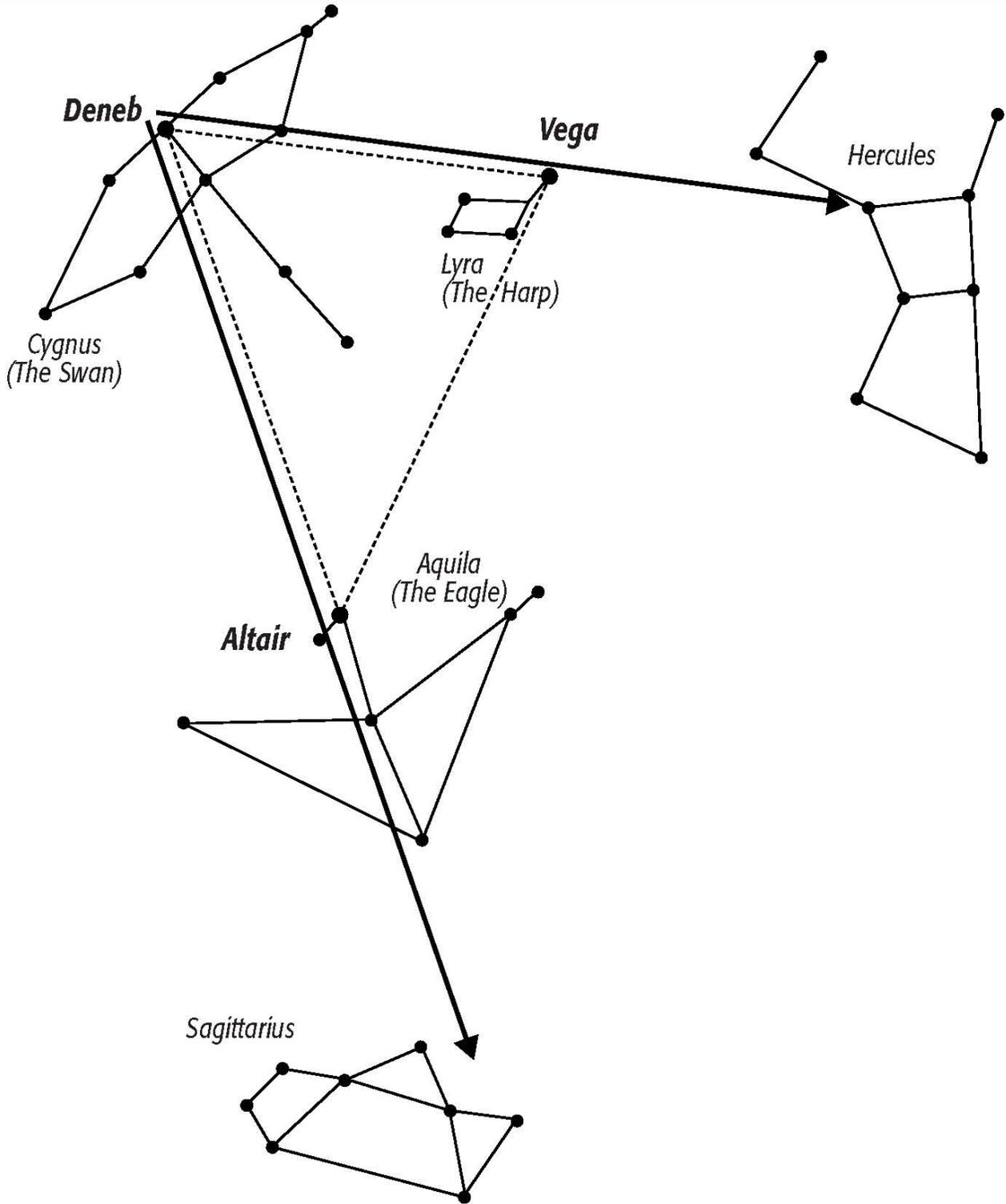
Connecting the Dippers



Arcing Along



Summer Triangle



Fun with Astronomy Mystery Shadows: Solar and Lunar Eclipses

Activity Series:
Fun with Astronomy
Grade: 3rd & up
Time: 45-60 min

Main Idea

An eclipse is an astronomical event that occurs when one celestial object moves into the shadow of another. As the moon rotates around the Earth, sometimes its shadow hits the Earth, causing a solar eclipse. Also, sometimes the Earth's shadow falls across the moon causing a lunar eclipse (only during a full moon). Eclipses occur when the Sun, Earth and moon are in a straight line, which doesn't happen every month because the moon's orbit is tilted in relation to the Earth's orbit around the Sun.

Motivator

A lunar eclipse (luna is Latin for moon) is one of the most beautiful events that can be viewed in the sky. The sun, however, can never be viewed directly, even during a solar eclipse. But there are other methods of observing a solar eclipse. Eclipses of the Sun and moon have always left a deep impression on people. The loss of the Sun, which Ancient people called the "bringer of life," was considered a bad omen. For centuries, people feared solar eclipses. Today some people travel around the world to view one.

Pre-Activity Questions

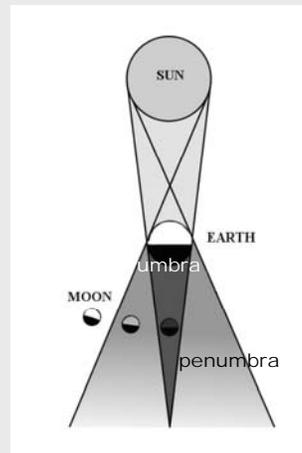
Before you start the activity, ask the students:

- Have you ever seen a lunar or solar eclipse or pictures of one?
- Do you know what causes eclipses?
- Do you know the difference between a solar and a lunar eclipse?

Activity 1: Lunar Eclipse

- Ping pong ball
- Hula-hoop (or large quilting hoop)
- Lamp without a shade (or clamp lamp)
- Dark room
- Tape

1. Set up the lamp at the level of the participants' heads.
2. Tape the ping pong ball to the hula-hoop so it sticks up from the edge. The ping pong ball represents the moon.
3. Have a student hold the hula-hoop around his/her head (which is representing the Earth) at a slight tilt. Darken the room.
4. The student representing Earth should orbit in a slow counterclockwise circle around the lamp, while revolving the hula-hoop around his/her head counterclockwise to model the moon's orbit around the Earth and the Earth's orbit around the Sun. Try it first



Objectives

- To learn how and why solar and lunar eclipses occur.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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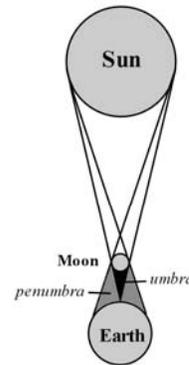
Fun with Astronomy: Mystery Shadows: Solar and Lunar Eclipses

without orbiting the Sun.

5. Watch for a point where the moon (the ping pong ball) is in a line with the Earth and Sun and on the opposite side of the Earth from the Sun. The moon will pass into the Earth's shadow and a lunar eclipse will occur.

Activity 2: Solar Eclipse

1. Follow the same procedure as described in Activity 1.
2. But now watch for a point where the moon (the ping pong ball) is in a line with the Earth and Sun and between the Earth and the Sun. The moon's shadow will pass across the Earth and block the light from the Sun on a small part of the Earth, causing a solar eclipse.



Science Checkup - Questions to ask to evaluate what was learned

- Which type of eclipse is visible to more people on Earth? (See background resources, bullet 1)
- What phase does the moon need to be in for a lunar eclipse to occur? (See background resources, bullet 2)
- What phase does the moon need to be in for a solar eclipse to occur? (See background resources, bullet 3)
- Why doesn't a solar or lunar eclipse happen every time that the moon is at full or new phase? (See background resources, bullet 4)

Extensions

- Check out the NASA eclipse site: <http://eclipse.gsfc.nasa.gov/eclipse.html>
- Look up the date and time of the next lunar eclipse and try to observe it.
- Check out the "Windows to the Universe" lunar and solar eclipse pages: <http://www.windows.ucar.edu/tour/link=/moon/eclipse.html&edu=elem>
http://www.windows.ucar.edu/tour/link=/sun/atmosphere/solar_eclipse.html&edu=elem

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Fun with Astronomy: Mystery Shadows: Solar and Lunar Eclipses

Vocabulary

Lunar eclipse: A darkening of the moon, as viewed from Earth, caused when our planet passes between the Sun and the moon.

Solar eclipse: A phenomenon in which the moon's disk passes in front of the Sun, blocking sunlight. A total eclipse occurs when the moon completely obscures the Sun's disk, leaving only the solar corona visible. A solar eclipse can only occur during a new phase of the Moon.

Umbra and Penumbra: The Earth's shadow is broken up into two parts. The umbra is the darker part of the shadow where no part of the Sun can be seen. The penumbra is lighter than the umbra, because part of the Sun can be seen. During a lunar eclipse, when part of the moon passes through the umbra, this is called a partial eclipse. When the entire moon passes through the umbra, this is called a total eclipse. When the moon only passes through the penumbra, this is called a penumbral eclipse.

Background Resources

- Because the Earth's shadow is larger than the Moon's shadow, a lunar eclipse is visible to everyone on the night side of Earth.
- An eclipse of the Moon (or lunar eclipse) can *only* occur at Full Moon, and only if the Moon passes through some portion of Earth's shadow.
- An eclipse of the Sun (or solar eclipse) can *only* occur at New Moon when the Moon passes between the Earth and the Sun. If the Moon's shadow happens to fall upon the Earth's surface at that time, we see some portion of the Sun's disk covered or "eclipsed" by the Moon.
- Since a New Moon occurs every 29 and 1/2 days, you might think that we should have a solar eclipse about once a month. This doesn't happen because the Moon's orbit around Earth is tilted five degrees to the plane of Earth's orbit around the Sun. As a result, the Moon's shadow usually misses Earth as it passes above or below our planet at New Moon. At least twice a year, the geometry lines up just right so that some part of the Moon's shadow falls on Earth's surface and an eclipse of the Sun is seen from that region of Earth. Remind your students of the slightly tilted hula-hoop — this represents the five-degree tilt of the Moon's orbit.

Fun with Astronomy

Going Through a Phase: Moon Phases

Activity Series:
Fun with Astronomy
Grade: 3rd & up
Time: 45-60 minutes

Main Idea

The moon's phases are a commonly misunderstood occurrence. As the position of the moon changes in relation to the Earth and the Sun, the amount of the moon's lit surface that we see changes.

Motivator

Have you ever wondered why sometimes the Moon appears just as a sliver and sometimes it's a whole circle? Is the Moon really changing size or shape?

Pre-Activity Questions

Before you start the activity, ask the students:

- What is the moon made of? (Rocks similar to those on Earth, but the moon has no atmosphere, 1/6 the gravity of Earth, and no liquid water.)
- Why does it shine? (It reflects light from the Sun.)
- Do other planets have moons? (All planets except Mercury and Venus have moons. Earth is the only planet with just one moon.)
- What do you think causes the phases? (Accept all answers, then explain they are going to do an activity to demonstrate what causes the moon's phases to conclude which idea is correct.)

Activity

- Lamp without a shade or clamp lamp
- softball or large polystyrene ball on a stick
- A dark room.
- Alternatively, you can use polystyrene balls (2" or larger) for each person, held with a stick or pencil.

1. You will need a room that can be darkened. Darken the room after you have everything set up and have provided instructions.
2. Place the lamp so that the bulb is approximately at head level with the participants
3. Give one person (who is representing the Earth) the softball (representing the moon) and have them stand facing the lamp with the ball held at arm's length and positioned just below the light bulb. If you are using polystyrene balls for each participant, have them stand in a circle around the bulb and do the activity simultaneously.
4. The phase that they started in facing the bulb was the New Moon phase. The ball should appear dark.
5. Now have them turn slowly around to the left (counterclockwise) to go through the phases and have them name each phase. A good way to teach "counterclockwise" is the "right hand rule" – hold your right hand out in front of you, stick your thumb up in the air and curve your fingers. The way your fingers are pointing is counterclockwise – the direction almost eve-

Supplies

Objectives

- Understand why the Moon appears to go through phases each month.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Everything in the Solar System rotates and orbits.

6. After the first person has had an opportunity to see the phases, then pass the ball on to the next person and repeat the process (unless each person has a ball.)
7. Make copies of the moon phase pictures on page 4. In groups, have participants cut out the pictures, put them in order and add names of phases. A key is provided for the leader.
8. Try the activity with the ball and light again to reinforce or check answers for phase names and order of phases.

Science Checkup - Questions to ask to evaluate what was learned

- Does the moon rotate? (Yes! See diagram on page 3. This is confusing to many people, since we always see the same side of the moon. The moon is in “synchronous rotation” with the Earth. This means that the moon takes as long to rotate on its axis as it does to make one orbit around the Earth. Therefore the same hemisphere is always pointed toward the Earth. If the Earth did this, a day and year would be the same length of time! You can demonstrate this by having one person (the Earth) turn around in a circle standing in place with another person (the Moon) walking in a circle around the Earth in an orbit. The two people always face each other (we always see the same side of the Moon). Although it doesn’t seem like it, the outside person is rotating as she orbits.
- How have people used the phases of the Moon throughout history?
- What causes the moon to shine? (Reflected light from the Sun)
- Can you think of examples of holidays that are scheduled based on the phase of the moon? (Easter, Chinese New Year, Passover ...)

Extensions

- Have youth observe the phases of the Moon and record them for a month. This would be a good activity to do before the demonstration of Moon phases described above because it provides data and evidence for their ideas about moon phases.
- Try the **Sky Tellers moon phases activities**: http://www.lpi.usra.edu/education/skytellers/moon_phases
- **Windows to the Universe: Moon Phases** http://www.windows.ucar.edu/tour/link=/the_universe/uts/moon2.html&edu=elem ; Lunar Lollipops http://www.windows.ucar.edu/tour/link=/teacher_resources/lunar_edu.html
- **The Phases of the Moon by Noreen Grice**: http://analyzer.depaul.edu/SEE_Project/MoonPhases/MoonPhases.htm
- **Oreo cookie moon phases by Chuck Bueter (for younger children)** <http://analyzer.depaul.edu/paperplate/Oreo%20Moon%20Phases.htm>
- **Moon Finder activity with paper plates by Chuck Bueter** <http://analyzer.depaul.edu/paperplate/Moon%20Finder.htm>
- **Paper Moons – moon phases book from paper plates by Sharon Mendonsa** <http://analyzer.depaul.edu/paperplate/Paper%20moons.htm>

Vocabulary

Phases: Stages that the Moon goes through, in which the amount of the lit half of the Moon that we can see changes.

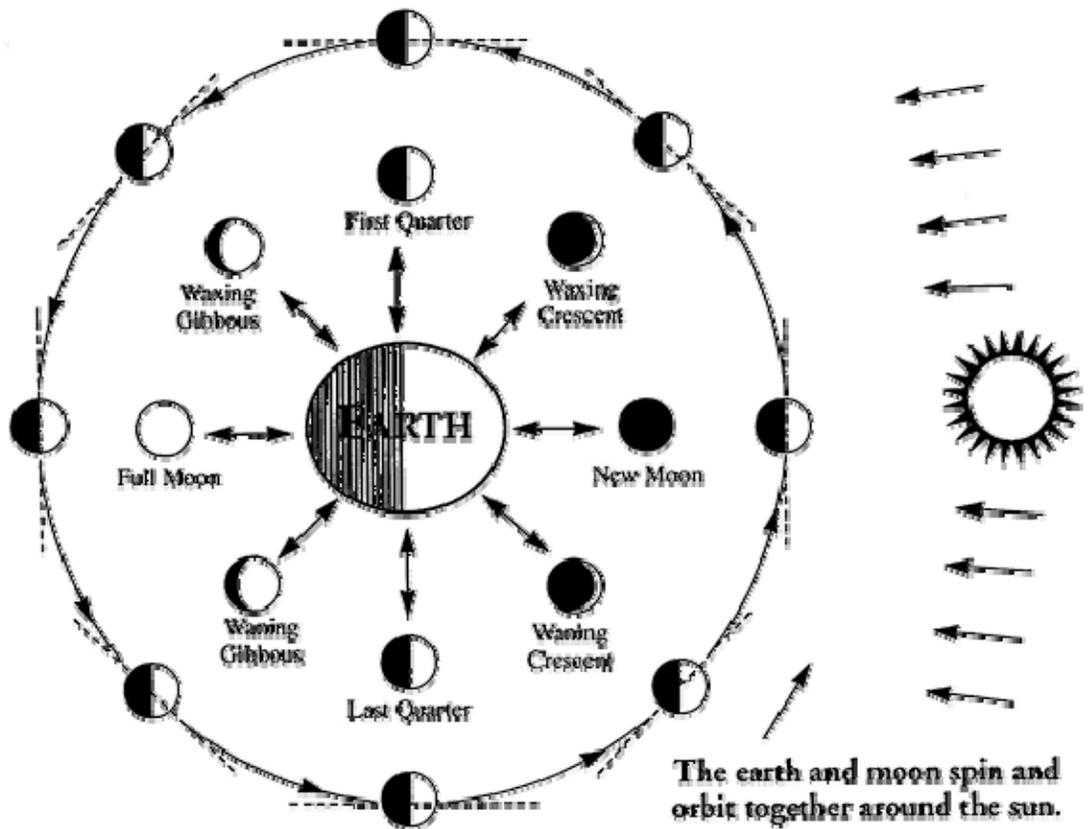
Waxing: When the lit part of the Moon is getting bigger each day (from New to Full).

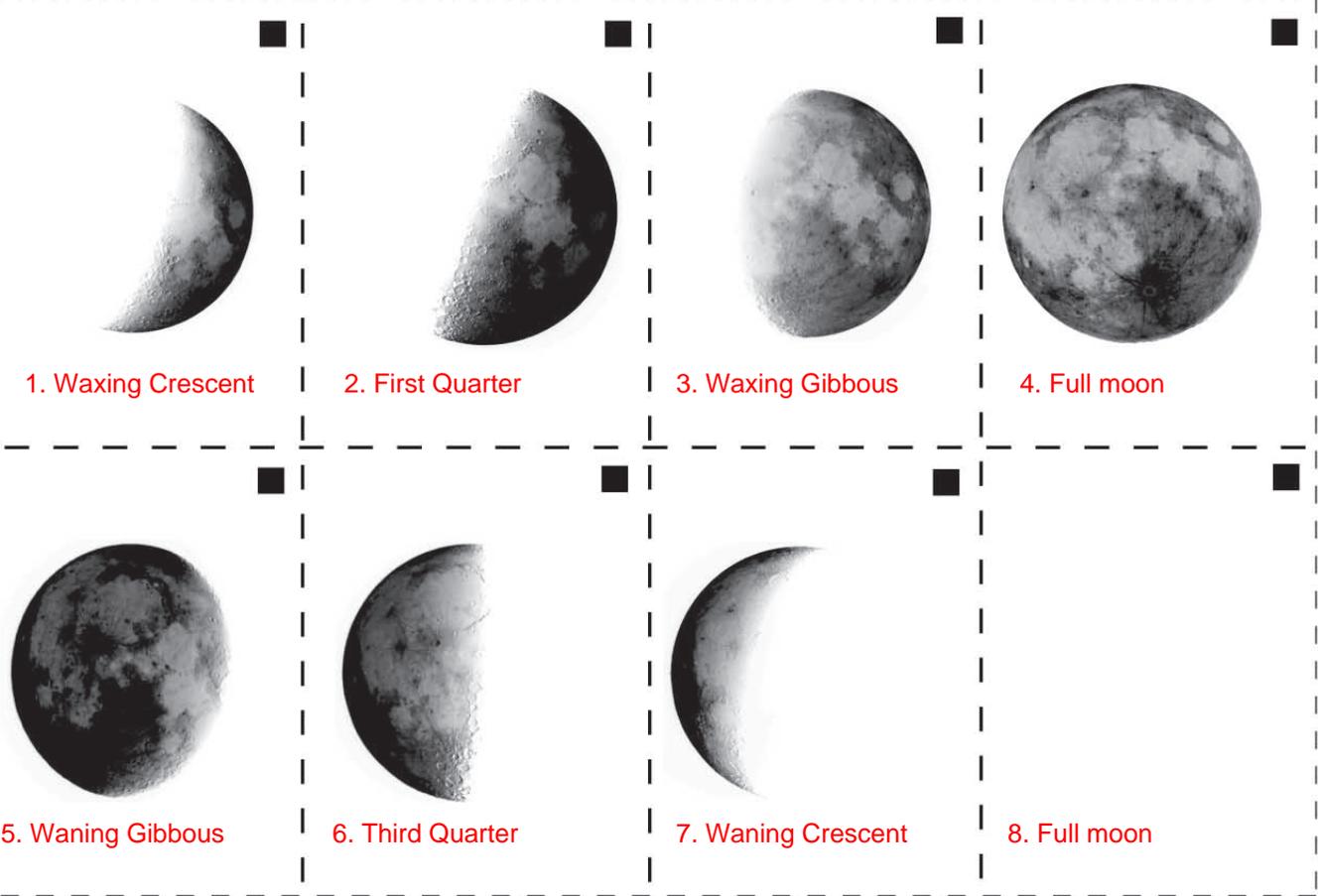
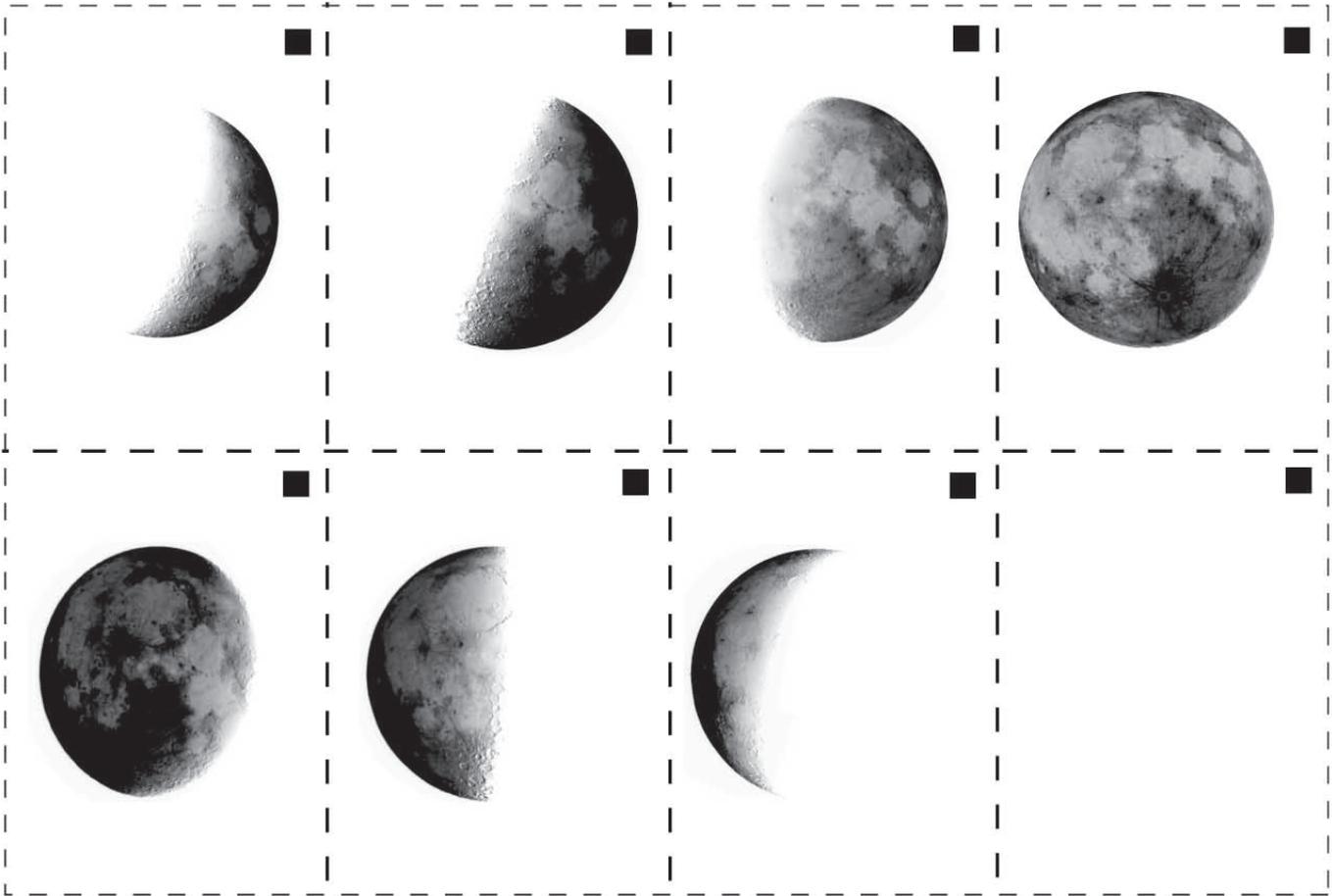
Waning: When the lit part of the Moon is getting smaller each day (from Full to New).

Background Resources

- Phases of the Moon site: http://aa.usno.navy.mil/faq/docs/moon_phases.php
- Windows to the Universe: http://www.windows.ucar.edu/tour/link=/earth/moons_and_rings.html

Phases of the Moon





How Big and How Far? Scale model of our solar system

Activity Series:
Fun with Astronomy
Grade: 2nd & up
Time: 45-60 min

Main Idea

Scale models make it easier to comprehend the vast sizes and distances in our solar system.

Motivator

Did you know that Mercury, the closest planet to the Sun, is still 36 million miles away? Earth is 93 million miles from the Sun? Don't know how far 93 million miles is? Let's find out by making a model of our solar system.

Pre-Activity Questions

Before you start the activity, ask the students:

- How many stars are in our solar system? (One, our Sun)
- How many planets are in our solar system? Can you name them in order? (See background resources, bullet 3)
- Do you know any mnemonic (memory) phrases to help remember the planets? (See background resources, bullet 4)
- Do you know the two main types or groupings of planets? (See background resources, bullet 5)
- How is Pluto now classified? (See background resources, bullet 6)

Activity

- Basketball
- Grain of sand
- Two peas of different sizes
- BB
- Golf ball
- Ping pong ball
- Two gum balls
- Meter stick
- A half-mile field, football field or at least 15 feet of clear space
- Cardboard and sturdy bamboo skewers (optional for making signs)

You could also use other objects of similar size and scale to each other.

1. This activity demonstrates the relative placement (order from the Sun) of the planets and the relative size difference between the planets.
2. View the chart on the next page and decide which model you will do. The field model is recommended if you have the space. Or you can try both.
3. Assign each of the objects to a participant.
4. Have the whole group pace out (or measure) the distance to each planet. You might want to attach the smaller objects to a piece of cardboard, attach a stick, plant the sign in the ground at each planet's location and go on to the next one. Leave the basketball Sun wherever you start.
5. Talk about each planet as you take your journey through the solar system. Ask the participants what they know.

Supplies

Objectives

- To develop an understanding of the vast scale of our solar system and the order and relative sizes of the planets.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Fun with Astronomy

How Big and How Far? Scale model of our solar system

Celestial Body	Object to Represent	Distance from Sun		
		15 foot Model	Football Field Model	Large Field (approx. 1/2 mile). Pace = ~ 3 feet
Sun	Basketball			
Mercury	Grain of sand	1.8"	1 yard	10 paces from Sun
Venus	Smaller pea	3.1"	2 yards	8 paces from Mercury
Earth	Larger pea	4.5"	3 yards	8 paces from Venus
Mars	BB	6.8"	4.5 yards	18 paces from Earth
Jupiter	Golf ball	2' 0"	15 yards	106 paces from Mars
Saturn	Ping-pong ball	3' 7"	26 yards	138 paces from Jupiter
Uranus	Gum ball	7' 6"	51 yards	279 paces from Saturn
Neptune	Gum ball	11' 4"	79 yards	315 paces from Uranus

Background information on the planets

Mercury: Solid and rocky, diameter is 38 percent the size of Earth's; almost no atmosphere; no moons; day = 58 Earth days, year = 88 Earth days

Venus: Solid and rocky; diameter is 95 percent of Earth's; thick atmosphere of mostly carbon dioxide 92 times Earth's sea-level pressure; no moons; day = 243 Earth days, year = 225 Earth days (a day is longer than a year!)

Earth: You know a lot about Earth!

Mars: Solid and rocky, diameter is 53 percent of Earth's; very thin atmosphere of mostly carbon dioxide with less than 1 percent of the air pressure on Earth; two small moons (sort of look like potatoes, probably captured asteroids); day = 24.6 Earth hours, year = 1.9 Earth years

Jupiter: Gas (mostly hydrogen and helium), liquid hydrogen, liquid metallic hydrogen, rock and metal core; the largest planet (diameter is 11 times bigger than the Earth's); year = 11.9 Earth years, day = 9.9 Earth hours; more than 60 moons

Saturn: Gas (mostly hydrogen and helium), liquid hydrogen, liquid metallic hydrogen, methane, ammonium, and water ices; rock and metal core; diameter is 9 ½ times the Earth's; day = about 10.6 Earth hours; year = 29.5 Earth years; more than 60 moons; spectacular ring system made of water ice particles

Uranus: Pronunciation "YOOR-a-nus"; mostly methane ice on inside, liquid hydrogen, rock and metal core; has rings; orbits the sun on its side; diameter is four times bigger than Earth's; day = 17 Earth hours; year = 84 Earth years; has at least 27 moons, most named after Shakespearean characters

Neptune: Mostly methane ice on inside, liquid hydrogen, rock and metal core; has rings and at least 13 moons; diameter is almost four times bigger than Earth's; day = 16 Earth hours; year = 165 Earth years

Science checkup - Questions to ask to evaluate what was learned

- Which planets are closer to the Sun than the Earth? Which are farther away?
- What are some of the things that planets are made of?
- What are the similarities and differences between planets closer to the Sun and planets farther away?

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Fun with Astronomy

How Big and How Far? Scale model of our solar system

Extensions

For more information on the solar system, check out these and other Web sites:

- **Windows to the Universe:**
http://www.windows.ucar.edu/tour/link=/our_solar_system/solar_system.html
- **Welcome to the Planets:** <http://pds.jpl.nasa.gov/planets/>
- More information on the **reclassification of Pluto:**
<http://www.astro.cornell.edu/~jlm/planet.html>
- **Modeling the Solar System:** This set of activities includes a fun solar system model using fruits, vegetables, nuts and seeds (e.g. head of lettuce, cantaloupe, lemon, lime ...)
<http://solarsystem.nasa.gov/educ/docs/modelingsolarsystem.pdf>
- **Solar System Scale Model Meta Page:** Links to other sites, check out the “Build a Solar System” site:
<http://www.vendian.org/mncharity/dir3/solarsystem/>
- **Pocket solar system:** This activity uses adding machine tape and is a fun thing for kids to take home – it illustrates the relative distance between planets and the order of the planets

Vocabulary

Scale Model: A representation or copy of an object that is proportionally larger or smaller than the actual object and helps us to understand the object or system.

Geocentric: An older theory that the Earth is the center of the universe and other objects go around it. The distinction between the solar system and the universe was not clear until modern times. Belief in this system was common in ancient Greece and China.

Heliocentric: The modern accurate system, in which the Sun is at the center of the solar system.

Asteroid Belt: A region of the solar system located roughly between the orbits of the planets Mars and Jupiter. It is occupied by large numbers of irregularly shaped rocky bodies called asteroids

Kuiper Belt: A region of icy objects beyond Neptune like the asteroid belt, but much larger, with icy bodies rather than rocky ones. Pluto is the most familiar object in the Kuiper Belt.

Background Resources

- Around the year 330 BC, Heraclides may have developed the first known model of the solar system, but his model was geocentric, meaning that the Earth — not the Sun — was at the center of the solar system. Within the following century, Aristarchus, another Greek scientist, presented an argument for a heliocentric (Sun-centered) model of the solar system. His ideas were rejected at the time and not revived until 1,800 years later by Copernicus.
- There are eight planets in our Solar System: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
- There are several examples of memory phrases to help students remember the order of the planets, including “My very educated mother just served us noodles.”
- Mercury, Venus, Earth and Mars are all rocky or “terrestrial” planets. Jupiter, Saturn, Uranus and Neptune are known as gas or “gaseous” planets.
- Since 2006, Pluto has been considered a dwarf planet. Pluto doesn’t fit in either group of rocky or gaseous planets. Leaving Pluto out (although it is still out there!) makes distance models a little easier. (See extensions for more information on Pluto.)
-

Activity Series:
Fun with Astronomy
Grade: 2-6
Time: 45-60 min



Main Idea

Constellations have fascinated humans throughout history and are fun to identify and teach to others, but it takes practice to learn them. Constellations help us tell stories, find stars in the night sky, and identify the season.

Motivator

Throughout human history, people in all parts of the world have observed the stars. By associating groups of stars with a character from a story, it made it easier to remember where star patterns were located in the sky. The ancient constellations helped people to note the passage of time, navigate and remember important mythological stories and events. Using the sky as a calendar and timekeeper was a strong part of many cultures.

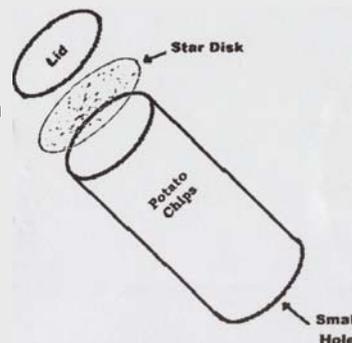
Pre-Activity Questions

Before you start the activity, ask the students:

- How many stars are there in our Solar System? (one, the Sun)
- What is a star? (A hot ball of hydrogen and helium gas that shines because of nuclear reactions in its core.)
- Do you recognize any constellations when you look at the sky?
- Are all stars in a constellation the same distance from Earth? (No)
- Why don't we see stars during the day? (the sun is too bright)

Activity

- A Pringles® can for each participant, with clear plastic lid.
- Black construction paper
- Hammer
- Large nail
- Copies of the constellation template (on page 3)
- Pin or needle
- Decorating materials (optional)



1. Use the large nail and the hammer to punch a hole into the bottom (the metal end) of the Pringles can.
2. Place the end of the can on top of the construction paper and trace a circle around the outside of it. You may want to make several circles for different constellations.
3. Now line up the constellation template/s with the circle/s of construction paper that you have drawn, and poke holes in them using the needle or pin, on the places that stars are indicated.
4. Cut out the circle(s).
5. Place one of the circles that you have cut out into the lid of the Pringles can and recap it.

Objectives

- Learn to identify and show others a few well-known constellations
- Learn more about stars.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
 - Hypothesize
 - Evaluate
 - State a Problem
 - Research Problem
 - Test
 - Problem Solve
 - Design Solutions
 - Develop Solutions
 - Measure
 - Collect Data
 - Draw/Design
 - Build/Construct
 - Use tools
 - Observe
 - Communicate
 - Organize
 - Infer
 - Question
 - Plan Investigation
 - Summarize
 - Invent
 - Interpret
 - Categorize
 - Model/Graph
 - Troubleshoot
 - Redesign
 - Optimize
 - Collaborate
 - Compare
- Contributed By**
Nancy Schaff,
Cornell Center for
Radiophysics &
Space Research in
the Department of
Astronomy

6. (Optional) Decorate the can with whatever materials you have (leftover wrapping paper works well).
7. To view the constellation, point the capped end towards a light and look through the hole in the base of the can.

Alternative Method: *If you cannot obtain Pringles cans, a toilet paper or paper towel tube can be covered with black construction paper or a double layer of black tissue paper on both ends. Poke star holes through one end (you will need to shrink down the constellation template to a smaller diameter), punch a nail hole in the other end, and decorate.*

Science Checkup - Questions to ask to evaluate and extend learning

- Why have people named patterns of stars throughout history and created stories about them? Was it useful to be able to identify different constellations at different times of the year? If so, why?
- Do you think you can go outside and find a constellation? Do you know any well enough to find them in the night sky?
- How many stars are in our Solar System? (One, the Sun.) How many stars are there in the Milky Way Galaxy? (billions) All of the stars we see in the night sky are in the Milky Way Galaxy.
- Are the stars we see all the same size and distance from Earth? (No, there are many different sizes with different brightnesses and different distances from Earth.)
- Are there different colored stars? (Yes, blue stars are very hot and don't live long; red stars are cooler; our yellow star, the Sun, is a medium-sized star and will live a long time.)

Extensions

- Learn more about constellations by picking a favorite, learning the story behind it and sharing it with others.
- Observe the sky on a clear night and make up your own constellations.
- Create a Constellation activity – from the Pacific Science Center
<http://www.pacsci.org/download/astro_ad_constellation.pdf> or
<<http://www.astrosociety.org/education/activities/astroacts02.html#4>>
- Try activities from the Lunar & Planetary Institute “Sky Tellers” constellation unit
<<http://www.lpi.usra.edu/education/skytellers/constellations/>>

Vocabulary

Constellation: A group of stars that, when viewed from the earth, are in an obvious pattern. They are usually named for mythological gods, people, animals and objects. Modern astronomers divide the sky into 88 regions called constellations that contain named star patterns.

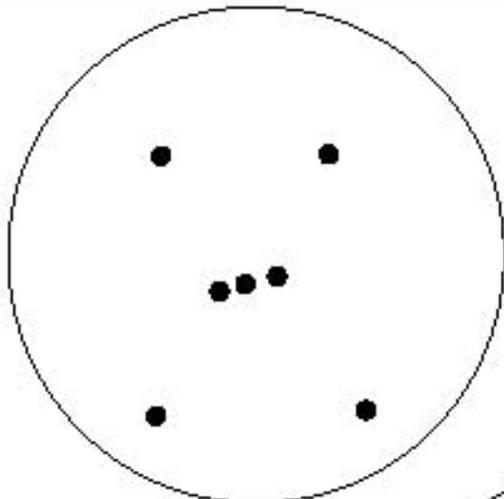
Background Resources

- Constellations are imaginary patterns in the sky that poets, farmers and astronomers have named over thousands of years. Many of them were named after ancient gods, creatures and objects in Greek myths. Some historians suspect that many of the myths associated with the constellations were invented to help farmers remember them.
- In some regions of the world, there is not much differentiation between the seasons. Since different constellations are visible at different times of the year, farmers used them to tell what month it is. When they saw certain constellations, they would know it was time to begin the planting or the reaping.

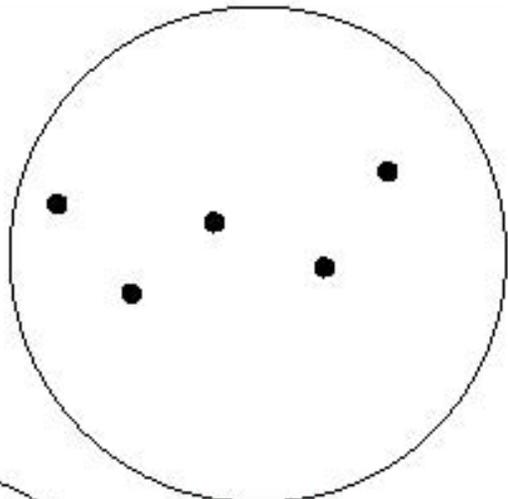
Find this activity and more at: <http://nys4h.cce.cornell.edu>

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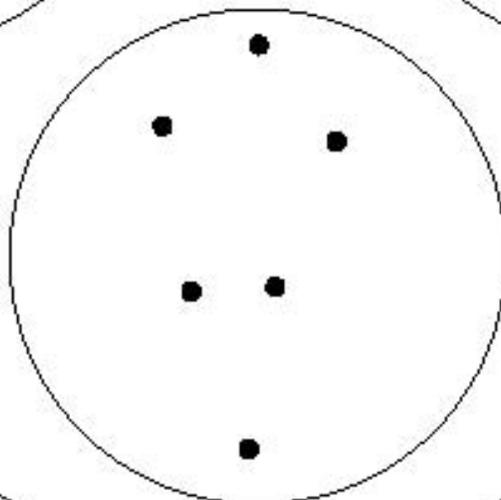
Constellation Patterns



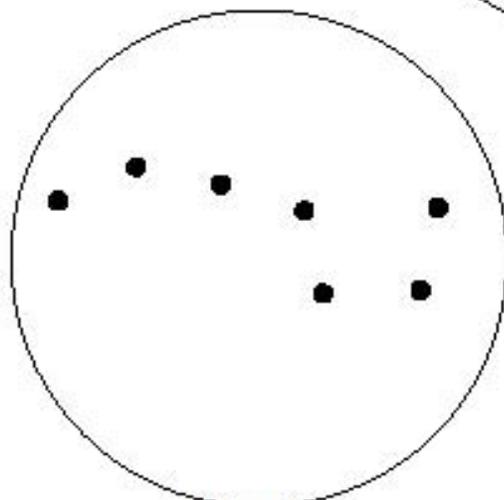
Orion



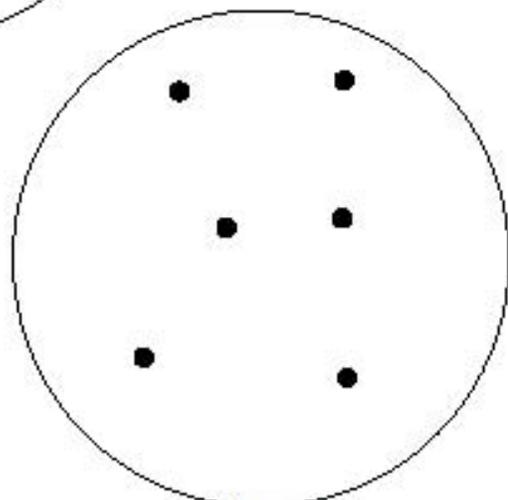
Cassiopeia



Boötes

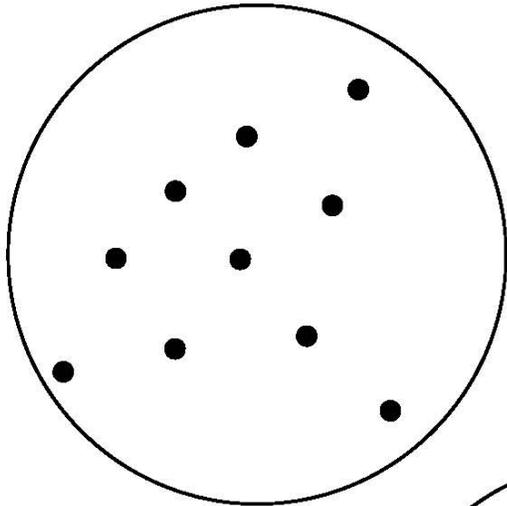


Ursa Major

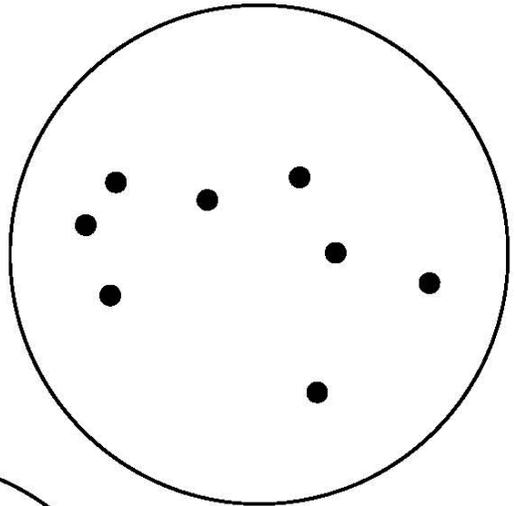


Hercules

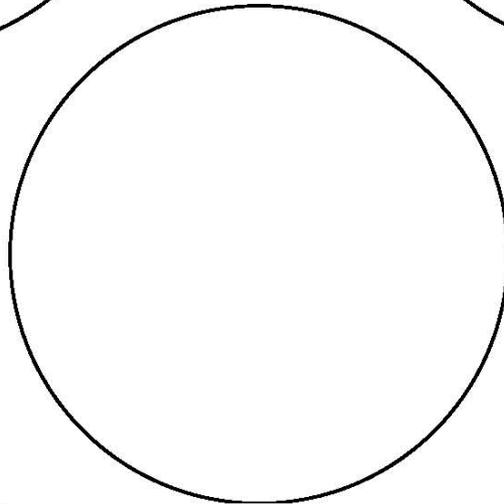
More
Worksheet 7.2
Constellation Patterns



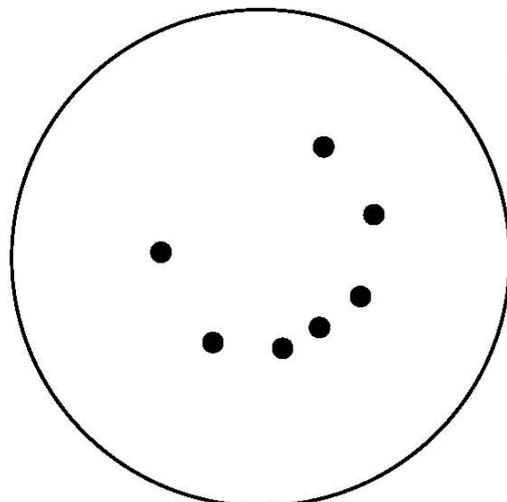
Cygnus



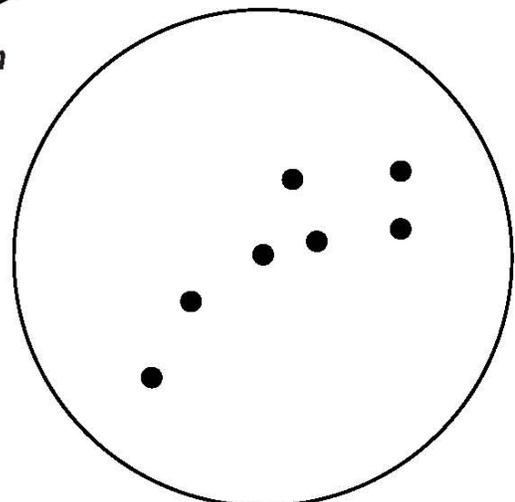
Sagittarius



Make Your Own



Corona Borealis



Ursa Minor

Fun with Astronomy: What Time is It? Make a Sundial

Activity Series:
Fun with Astronomy
Grade: 3rd & up
Time: 1 hour

Main Idea

Our concept of time is based on motion of the Sun. Sundials work on the simple principle that as the sun moves through the sky, the gnomon, or centerpiece pointer, casts a moving shadow on the dial to indicate the passage of time.

Motivator

Did you know that ancient people could tell the time of day just by looking at the sun's position in the sky? You can make a simple instrument called a sundial to help you tell time without a watch.

Pre-Activity Questions

Before you start the activity, ask the students:

- Where is the sun at noon?
- How long is a day?
- Does the number of hours of daylight change during the year?
- Do you know how to find the North Star (Polaris) in the sky?

Activity

- Copies of the sundial design on cardstock (one for each student)*
- Scissors
- Tape
- Crayons or markers
- The latitude at which you live
(see http://jan.ucc.nau.edu/~cvm/latlon_find_location.html)
- Blocks of wood or stones (optional)

*Note: * If you don't have access to cardstock, you can print out the sundial and have the kids bring in empty cereal boxes or other cardboard. Glue the design to the box, then cut through both layers.*

1. Cut out the base of the sundial and the sundial's gnomon.
2. Color the sundial if desired.
3. Cut the centerline on the base of the sundial.
4. Fold the tabs on the base down and tape them to each other.
5. Cut the gnomon to the approximate degree of latitude for your location.
6. Slide the gnomon up through the center slit in the base and fold the tabs against the bottom of the sundial and tape them there.
7. Glue the sundial to a block of wood or use stones to keep from blowing away (optional).
8. Bring the sundial outside, and point the number 12 toward North.

*Remember, during daylight savings time you must **ADD** one hour to the time.*

Objective

- To build a paper sundial that can be used at home.
- To learn how to tell time using a sundial.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

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Radiophysics &
Space Research in
the Department of
Astronomy

Fun with Astronomy: What Time is It? Make a Sundial

Science Checkup - Questions to ask to evaluate what was learned

- Why do you think you add one hour to the sundial's time during daylight savings time?
- What would happen if you had the gnomon pointing south instead of north?
- Why is it important to cut the gnomon to a particular angle correlating to the correct latitude?

Extensions

To learn more about sundials check out these sites:

- <http://www.sundials.org/faq/>
- <http://www.phy6.org/stargaze/Sundial.htm>
- *Sky Tellers* "Day and Night" and "Polaris" activities at http://www.lpi.usra.edu/education/skytellers/day_night/
- <http://www.lpi.usra.edu/education/skytellers/polaris/>
- Making a pocket sun clock from the Pacific Science Center: www.pacsci.org/download/astro_ad_sun_clock.pdf

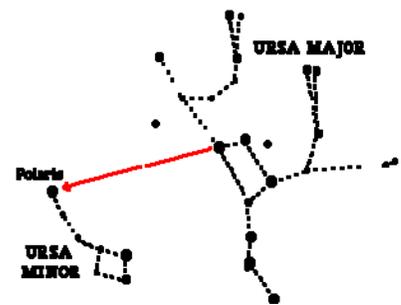
Vocabulary

Gnomon: The centerpiece of a sundial, which stands at a particular angle that correlates to a specific latitude, in order to cast the appropriate shadow onto a sundial.

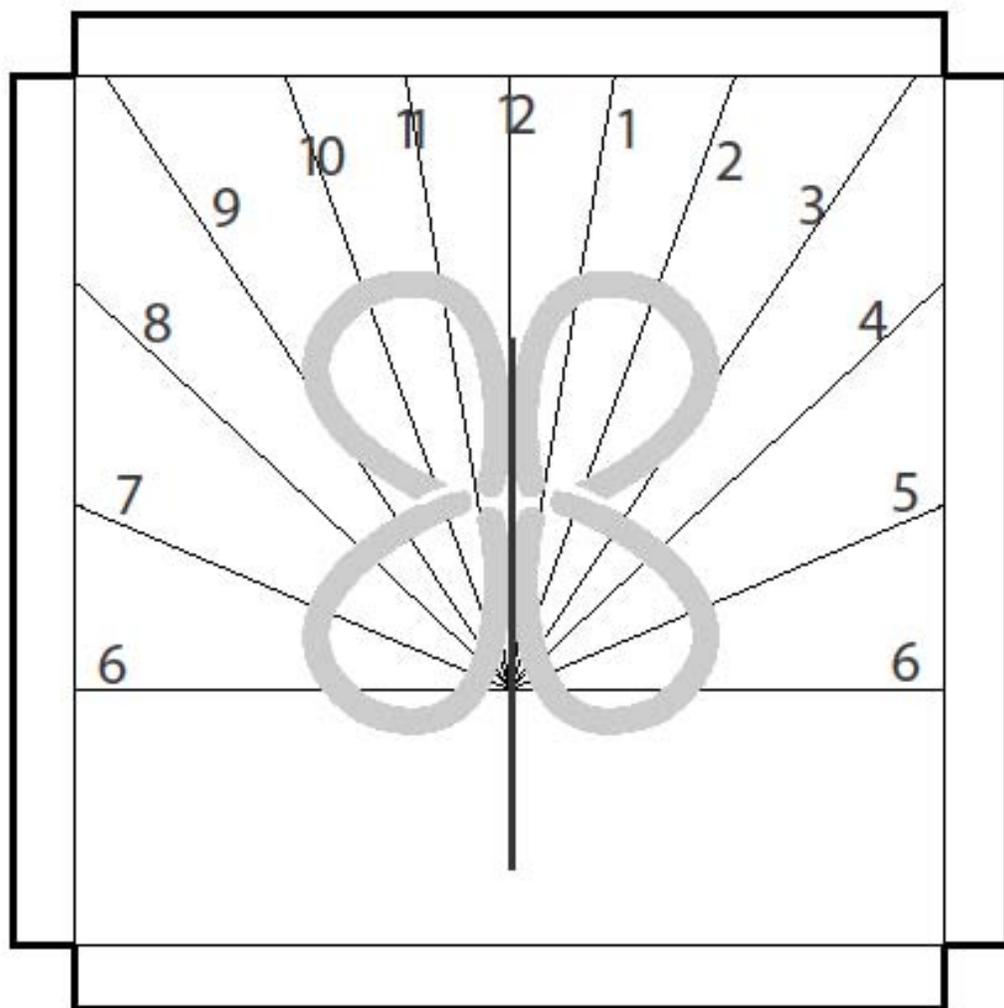
Lines of Latitude: Imaginary lines that run parallel to the equator that tell a point's location north or south of the equator.

Background Resources

- Sundials are the oldest time-measuring devices and may be the earliest scientific instruments. The earliest sundials known from the archaeological record are obelisks (3500 BC) and shadow clocks (1500 BC) from ancient Egypt and Babylon. Sundials are believed to have existed in China since ancient times, but very little is known of their history. Sundials were also used in ancient Greece and Rome. In central Europe, sundials were the most common method to determine time, even after the mechanical clock was developed in the 14th century. The sundial was actually used to check and adjust the time on mechanical clocks until late into the 19th century. Sundials come in all shapes and sizes, from tiny pocket dials to huge dials in observatories or parks. Although their main purpose is to tell the time, they are often used as focal points in gardens, as art in the form of sculptures and even as jewelry.
- To find the North Star (Polaris), find the Big Dipper (part of the constellation Ursa Major) in the sky. While looking at the Big Dipper go to the two stars that make up the end of the bowl. Follow the line that these two stars make until you reach the next bright star (but not nearly the brightest star in the sky). This star is the North Star (Polaris). Polaris is the end of the handle of the Little Dipper (Ursa Minor).
- At noon, the sun is approximately south but not directly overhead (as many people think.) For most locations, local solar noon does not occur at exactly 12 noon because time zones cover a great distance east to west (and daylight savings time will also affect the actual time).
- Our 24-hour day is actually a solar day, which is the time it takes for the Sun to make one circuit around the local sky. We think of a day as the length of time it takes for the Earth to rotate once, but that is actually about 4 minutes less than 24 hours. A solar day is just a bit longer because the Earth is orbiting the Sun at the same time it is rotating.



Sundial Base

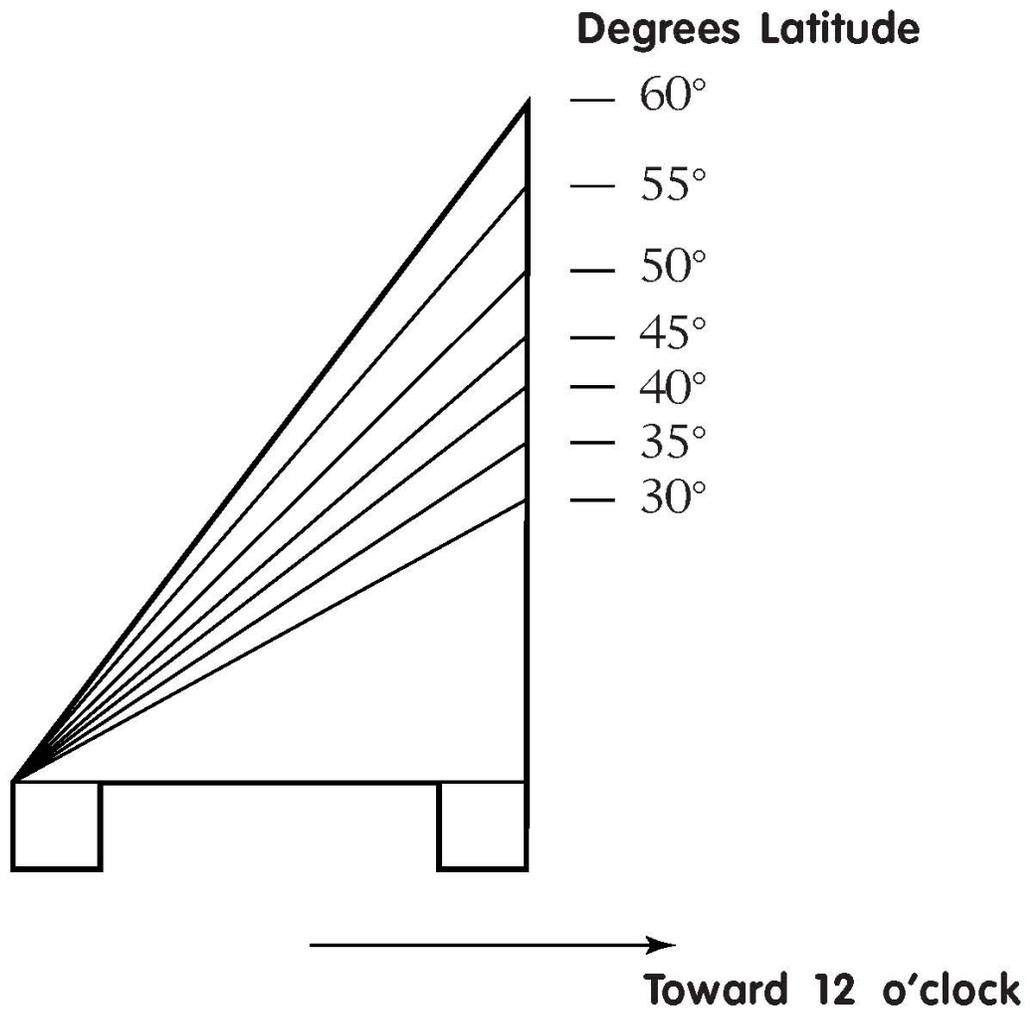


Instructions

1. Cut out around black lines.
2. Fold tabs down.
3. Place gnomon along black line in center of sundial.

Worksheet 8.2

Sundial Gnomon



Instructions

1. Cut out along dark black lines.
2. Cut the line at the correct latitude.

Climate

About the 4-H Science Toolkit Series: Climate

In this series of activities, children will explore the impact of weather and climate on humans, animals and plants and begin to understand what causes wind, snowfall, storms and other weather events.

Children will create construction paper snowstorms, indoor thunderstorms, learn how a tree stump can reveal the climate of a region and create an instrument to measure wind speed. By recreating these natural events, children experiment with the various factors that affect weather and climate – humidity, air pressure, temperature and elevation.

They will also learn how weather forecasters use tools like contour maps to predict snowfall and temperature and discuss how animals and plants adapt to changing weather conditions.

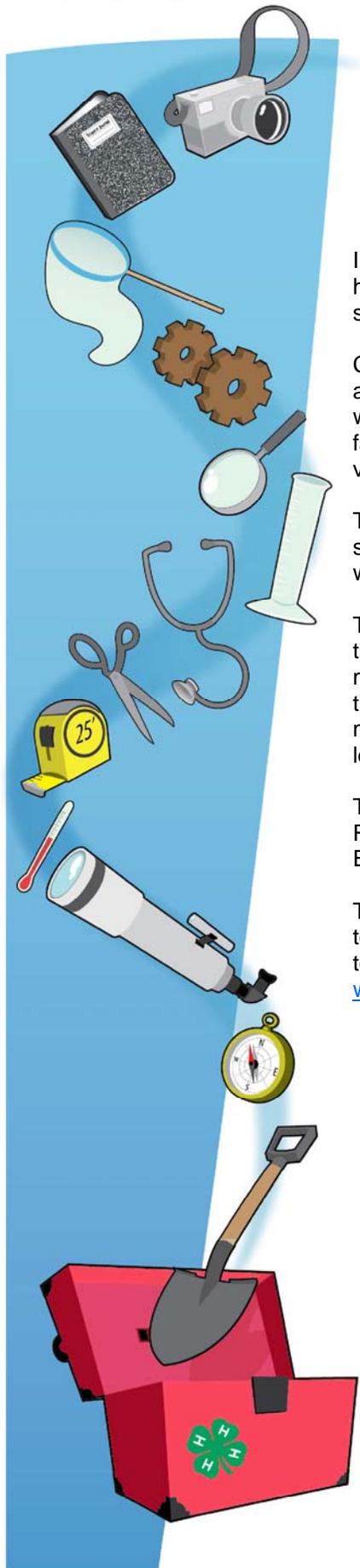
These hands-on activities allow students to predict what will happen, test theories, then share their results. By gaining an understanding of the basic forces affecting climate, some of the mysteries of storms and wind are revealed and children can see the impact of human activity on climate and environment. They'll be introduced to climate vocabulary, gain an understanding of the importance of species diversity and learn how to be good environmental stewards.

The lessons in this unit were developed by and are connected to the Paleontological Research Institution in cooperation with Cornell University and Cornell Cooperative Extension.

To find out more about climate and its relation to the environment, visit the Paleontological Research Institution at www.pri.org and to find numerous resources related to climate, weather and environment, check out the 4-H Resource Directory at www.cerp.cornell.edu/4h.

Climate Table of Contents

- What Causes a Storm?** Learn about the physical forces that cause rainfall and snowstorms.
- Focus on Snowfall.** Discover how precipitation varies between locations
- Temperature through Time.** Determine temperatures of past years using proxies like tree stumps.
- Focus on Wind.** Create an instrument for measuring wind.
- Water's Incredible Journey.** Understand the water cycle.
- Climate and Organisms.** Understand the impact of climate on animals and plants and how they adapt.



Climate: What causes a storm?

Activity Series:

Climate

Grade: 3-6

Time: 60 min

Main Idea

It takes a number of factors to cause rain, including humidity, warm temperatures and wind. Other atmospheric properties -- including density, air pressure, moisture and temperature -- define an air mass that is involved in the creation of a thunderstorm.

Motivator

Climatologists and meteorologists are the scientists who study the reasons why rain happens. Let's create our own rain and thunderstorms to learn about the conditions that cause rain.

Pre-Activity Questions

Before you start the activity, ask the students:

- Does it rain often in a desert?
- Does it rain often at the North Pole or in other arctic areas?
- Why do you think so? What causes a thunderstorm to happen?

These activities will help us find out about the basic forces needed to create rain and thunderstorms.

Objectives

- Learn about the water cycle.
- Discover forces that contribute to rainfall and storms.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

Contributed By

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County

Activity 1: Cloudy sky — make it rain!

- Empty, clean glass jar (pickle jar, jam jar)
- Disposable pie pan
- 6-8 ice cubes
- Hot water

1. Pour hot water into the glass jar and cover it with the pie pan (right-side up).
2. Let sit for approximately one minute. What's happening inside the jar?
3. Place the ice cubes in the pie pan and watch what happens in the jar. Now what's happening in the jar? Why are droplets forming on the pie pan?

Activity 2: Stormy weather — make a thunderstorm!

- Clear plastic/glass container (9x11 baking pan recommended)
- Water with blue food coloring
- Lukewarm water
- Red food coloring
- Ice cube tray

Supplies

Supplies

Climate: What causes a storm?

Preparation (to be done before meeting):

Mix water with blue food coloring and pour into ice cube tray; freeze.

Activity:

1. Pour 1 inch of clear lukewarm water into the container, enough to cover ice cubes, but not too much to allow floating. Ask students what will happen when you add blue ice cubes to one end and red food coloring to the other.
2. Add one or two prepared ice cubes to the far end of the container.
3. Add three drops of red food coloring to the other end of the container.
4. Observe what happens to the water. Where does the cold water travel in the container? Where does the lukewarm water travel? Why is that happening?
5. Leave the container for a period of time and re-examine after all of the ice has melted and the water has come to room temperature. What has happened?
6. Repeat with a container of different size/shape, or by adding more/less water, predict what

Science Checkup - Questions to ask to evaluate what was learned

For activity 1:

- Why do you think we saw moisture in the jar and water drops? What was happening in the jar?
- Why do you think it was hard to see through the jar after we put the pie plate on top?
- What is the pie plate surface imitating/modeling from nature when rain forms in the atmosphere? (Answer: dust particles)

For activity 2:

- If you think of the lukewarm water as a normal summer day and the ice cubes as a cold front moving in, what does this experiment show you could happen under these circumstances?
- What happened when you used a different container? Why do you think you saw a different pattern to the colors?
- When you let the container sit for awhile, why do you think you got the result that you did? What happened to all of the various colors?

Extensions

- Introduce your group to the Community Collaborative Rain, Hail and Snow Network. CoCoRaHS is a unique, non-profit, community-based network of volunteers of all ages and backgrounds working together to measure and map precipitation (rain, hail and snow). Find out more at cocorahs.org.
- If you are already involved in the network, think about the characteristics of your community as you make rainfall observations. What does it feel like in the hours before a rainfall? Is it warm? Do your clothes feel like they are sticking to you because the air is so moist? What does it mean when someone describes the air as thick? Record these observations as you record your precipitation data.
- In addition to daily precipitation reports, CoCoRaHS allows you to upload information about intense rainfall and snowfall events. During the next predicted thunderstorm in your community, keep a piece of paper near the window and record when the rain first starts, when the heaviest rain occurs and subsides, and write a descriptive note about the storm event every half hour during the storm. You can then record these observations along with your daily rainfall report or under the "intense precipitation" section once you've logged into your account.

Vocabulary

Humidity: The amount of moisture available in the air.

Air mass: A large body of air with temperature, pressure, and moisture uniform throughout its mass but

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Climate: What causes a storm?

changed by the environment through which it passes.

Precipitation: Rain, snow, or hail, all of which are formed by condensation of moisture in the atmosphere and fall to the ground.

Condensation: Tiny drops of water that form on a cold surface such as a window, or on tiny airborne dust particles, when warmer air comes into contact with it.

Climate belt: An area where the weather is nearly the same.

Spatial Variability: When measurements for something – for example, rainfall or snowfall – can differ greatly at different locations.

Background Information

For activity 1:

- A number of forces come together to create rain, including water availability in the air (humidity), a warm temperature to keep rain from turning to snow and winds to bring clouds and low pressure systems together to create a storm.
- In this activity, the hot water warmed the air inside the jar, allowing the air to expand and carry moisture.
- The moist air is trapped inside the jar by the pie pan, so when the ice is placed in the pie pan, the air in the jar is cooled. Cold air cannot hold as much water as warm air, so the water condenses on the pie pan and sides of the jar, making water droplets. These flow down the side of the jar, creating “rain.” In the same way, warm, moist air from the Earth rises into the atmosphere, where eventually it is cooled, condenses and creates clouds and rainfall.
- When the hot water was poured into the jar and the pie pan was placed on top, the jar became opaque and hard to see through. This is the same process that forms clouds and fog. If we envision the jar as the Earth and atmosphere, the cloud forming is in the upper atmosphere. If we envision the top of the water as the Earth surface, the cloud forming represents fog, which occurs when the conditions for cloud formation exist at the Earth’s surface.

For activity 2:

- The lukewarm water represents a normal, warm summer day. The addition of the ice cubes represents a cold front moving into the system. Cold air is denser than warm air, and as we saw in the activity, the cold forces the warm air up. Forcing the warm, moist air up in the atmosphere cools it, creating rainfall. Further, the air is then unstable, creating high winds and other characteristics typical of a thunderstorm.
- If you used a container with a different shape (circular, one with an uneven bottom, etc.) you may notice other phenomena. For instance, low points in a container with an uneven bottom may allow concentration of the cold, blue food coloring/water. This water is more dense and can concentrate in the low points without mixing.
- Some places in your container may not be affected by the food coloring and remain clear for a time. This represents the spatial variability of storms, and the monitoring of the variability of storms and precipitation is one of the reasons that CoCoRaHS was established.
- Once all of the water returns to room temperature, the water has freely mixed and is of equal density. The result is that the water has turned a shade of purple. This represents the aftermath of a storm. Once the pressure has been resolved, the system re-equilibrates.
- Thunderstorms happen when two very differently characterized air masses are forced together by wind movement or some other event. The air masses have to contain water and warm and cool conditions must combine. Warm air is capable of holding more water vapor in it than cool air. When a low pressure, high density cold front comes in, it forces the warm, moist air mass up. The higher in the atmosphere you travel, the cooler the temperature is. This activity allows us to see how a cool, dense mass can force a warmer, less dense mass upward, as well as observe the instability of the masses once this has occurred. Finally, if we let them interact long enough, the system re-equilibrates.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Climate: Focus on snowfall

Activity Series:

Climate

Grade: 3-6

Time: 60 min

Main Idea

Weather forecasters can use contour maps to help find patterns in snowfall amounts during a storm.

Motivator

Ever wonder why you get three inches of snow at your house, while your friend up the hill gets two feet? A contour map can help show us why.

Pre-Activity Questions

Before you start the activity, ask the students:

- ❑ Ever wonder why you get three inches of snow at your house, while your friend up the hill gets two feet? A contour map can help show us why.

Activity: Confetti snow maps

- ❑ Colored construction paper
- ❑ At least 15-20 paper cups. You may choose to use a numbered cup for each individual, or assign each group/individual a row of cups. Groups may choose to name their cups instead of numbering them, as long as each cup is distinctly identifiable
- ❑ Graph paper (Students could make their own graph paper on a plain piece of paper.)

Preparation (to be done before meeting):

Decide what amount of snowfall each color will represent.

For example:

- Blue and green may be light snowfall, 1 piece = 1 inch of snow
- Orange and red may be heavy snowfall, 1 piece = 2 inches of snow
- Or all colors could equal the same amount of snow

Cut construction paper into tiny pieces, so there is a large amount of multi-colored confetti available.

Activity:

1. Place the cups in a grid on the floor (4x4, 5x3, 3x3, etc., depending on the number of participants. See below.)

*Note: Cups should not be placed too far apart; a grid with around 20 cups should cover no more than ~2 to 3 square feet.

OOOOO
OOOOO
OOOOO
OOOOO

*This would be a 4x5 grid shape

Objectives

- Discover that precipitation varies between places.
- Create a contour map.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare
Recognize patterns

Contributed By

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County

Climate: Focus on snowfall

2. Students should draw on their graph paper a grid that matches the arrangement of the cups on the floor, noting the name or number of each cup and labeling them. (See chart at right.)

Bobby's Cup	Jamie's Cup	Jill's Cup
Eleanor's Cup	Billy's Cup	Fred's Cup
Kate's Cup	Nikki's Cup	Jared's Cup

3. Grab a handful of confetti and toss it randomly over the grid arrangement of the cups
 4. Have groups count the number of confetti pieces in their cup (i.e. four red pieces, two blue pieces, etc.) Be sure students record those numbers in the appropriate place on their graph paper.

Bobby's Cup Red/orange-1 Blue/green-2	Jamie's Cup Red/orange-2 Blue/green-0	Jill's Cup Red/orange-1 Blue/green-1
Eleanor's Cup Red/orange-0 Blue/green-3	Billy's Cup Red/orange-1 Blue/green-0	Fred's Cup Red/orange-1 Blue/green-1
Kate's Cup Red/orange-0 Blue/green-2	Nikki's Cup Red/orange-0 Blue/green-1	Jared's Cup Red/orange-2 Blue/green-1

Climate: Focus on snowfall

5. Have students share their information with each other or record information on one large grid on a chalkboard or sheet of paper and allow students time to record from that master copy (see grid above).

6. Ask students to total up the amount of snow that fell in their cups and in their neighbors' cups (see totals below)

Bobby's Cup Red/orange-1 Blue/green-2 Total: 4 in	Jamie's Cup Red/orange-2 Blue/green-0 Total: 4 in	Jill's Cup Red/orange-1 Blue/green-1 Total: 3 in
Eleanor's Cup Red/orange-0 Blue/green-3 Total: 3 in	Billy's Cup Red/orange-1 Blue/green-0 Total: 3 in	Fred's Cup Red/orange-1 Blue/green-2 Total: 4 in
Kate's Cup Red/orange-0 Blue/green-2 Total: 2 in	Nikki's Cup Red/orange-0 Blue/green-1 Total: 1 in	Jared's Cup Red/orange-2 Blue/green-1 Total: 5 in

7. Have students choose a color for each total and color the grid points the correct color. (For instance, all the 5 inch cups are blue, all the 4 inch cups red, all the 3 inch cups pink, all 2 inch cups orange, all 1 inch cups yellow, all empty cups purple, etc.) OR go to step 8.

8. Students then may wish to make contour maps of snowfall by outlining all of the colored areas. This step works significantly better with a larger grid than the 3x3 that has been demonstrated thus far, so you may choose to skip this step if working with younger children or fewer cups.

9. Circle the cup/grid square with the highest amount of snowfall. If more than one cup had the same

highest amount, make a circle that encompasses all of them, but none of the other snowfall amounts (how can you do this if some of the lower areas are in between?)

10. Find the cup/cups with the next highest amount of snowfall. Make a circle that encompasses them and the smaller circle with the higher amounts of snowfall. Be sure to avoid the lower amounts of snowfall.

11. Find the next highest amount of snowfall.

12. Repeat steps 10 and 11 until all snowfall amounts have been graphed in a contour map.

Bobby's Cup Red/orange-1 Blue/green-2 Total: 4 in	Jamie's Cup Red/orange-2 Blue/green-0 Total: 4 in	Jill's Cup Red/orange-1 Blue/green-1 Total: 3 in
Eleanor's Cup Red/orange-0 Blue/green-3 Total: 3 in	Billy's Cup Red/orange-1 Blue/green-0 Total: 3 in	Fred's Cup Red/orange-1 Blue/green-2 Total: 4 in
Kate's Cup Red/orange-0 Blue/green-2 Total: 2 in	Nikki's Cup Red/orange-0 Blue/green-1 Total: 1 in	Jared's Cup Red/orange-2 Blue/green-1 Total: 5 in

Science Checkup - Questions to ask to evaluate what was learned

- How can snowfall totals affect where people decide to live?
- How can snowfall in one region be a benefit to another region?
- Is there any pattern to the contour map you made?
- How could a map like this help you during the next snowfall?

Extensions

- You may wish to make a 3-D model of the contour map, visually representing the density of snowfall with Play-Doh, paper mache or cup stacking, to better represent the amount of snowfall. This may be an appropriate county/state fair project with enough preparation.
- Using the CoCoRaHS Web site: <http://www.cocorahs.org/>, after a heavy snowfall in your area, print off a map of your state or county with all of the stations and their recorded snowfall data. Using what you've learned from this activity, draw a contour map of snowfall in your area and determine which parts of the county or state were hit hardest, and which received little to no snowfall

Vocabulary

Contour map: A map that uses curved contour lines to show a pattern; in our case it shows snowfall amounts.

Random: Something that has no identifiable pattern, plan, system, or connection.

Variable: Something that can change or vary, such as snowfall amounts in different regions.

Background Information/Resources

- This activity allows students to see that snowfall and other forms of precipitation can be variable.
- These precipitation patterns do exist in real life and affect where people live, where animals live and how snowfall buildup in one area can replenish rivers and lakes in many other areas. These patterns can seem very random over an area, with one side of town getting hail or snowfall, and the other side of town having nearly no snow or hail.
- Have students talk about different regions that experience different amounts of snowfall and other precipitation. Talk about how that precipitation affects where people are living. Snow falls on a mountaintop year-round. Few people live up in mountainous areas, yet the snow melts into the valleys below where people have settled
- Snow falls in the northern U.S. states. That snow melt trickles down streams and lakes and feeds more arid regions in the south like New Mexico and Arizona.

Climate: Temperature through time

Activity Series:

Climate

Grade: 3-6

Time: 60 min

Main Idea

All over the planet, organisms react to changing temperatures. From an organism's habitat, one can infer what type of climate, what consistent temperatures and how much or how little precipitation the organism can tolerate. With that knowledge, we can learn things about temperature long before we had accurate thermometers all over the globe. We can use nature's thermometers, the organisms themselves, to help figure out the temperatures of regions all over the planet for hundreds of years!

Motivator

Did you know that by looking at tree rings, you can "see" into the past, to determine what the weather and temperature were hundreds of years ago? Let's take a look and find out how.

Pre-Activity Questions

Before you start the activity, ask the students:

- How can you tell a tree's age by looking at an old tree stump?
- What other kinds of information can you gain?
- How could you find weather information for 200 years ago?

Activity: Tree ring treasure hunt

- The History of Temperature handout
- The Stump Worksheet

The Stump Worksheet

In this activity, we will learn a little about how to read tree rings from a tree cookie like the one you see below. In the first part of the worksheet, we'll learn how to read the tree rings, and in the second part of the worksheet, we'll learn how to make a timeline from the tree rings.

Look at the tree stump picture on the next page to start the activity.

Supplies

Objectives

- Learn about using proxies to determine past temperatures.

Learning Standards

(See Matrix)

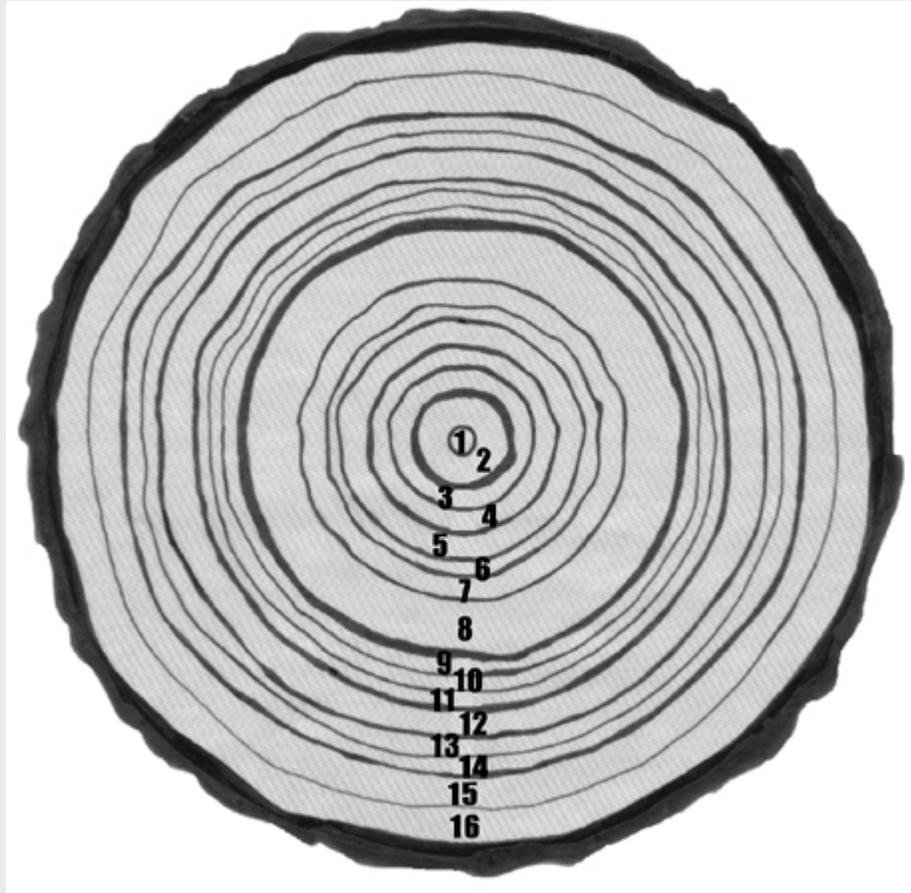
Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Climate: Temperature through time



Part 1: Reading the tree rings

1. This tree was cut three years ago. Write that year: _____
2. How old was the tree? _____
3. What year did the tree start growing? _____
4. Find the ring that grew the year you were born. Was it a wet or dry year? How do you know?
5. _____
6. In what year of growth was there the least rainfall? _____
7. In what year of growth was there the most rainfall? _____

Part 2: Making a timeline from tree rings

1. Take your tree cookie and fold it in half, so that the tree rings make a "C" shape.
2. Place the folded tree cookie on a clean sheet of paper.
3. With a pencil, place a small tick mark on the clean sheet of paper where each tree ring stops.
4. Remove the folded tree cookie paper.
5. You now have a series of vertical lines (tick marks). With a ruler, draw a horizontal line connecting each of the tick marks.

Climate: Temperature through time

6. Extend the tick marks so each is around ¼" long.
7. Based on what you learned in part 1 of this exercise, label the year each tick mark represents.
You now have created a timeline from your tree rings!

Science Checkup - Questions to ask to evaluate what was learned

- What can tree rings tell us about the weather the tree lived through?
- What else can tree rings tell us other than information about weather and the age of the tree?
- What would wider rings signify?
- What would narrow rings signify?

Extensions

- If you can, find tree rings from two different trees growing in the same area. Do you see any patterns in the rings?

Vocabulary

Proxy information: Information you receive from another source, second-hand information.

Adapt: The way a plant or animal changes to suit different conditions or a different purpose.

Dendrochronologists: Scientists who study tree rings

Infer: To derive by reasoning; to conclude or judge from premises or evidence.

Background information

- Thickness of the tree rings tells us about the environment that the tree was growing in. If another tree starts growing 50 years after the first tree, and the second tree continues to grow for 50 years after the first tree has died, the years that both trees were alive at the same time will have the same tree rings. This is because they lived under the same environmental conditions. By finding multiple trees of different ages, we can 'paste' the tree rings together by matching up the parts of each tree that were alive at the same time. Just like a bar code, each series of years has its own unique signature, and when trees are alive during the same period of time, their signatures are the same. Some of the environmental conditions that can be inferred from tree rings include moisture, temperature, precipitation and even gas composition of the atmosphere.

The History of Temperature

We take our understanding of temperature for granted today. As we get up in the morning to start our days, newspapers and television sets forewarn us of the expected temperature highs and lows each day, so we are prepared when we leave the house. Many of us also look outside our window to see a thermometer displaying the temperature at our house at that moment. Our instruments for predicting and recording temperature have gotten much better through time, and we can certainly be thankful. Since around 1850, our thermometers have been accurately calibrated and our recordings have been frequent enough throughout the day for us to have a very accurate record of temperature each day in regions around the Earth.

We also can approximate (make an intelligent guess) the temperature without turning on our tv or looking out the window. Based on the area where you live, you know that winter will be chilly and summer will be warm. Farmers do this, too. Farmers and gardeners want to

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Climate: Temperature through time

know when the last frost will be in their area so that they can plant their crops and flowers without fear of losing them to cold weather. To do this, they look up the temperature in their area in past years for each day to determine a good time to plant their crops. Using that information, they predict the earliest safe time to plant in their area that year, so that their plants will have plenty of time to grow without perishing in the cold weather.

Weather patterns that are consistent in an area for a long period of time constitute a climate. Having a warm or cold climate does not mean that every day will be warm or cold, certainly a cold climate can have some hot days, and a warm climate like Florida can have some very chilly days, even snowy days! But, on average, a warm climate will have mostly warm days and a cold climate will have mostly cold days.

Humans are not the only creatures on Earth that are affected by changing temperatures; birds migrate south for the winter, deciduous trees shed their leaves and slow their growing until spring, bears hibernate until there is more food for them to feed on. All over the planet organisms react to changing temperatures. And where an organism lives relates to what type of climate, what consistent temperatures and precipitation the organism can tolerate. We certainly don't find palm trees in Canada, nor do we see many pine trees in Florida. Organisms may adapt their physiology and/or their behavior to a particular climate over long periods of time, so that they are able to handle the consistent temperatures and precipitation in their environment.

With that knowledge, we can learn things about temperature long before we had accurate thermometers all over the globe. We can use nature's thermometers, the organisms themselves, to help figure out the temperatures of regions all over the planet for hundreds of years!

This data is called proxy information, because it is recorded with second-hand knowledge. Think about a conversation you had recently with your parents, where you recount what you and your friends did at school one day, or at the beach. They don't get the accurate account of how you spent every minute of your day, but by the end of your story, especially if you were very detailed, they understand what you did, who was there, if you had fun, if you have homework, and other important information. They experienced your trip 'by proxy,' with second-hand information.

We're going to focus in on using trees as a proxy today. Trees can live a long time. There are some redwood trees in the US that are nearly 2000 years old! When trees die, often they fall into the swamp in which they are growing, or into a nearby lake and are preserved until geologists find them. And how do we calculate the age of the tree? Tree rings! Each year, a tree grows a new ring of wood under their bark. The width of the ring tells us about the climate that year because the growth rate depends largely on temperature and precipitation during the growing season. Trees grow more during warm, wet years (wider rings), and less during cold, dry years (narrow rings). They can also tell stories about extraordinary events that happened during the tree's life, like fires, that may have affected growth. Scientists who study tree rings are called dendrochronologists (dendro=tree, chronology=timeline).

When you look at the rings of trees alive since 1850, the width of the ring can be calibrated to the accurately recorded temperature and precipitation conditions of the year. Then, the older rings of live trees and those of dead trees can be used as proxies of temperature and precipitation for those years before we had accurate temperature records. In the case of the redwoods, we could get a temperature/precipitation record of the northwestern US for almost 2000 years!

Climate: Focus on wind

Activity Series:

Climate

Grade: 3-6

Time: 60 min

Main Idea

Wind is the movement of air masses caused by the tendency of a temperature gradient to seek equilibrium. Wind is an important factor in creating our global climate.

Motivator

Did you know that wind causes ocean currents and helps move weather across the Earth? We're going to create a device, called an anemometer, to measure how strong the wind is blowing!

Pre-Activity Questions

Before you start the activity, ask the students:

- Do you know how weather forecasters measure wind?

Activity: Make your own wind dial

- Five 3-oz paper Dixie cups
- Two straws
- Pin
- Paper punch
- Scissors
- Stapler or tape
- Sharp pencil with eraser

Activity:

1. Take four Dixie Cups and punch a hole in each, about one half inch below the rim.
2. Punch four equally spaced holes in the fifth cup, about a quarter inch below the rim.
3. Punch a hole in the center of the bottom of the fifth cup.
4. Take one of the first four cups and push a straw through the hole.
5. Fold the end of the straw, and staple it to the side of the cup across from the hole.
6. Repeat for another "one-hole" cup and the second straw.
7. Slide one cup and straw assembly through two opposite holes in the cup with four holes.
8. Push that straw through another "one-hole" cup, so that there is a cup on either end of the straw and one in the middle.
9. Bend the straw and staple it to the newest cup, being sure to make the cup face the opposite direction from the first cup. De-

Objectives

- To understand how wind is measured by making your own wind measuring device.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Construct
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Climate: Focus on wind

pending on your material, it may be easier to tape than staple pieces together. If you choose to tape, please use evenly sized pieces throughout to keep the weight similarly distributed.

10. Repeat steps 7-9 with the other cup and straw assembly and remaining "one-hole" cup.
11. Align the four cups so that their open ends face in the same direction, clockwise or counterclockwise around the center cup.
12. Push the straight pin through the two straws where they intersect.
13. Push the eraser end of the pencil through the bottom hole in the center cup as far as it will go.
14. Enjoy your new anemometer!

Science Checkup - Questions to ask to evaluate what was learned

- Why do scientists measure the wind speed and direction?
- What can changes in the wind tell weather forecasters?
- Why is the wind so important to our understanding of what weather might be coming next?

Extensions

- Have the group build a pinwheel from paper and sticks or pencils and a pin as a way to demonstrate wind turbines and wind energy. Encourage exploration of how a pinwheel operates compared to an anemometer and how kinetic energy of wind is converted to electricity in a wind turbine.

Vocabulary

Anemometer: An instrument that calculates wind speed.

Velocity: How fast something is moving.

Drag: The resistance experienced by an object as it moves through a medium, like air or water.

Friction: The resistance experienced by an object as it rubs against another object.

Background resources

- A wind dial, or anemometer, allows you to calculate the speed of the wind by measuring the revolutions (spins) of the cups. The wind carries things such as small particles, bugs, moisture and weather with it, so to understand climate, it is important to understand wind. Think about the direction of wind in your area. Does wind generally come from the same direction? Why or why not?
- To calculate the velocity at which the anemometer spins, determine the number of revolutions per minute (RPM), the number of spins the cups take in one minute. Next, calculate the circumference (in feet) of the circle made by the rotating paper cups. Multiply your RPM by the circumference of the circle and you will have an approximation of the velocity at which the anemometer is spinning (in feet per minute), which is about the speed of the blowing wind. It is important to remember that some forces are being ignored in this model, like drag and friction, which is why this is only an approximation of speed.

Climate: Water's incredible journey

Activity Series:

Climate

Grade: 3-6

Time: 60 min

Main Idea

Water is a limited resource on earth and is constantly being reused. There is only a small amount of fresh water available, but salt water and contaminated water travel through a series of ecological systems to become freshwater.

Motivator

Did you know the glass of water you had with lunch might be the same water that a Tyrannosaurus Rex drank millions of years ago?

Pre-Activity Questions

Before you start the activity, ask the students:

- Can water be created or destroyed?
- How much of the earth's water is actually drinkable?

Activity: The incredible journey game

- Nine large pieces of paper
- 30-50 beads in each of nine different colors (dependent on number of participants)
- A pipe cleaner for every person participating
- Nine home-made dice (see below for description)

Preparation

1. On each sheet of paper, draw (or have students create in a previous meeting) each of the nine scenes below and label each:
 - Clouds
 - Animals
 - Lakes
 - Soil
 - Groundwater
 - Rivers
 - Ocean
 - Plants
 - Glacier
2. Out of old gift boxes, shoe boxes or mug boxes, create nine six-sided dice that are around 15 inches per side. Each die will be associated with one of the scenes above and will have six different labels.
3. See the table on the next page, which explains how to label your dice.

Objectives

- To understand the hydrological cycle.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Climate: Water's incredible journey

Station	Die Side Labels
Soil	Plant, river, groundwater, cloud, cloud, stay
Plant	Clouds, clouds, clouds, clouds, stay, stay
River	Lake, groundwater, ocean, animal, clouds, stay
Clouds	Soil, glacier, lake, ocean, ocean, stay
Ocean	Clouds, clouds, stay, stay, stay, stay
Lake	Groundwater, animal, river, clouds, stay, stay
Animal	Soil, soil, clouds, clouds, clouds, stay
Groundwater	River, lake, lake, stay, stay, stay
Glacier	Groundwater, clouds, river, stay, stay, stay

Activity:

1. Choose a bead color to represent each of the nine stations. Place the nine large sheets of paper with scenes, their respective dice, and their beads around the room. If outside, you may wish to place things relative to their geographic positions (i.e. plants, animals, rivers, lakes, and soil closer together, ocean slightly offset, groundwater and glaciers a distance from the others).
2. Hand out pipe cleaners to students and explain to them that they are going to travel around the room as water molecules going through the water cycle. Their pipe cleaners are their timelines, and as they travel from place to place they will collect a bead to represent the time they spent in each place.
3. Instruct students to place a hook or knob at the end of the pipe cleaner so beads don't fall off of their timelines.
4. Assign an even number of students to each station, if possible.
5. Ask students about the water at each station and how it could travel from one station to another. Tell students that as they travel, they need to think about how their water molecule would travel from one place to another (melt, evaporate, etc.)
6. Explain to the students that in this game, a roll of the die determines where water will go. At each station, line up in a single file line, collect a bead and place it on your pipe cleaner, then roll the die. If the die tells you to go to a different station, go to that station and repeat. If the die rolls "stay", return to the back of the line in your station and repeat. Be sure to collect beads every time before the die is rolled.
7. Tell students that each bead represents 10 years in the cycle of their water molecule. Have them total up how much time they spent in each station. Use discussion points below to supplement steps six through eight.
8. Choose one or two students' timelines to discuss. Write how much time they spent at each station on the board or a sheet of paper. Discuss where water spends most of its time (oceans, clouds, glaciers, groundwater) and why that might be the case (huge storage capacity, less likely to cycle).
9. Draw the hydrologic cycle on the board or a sheet of paper with all of the stations represented in one scene. Using a red pen for water traveling in gas form and a blue pen for water in liquid/solid form, draw the path of one student's water molecule journey. Be sure to put arrows in the direction of travel.

Climate: Water's incredible journey

Science Checkup - Questions to ask to evaluate what was learned

- ❑ Where did you spend much of your time as a water molecule? Why do you think that's so? (They may say they got caught in the glaciers, in groundwater, or the ocean or that there were always long lines at those stations.)
- ❑ Why are some students' pipe cleaners full of various colors and others have only one or two colors? What can this tell us about the time water spends in animals or plants versus in water storage areas?

Extensions

- This lesson offers a good opportunity for introducing watersheds, what can impact a watershed and why watersheds are important.

Vocabulary

- **Molecule:** The smallest part of a compound, it consists of one or more atoms held together by chemical forces.
- **Groundwater:** Water that's underground in soil or permeable rock, which feeds springs and wells.

Background information

- The hydrologic cycle is the basis for most of our weather events and climate regimes. It is very important for students to understand that there is only so much water available to us on the Earth, and only a small percentage of it is fresh water. The water on the planet today has been cycling for millions of years, so it is possible that the water we drink today may have been the same water that was ingested by a dinosaur more than 70 million years ago.
- One example of the hydrologic cycle looks like this: Water falls as rain from a cloud to the lake; it is absorbed into groundwater; then expelled from the groundwater by a spring or river; ingested by an animal and panted out or expelled in urine; finally, evaporated back into the clouds.
- Different paths can take varied amounts of time to occur, so it's also important to know how long water remains in each part of the cycle.

Climate: Climate and organisms

Activity Series:

Climate

Grade: 3-6

Time: 60 min

Main Idea

When a climate changes, the animals in that environment can either adapt, move or die. Students will discover how important it is to have a variety of species in an environment.

Motivator

Meteor strikes and a warming earth brought about death for dinosaurs, saber tooth tigers, mastodons and mammoths. What if they had been able to adapt to the climate changes?

Pre-Activity Questions

Before you start the activity, ask the students:

- Why do you think some species of birds live only in northern climates and some only in the south?
- What can animals do to adapt to changes in their climate related to temperature, rainfall or a lack of food?

Activity: Climate change game

- Three to five recess balls/rubber balls
- Color-coded cards or stickers for your group; two green, three red, four blue and five yellow

1. Give out color cards or stickers.
2. If possible, use a large room, gym or a yard to play the game. Tell the youth to spread out far enough to toss the balls to each other with a bit of difficulty and tell them that all colors need to spread evenly in the space
3. Explain that you are representing an environment; green cards are plants, red cards are animals, blue cards are habitats and yellow cards are humans. The balls being tossed represent the climate.
4. Discuss the options (in background) that organisms have when there is a rapid change in their environment: moving to a new environment, adapting to the changes in their environment or dying. Explain that the first time someone drops the ball, they may take three large steps away from everyone else in an attempt to move to a new environment or adapt. The second time they drop the ball they have unsuccessfully adapted to or left the environment and must sit down
5. Begin tossing a ball (or multiple balls if you have enough participants) around the group
6. As youth begin to sit down, have them announce the color card they carried and their place in the environment.

Supplies

Objectives

- Understand how animals adapt to climate change.
- Learn about species diversity.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Climate: Climate and organisms

7. Once all of the plants have perished, pause the game.
8. Ask youth why the plants perished (they explain that they got too far away to catch the ball, etc.) Explain that some plants have a very hard time adapting to their environment because they cannot move to another area, so if they cannot adapt quickly, they will die. Ask youth who eats the plants? Explain that without a food source, the animals cannot survive long in their environment and must either adapt to the smaller food amount or move to a new area. All animals must take three large steps back.
9. Restart game. Once all animals or habitats have perished, pause the game.
10. Talk about how a lack of animals would make it hard for humans to survive because animals provide a food source for humans. If all animals have perished, humans must take three large steps back. If all habitats have perished, ask youth how animals or humans can live without a habitat (they will explain that they cannot, and would have to move to find a new home). Animals and humans, in this instance, would both take three steps back.
11. When there is only one person left standing, stop the game and have a discussion about what happened when they had to step backward, when they perished and how the game progressed.

Science Checkup - Questions to ask to evaluate what was learned

- Give some examples of organisms that adapt physiologically mainly and some that can adapt either physiologically or behaviorally.

Extensions

- Play the game “telephone” with kids demonstrating how small changes over the course of many generations can result in huge, unexpected even unrecognizable change.
- The “telephone” game can be adapted by using drawing instead of speech. Have someone draw a cartoonish animal, then the next person gets 10 seconds to study the picture. Then, they draw it from memory. Repeat for many “generations” and compare the first and last pictures.

Vocabulary

Phenology: The study of regularly recurring biological phenomena such as animal migrations or plant budding, especially as influenced by climatic conditions.

Genetics: The branch of biology that deals with heredity and genetic variations

Background Information

- In geologic time, we can't observe the “warning signs” of extinction as well as we can today. Today, we notice if the mating season of endangered species are shortening and if our plants are changing their times of budding, growth and fall coloration. This is called phenology. These local changes are responses to climate changes. If some individuals from a species are able to adapt and survive through these changes, these genetic traits are passed down to their offspring. Note that this isn't a choice the individual makes, but rather something they are capable of genetically, just like some of us are double-jointed or were born with red hair. If these traits can be used to adapt to an environment successfully, they have a survival advantage over other individuals. Of course, this is an evolutionary adaptation, and takes multiple generations to create a breed of organism capable of surviving in a totally new climate. Some organisms can adapt within their lifetime by changing their behaviors.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Climate: Climate and organisms

- Since adapting to a climate takes time, and the only way to adapt is to have certain genetic traits passed down, certain organisms have a better chance of adapting than others, simply because they reproduce more frequently. In our lifetime, we may see three or four generations of humans together. If we're really lucky, we'll see five. But in that same time frame, we could see maybe 40 generations of cats, and too many generations of beetles, ferns or flowers to count. Since many organisms reproduce much more quickly than humans, they are more likely to adapt to a rapidly changing environment than we are. What other organisms today reproduce slowly? How would they be affected by a rapidly changing environment?

Entomology

About the 4-H Science Toolkit Series: Entomology

This series of activities is designed to get children outside, learning about their environment by focusing on a subject all kids find fascinating – bugs.

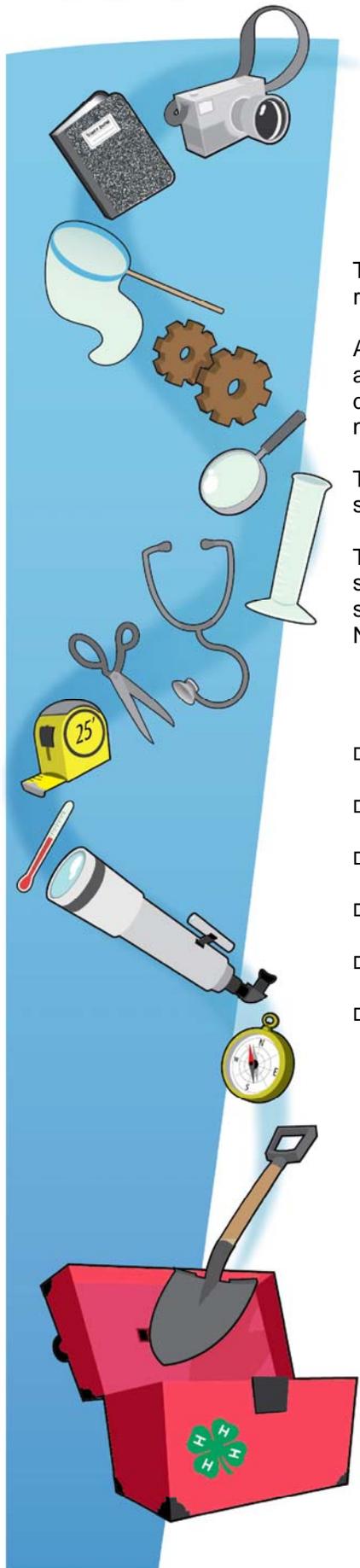
All of these adventures call on students to predict what will happen, test their theories, and share their results. They'll be introduced to entomology vocabulary, gain an understanding of the life cycles of plants and animals and learn how to be good environmental stewards.

The lessons in this unit were developed by and are connected to the Cornell University Department of Entomology.

To find out more about entomology activities, visit the Department of Entomology Web site at <http://blogs.cce.cornell.edu/nys4-h-entomology/> and to find numerous resources related to the inserts, outdoor exploration and the environment, check out the NYS 4-H Resource Directory at www.cerp.cornell.edu/4h.

Entomology Table of Contents

- Pollinator Power:** Observe and understand pollination and design flowers to attract pollinators.
- Ballooning Spiders — Aerial Dispersal:** Explore the way spiders leave their nests.
- Beetle Scavenger Hunt:** Learn about some of the 80,000 different species of beetles and how to tell them from other insects.
- The Hornet and Yellow jacket Nest:** Learn how yellow jackets and hornets create their nests full of combs
- Canaries of the Pond and Stream:** Discover how to measure the quality of a stream by collecting and cataloguing the insects that live there.
- Exploring Plant Galls:** Wander into the woods to find unusual growths on plants and learn what caused them and what might live inside.



Entomology: Pollinator Power

Activity Series:
Entomology
Grade: 3-6
Time: 60 min

Main Idea

Pollination is the transfer of pollen from the anther to the stigma of a plant. This is necessary for the production of seeds and the reproduction of the plant species. Insects are the main groups of pollinators. The color, shape and smell of flowers help direct the pollinators to the right place.

Motivators

Did you know that one out of every four mouthfuls of food that we eat requires the assistance of a pollinator? About 80 percent of flowering plants are dependent on animal pollinators and about 130,000 to 300,000 animal species assist with pollination.

Pre-Activity Questions

Before you start the activity, ask the students:

- Name some pollinators that you know?
(bees, honey bees, wasps, flies, butterflies, hummingbirds, beetles, Madagascan Lemur)
- How does a flower attract a pollinator?
(smell, color, shape)
- Some plants do not require insects or other animals for pollination. How do they get pollinated?
(wind, water)

Activity: Design and Build a Flower

Supplies

- Construction paper
- Tissue paper
- Two or three pieces of graph paper
- Scissors
- Glue
- Tape
- Markers
- Pipe cleaners or small dowels
- Reference chart on parts of a flower
- Perfect Pairs worksheet
- My favorite pollinator worksheet
- Reference books on insects
- Magazines with flower/insect pictures to cut up
- Paper egg cartons, cut into cups
- Sugar water (one part sugar, three parts water)
- Eye dropper

1. Read the Perfect Pairs and My Favorite Pollinator worksheets. Using the Internet or recycled nature magazines, find pictures of the listed pollinators and their favorite flowers.

Objectives

- Observe and understand pollination.
- Design a flower to attract a pollinator

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

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Department of Entomology
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Entomology: Pollinator Power

2. Decide which type of insect you would like to work with, and then brainstorm a locally found example of this insect. For example, if you were to choose a bee, you could use the honey bee as your insect. Honey bees are found almost everywhere because they are raised by beekeepers. If you are working in groups, keep the name of your pollinator a secret from the other groups. Read about the specific flowers that attract your pollinator. What shapes are the flowers? What colors?
3. On the graph paper sketch a design for your flower. Keep in mind the materials you have on hand to build the flower, as well as your insect's preferences. Be sure to include the basic parts of a flower: stamens (anthers and filaments), pistil, petals, leaves and sepals. You will use an egg carton cup to hold the nectar, so plan accordingly.
4. Review the design one last time before you start building. Does it meet your insect's requirements? If so, build away! If not, go back to the drawing board.
5. Analyze your flower model. Does it look like your drawing? Do you need to change your plans? Should you try again?
6. If you are working in groups, conduct a flower survey. Ask five people (who are not in your group) what type of insect pollinates your flower? Review your results. Were most of the responses correct? If not, do you need to change your design?
7. Test your model: On a sunny afternoon, choose an outdoor spot that can be observed from a window and is close to pollinator territory.
8. With assistance from an adult, take your flower out to the site and "plant it" in the ground. You may need to attach a stake to help it stand. Once you are sure it's stable, have the adult use the eyedropper to fill the cup with sugar water.
9. Take turns watching your flower from the window. Record any insects that you see land or climb on your flower and how long they stay. If you are working as an individual, you may want to check the flower from time to time and only stay if you see an insect. Or you can videotape your flower.
10. At the end of the afternoon, compare results with other groups. Which flowers were visited the most? What flowers were only visited by one type of insect? (If you are working on your own, you may want to design several different types of flowers and put them out together to compare results).

Science Checkup - Questions to ask to evaluate what was learned

- Which of the following could help pollinate plants?

Bats	Bees	Bumble bee	Flies	Moth
Honey bee	Human	Hummingbird	Mouse	Slug
Wasp	Water	Wind		
- What characteristics might attract a pollinator to a plant? (smell, shape, color)
- What would happen if honeybees disappeared? (fewer fruits and vegetables for a while; other pollinators might take over and fill the niche; farmers might have to learn to pollinate by hand; we might have different foods available to eat)

Extensions

- Insects are not only attracted to flowers by their shape and color, but also by smell. Cut five flower shapes from blue cardboard. Place them in your outdoor observation area with milk jug

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Entomology: Pollinator Power

caps in the center. Have an adult place a cotton ball dipped in a different scent in each cap. Suggested scents include: peppermint, orange, vanilla, (all extracts), lemon juice, pickle juice, and different kinds of perfume. Observe from the window. What pollinators are attracted to what scents?

- Pollinators help us by supporting the diversity of plant life around us. Experience this diversity by holding a honey tasting. Contact a local beekeeper and obtain samples of different types of honey. The color and flavor of honey vary depending on its source (different kinds of flowers). Clover honey is the most common, but you can also find wildflower and buckwheat honey in your area.
- Plants and pollinating insects have developed a good relationship. The insects help the plants maintain a healthy gene pool and the plants provide the insects with an energy-filled food. A threat to one will hurt the other, and will affect the biodiversity of an area. There are three main factors that are causing the decline of pollinators: loss and fragmentation of habitat, degradation of remaining habitat and pesticide poisoning. Work with an adult or older teen to find out more on these topics.

Vocabulary

Cross-pollination: Transfer of pollen between flowers on separate plants. This is important for genetic biodiversity.

Flower Constancy: A strong preference for one type of flower. Some insects, like bees, visit the same type of flower on each trip. Other insects move around to any source of nectar they can find.

Nectar: A sugar-rich liquid that supplies energy for pollinators. The nectar is located deep inside the flower, and as the insect crawls downward, it gets covered with pollen. The insect moves from flower to flower and spreads pollen along the way.

Pollinators: Anything that carries pollen such as wind, water or animals. Wind and water are not efficient pollinators. Plants that rely on these processes must produce a lot of pollen in order for some of it to get to the correct plant. Animal pollinators are more efficient because they are attracted to the flowers and purposefully move from plant to plant. Animal pollinators range in size from the very tiny fig wasp, all the way up to the 10-pound Madagascan Lemur. The most common insect pollinators are: native bees, honey bees, flies, butterflies, moths and beetles. Bees are the only pollinators that deliberately gather pollen to bring back to their nests for their offspring.

Pollination: The transfer of pollen from the anther to the stigma of a plant. This process is necessary for the production of seed, and the reproduction of the plant species.

Self-pollination: Transfer of pollen within the same flower or among flowers on the same plant.

Background Information/Resources

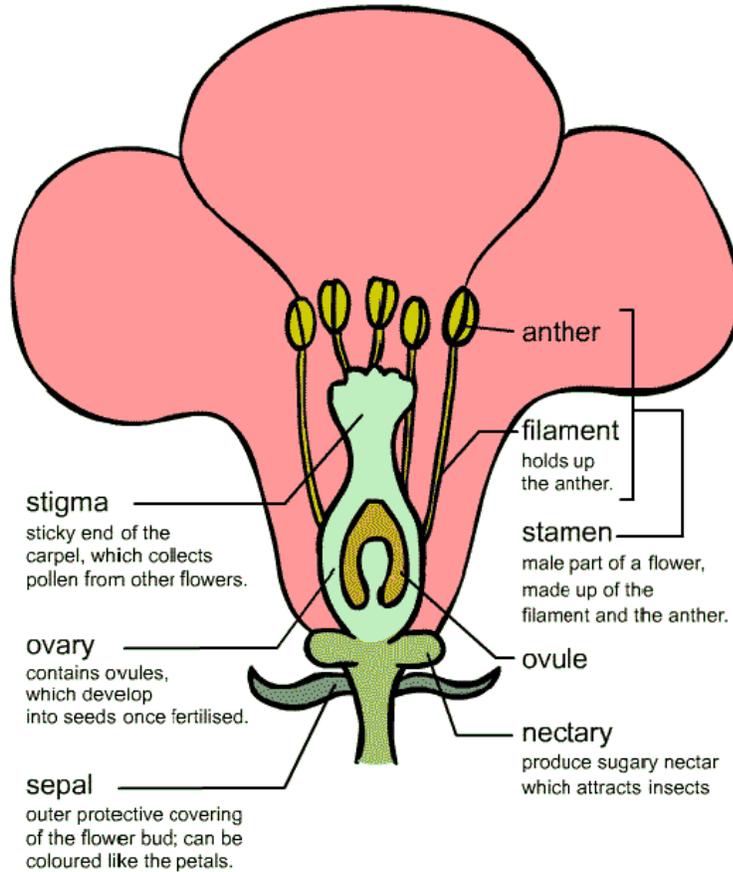
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Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Entomology: Pollinator Power

Design-A-Flower Resources: Parts of a Flower



Design-A-Flower Resources: Perfect Pairs

Flower	Flower shape	Pollinator
Blueberry blossom	Bell Shaped	Bumble bee
Queen Anne's Lace	Upright platform	Silvery Blue Butterfly
Apple Blossom	Flat or bowl shaped	Honey bee
Trumpet Vine	Deep, tube shaped	Hummingbird

Entomology: Pollinator Power

Design-A-Flower Resources: My Favorite Pollinator

The flowers on plants have developed, over time, in ways to attract pollinators. The color, shape and smell of their flowers help direct the pollinators to the right place. For example, flies have short mouth-parts and need open flowers to reach the nectar. Butterflies and moths, on the other hand, have long tongues so they can feed at both simple and complex flowers. Colors are important as well. Most pollinators see a wide range of color but tend to have their favorites. Some flowers have ultraviolet markings that insects can sense, but we cannot see.

POLLINATOR	FLOWER PREFERENCES
Bees	Yellow, blue, or purple flowers. They cannot see red, but sometimes are attracted to flowers with ultraviolet markings. Small bees, which have short tongues, prefer clusters of tiny flowers.
Beetles	They prefer wide-open flowers with lots of landing space, generally in dull colors.
Butterflies	Blue, yellow, red, pink, or orange flowers that they can land on, like flat-topped clusters.
Moth	Light colored flowers (white or green, i.e.) that open at dusk.
Hummingbirds	Red, orange, or purple tubular flowers with lots of nectar. Do not need a landing area, since they can hover.
Flies	White, yellow, green, or cream-colored flowers with simple bowl shapes that their short tongues can reach.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Entomology: Ballooning Spiders- Aerial Dispersal

Activity Series:
Entomology
Grade: 3-6
Time: 45-60 min

Main Idea

Learn how baby spiders weave their own “parachutes” when they’re ready to leave the nest.

Motivator

Let’s design and create a parachute for our baby spider (seed) to fly away with.

Pre-Activity Questions

Before you start the activity, ask the students:

- What would happen if we just put our seeds (spiderlings) into the jug, turned it upside down in the room, then opened the cover?

Test your theory.

- What happens if we take this jug outside and do the same thing?
- What would make a difference? (A: Wind, gravity)
- How can we help our spiderlings travel further? (A: Let them climb up on something and jump off, make a parachute to carry them further)
- What other ways might spiders move away from the egg case as they hatch? (A: Walking, hitchhiking on a seed or leaf)
- Why would spiderlings want to move away from the egg cases once they hatch? (A: Spiders would eat each other, there would not be enough food for all.)
- How can the mother spider help her young even though she will not be there when they hatch? (A: Choose a spot that’s protected and gives them space to leave quickly when they hatch.)

Activity

- A spider egg case to examine (someone needs to find one and bring it to the meeting, handle gently)
- Package of seeds to represent baby spiders (carrots work well)
- Bag of craft-store feathers
- Sewing thread
- Scissors to cut thread and trim feathers
- Glue (fast drying) or child-safe nail polish

1. Each person gets a seed and two pieces of string about 10” long.
2. Place a drop of glue on your seed, and lay the two pieces of string so that the middle of the strings cross on the drop of glue on the seed (an “X”). Let the glue dry.
3. Each person chooses a feather, which will be the parachute their seed will use. Attach the other ends of the string to the feather (glue, or tie them on). If you would like to cut your feather into a certain shape, feel free to do so.
4. Go outside. When a breeze blows, have everyone line up on a line, and at the count of “Three,” try out their parachutes.

Supplies

Objectives

- To learn how spiders leave their nests through aerial dispersal.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Entomology: Ballooning Spiders- Aerial Dispersal

5. Measure the distance from the line that each person's "spiderling" dispersed.
6. Ask these questions: For the people whose spiderling moved the farthest: Why do you think yours ballooned further than others in this experiment? What shapes seem to move the furthest?
7. Have students practice the vocabulary using the word puzzle sheets.

Science Checkup - Questions to ask to evaluate what was learned

- Why might dispersal be important for baby spiders?
- What factors will help spiderlings disperse farther away from the egg sac?
- Is aerial dispersal a good tactic for small things such as insects?
- What other plants or animals use airborne dispersal?

Extensions

- Have people put their names on their creations and fly them on a day when there is a gentle wind, a strong wind or when it is raining lightly, and find out what happens in each instance.
- Ask students to do the experiment again, using the knowledge they gained from the first set of data. Ask them to refine their "ballooning" spider so that it will travel a different distance.
- Students can try cutting their feathers into various shapes. Have some use feathers upside down, some right side up.
- Have a discussion about how other animals and/or plants disperse. Look for some examples and bring some in for the group to view.
- Watch a real spider egg case. If you are lucky enough to see the young hatch, find out how they disperse and how far they go.
- For young children, a pinata might help to illustrate the spiders' egg case. Children can help the spiderlings (treats) burst out of the case with the use of a stick. Do they all come out at once? (Sometimes you need to help them out by hitting the pinata again.)
- Have the students read and learn about other types of spiders. Where do they put their eggs and how do the young disperse? For example, what does a wolf spider do?
- Learn more about spider silk. Explore the Internet for more information.

Vocabulary

Aerial dispersal: Being carried by air currents.

Arachnid: An invertebrate animal that has two main body sections and eight legs, no antennae.

Ballooning: A method of floating away on a warm wind or being carried through the air (for spiders, held up by strands of silk).

Dispersal: Moving away from a center or source.

Egg sack or cocoon: The sack the spider places its eggs in.

Order: A group of related organisms.

Predator: An animal that lives mostly by killing and eating other animals. (For spiders, often insects or other arachnids are their predators.)

Spider: Order Araneida of arachnids. Has two main body sections, four pairs of legs, and two or more pairs of spinneretes for making silk.

Spiderling: Baby spider.

Spinnerete: A spider's silk spinner organ, usually on the underside of the abdomen.

Spiders I

F N H J R M K Z E E D B G A U
H W T A O I Q V F U N A N Z S
D E G G E L T H G I E L I M Z
B Y S Y A Q B D F S N L H O D
X L B P L L I O P D P O S I F
Y Q A H I N U I L R Y O I C A
J R B C H D D T E A Y N F L N
W T O C K E E D N S X I C E G
A O A A R W A R G A Q N B G S
E R R L D T I B Z K R G V G B
A T I B O U W D U L E A K C C
W N H R S I L K O H G K T A Y
G T Z G S W P R T W A N U S V
R E D I P S F L O W S Z J E S
L U Z S D W L M P L K E F T F

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwards

ARACHNID
BALLOONING
BLACKWIDOW
BOLA
EGGCASE
EIGHTLEGGED
FANGS
FISHING
ORB
PREDATOR
SILK
SPIDER
SPIDERLING
TARANTULA
WOLFSPIDER

Spiders II

N E A B S V R M W B R M T I N
N S R E I G H T L E G G E D C
D A A W L G N A D P S Y Y H T
Z C C S K Q C I E J M N B L N
D G H J M K P V N G G I Z U N
W G N K W S P I B O R B K J C
W E I I F Y Z S W M O O Z R C
T X D L L K T I B T T L N O C
E O O T A R A N T U L A L T B
W W V L F W E C Y G S G N A F
I D A W L C H D V M T O S D B
C D Q T F I S H I N G J O E Y
Q O M U B I G O A P G L J R Q
M X U E S X E J J J S O W P C
U U A K V U V T R C K M I X H

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwards

ARACHNID
BALLOONING
BLACKWIDOW
BOLA
EGGCASE
EIGHTLEGGED
FANGS
FISHING
ORB
PREDATOR
SILK
SPIDER
SPIDERLING
TARANTULA
WOLFSPIDER

Entomology: Ballooning Spiders- Aerial Dispersal

Background Information

- Dispersal is a very important part of a spider's life cycle. Large numbers of spiderlings hatch from the egg sac at the same time. If they did not move away, they would be overcrowded and would compete for a limited food source. When food is in short supply, many spiders turn to cannibalism.
- Read parts of *Charlotte's Web* by E. B. White to the class, especially the section where eggs hatch and young tumble out. Remind them that they may know about this book and have read it or seen the movie.
- Many spiders produce eggs in the fall, which are wrapped in a silky cocoon, called the egg case. The eggs are first stuck to a silk platform (as many as 200 in some instances), then covered with silk threads. Later, they are wrapped in loose silk, with a final layer of dense, colored silk on the outside. The egg case is suspended in place by lines of silk that hold it safely through the winter.
- In the spring, the eggs hatch and the transparent spiderlings move out from the egg case. If they all stayed with the egg case, the spiderlings would soon get hungry and would start to nibble on each other.
- When the young spiders are ready to disperse they climb up onto stems, twigs or other objects. The spider stands on its toes and releases a stream of silk from its spinnerets. The silk gets picked up by air currents, and when the pull is good enough, the spider lets go and is carried up into the air. This is "ballooning." The spider continues to release silk lines that the wind lifts along with the spider and floats it off to a new area. This is called aerial dispersal. This is somewhat like a kite or a parachute. The spiderlings get carried off in all directions and land when the silk breaks or the breeze stops blowing.
- Sometimes masses of ballooning threads can be seen in the air. Older spiders may use ballooning also. However, because their bodies are heavier, they will require stronger breezes to get them airborne.
- Spider silk is a protein with amazing properties. It can stretch to almost double its length before breaking and when compared to a steel wire of the same diameter, it is stronger. Many spiders recycle silk by eating their old silk before rebuilding a new web.
- For most spiders, silk is important and used on a daily basis. There are at least seven types of spider silk known. Silk is used for lining burrows, protecting the eggs, catching prey and moving about.
- Aerial dispersal is not limited to spiders. A number of insects also use this method of dispersal. The caterpillar of the gypsy moth is one. The tiny caterpillars are lightweight and very hairy, and they spin down on silken threads from a leaf. When a wind comes along, the caterpillar is picked up and transported to a new area some distance away. The hairiness of these small caterpillars helps keep them airborne for a long period of time.

Background Resources

- *Charlotte's Web* by E. B. White, especially Chapters 19, 21 and 22.
- Field guide to spiders, or a field guide to insects and spiders (many choices)
- Golden Nature Guide to Spiders and their Kin

Entomology: Beetle Scavenger Hunt

Activity Series:
Entomology
Grade: 3-6
Time: 45-60 min

Main Idea

Youth will learn that there are more kinds of beetles on earth today than any other kind of insect. Beetles have fascinating life cycle stages and can live in a variety of habitats.

Motivator

There are more than 80,000 species of beetles living on Earth. Let's explore our environment to find some of these critters.

Pre-Activity Questions

Before you start the activity, ask the students:

- What makes a beetle a beetle?
- What insect Order (group) are beetles classified in?
- How do beetles grow?
- What are the stages in the life cycle?
- List some things that beetles feed upon.
- What kind of mouthparts do beetles have?

Supplies

Activity

- Plastic jars with lids for collecting insects (peanut butter jars work well)
 - Field, meadow or wooded area
 - Insect net (helpful, but not necessary)
- OR -
- Accurate models of beetles (plastic or rubber toys, 10-20), plus a model of a beetle with its wings spread (or a photograph of the beetle with wings spread) and a model or photograph of life cycle of beetle.

1. After learning a little about beetles, have each participant take a plastic jar outside and find a beetle.
2. Have them note where they found it and what it was doing when it was found.
3. Bring it back to share with the rest of the class. Count how many different types of beetles each group found.
4. If there is time, have students make a quick sketch of their beetle(s).
5. After you have looked at the beetle, it should be returned to the place it was taken from.
6. Have students label the parts of a beetle on the worksheet.
7. Have students practice the vocabulary using the word puzzle sheets.

Objectives

- Distinguish beetles from other insects.
- Know where they live (habitat), what they eat (food), their life cycle and body parts.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
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- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Entomology: Beetle Scavenger Hunt

Science Checkup - Questions to ask to evaluate what was learned

- What makes an insect a beetle?
- What are some characteristics that make one type of beetle different from another?
- Do you think you would find even more types if you searched in different habitats?
- Would the time of day or night make a difference in what you found?
- What kinds of things do beetles eat?

Extensions

- Try keeping different types of beetles in the proper habitats for a week or two. Try to discover what kind of beetle you have, using books and field guides to help you identify it. REMEMBER - you must provide food for your beetle(s).
- Can you keep a water beetle? What about a beetle that lives in the bark of dead trees? Or in a bracket fungus that grows on the tree?
- In the fall of the year, collect some acorns or hickory nuts and keep them in a clear container, with a screen top. What happens? Is something chewing the nuts or their shells? If you open one up, what do you find inside? Write a short story about it, or keep a notebook with the “data” in it. What does it eat? Where did you find it?
- When you are done with your observations, the beetle should be returned where you found them.
- Use books or the Internet to find out more about these beetles. Where did they get these names?

Scarab beetle
Hercules beetle
Stag beetle
Rove beetle
Ladybird beetle
Burying beetle
Bark beetles (bark engravers)
Weevils
Tiger beetle
Colorado potato beetle
Diving beetle
Whirligig beetle
Dung beetle

Vocabulary

Coleoptera: The Order (group) of insects to which the beetles belong: “Coleo”(sheath-like) + “ptera” (wing).

Elytra: The leathery or hard forewings or front wings of a beetle, often meeting in a straight line down the back.

Exoskeleton: Skeleton on the exterior of the body.

Segment: A ring or subdivision of the body, made of repeating sections.

Mandibles: The first pair of mouthparts that often form biting organs; the jaws in insects.

Maxillae: The mouthparts behind the mandibles of insects.

Palps: Mouth feelers.

Adult: A mature insect.

Larva: An immature insect, a grub in the case of beetles.

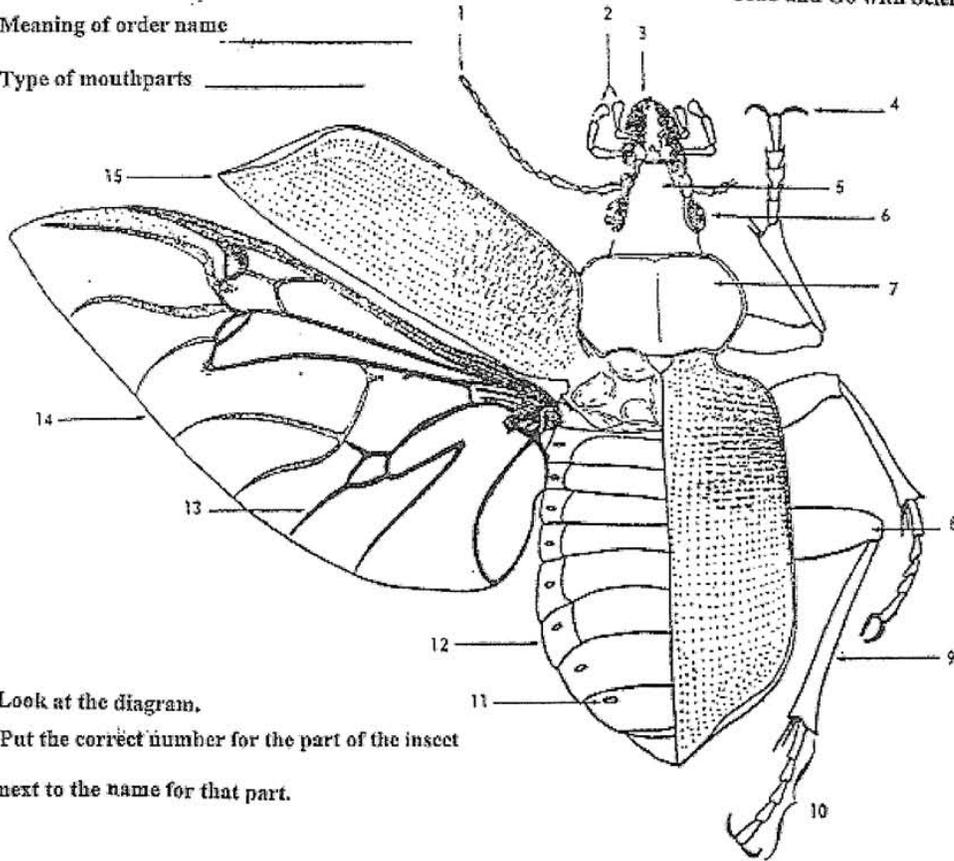
Pupa: An insect in an intermediate inactive stage of its growth, often enclosed in a cocoon or case; the stage between larva and adult, in insects.

Order: A group of related organisms.

BETLES

Entomology - C. Class
Grab and Go with Science

Order _____
 Meaning of order name _____
 Type of mouthparts _____



Look at the diagram.
 Put the correct number for the part of the insect
 next to the name for that part.

- | | | | |
|------------------|--------------|--------------|--------------|
| ___ abdomen | ___ clytra | ___ hindwing | ___ spiracle |
| ___ antenna | ___ femur | ___ mandible | ___ tarsus |
| ___ claws | ___ forewing | ___ palps | ___ tibia |
| ___ compound eye | ___ head | ___ pronotum | ___ vein |

4-H ENTOMOLOGY WORKSHEET - 5

UNIVERSITY OF CALIFORNIA AGRICULTURAL EXTENSION SERVICE

BEETLES I

O C S L A T I G E R S E L S X
M T O E A R R G S P E X A T T
X A A L L R T O G G L O D A K
G A X T E U V Y V E B S Y G C
P X R I O O C A L E I K B S D
K R A B L P P R F E D E I E D
P A L P S L O T E Z N L R B E
D I V I N G A D E H A E D H T
S C A R A B J E A R M T P H N
S R E V A R G N E R A O U W E
D J A U G R L Q O F O N P O M
R Q P N Y U U F A D A L A G G
G I G I L R I H W O D E O Q E
G N I Y R U B T L U D A L C S
N X X Y T V Q V S L I V E E W

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwards

ADULT	EXOSKELETON	PUPA
BARK	HERCULES	ROVE
BURYING	LADYBIRD	SCARAB
COLEOPTERA	LARVA	SEGMENTED
COLORADOPOTATO	LEAF	STAG
DIVING	MANDIBLES	TIGER
EGG	MAXILLAE	WEEVILS
ELYTRA	PALPS	WHIRLIGIG
ENGRAVERS		

BEETLES II

E C O G M T A H M L D Q D H O
N G O D I V Q A Y R W I C T S
G A D L R G N V I M V X A L E
R T B A E D I B B I A T W U L
A S L A I O Y L N U O H E D U
V A S B R D P G R P R L E A C
E R L M A A G T O I E Y V E R
R E B L G E C D E A H G I G E
S P A L P S A S F R K W L N H
T X R K A R T Y L E A C S L G
E I K L O D E T N E M G E S C
F V G L E X O S K E L E T O N
Q N O E B M A X I L L A E Z Y
D C X R R N Z G F A P U P S G
A F E Y X Z U N G C G X A E A

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwards

ADULT	EXOSKELETON	PUPA
BARK	HERCULES	ROVE
BURYING	LADYBIRD	SCARAB
COLEOPTERA	LARVA	SEGMENTED
COLORADOPOTATO	LEAF	STAG
DIVING	MANDIBLES	TIGER
EGG	MAXILLAE	WEEVILS
ELYTRA	PALPS	WHIRLIGIG
ENGRAVERS		

BEETLES III

L M H T D U Q O D H K J B B O
T P R S I J M N V A L R M T V
D D A E V G U P R E A W A I K
E M S L I V E E W I D T X B R
O V N U N G T R T E O M I A S
E W O C G P J K T P G A L R L
Q W T R O H K N O W S D L A W
Q J E E E W E D X H Z U A C H
W V L H Q M A N D I B L E S E
X O E N G R A V E R S T F P N
C P K E O L R F T L F A E L L
Q N S L V U T D R I B Y D A L
E L O B U R Y I N G D V R P J
I C X M D X L T P I W V R U S
A S E S B T E F O G A T S P Y

CAN YOU FIND THESE WORDS?

Up, Down, Left, Right, Diagonally, Forwards or Backwards

ADULT	EXOSKELETON	PUPA
BARK	HERCULES	ROVE
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ENGRAVERS		

Entomology: Beetle Scavenger Hunt

Background Information

- Beetles are insects, therefore their bodies are made up of three body regions: the head, thorax, and abdomen. They have three pairs of legs, and one pair of antennae.
- Beetles also have two pairs of wings. The first pair or forewings are hardened and protect the more delicate hind wings. These forewings are known as “elytra.” In fact, the word Coleoptera, the name for the group of insects to which the beetles belong, means “sheath-like wings.” The hind wings are larger than the elytra, and when the beetle is at rest, the hind wings are folded neatly over the body. They must be unfolded to fly, then tucked back in when the beetle lands.
- The beetle has chewing mouthparts. The jaws (consisting of large, visible mandibles, and a second pair just below those called the maxillae) work from side to side. There are also one or two pairs of palps, which help to push the food around in the insect’s mouth. The mandibles are used to bite and tear bits of food; the maxillae help shred these bits into smaller pieces before they are passed into the digestive tract.
- Insects are cold-blooded. They cannot regulate their own temperature, but depend on the air around them to warm them. When it is warm, they are active, but when it is cool, activity slows down.
- Some beetles have special ways to avoid being eaten by other insects or animals. The Japanese Beetle, a pest of roses and grapes and many other plants, will grow tense, stop feeding, and lift its hind legs when danger approaches. Then it will either fly away or drop to the ground. Some weevils tuck their legs under their bodies, fall to the ground and play dead. Some Water Beetles dive into the water and stay there holding onto a plant or rock, breathing air that they carried with them, until danger has passed (usually about 20 to 30 minutes).

Background Resources

- *Some Beetles of New York*. John A. Wilcox. New York State Conservationist Magazine. February/March, 1960.
- Any field guide to the insects (many choices including: *Peterson Field Guide series*, *Audubon Field Guide series*, *Golden (Nature) Guide series*, *Simon and Schuster’s Guide*, *National Wildlife Federation Field Guide*. For younger children: *Peterson First Guide series*.)
- *A Field Guide to the Beetles of North America* by Richard E. White, Roger Tory Peterson and Peterson.

Entomology: The Hornet and Yellowjacket Nest

Activity Series:
Entomology
Grade: 3-6
Time: 45-60 min

Main Idea

Youth will learn how each bee works in the colony and how they build their intricate nest. Yellow jackets and hornets are types of wasps living together in a colony, which starts from a single queen each spring.

Motivator

You are the detective, discovering the secret of a bees' nest and telling others about the colony.

Pre-Activity Questions

Before you start the activity, show students a hive and ask:

- How many hornets or yellowjackets do you think lived in this hive?
- What is the hive made of?
- Can you tell us about the life cycle of a hornet or yellowjacket?
- What are the steps in the life cycle, starting with the egg?
- Is the nest thicker or thinner on top?
- Why do you think it was built this way?
- How many openings are there for the hornets or yellowjackets to go in or out of the nest?

Activity

- An abandoned aerial hornet or yellowjacket nest (best collected during the winter)
- A serrated bread knife (for adult use only)
- Notepaper
- Pencils
- Ruler and/or tape for measuring nest size

1. Cut the nest in half vertically with the serrated knife. Examine the overall structure. (Notice that it is thicker on top.) Write down the number of layers of comb (the inside of the hive). The layers closer to the top are larger, and get smaller toward the opening.
2. Remove the comb, keeping the two halves of each layer in the same place so you can see which ones are larger. While looking at the comb, ask: Do you see different size cells? (Two different width cells should be obvious.) Are some of the cells still capped?
3. Open one of the cells gently and remove the contents using your pencil point to push it out, or tweezers to pull out. What is it?
4. Have the group split up and give each group one comb. Have students count and record the number of cells of each size group:
small cells _____ **large cells** _____
 (worker cells) (brood cells)
5. If the wasps use each worker cell three times during the growing season, and the queen and drone cells only once, how many wasps might have been in this colony if they all survived?
6. In other words, multiply the number of small cells you counted by 3, then add to that the number of large cells to find the total number of wasps possible if all had lived and were present at the same time.

Supplies

Objectives

- Learn how hornets and yellowjackets build their nests
- Explore what they eat, how the nest functions and their life cycle.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

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Baldfaced hornet. Photo by Johnny Dell, from <http://Bugwood.org>.



Inside a baldfaced hornet nest, showing open cells, capped cells (with pupae), a larva (near center of photo), and an adult worker. Photo by Carolyn Klass, Cornell University.



Nest made by baldfaced hornets. Photo by Sturgis McKeever, Georgia Southern University, from <http://Bugwood.org>.



Yellowjacket wasps on a small nest. Photo by Howard Ensign Evans, Colorado State University, from <http://Bugwood.org>.

Entomology: The Hornet and Yellowjacket Nest

Science Checkup - Questions to ask to evaluate what was learned

- What would you do if you saw a wasp or hornet starting to make a nest near your front door under the roof?
- Would you remove the nest now, when there are only a few workers in it, or would you wait longer? Why?
- Since these insects use a sting as a defense, they are often disliked by people. Some people are afraid of them and some may be allergic to the venom in the stings. If you were responsible for the school grounds, you would want to keep the hornets and yellowjackets away from the playgrounds. You would want to control them before the nests got large, and the chances of someone getting stung increased.

Extensions

- Measure and record the size of the nest: length, width and circumference at widest part.
- Make a drawing of the nest.
- Explore how the wasp makes the paper covering of the nest. Make a paper mache nest that is hollow inside and as long and wide as your head. (Use a balloon as the basis for the nest, cover the balloon with strips of newsprint dipped in a flour and water solution. Let dry a few days, then pop the balloon. When dry, cut your "nest" in half with a serrated knife, cut holes in the appropriate places for eyes and a hole to breathe from. Make this into a mask by decorating it any way you wish. (Materials needed: strips of newspaper, balloons, flour and water paste or other paper mache paste, elastic to make a band for the mask to hold it on your head when finished.)

Vocabulary

Annual: Yearly, each year.

Cell: A small enclosed part or division, an individual six-sided structure that together with others makes up the comb.

Colony(Colonial Wasps): A group of living things of one kind living together.

Comb: (honeycomb): A group of six-sided cells built by wasps in their nest to contain brood and food. Honeycomb is made of wax by honeybees.

Hornet: Any of the larger social wasps (colonial living wasps).

Petiole: The stem or first part of a wasp nest that is quite strong and attaches the hive to a branch or other structure.

Pupa: An insect in an intermediate inactive stage of its growth, often enclosed in a cocoon or case. The intermediate stage of growth between a larva and adult in complete metamorphosis. For example, when moth larvae (caterpillars) form cocoons, they enter the pupal stage of their development.

Regurgitate: To throw or pour back out, the casting up of incompletely digested food (as by some birds and insects in feeding the young).

Wasp: A winged insect related to the bees and ants that has a slender body with the abdomen attached by a narrow stalk. The females (queens and workers) are capable of giving a painful sting when alive. Wasps belong to the insect order Hymenoptera.

Yellowjacket: A small, colonial wasp with yellow markings on a black body that commonly nest in the ground or above ground.

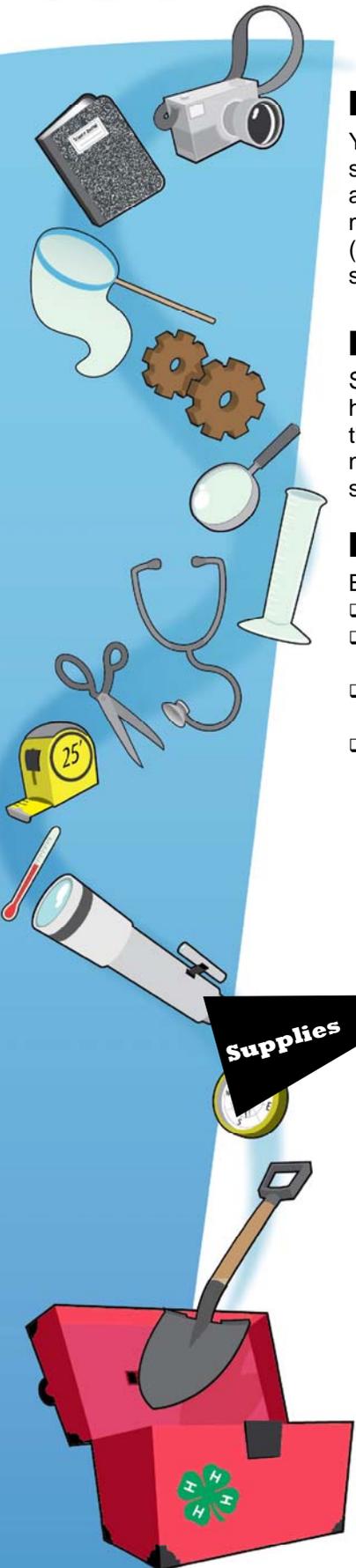
Entomology: The Hornet and Yellowjacket Nest

Background Information

- The aerial hornets and yellowjackets that live in the northeastern United States are annual nesters, which means that they start a new nest each year.
- The nest is started by a mated queen that has overwintered successfully. She begins by gathering “wood” and chewing it up into small particles, mixing it with saliva, then placing it in the spot she has chosen for a nest.
- At first she “glues” this material to the structure that will hold the nest, often an overhanging roof or other solid piece of wood in a protected location. This forms the petiole of the nest. Then she begins to draw out the “paper mache” that she makes into a protective envelope and a group of six-sided cells -- usually five or six in the group.
- When these are partially completed, she lays an egg in each one and continues working on the cells and the envelope of the nest. Meanwhile, the eggs incubate, and the larvae hatch in approximately five days. The envelope will protect the nest from weather, and will surround the comb and help the insects to regulate both the temperature and moisture in the nest.
- When the first group of larvae hatch, they are hungry. Being legless creatures they depend on the queen to feed them. The queen goes out in search of insects such as caterpillars or flies, which she captures, chews up, and then regurgitates to her larvae. This is a full-time job when the larvae are actively growing (about two weeks).
- When the larvae are grown, they spin a cap of silk over the cell they are in, and in this location they undergo pupation, a resting stage in which the larva changes greatly, develops legs, wings and antennae and gradually transforms into an adult.
- After about 14 days, the adult is fully formed and ready to emerge from its pupal cocoon. It chews a hole in the cocoon cover and pulls itself out. After a few hours, its body is hardened off, its wings expanded and it is ready to take on the life of a worker.
- The workers from this point on will take over the duties of the upkeep and expansion of the hive, leaving the queen to lay eggs for the rest of the colony. Workers keep building cells and feeding other larvae as they develop. In the life of the colony, the worker cells may be used a maximum of three times for brood during the growing season.
- As fall approaches, the queen continues to lay eggs, some in larger cells the workers have built. These eggs will develop into a brood of new queens and males (drones) which will fly out on warm days, form mating pairs, and then the queens will seek protected places to spend the winter. The larger brood cells are used only once in the life of a colony. Although a few queens may return to the original nest, most find tufts of grass or decaying portions of trees to hibernate in and wait for spring. The old queen, workers and drones die in the fall.

Entomology: Canaries of the Pond & Stream

Activity Series:
Entomology
Grade: 3-6
Time: 20-60 min.



Main Idea

Youth will explore ponds and/or streams to collect and identify the various species that are living there. The diversity of organisms found in an aquatic environment is an indicator of habitat quality and overall environmental quality. The presence or absence of certain macroinvertebrates (large organisms that don't have backbones, such as insects) tells us something about the health of the aquatic ecosystem.

Motivator

Share the following anecdote: Because canaries are more sensitive than humans to dangerous gases in the air, coal miners used to take them into the mines to measure air quality. Their death indicated when the air was not safe to breathe. Aquatic organisms can play a similar role as the absence or presence of certain species is an indicator of water quality.

Pre-Activity Questions

Before you start the activity, ask the students:

- What is biological diversity?
- What might a high diversity of life suggest about a habitat? A low diversity?
- What environmental conditions are important for organisms to survive in an aquatic environment?
- How can you minimize the impact you may have on the environment (stream banks, spawning sites, vegetation) while you're collecting?

Activity

For Each Team:

- Ice-cube trays or shallow white-bottomed pans
 - D-nets
 - Plastic spoons
 - Magnifying glasses or bug boxes
 - Identification charts/books
1. Divide your group into pairs. Provide each pair with some collection gear and identification books/charts. Demonstrate collection techniques with the D-net, scoop nets, etc.
 2. Allow the pairs to collect their own samples and/or observe collected specimens. How many different kinds of specimens did each group collect?
 3. Record findings and discuss what everyone found.
 4. Combine everyone's observations and decide how to rate the quality of the ecosystem.
 5. Demonstrate returning the contents of a pan to the pond or stream from which it came and have everyone do the same with their collections.
 6. Travel to another location and collect again. Compare results.

Supplies

Objectives

- Observe and collect aquatic macroinvertebrates correctly.
- Use biological diversity indexes to rate the health of an aquatic ecosystem.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

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Entomology: Canaries of the Pond & Stream

Science Checkup - Questions to ask to evaluate what was learned

- What does biodiversity mean?
- How does biodiversity relate to the health of the water?
- Explain how water quality can be good for one creature and bad for another.

Extensions

- Conduct some chemical or physical tests to measure water quality (pH, dissolved oxygen, speed, temperature, depth, etc.).
- Visit your pond or stream several times throughout the year to discover changes. Be sure to use physical and biological tests in your investigations. What changes do you notice?
- Keep written records of your work so that your group (or a different one) can compare results in the future.

Vocabulary

Aquatic: Pertaining to water.

Biological Diversity: Variety of different species.

Biomonitoring: Determining the health of a water body by taking a count of the number of different types of living organisms and their tolerance to pollutants.

Macroinvertebrates: Organisms, without a backbone, large enough to be seen without a microscope.

Water Quality: A measure of the health of a water body (can be measured with chemical, biological or physical parameters.)

Background Resources

- Water Project Unit 3: Water Quality Matters, Joy R. Drohan, William E. Sharpe, Sanford S. Smith, Penn State University, 2004
- Water Worlds, Experience 4-H Natural Resources Series, Janet E. Hawkes, Kurt Jirka, Marianne Krasny, Diane Held Phillips, Cornell Cooperative Extension, 1988
- Pond and Stream Safari, Experience 4-H Natural Resources Series, Karen Edelstein, Cornell Cooperative Extension, 1993
- A very nice key to identifying macroinvertebrates can be found on this website. Very useful if you can take pictures of your organisms or if you can bring a lap top into the field.
<http://people.virginia.edu/~sos-iwla/Stream-Study/Key/MacroKeyIntro.HTML>
- Macroinvertebrate identification charts and books.

Entomology: Exploring Plant Galls

Activity Series:
Entomology
Grade: 3-6
Time: 45-60 min

Main Idea

A gall is an abnormal growth on a plant. Many galls on plants are caused by insects. They provide a home where insects can grow and develop. A few plant pathogens (disease-causing organisms) such as bacteria and fungi may also cause galls.

Motivator

When you see a bump on a tree or a funny-looking growth on a plant, do you ever wonder what might be inside? Or why it happened?

Pre-Activity Questions

Before you start the activity, ask the students:

- Where should we go to look for plant galls?
- What do you think we will find inside the galls we collect?

Activity

(See fact sheet "Some Plant Galls" for illustrations and descriptions of common galls):

- Meadow or wooded area to look for plant galls
- Bag for collecting
- Sturdy garden shears for clipping branches with galls
- Hack-saw for cutting woody galls (adult supervision required)
- Pocket knife (adult use only)
- Magnifying glass, hand lens or microscope
- Notepaper
- Pencils to write/draw with
- Insect guide

1. Take the class out first to show them the collection area and show them a few galls so they know what to look for. Then, go on a gall hunt - see who can collect the most different types of plant galls (abnormal growths on plants) in 10 minutes.
2. Bring collected "galls" back to the meeting site.
3. Carefully cut open one gall of each type to see what is inside, (without destroying whatever is inside). If the plant tissue is soft, a pocket knife or pair of scissors may be best, but if the plant material is hard and woody, you may want to put the gall in a vise to hold it, and gently cut through with a hack-saw.
4. Make a chart of what you found, or draw a picture of a gall or two.

Helpful Hint:

When galls are collected during the winter, it is a good bet that the gall makers will emerge the following spring when the temperatures warm up and plants begin new growth. You may be able to find the adults of insects whose larvae you saw earlier in the season. Add these to your collection even if you do not know the names of the insects causing the galls. A scientist may be very interested to see what you have reared, and may be able to help you with some identifications too.

Objectives

- Be able to recognize plant galls and know what causes them.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
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- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

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Entomology: Exploring Plant Galls

Science Checkup - Questions to ask to evaluate what was learned

- Where could you go to look for plant galls?
- What caused the galls you found?
- If the gall was caused by an insect, why would the insect want to live in there?

Extensions

- There are more than 100 species of gallmakers that attack oaks alone. The galls come in many sizes and shapes and may be found on leaves, stems, flowers and even roots. Have the group explore some oak trees to see how many different galls they can find on this one host.
- Keep a record book. Write down what you find and attach your note to the gall you collect or draw a picture of the gall in your notebook. Ask: What is the host plant? Is there only one insect cell inside or many? Are the insects present? Do you see larvae? Adults?
- Start a collection of plant galls and gall makers. If you are able to collect mature galls when the insects are still inside, you might try keeping them in a jar with a lid with a few holes punched in for air (or a piece of nylon stocking stretched over the top and held in place with a rubber band) and wait to see if anything comes out of the gall.

Vocabulary

Develop: To grow toward maturity

Gall: A swelling or growth on a plant part; an abnormal growth of plant tissue.

Host plant: The plant with the growth on it.

Immature: Not yet fully grown

Larva: A wingless form of an insect that hatches from an egg, such as a grub or caterpillar

Order: A group of related organisms.

Background Information

- A gall is an abnormal development or outgrowth of plant tissue resulting from an irritation. It is often caused by insects, but bacteria or fungi can also cause galls. When insects are the culprit, the immature, or larva stage, is found inside. The larvae cause irritation and the extra growth to occur, and they may also gain their food from the inner walls of the gall, where they are living.
- Galls interfere with the normal function of twigs and other plant parts, causing curling, stunting and tumor-like growths. Some galls are harmful to the plant, while others are not.
- Of the insects, the Hymenoptera (the ants, bees and wasps) and the Diptera (the two-winged flies) are the two orders that cause the majority of plant galls. A number of oak galls are caused by tiny gall-making wasps and the goldenrod ball gall is an example of a fly-caused gall. Aphids and mites also cause a large number of galls.
- Bacteria may cause galls on the stems and crowns of plants such as blackberry or roses. Fungi may cause galls that at various times in the season produce fungal spores. If there is no hollow area inside the gall, it may be caused by bacteria or fungi.
- **A gallmaker's life cycle:** The goldenrod ball gall will serve as our example. A female picture-winged fly lays her shiny white egg in the bud tissue at the top of a young goldenrod plant. She usually lays one egg per plant. She makes a little hole in the stem with her ovipositor (egg laying tube) and then puts the egg in the hole. The young larva (maggot) bores down into the growing part of the stem and begins to hollow out a chamber. A gall begins to form, probably in response to some chemical the larva gives off, and this gall will provide both shelter and food for the gall fly larva. The insect inside the gall remains as a larva until late March or April in the Northeast, when it changes into a pupa. (The pupa is a resting stage of the life cycle, in which the insect transforms from a larva to an adult.) A few weeks later when the goldenrod has just started to grow, the adult fly emerges, mating occurs and the female will begin the cycle again by laying an egg in the young goldenrod plant.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Entomology: Exploring Plant Galls

Some Plant Galls

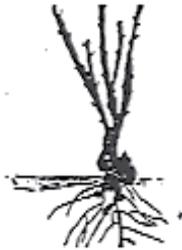


COOLEY SPRUCE GALL - A 1 to 1½ inch cone-shaped overgrowth that first appears on the tips of the spruce branches in early June. If cut open, one will find numerous tiny gray aphids (adelgids) inside. The galls open in August and September, and the adults emerge to lay eggs. The young adelgids overwinter on the buds and twigs of the host tree.



GOUTY OAK GALL - Caused by a wasp, these galls appear on the stems of black, red, pin and scarlet oaks. They have been known to cause small branches to be killed and break off the tree.

Other common galls include the hickory leaf and petiole gall, first appearing on leaf petioles and small stems in June as hollow green growths, they later turn black. The cause of this gall is a phylloxeran, a small aphid-like insect. The poplar petiole gall is seen as a swelling of the leaf petiole which turns black upon maturity, and it is caused by an aphid.



CROWN GALL is one example of a gall that is harmful and often kills plants. It is caused by a bacterium. Crown gall is usually found at or near the soil level and appears as rough-shaped, hard or soft, spongy swollen tumors. The color of the galls varies from flesh-colored to greenish or dark. Where this gall is discovered it is best to discard the plant altogether.

WILLOW PINE CONE GALL - CAUSED BY A MIDGE
Rhabdophaga strobiloides



SAWFLY GALLS ON A WILLOW LEAF
Pontania proxima



SHOOT GALLS ON WILLOW - CAUSED BY SAWFLIE
Tenthredinidae: *Euura* sp.



HORNED OAK GALL - CAUSED BY A GALL WASP
Callirhytis cornigera

Flight

About the 4-H Science Toolkit Series: Flight

In this series of activities, children create various vehicles for flight – from kites to boomerangs to flying saucers. Through their creation and flight experiments, they learn about the science behind flight and begin to understand terms like drag, lift and payload. They also explore how flight is affected by factors such as the shape of an object, how it is thrown or launched and environmental factors such as wind speed.

Students use everyday materials such as paper, tape, paper plates, cardboard and tissue paper to create their flying objects. Then they try flying them, measuring and recording their results, using different methods of launching or throwing, attaching various materials or weights or turning or bending the actual object to determine how these changes affect how fast or far an object will fly.

All of these adventures call on students to predict what will happen, test their theories, then share their results. They'll be introduced to flight vocabulary, gain an understanding of aerodynamic shapes and learn how scientists measure their results.

The lessons in this unit were developed by and are connected to the Department of Fiber Science & Apparel Design at Cornell University.

To find out more about fiber science, visit the Department of Fiber Science & Apparel Design at <http://www.human.cornell.edu/fsad/> and to find numerous resources related to aerospace technology and rocketry, check out the 4-H Resource Directory at www.cerp.cornell.edu/4h <<http://www.cerp.cornell.edu/4h>> .

Flight Table of Contents

- Rockin' Rocket:** Understand how rockets are launched and how scientists determine how much weight a rocket can carry.
- Hanky Parachute:** Learn how parachutes work.
- Straw Kites:** Build kites to experiment with lift and drag.
- Spinning Saucers:** Discover what makes a round objects like a saucer fly best.
- Boomin' Boomerangs:** Learn why a boomerang works and try different boomerang shapes.
- Awesome Airfoils:** Discover why the shape of an airplane wing helps airplanes fly.

Flight: Rockin' Rocket

Activity Series:

Flight

Grade: 3-6

Time: 30-60 min

Motivator

British rocket brigades bombarded Fort McHenry in Maryland during the War of 1812, and it was these "bombs bursting in air" that inspired the writing of our national anthem, "The Star-Spangled Banner."

Main Idea

Rockets are thrust into the air by a propellant. Rockets will travel different distances when moving horizontally, vertically, or at a 45-degree angle.

Pre-Activity Questions

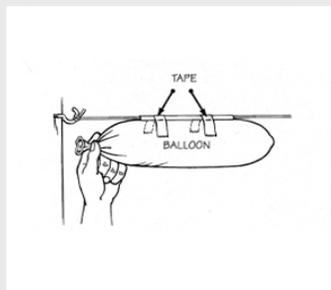
Before you start the activity, ask the students:

- Can you name a NASA rocket?
(Possible Answers: Minuteman, Saturn, Atlas, Titan.)
- Did you know that the space shuttle is pushed into orbit by several rocket engines and rocket boosters?

Activity

- Scissors
- Monofilament fishing line
- Plastic drinking straws
- Balloons (long, sausage-shaped)
- Masking or freezer tape
- Measuring tape or yardstick
- Pen, pencil, chalk, or marker
- Paper or chalkboard to record results

1. Cut pieces of monofilament line (at least 10 feet long) so that you have one for each two participants.
2. Fasten one end of the lines to a stable object such as the ceiling, wall, door or chair.
3. Thread a plastic drinking straw onto each line. Fasten loose end of line to a stable object to achieve a horizontal position.
4. Assign one partner to prepare the balloon and one to record distance traveled.
5. Blow up a balloon, but don't tie the end. Tape the inflated balloon to the straw. Position balloon underneath straw with its "nose" pointed toward the length of string.
6. Release balloon and record the distance traveled.
7. Repeat same exercise three times. Then average your results.
8. Move one end of string so that it creates a vertical track. Repeat three trials, record distances and average results.
9. Move string so that it creates a 45-degree angle. Repeat three trials, record distances and average results.
10. Make chart comparing average performance along horizontal, vertical and 45-degree-angle tracks.



Objectives

- Make a rocket
- Record distance traveled at different angles
- Average and compare results

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Flight: Rockin' Rocket

Vocabulary

Rocket: Vehicle propelled by ejection of gases.

Rocket engine: Part of rocket that carries the fuel and oxygen.

Science Checkup - Questions to ask to evaluate what was learned

- Did the distance the balloon traveled change with the angle of ascent? How?
- Can you guess how balloon rockets differ from real rockets?
(A rocket carries its fuel and oxidant on board; the interior air of a rocket is extremely hot.)

Extensions

- Inflate some balloons and release them into the air. How does the action of these balloons differ from the action of the rocket balloons?
- Try taping weights (pennies work well) onto your balloon. How many pennies can it carry?
- Position teams at each end of the string so they can exchange written messages via the balloon rocket.
- Compare performance of rockets made from a variety of balloon shapes and sizes.
- Modify the balloons with attached wings, pointed nose cones, streamers, or other features.

Background Resources

- *Rockin' Rocket* is adapted from the *Rocket 1: Rocket Blast Off* activity in *The Fabric/Flight Connection*, Cornell Cooperative Extension, Cornell University. See NYS 4-H Resource Directory, <http://www.cerp.cornell.edu/4h/search_result_details.asp?pid=1547> or FSAD Outreach <http://www.human.cornell.edu/che/fsad/outreach/programs/youth-programs/fiber_science_and_technology.cfm>
- *Aerospace Technology Education Series: Powered Flight*, Steve Bachmeyer, Pitsco, Pittsburg, KS. 1994.
- Rocket Science Projects Web site, www.ScienceBuddies.org
- Curious About Astronomy Web site: How do I build a model rocket?, curious.astro.cornell.edu/question.php?number=11

Flight: Hanky Parachute

Activity Series:
Flight
Grade: 1-5
Time: 30-60 min

Main Idea

Many factors determine how quickly a parachute will descend, including the weight of the payload, size of the parachute and air permeability of the parachute material.

Motivator

The first parachutist was a dog. His owner made the first successful human jump eight years later in 1793.

Pre-Activity Questions

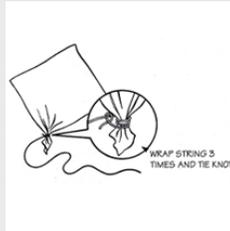
Before you start the activity, ask the students:

- How are parachutes used? (Dropping people or supplies; skydiving; slowing the speed of race cars.)
- Should parachutes drop quickly or slowly? How do you think you could speed up or slow down a parachute?

Activity

- Handkerchief or other square of fabric
- Four strings at least 12 inches (30.5 cm) long
- Plastic container with snap-on lid (yogurt cup, film canister, etc.)
- Miscellaneous items to add weight by increments (e.g., popcorn, beans, pennies, washers)
- Stopwatch or watch with second hand (optional)

1. Gather corner of hand handkerchief or fabric. Wrap piece of string around point three times, and tie. Repeat for other corners.



2. Bring ends of strings together, trying to make them equal in length, and tie an overhand knot.

Supplies

Objectives

- To understand the various qualities of different parachutes

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

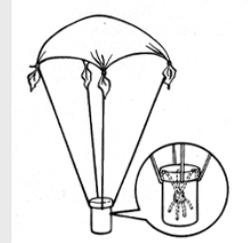
Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
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Model/Graph
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Redesign
Optimize
Collaborate
Compare

Contributed By

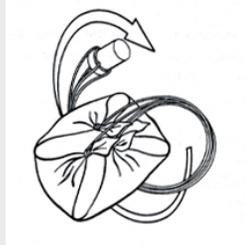
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Flight: Hanky Parachute

3. Place knotted string ends inside film canister and fasten lid.



4. Wrap strings around canopy and toss it in the air. Practice until canopy opens and canister floats to the ground.



5. Repeat several times, loading more weight into canister with each toss.
6. Rank speed of descent of each trial and compare. For example, first place (fastest) carried 25 beans; second place, 15 beans; third place (slowest), 5 beans. For more accurate times, use a stopwatch.

Science Checkup - Questions to ask to evaluate what was learned

- Did all the parachutes open each time? If not, describe what happened.
- What happened if the parachute strings crossed?
- Did you toss the parachute to the same height every time?
- What worked best, a high toss or a low toss?
- What happened when you added weight to the canister? Was it harder to toss? Did the parachute open better? Did it drop faster or slower?

Extensions

- Repeat drops, but add extra weight to the parachute instead of to the canister. Add weight by applying metallic tape, cloth patches, painted designs, or glued objects.
- Try using different materials for the parachute, some heavier and some lighter than your original parachute.
- Try making larger and smaller parachutes. Can they carry more or less payload?

Vocabulary

Air Permeability: How easily air passes through the material

Parachute: A canopy that traps and holds air.

Payload: Person or object carried by the parachute.

Canopy: the part of a parachute that opens up to catch the air.

Flight: Hanky Parachute

Background Resources

- Hanky Parachute is adapted from the *Parachute 2: Bail Out activity* in *The Fabric/Flight Connection*, Cornell Cooperative Extension, Cornell University. See NYS 4-H Resource Directory, <http://www.cerp.cornell.edu/4h/search_result_details.asp?pid=1547> or FSAD Outreach <http://www.human.cornell.edu/fsad/outreach/programs/youth-programs/fiber_science_and_technology.cfm>
- *Aerospace Technology Education Series: On the Step & Go*, Steve Bachmeyer, Pitsco, Pittsburg, KS. 1991.
- *Parachutes: How They Work*, Eloise Katherine Engle, Putnam, NY, NY. 1972.
- Make a Parachute <www.seed.slb.com/en/scictr/lab/parachute/index.htm>
- Parachutes <www.nationalmuseum.af.mil/shared/media/document/AFD-060512-010.pdf>

Flight: Straw Kites

Activity Series:
Flight
Grade: 3-6
Time: 30-60 min



Main Idea

Youth build kites to demonstrate lift (upward force to achieve and maintain flight) and drag (kite tails help steer and stabilize kites). They experiment with different kite materials.

Motivator

The first known kite was constructed by the Chinese more than 3000 years ago to frighten their enemies. Do you think kites are scary?

Pre-Activity Questions

Before you start the activity, ask the students:

- Do you own a kite? Describe the materials it is made of.
- Do all kites have tails? (A: No.)
- Do you know the purpose of a kite tail?
(A: Help steer and stabilize.)

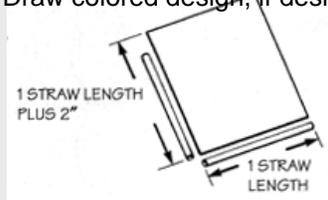
Supplies

Activity

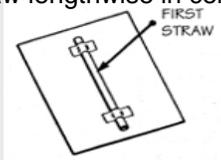
- Typing Paper
- Tyvek (a Tyvek mailer yields two kites)
- Tissue Paper
- Scissors
- Waterproof paints or markers (optional)
- Nine plastic straws
- Cellophane tape
- Elmer's white glue
- Hole punch
- Kite string, 12 inches (30.5 cm) for bridle; 60 yd. (55m) for the towline or flying line

1. Cut paper as follows:

- Length = length of straw + 2 inches (5 cm)
- Width = length of straw.
- Draw colored design, if desired.



2. Place one straw lengthwise in center of paper and tape into place.



Objectives

- Make and fly a kite
- Experiment with various kite materials and observe their effects

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

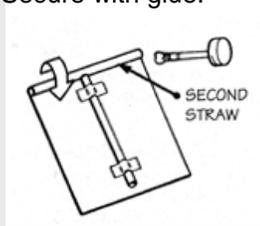
- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

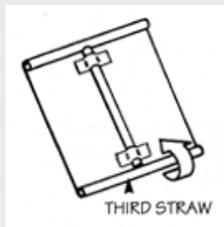
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Flight: Straw Kites

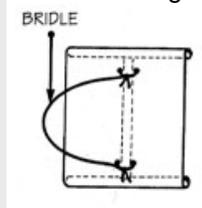
- Place second straw on top edge of paper. Glue straw to edge and roll it down paper until it meets center straw tip. Secure with glue.



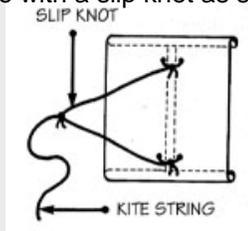
- Place third straw on bottom edge, glue, and roll it up until it meets bottom tip of center straw. Secure with glue.



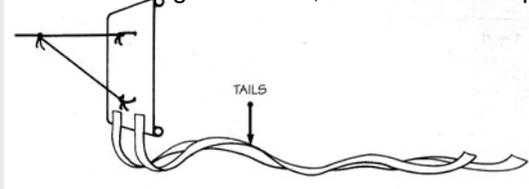
- Make bridle by punching two holes on either side of center straw near top straw and two holes near bottom straw. Tie bridle string so it is about 4 to 6 in. (10 to 15 cm) from face of kite.



- Attach kite string to bridle with a slip knot as shown.



- For tails, cut strips of paper about 1 inch (2.5 cm) wide and glue to kite. In light breezes, use fewer tail sections. In stronger breezes, use more tail strips for added stability.



- Repeat using different paper.
- Fly your kites and compare how the different materials behave.
- Shorten or lengthen kite tails and fly kites again.

Flight: Straw Kites

Science Checkup - Questions to ask to evaluate what was learned

- What are the finished dimensions of your straw kite?
- How did kites made from different materials behave?
- What happened when the kite tails were shortened or lengthened?

Extensions

- Did you know that you can recycle your Tyvek envelopes?
- Did you know that people wear protective coveralls made of Tyvek when they are removing asbestos from buildings?
- For additional information on Tyvek, write to E.I. du Pont de Nemours & Co., Wilmington, DE 19898, or search the Internet.

Vocabulary

Bridle: Strings that connects the kite to the towline; the bridle controls the angle of flight.

Drag: Air resistance to the movement of an object.

Kite: A light frame covered with thin material that is attached to a string and flown in the wind.

Lift: Upward force that overcomes gravity.

Tyvek: Registered trademark of DuPont for a spunbonded olefin fabric that is tear-resistant and inexpensive. It is used for mailers, protective coveralls, and kites.

Background Resources

- Straw Kites is adapted from the *Kite 2: Straw Kite activity* in *The Fabric/Flight Connection*, Cornell Cooperative Extension, Cornell University. See NYS 4-H Resource Directory, <http://www.cerp.cornell.edu/4h/search_result_details.asp?pid=1547> or FSAD Outreach <http://www.human.cornell.edu/che/fsad/outreach/programs/youth-programs/fiber_science_and_technology.cfm>
- *Aerospace Technology Education Series: Fly a Kite*, Steve Bachmeyer, Pitsco, Pittsburg, KS. 1991.
- *Kiteworks: Explorations in Kite Building and Flying*, Maxwell Eden, Sterling, NY. 1989.
- *Kites*, David Pelham, Overlook Press, Peter Mayer Publishers, Inc., Woodstock, NY. 1976, 2000.
- How to Make and fly Kites — A Complete Guide, www.howtomakeandflykites.com
- Making and Flying Kites, www.making-and-flying-kites.com/
- The Best of the Best Kite Making Plans, members.tripod.com/~TKOGunn1/kiteplans.htm

Flight: Spinning Saucers

Activity Series:
Flight
Grade: 1-4
Time: 45 min.

Main Idea

Round objects sail best with a circular rotation and balanced weight.

Motivator

University of Florida professor Subrata Roy made a 6-inch flying saucer and plans to create human-sized variations in the future. He prefers the description “wingless electromagnetic air vehicle.”

Pre-Activity Questions

Before you start the activity, ask the students:

- Have you seen or read stories about unidentified flying objects (UFOs)?
- Do you know the purpose of a flying saucer?

Activity

- Paper plates
- Cellophane tape or stapler with staples
- Scissors
- Decorations (crayons, markers, stickers, glue, tissue paper, aluminum foil, glitter, tinsel, paper clips, ribbons, pipe cleaners, scraps of cloth or paper, etc.)

1. Staple or tape together two paper plates so that the inside (eating) surfaces face each other.
2. Decorate your flying saucer. You can draw/color designs or attach streamers, weights, pictures, ribbons, glitter, etc.
3. Sail your saucer outdoors or in a spacious room.

Science Checkup - Questions to ask to evaluate what was learned

- How many different saucers did you make?
- Which sailed the farthest and which sailed in the straightest line?
- Describe the arm and wrist movements you used. Did you try spinning it like a Frisbee? Or throwing it like a baseball? Or another method?
- Did you change the weight of the saucer with your decorations?
- Did the weight of the plate affect the way the saucer sailed? How?
- Was it important to place the weights evenly around the plate?
- Did streamers affect the speed or balance of your saucer? How?

Extensions

- Hold a distance competition, setting markers every 10 feet. Each player gets three throws. Average the distances and name a winner!
- Use reflective tape or glow-in-the-dark stickers and sail the saucers at night.

Objectives

- Observe the effects of added materials and throwing patterns on the flight of a saucer.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Flight: Spinning Saucers

- Use reflective tape or glow-in-the-dark stickers and sail the saucers at night.
- Try to sail your saucer through suspended hoops of different sizes (hula, quilting, and embroidery hoops).

Vocabulary

Circumference: The distance around a circle.

Diameter: The distance across a circle through the center.

Background Resources

- *Spinning Saucer* is adapted from the “*Disk 1: Flying Saucer*” activity in the *Fabric/Flight Connection*, Cornell Cooperative Extension, Cornell University. See NYS 4-H Resource Directory, <http://nys4h.cce.cornell.edu/Documents/TheFabricFlightConnection.pdf>
- *Things That Fly*, Kate Little, Tulsa, Okla.: EDC, 1987.
- *Flight and Flying Machines*, Steve Parker, Rev. Ed. New York: Dorling Kindersley, 1993.
- The World’s first flying saucer, <http://www.scientificamerican.com/article.cfm?id=worlds-first-flying-saucer>

Flight: Boomin' Boomerangs

Activity Series:

Flight

Grade: 3-5

Time: 45 min.

Main Idea

Youth create a cardboard boomerang and learn how to throw it. Then they construct new boomerangs out of different materials and compare the flights.

Motivators

The oldest boomerang ever found is said to be about 30,000 years old. It was discovered in a cave in the Carpathian Mountains in Poland and was made of mammoth tusks!

Australian aborigines still sometimes use the returning boomerang as a hunting tool.

Pre-Activity Questions

Before you start the activity, ask the students:

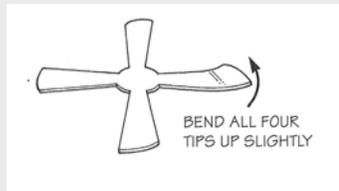
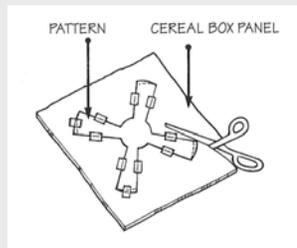
- How are boomerangs used? (Examples: for hunting, percussion musical instruments, fire-starters, sporting competitions and toys)
- How far do you think a boomerang can fly? (World record is 238 meters – about 780 feet!)

Activity

- Boomerang pattern
- Two pieces of cardboard at least 7 inches (18 cm) square (medium-sized cereal box panels work well)
- Pencil or pen
- Scissors
- Masking tape

1. Tape boomerang pattern to cardboard and cut out first boomerang.
2. Reshape boomerang pattern by cutting along dotted lines at blade tips.
3. Tape reshaped pattern to another piece of cardboard and cut out second boomerang.
4. Bend a smooth upward curve in the arm tips of both boomerangs.
5. Fly and compare your two boomerangs.

To fly your boomerangs, grasp one blade between your thumb, index finger and middle finger. Hold the boomerang straight up and down. Twist your wrist toward your body and throw it level and straight ahead, as you would a Frisbee.



Objectives

- Make and throw a boomerang
- Compare the performance of different boomerang shapes

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Flight: Boomin' Boomerangs

If the boomerang does not come back to you after a couple of throws, bend the three arms down slightly and try again. If it still doesn't work, try bending them up instead. Everyone throws a little differently, so what works for one person may not work for another.

Science Checkup - Questions to ask to evaluate what was learned

- Describe the flight of the two boomerangs. What differences did you observe? The boomerang with airfoils (leading edges are longer than trailing edges) should produce more lift and fly farther.
- The curved-up tips help hold the boomerang upright. Did you try flying your boomerang with the tips curved downward?

Extensions

- How far can you throw each boomerang and still make it return?
- Try throwing the boomerangs at different angles. Which is the best for your boomerang?
- Make boomerangs from materials of different weights and thicknesses. Styrofoam meat trays are a good choice. Observe how differently they move.

Vocabulary

Leading Edge: Front edge of a flying object.

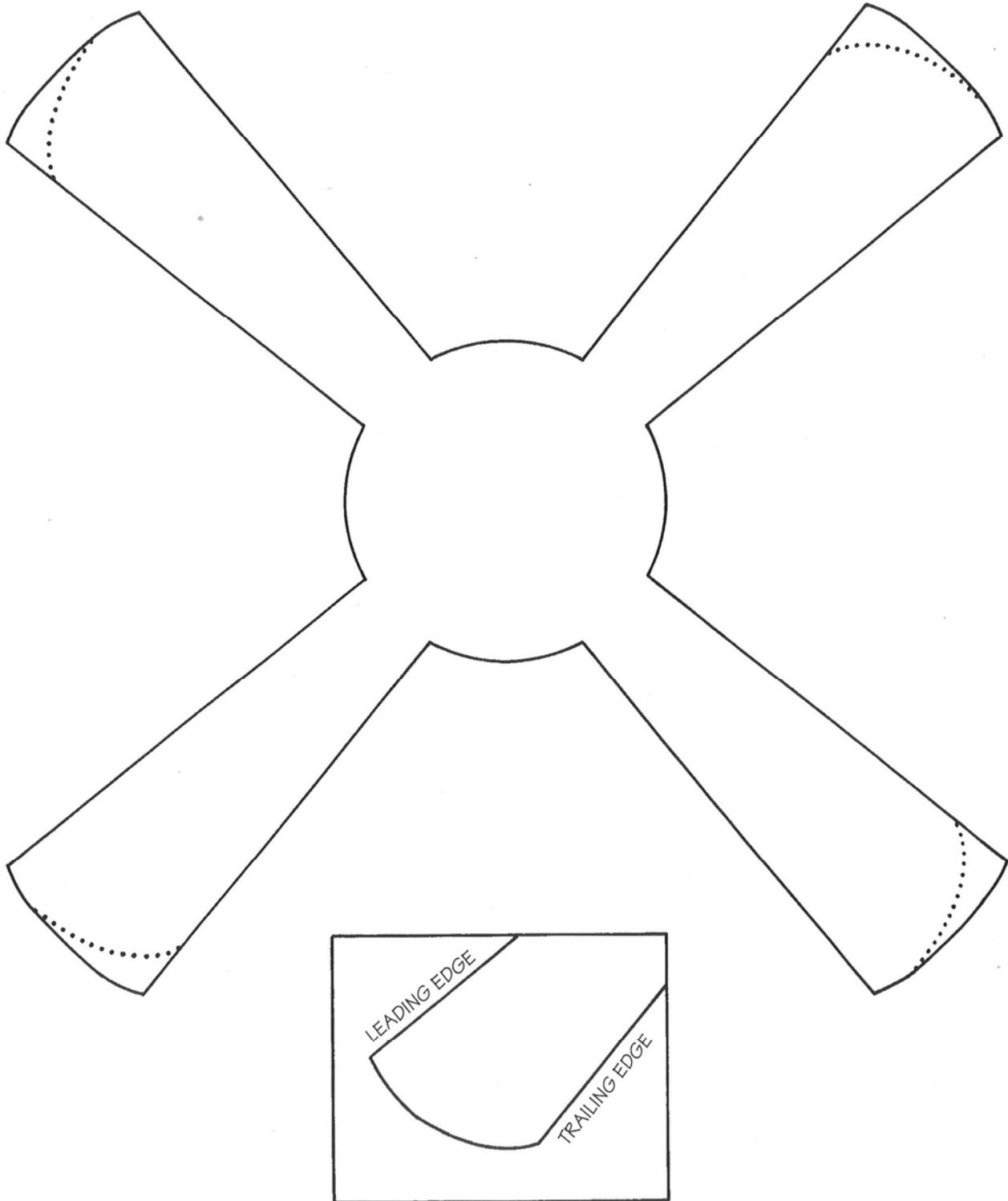
Trailing Edge: Back edge of a flying object.

Background Resources

- This activity is adapted from the "Boomerang 2: Cross-Stick Whirler" activity in the *Fabric/Flight Connection*, Cornell Cooperative Extension, Cornell University. See NYS 4-H Resource Directory, <http://nys4h.cce.cornell.edu/Documents/TheFabricFlightConnection.pdf>
- *Fly It! Making and Flying Your Own Kites, Boomerangs, Helicopters, Hang Gliders, and Hand-Launched Gliders*, John Kaufmann, New York: Doubleday, 1980.
- How to Make a Boomerang with Kids, http://www.ehow.com/how_4853_394_boomerang-kids.html
- Boomerang Association of Australia, <http://www.boomerang.org.au>

Flight:
Boomin' Boomerangs

Boomerang pattern



Flight: Awesome Airfoils

Activity Series:

Flight

Grade: 3-6

Time: 45 min.

Main Idea

The airfoil shape allows the air above the curved surface to move faster than the air below. Fast moving air has a lower air pressure than slow moving air. The higher air pressure below the airfoil creates lift that overcomes gravity and allows objects to fly.

Motivator

The first U.S. coast-to-coast airplane flight was in 1911 – it took 49 days!

Pre-Activity Questions

Before you start the activity, ask the students:

- Describe the shape of an airplane wing.
- Can you think of other things with a similar shape? (Examples: propellers, sails)
- Have you wondered why people say that airplanes “lift off”? (See vocabulary: lift)

Activity

- Piece of paper (8 ½ in. square works well)
- Cellophane tape

1. Fold paper diagonally, leaving a 1 inch (2.5 cm) space along edges.
2. Fold bottom edge up about 1 inch (2.5 cm).
3. Bring outside points of base together, tucking one inside the other (bend, don't fold) and secure with tape.
4. Grasp airfoil at the apex – the point farthest away from the folded base —and throw as if throwing a baseball, overhanded.

Science Checkup - Questions to ask to evaluate what was learned

- Compare the shape of this airfoil to the shape of an airplane wing.
- Which side of the airfoil was in the downward position? (The airfoil side with the apex is heavier and is kept in the downward direction by gravity, which stabilizes its flight)
- Can you imagine why this shape is important? (See vocabulary: airfoil)

Extensions

- Try throwing the airfoil underhanded as in a softball pitch.
- Try larger pieces of paper.
- Draw an airplane that has its wings curved upward and joined together.

Objectives

- Understand why an airfoil shape facilitates flight.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Flight: Awesome Airfoils

Vocabulary

Airfoil: Streamlined structure that is flat on the bottom and curved on the top. The leading edge is longer than the trailing edge.

Apex : The top or peak.

Lift: Upward force that overcomes the effect of gravity.

Wingtip: The part of the wing that is most distant from the main body of a fixed-wing aircraft.

Background Resources

- Awesome Airfoil is adapted from the “*Airplane 2: Airfoil*” activity in *The Fabric/Flight Connection*, Cornell Cooperative Extension, Cornell University. See NYS 4-H Resource Directory, http://www.cerp.cornell.edu/4H/search_result_details.asp?pid=1547>
- *Gliders: How to Build and Fly Them*, Paul Garrison, New York: Drake, 1978.
- *Airborne: The Search for the Secret of Flight*, Richard Maurer, New York: Simon and Schuster for Young Readers, 1990.
- *The Best Paper Aircraft*, Campbell Morris, New York: Perigee, 1986.
- NASA SciFiles, http://scifiles.larc.nasa.gov/text/kids/Problem_Board/problems/flight/lift2.html
- More on Bernoulli’s Principle, http://www.sciencekidsathome.com/science_topics/flight.html#Trivia%20Answers
- Paper airplanes, <http://www.fatlion.com/science/paperairplanes.html>

Geospatial Science: What Is GPS?

Activity Series:
Geospatial Science
Grade: 3-6
Time: 60 min

Main Idea

The Global Positioning System is a system of satellites, ground control units and receivers. A GPS can pinpoint a user's location to within just a few feet.

Motivator

Global positioning systems are everywhere, whether you know it or not. Everyone from farmers to fighter jet pilots use the technology. If you've ever looked at someone's home address on an internet map, you've used it too!

Pre-Activity Questions

Before you start the activity, ask the students:

- Who do you think originated the concept of a GPS? (U.S. Army)
- Did you know that a pizza delivery driver inspired the first GPS for use in cars?
- When someone asks you where you live in relation to school, have you ever answered with a time — about 20 minutes away?

Activity 1

You Measure Distance with a Clock?

- Five volunteers (a "satellite", a "signal", two "hikers" and a "timer")
- Stopwatch (watch, clock with a second hand, cell phone with a timer, etc)

1. The "satellite" should close his/her eyes while one of the "hikers" stands some distance away. The "signal" will stand by the "satellite".
2. When everyone is ready, the "signal" leaves the "satellite" and walks (do not run) to the "hiker." When the signal reaches the "hiker," the "signal will yell out "stop!" Have the "timer" time how long it takes for the signal to reach the hiker from the satellite.
3. Have the "satellite" keep their eyes closed and repeat this process with the other "hiker. This time, the "hiker" should be a different distance (twice as far or half as far is good) from the "satellite."
4. Can the satellite tell which of the two "hikers" is further away? How?(By noting how long it is until the signal says "stop.")

Science Checkup - Questions to ask to evaluate what was learned

- What is the formula for speed? (Distance divided by time, i.e. miles/hour or meters/second)
- It is important for the signal to be traveling at the same speed at all times. What would happen if the signal were to speed up or slow down? (Errors in the distance between the satellite and the hiker.)

Objectives

- Learn what global positioning systems are used for and how they work

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Geospatial Science: What Is GPS?

Supplies

- ❑ Three pieces of rope of different lengths (Between 10 - 25 feet long)
- ❑ Sidewalk chalk
- ❑ Four temporary place markers (pieces of tape, cones, etc)
- ❑ Six volunteers (three “satellites” and three “signals”)
- ❑ Large open area where you can draw with chalk on the floor or ground

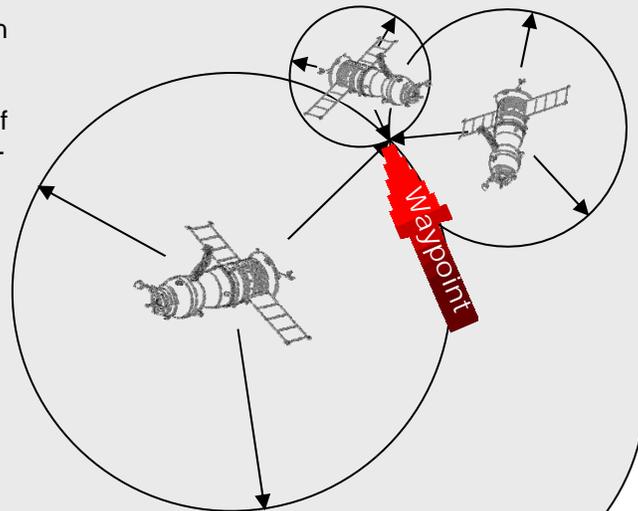
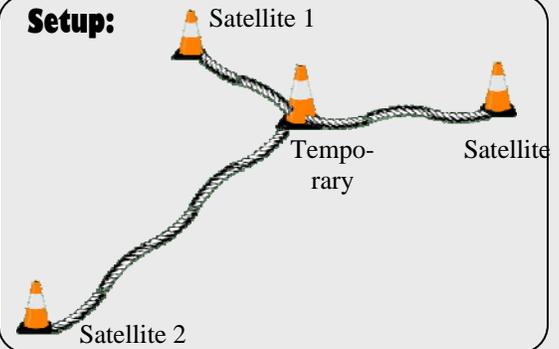
Do this before the students arrive:

1. Use a temporary place marker in the center of a large open area.
2. Lay each of the three ropes on the floor, starting from the original place marker and radiating out in different directions.
3. At the end of each rope, put another place marker. Then, pick up the ropes and lay each rope in a pile, near its far end place marker. Pick up the center place marker.

With the students:

1. Each of the three “satellites” should stand on one of the three place markers and pick up one end of the rope.
2. Each “signal” should pick up the other end of the rope, and walk in a circle around the satellite, drawing this path on the ground with the chalk.
3. Each of these circles represents the area where a hiker could be.
4. After the first circle is drawn, the **waypoint** could be anywhere on that circle.
5. After the second circle is drawn, the hiker could only be in the area where the two circles intersect.
6. The point where all three circles cross is the location of the waypoint and should be the same as your original center place marker.

Setup:



Science Checkup- Questions to ask to evaluate what was learned

- ❑ Why is it important to use three satellites when trying to find your location? (The points where two signals cross could be thousands of miles apart in real life. If you only had one signal, your hiker could be anywhere along the arc.)
- ❑ Would it make a difference if your GPS receiver was able to pick up signals from more than three satellites?
- ❑ Using the distance from three different points in order to determine your exact location is called what? (Trilateration! It is how GPS receivers figure out where you are! “Tri” come from the Latin **tres** word for three, while “lateral” comes from the Latin **latus**, meaning sides).

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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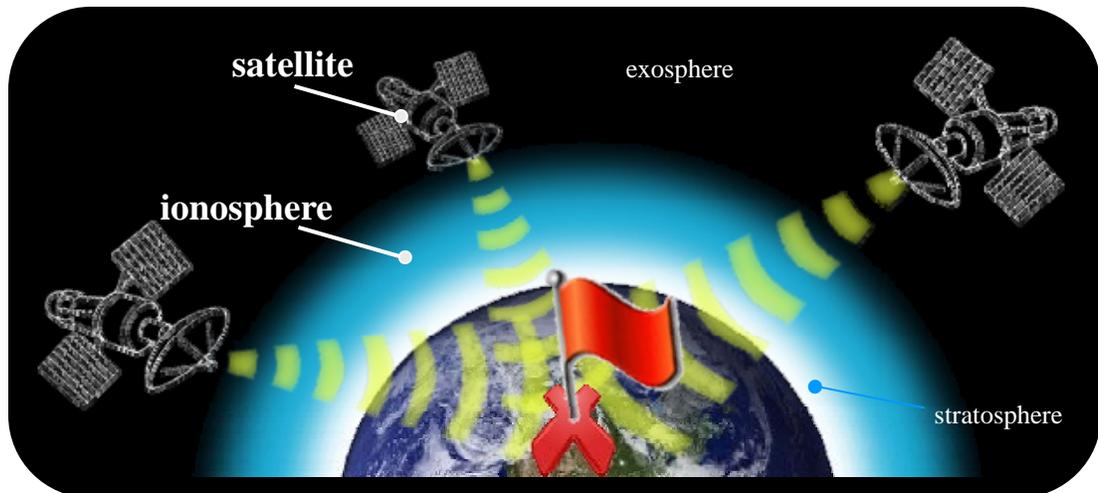
Geospatial Science: What Is GPS?

Extensions

- Sometimes, obstacles interfere with the path of the satellite signal. Have another student represent a skyscraper or a canyon wall, by standing in the field somewhere near the “satellite” but not directly between the “satellite” and the “hiker.” When the signal is sent from the “satellite,” the signal should bounce (gently!) off of the obstacle before going out to its normal arc. Would this affect the accuracy of the GPS? How?
- There are some layers of the earth’s atmosphere (specifically, the ionosphere) that affect the speed of a satellite signal. To illustrate this, have the “signal” crab-walk a portion of the distance. What effect does that have? In the real GPS system, accurately surveyed ground stations determine correction factors to take this into account and provide accurate readings.

Vocabulary

- **Ionosphere:** The region of the earth's atmosphere between the stratosphere and the exosphere, consisting of several ionized layers and extending from about 50 to 250 miles (80 to 400 km) above the surface of the earth.
- **Satellite:** A device designed to be launched into orbit around the earth.
- **Trilateration:** The measurement of three unique distances between points for the purpose of establishing relative positions of the points. Illustrated by the yellow beams, below.



Background Resources

- Hinch, Steven. “*Outdoor Navigation with GPS.*” Wilderness Press.
- Latham, Lawrence and Alex Latham. “*GPS Made Easy: Using Global Positioning Systems in the Outdoors.*” Mountaineers Books.

Geospatial Science: Geocaching

Activity Series:

Geospatial Science

Grade: 3-6

Time: 60 min.

Main Idea

Geocaching is a fun and exciting activity using the Global Positioning System (GPS) to explore the great outdoors. Imagine a giant treasure hunt with thousands of treasure boxes hidden all over the world! It's fun for everyone and it's a great way to get exercise and make new friends in the geocaching community!

Motivator

As of the writing of this Toolkit, there are more than 1 million geocaches hidden all over the world, and more than 65,000 geocachers registered at www.geocaching.com. Those numbers are growing every day!

Pre-Activity Questions

Before you start the activity, ask the students:

- ❑ When you head out on the trail, what should you bring with you? (first aid kit, water bottle, snacks, GPS receiver, map, compass, etc.)
- ❑ What kind of clothing do you think would be appropriate for an outing? (Long pants, long sleeves, boots and clothes that can get dirty)

Activity 1

- ❑ A GPS receiver (GPSr), ideally one unit for every two to three students
- ❑ A variety of weatherproof containers of different shapes and sizes
- ❑ An outdoor natural area, ideally a blend of natural areas including forest and field, but any outdoor area will do.

There are many kinds of geocaches but the simplest type is known as a "traditional" geocache.

1. Dig through your recycling bin at home to find a few different plastic containers that have good, sturdy lids. Butter tubs, whipped cream containers, or other similar containers make fine temporary geocaches. (Later, if you decide to hide a permanent geocache, you will want something much sturdier and weather-resistant.) Be sure to include a log book, or at least a strip of paper in a plastic bag, in your geocache.
2. Make a visit to a large outdoor space such as a local park, or a friend's big backyard.
3. Using a GPSr, take a walk and find a good place to hide your container. You will want to put it in a spot where it will blend in to the environment. You might want to paint it a dark color, or cover it with camouflage tape.
4. Once you have hidden the container, mark its location on your GPSr. It's a good idea to allow your GPSr to rest at the cache

Supplies

Objectives

- To practice more with GPS units by learning about geocaching

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Geospatial Science: Geocaching

location for a few minutes before you actually mark the location, so you can get the most accurate coordinates possible.

4. Share the coordinates of your geocache with your friends. Next time they are in the area, they can try to find the geocache that you have hidden! When you find a geocache, sign your nickname in the log book to prove that you found it.
5. If you plan to leave your cache in place for more than a few days, it's a good idea to use something sturdier than a recycled butter tub. Lock-n-Lock containers and surplus military ammunitions cans make good sturdy geocaches for more durable hides. Take a look at "Rules For Hiding A Geocache" for suggestions on hiding any long-term cache.

Science Checkup - Questions to ask to evaluate what was learned

- Would you consider geocaching a healthy form of exercise? Why or why not? (Yes! It's a good way to get outside, enjoy the fresh air, and stretch your legs.)
- Do you think geocaching has an impact on the environment? If so, is it a positive or a negative impact? Can you think of at least one positive and one negative? (Geocaching can have both positive and negative impacts. One benefit is that it can raise our awareness for the environment, the negative impact can come when geocachers trample vegetation creating new trails where there were none. It is important to take care of our environment.)

Activity 2

Supplies

- A GPS receiver (GPSr), ideally one unit for every two to three students
- Computer with internet connection

With more than 1 million caches hidden all over the globe, the world is your playground with geocaching! Plan a geocaching trip with some friends or family members at a local park.

1. First, you need to find the coordinates of official geocaches. There are a few different Web sites that list geocaches, but the largest one is www.geocaching.com. You will need to create a free user account to get started.
2. Once you have logged into the Web site, enter your zip code in the "Hide and Seek a Geocache" box. You will see a list of geocaches near you. Browse through the list, clicking on geocaches that sound interesting and take a look at the detailed cache description. Look for these things:
 - Difficulty and terrain ratings. Rated from one to five stars, these will give you a feel for how difficult the cache will be to find. Start simple and work your way up to more complex caches.
 - What kind of cache is it? Traditional caches are the most common, but there are many different variations, so you will want to know what you are looking for. Check out the site, http://www.geocaching.com/about/cache_types.aspx, for a detailed description of the cache types that geocaching.com recognizes.
 - What size is the cache? Caches range from very small to very large.
 - Read the description. Sometimes the cache hider will give hints about the cache in the

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Geospatial Science: Geocaching

- description.
- Look at the logs posted by the last people to find the cache. If the last four or five people to look for a cache couldn't find it, it could be missing. You can often learn a lot from other people's logs.
3. Take a family trip to the local park. Park the car, and hit the trail!
 4. Once you get near a geocache, you may find that your receiver is giving you mixed signals. Check out "loose bearings" in the vocabulary section.
 5. When you finally find a cache, there are a couple of basic guidelines:
 - Sign the log book. Use a nickname rather than your real name.
 - Take something. Some caches will have trade items. These are there for other cachers to take. Feel free to take one.
 - Leave something. If you chose to take anything from the cache, you are also expected to leave something behind. Some folks choose to leave trade items even when they don't take one. The rule of thumb is to trade equal or trade up! For example, if you take a baseball, you should leave something of similar or greater value, like a small first aid kit.
 - Re-hide the cache in exactly the same spot you found it.
 - When you return home, go back to the geocaching Web site and log your find. This helps the owner and other geocachers to know that the cache is still in good shape.

Science Checkup - Questions to ask to evaluate what was learned

- Sometimes when you find a geocache, your GPSr can still say that you are well over 30 feet away. How is this possible? (GPS receivers are not perfect, and every unit has a small amount of error. The unit used by the person who hid the geocache has a small unit or error, and your unit had error when you found it, compounding to up to 50 feet of error at times!)
- After you have found a few geocaches, write down a list of the different ways that caches have been camouflaged. How has camouflage helped these caches survive? Can you think of any animals in nature that use camouflage to survive? (Squirrels are gray to hide in the trees. Stick bugs are designed to look like branches)

Vocabulary

CITO: An acronym standing for Cache In, Trash Out. This ethic encourages geocachers to pick up litter and trash and leave the environment cleaner than they found it.

Geocache: A weather-resistant container hidden in a public, outdoor place, with its coordinates recorded on a GPSr and shared with others.

GZ (Ground zero): The area in which a geocache is expected to be found. Typically GZ is an area of approximately 30 feet around the actual cache.

Loose bearings: The point at which the direction on your GPSr no longer points in the correct direction, mostly because you've slowed down to a point that it doesn't know in which direction you're moving.

Muggle: A person who isn't familiar with the game of geocaching (as in "There were a few muggles around, so I decided to wait for them to leave before looking for the 'cache.'")

Background Information

- Geocache Listing Sites: www.earthcaching.com, www.geocaching.com, www.navicache.com
- Geocache Hiding Guidelines: <http://www.geocaching.com/about/guidelines.aspx>

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Geospatial Science: Geocaching

Rules for Hiding a Geocache

1. **Be Respectful of the Environment:** When you hide a cache, you may soon find a new trail of footprints from other geocachers, straight to your hide. Visitors to your cache could end up doing a lot of damage if you place your cache next to a new bird's nest, or some species of rare plant!
2. **Be Respectful of Private Property:** If you are hiding a cache on land that is not your own, be sure to place it on public land. If you place a cache on private land, be sure to get permission first!
3. **Never Bury a Geocache:** You don't want people digging up 30 feet of grass and leaves to find your cache. See #1.
4. **Don't Hide A Cache Anywhere That it Could Cause Unnecessary Harm:** If non-cachers were to see someone poking around at the cache site, would they be panicked? You wouldn't want to hide a cache near a railroad track or under a bridge.

Main Idea

A GPS Receiver (GPSr) is just one piece of the Global Positioning System, but it's the piece that most people are familiar with. There are many kinds of GPS receivers available, from simple handheld models to larger models with touch-screens for use in cars. This lesson helps students use the handheld models for geocaching and basic mapping.

Motivator

If you know how to use a GPS receiver, you can find all sorts of things and find your way around the earth!

Pre-Activity Questions

Before you start the activity, ask the students:

- What are some things a GPS could help you to do? (determine direction, plan a route, find a specific location, measure distance)
- What kinds of things would you like to learn about using a GPS?

Activity 1

- A GPS receiver, one unit for every two to three students
- The user's manual for the GPS receiver
- A handful of temporary place markers (cones, Frisbees®, anything that won't blow away in the wind)
- A large outdoor natural area
- Note pad and pencil

Since GPS receivers have varied settings and appearances, spend a few minutes setting up the receivers to make them consistent so everyone is looking at the same information.

1. Look through your instruction manual for the section on setting the **map datum**, the set of reference points your receiver will use as its data. Be sure that all of your receivers are set to the WGS84 Datum. (See "Map datum" under vocabulary.)
2. Now, look in your manual for information on setting the **coordinate format**. Different formats allow you to express your location in different ways, such as hemisphere (North, South, East or West), followed by latitude and/or longitude (degrees, minutes and/or seconds). Set your format to hddd mm.mmm, which stands for **h**emisphere, **d**egree, **m**inutes and **d**ecimal minutes.

Science Checkup - Questions to ask to evaluate what was learned

- What would happen if you used a different datum than someone else in your group? (Your unit may be referenced from a different starting point, so your waypoints could be significantly different.)

Objectives

- To learn to use a GPS receiver to find a location or object

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Geospatial Science: Using a GPS receiver

- ❑ What is the difference between formats? Why are there so many? (It's kind of like fractions or decimals, just different ways of saying the same thing. It's typically a regional choice.)

Activity 2: Where am I? Where are you?

The most basic functions of the receiver are to record your current location and to mark a different location. Do you know where you are right now? Your receiver may not... YET!

1. Turn on your receiver and let it find the satellites overhead. Make sure there is nothing above you (like a dense tree canopy), otherwise, the receiver may not connect to the satellites.
2. In your manual, find the section about how to record a **waypoint**.
3. Standing outside in a clear, open space, record your current location. Name this first waypoint, "test." You can delete this later, but for now, you're just practicing. While you are marking this location, take a look at the **coordinates** of the waypoint displayed on your GPS unit. This will include a direction and degrees of longitude and latitude. On your note pad, write down your coordinates.
4. Got the hang of it? Try it again! Move 50 steps away and try marking another waypoint. Name this one "test 2." On your note pad, write down the coordinates of this second waypoint. Take a look at the coordinates of "test 2." How do they compare to "test"? Are they the same? If not, are they similar?
5. How accurate is a GPS receiver? Try this experiment to find out. Pick out a nearby landmark (a water fountain, a light pole, etc.) or simply place a place-marker on the ground.
6. Have each member of the group take turns marking the location of the land marker and saving it in their receiver as "test 3."
7. Compare your coordinates with the others in your group. How similar are they? It is likely that they will be very similar, but not identical. Why do you think this might be? Remember that your receiver is communicating with satellites 12,000 miles away!
8. Another way to record a waypoint is to type in the coordinates. Remember that scrap where you wrote the coordinates to your original waypoints? Use your instruction manual and create a new waypoint by typing in those original coordinates.

Science Checkup - Questions to ask to evaluate what was learned

- ❑ Do you think your receiver is accurate enough for you? Why might someone need theirs to be more accurate? (You are using your unit for recreation. Firemen might need to find the gas shut-off valve to your house in the case of emergency. The purpose for which you are using the GPSr will determine the level of accuracy that is needed.)
- ❑ Would your receiver be good for recording the locations of telephones in your home? Why or why not? (GPSr's don't work well indoors because they need an unobstructed view of the satellites overhead.)

Activity 3: How can I get there from here?

Once you enter a waypoint into your unit, the receiver stores the coordinates for that waypoint in its internal memory. The first step in getting from here to there is finding that waypoint in your receiver.

(Continued on page 3)

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Geospatial Science: Using a GPS receiver

1. In your manual, look up how to find a waypoint and then look on your receiver for the waypoint called "test 2."
2. Once you find the waypoint, check your manual for help in how to "goto" or navigate to that waypoint.
3. Take a walk with your receiver and see how it works to help you go back to the place that you marked as "test 2."

Science Checkup - Questions to ask to evaluate what was learned

- How is your receiver like a compass? How is it different? (It can tell direction, but most receivers require that you are moving in order to tell direction.)
- Does your receiver consider obstacles that might be between you and your final destination? How do you know? (No, the receiver only knows the direction and the distance to the final destination. It always draws a straight line path.)

Activity 4 Putting it all together

Note: You will need two groups for this activity.

1. Give each group a place marker of some sort (a cone or a bandana).
2. Each group should take a short walk (no more than 300 feet) in different directions and put their place marker on the ground.
3. Each member of the group should mark the location of their place marker on their GPS receiver
4. Once the waypoints are marked, gather back at the starting place.
5. Share coordinates with the other group and enter the other group's coordinates into the receivers.
6. As a group, see if you can find the other group's place marker!

Science Checkup - Questions to ask to evaluate what was learned

- What factors might affect the accuracy of your receiver?

Extensions

- If people in your group have different models of GPS receivers, try Activity 4 with various receivers and see how accurate they are and how well they locate the placemarkers. Take your coordinates and enter them into Google Earth or mapquest.com to see your location from above or a street map of your location. These programs show you two of the myriad ways you can use coordinates to find a location or find your way around.

Vocabulary

Coordinate: Any of a set of two or more numbers used to determine the position of a point, line, curve, or plane.

Map Datum: A set of reference points on the earth's surface against which position measurements are made.

Coordinate Format: Any of a number of methods for displaying the coordinates of a given location on earth. Typical examples would include HDDDDDDDD, HDDD MM.MMM or HDDD MM SSS, where H is the Hemisphere (North, East, South or West), D is degrees of latitude or longitude, M is minutes (1 degree = 60 minutes) and S is seconds (1 minute = 60 seconds).

Waypoint: Waypoints are named coordinates representing points on the surface of the Earth.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Geospatial Science: Using a GPS receiver

Background Resources

- Download a manual for your GPS receiver at:
 - Garmin: <http://www8.garmin.com/support/userManual.jsp>
 - Magellan: <http://www.magellangps.com/support/index.asp>
 - DeLorme: <http://www.delorme.com/support/search.aspx>
 - Lowrance: <http://www.lowrance.com/en/Downloads/Manuals/>
- Check out geocaching.com for more information about GPS units and the sport of geocaching.

Lost Ladybugs

About the 4-H Science Toolkit Series: Lost Ladybugs

Some species of native ladybugs in North America are disappearing. In just the last 20 years, these beneficial predators of farm and garden pests have become extremely rare. This rapid decline is of great concern.

In completing this series of units, both age groups will learn about:

- Insect life cycles and the food web
- Biological control of insect pests
- The importance of biodiversity and the process of sampling
- Building their own sweep net
- Searching for, capturing, cataloguing and storing insects
- Submitting data to the Lost Ladybug Project

Students from both age groups will contribute to real scientific inquiry, and begin to explore their own scientific research questions.

All of these adventures call on students to predict what will happen, test their theories, then share their results. They'll be introduced to ladybug vocabulary, gain an understanding of the life cycles of ladybugs and their importance in the food web and collect bugs themselves to identify, observe and report about to the Lost Ladybug Project.

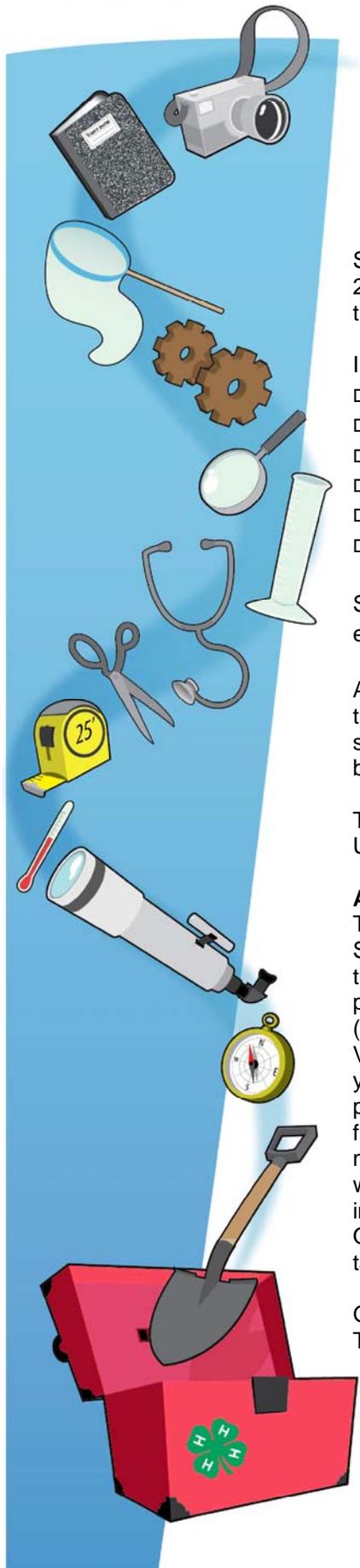
The lessons in this unit were developed by the Lost Ladybug Project based at Cornell University in the Department of Entomology.

About the project:

The Lost Ladybug Project was set in motion at a small number of schools in New York State in 2004. Now it is active in many states in the U.S. It is a citizen science project that asks anyone of any age to look for any ladybugs they can find, and then send in pictures of each one. One of the first major discoveries came in 2006 when Jilene (age 11) and Jonathan (age 10) Penhale found a rare nine-spotted ladybug near their Virginia home. This was the first nine spotted ladybug seen in the eastern U.S. in 14 years. Their finding confirmed that the species was not extinct and that with enough people working together we can find even these rare species. With recent funding from the National Science Foundation the Lost Ladybug Project has expanded and now anyone in North America can participate. Both common and rare ladybugs, whether native or introduced, are important to find. They all contribute to understanding where different species of ladybugs can be found and how rare they really are. Once we know where the rare ladybugs can be found, we can try to protect their habitat and save them!

General information about ladybugs and their life cycle are on the following pages. This information may be useful for the activities as well.

To find out more about the Lost Ladybug Project, visit www.lostladybug.org. To find numerous resources related to the insects, outdoor exploration and the environment, check out the 4-H Resource Directory at www.cerp.cornell.edu/4h.



All About Ladybugs

What are ladybugs?

Ladybugs are insects in the Coccinellidae family of the beetle order, Coleoptera. They are characterized by their oval-shaped body and distinctive coloring.

Is there a difference between lady beetles and ladybugs?

Although these insects are commonly called “ladybugs,” they are members of the beetle order, Coleoptera. The Coleoptera are unique from other orders in that they undergo complete metamorphosis (that is, have larva and pupa stages in their life cycle), and their forewings have modified into a hardened cover (elytra) that protects the insect. “True” bugs belong to the order Hemiptera, and include boxelder bugs, plant bugs, and squash bugs.



Immature True Bug

Though taxonomically incorrect, lady beetles are still commonly referred to as ladybugs. Other frequently used common names are ladybirds or ladybird beetles.

How did ladybugs get their name?

The most common legend as to how ladybugs got their name is that during the middle ages in Europe, swarms of aphids were destroying crops. The farmers prayed to the Virgin Mary for help – and help came in the form of ladybugs that devoured the plant-destroying pests and saved the crops! The grateful farmers named these insects “Our Lady’s beetles,” a name which had endured to present day.

What do ladybugs eat?

Both adult and larval ladybugs are known primarily as predators of aphids but they also prey on many other soft-bodied insects and insect eggs. Many of these are agricultural pest such as scale insects, mealybugs, spider mites and eggs of the Colorado Potato Beetle and European Corn Borer. A few ladybugs feed on plant and pollen mildews and many ladybugs supplement their meat diet with pollen.

What eats ladybugs?

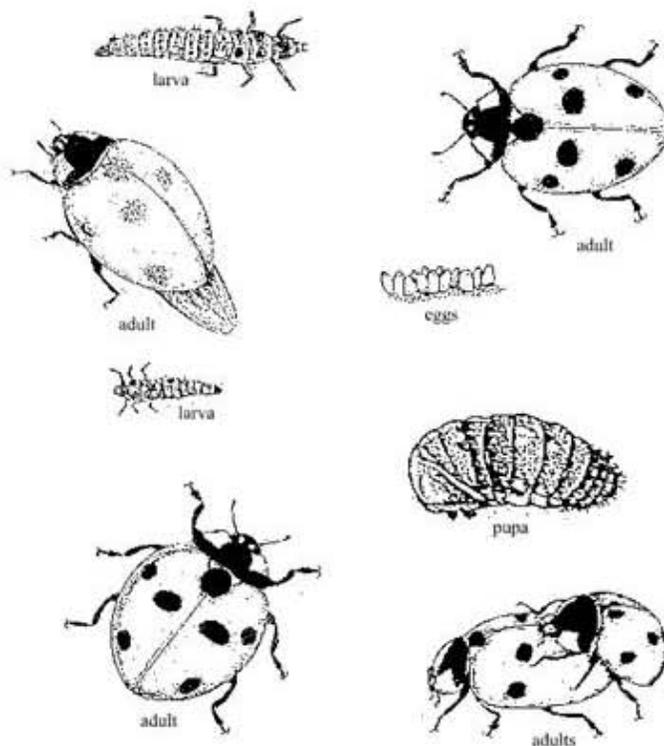
Ladybugs are not commonly eaten by birds or other vertebrates, who avoid them because they exude a distasteful fluid and commonly play dead to avoid being preyed upon. However, several insects, such as assassin bugs and stink bugs, as well as spiders and toads may commonly kill lady beetles.

How many different species are there in the US? In the world?

There have been over 500 species of ladybugs identified in the United States, and over 4500 in the entire world.

How long do they live?

After a female lays her eggs, they will hatch in between three and ten days, depending on ambient temperature. The larva will live and grow for about a month before it enters the pupal stage, which lasts about 15 days. After the pupal stage, the adult ladybug will live up to one year.



What do the different stages of the life cycle look like?

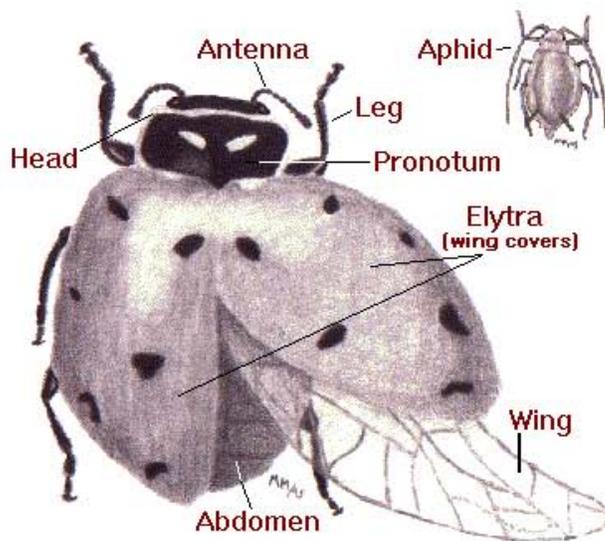
Life Cycle Stages

Eggs are tiny, spindle-shaped, and arranged in clusters.

Larvae are usually elongated, "alligator" shaped, slightly pointed at the rear, and their body is covered in tiny bristles.

Pupae are slightly round and dark colored. You can find them attached to a surface by their hind ends.

Adults are sphere-shaped, smooth, and have easily recognizable colors and markings.



What about ladybug anatomy?

Ladybug Anatomy

Ladybug in Flight
 Photo by Alex Wild, Champaign, Illinois, 2008



Why are they so brightly colored?

Ladybugs bright colors serve as a warning – they indicate any potential predators of the distasteful repellents the beetle will release if attacked. Ladybug spots are part of the bright warning pattern discussed in the previous question.

What's with them in my house during winter?

During the winter months, ladybugs seek out a warm place to hibernate. Many seek out cracks around buildings, including people's homes. They mass together to stay warm throughout the winter. Don't worry, they will not harm you or any part of your home, and they will be gone by spring.

How did non-native species get here?

Non-native ladybug species may have been introduced to the United States by scientists as an attempt to control crop-damaging aphids, or they could have hitched a ride with any vegetation that was brought over from Europe, Africa, or Asia.

Lost Ladybug Project: Food Webs & Biodiversity

Activity Series:
Lost Ladybug
Grade: 3-6
Time: 45 min.

Main Idea

Learn about Food Webs and what can happen when they are disrupted, learn the value of biodiversity.

Motivator

A single ladybug larva will eat about 400 medium-size aphids during its development to the pupal stage. An adult female will eat about 300 medium-size aphids before she lays eggs. She can eat about 75 aphids in a day and may consume more than 5,000 aphids in her lifetime! What would happen if all the ladybugs were gone?

Pre-Activity Questions

Before you start the activity, ask the students:

- What do you think ladybugs use their antennae for? (A: to touch, smell, and taste).
- What do ladybugs eat and what eats ladybugs?

Activity

- A copy of the Food Web Game Plan (from www.lostladybug.org)
- The right number of printed or drawn owls, toads, ladybugs, aphids, and plants.
- A single hole punch
- Yarn

How the Food Web Game Works:

1. **Please look at the Food Web Game Spreadsheet as you read along.** Let's start with Round ONE for a small number of participants. This would be shown in the upper left part of the spreadsheet.
2. To follow the sequence described in the spreadsheet, know that, for the sake of the game, predation begins at the top of this food chain. Let's say:
 - You have one owl that eats two toads (Predation rate = 2, cell #D3).
 - After predation there is still one owl and now only one toad (cell #E4).
 - Each toad would eat two ladybugs. But now there is only one toad so this toad eats two of the four ladybugs (cell #C5), leaving two ladybugs (cell #E5).
 - Each of the two ladybugs (one of each species) eats two aphids, leaving only one aphid (cell #E6).
 - Each aphid eats six plants. But now there is only one aphid left and therefore $9 - 6 = 3$ plants are left.

Supplies

Objectives

- To understand all animals are important to the food web
- To find out what happens when one species disappears

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Lost Ladybug Project: Food Webs & Biodiversity

That's the First Part of Round One.

3. Now each animal has time to recruit more members or reproduce. You have one owl that does not reproduce or "recruit" (call in more owls) very fast, so reproductive rate = 0 (cell #G3), so Generation 2 still has only one owl in it (cell #H3).
4. There is one toad with a recruitment rate of 2 (by reproduction or calling in). So, $1 + 2 \text{ new} = 3$ toads in Generation 2 (cell #H4)
5. There are two ladybugs (one of each species) with a recruitment rate of one each. So, $2 + 2 = 4$ ladybugs (2 of each species) in Generation 2 (cell #H5).
6. There is one aphid with a recruitment rate of 4. So $1 + 4 = 5$ aphids in Generation 2.
7. There are 3 plants with recruitment rates of 2. So, $3 + 6 = 9$ Plants.
8. **Voila! This is a STABLE Population!**
9. **Round Two is played the same way except that the ladybugs have all been eliminated by something other than the toads.** Aphids take over for a while. Disaster for the plants.
10. **Round Three allows for only ONE species (half the number) of ladybugs to participate.** In real life, predation and reproductive rates do not stay exactly the same with changes in population numbers. So, here we have also slightly changed these rates. The predation rate for toads is less because now it is harder to find ladybugs. The predation rate for ladybugs is higher because there are more prey available to fewer ladybugs. The result, by the second generation, looks almost stable. But one difference is that there are fewer species of ladybugs, so the possibility for one factor (e.g. disease) to drastically reduce the population is greatly increased. This would lead to the same results as Round Two.
11. If any trophic level contains only a single species, it can be vulnerable to a sudden decline and a loss of stability. Different species are more likely to have varying vulnerabilities to disease or weather conditions, so they will not decline at the same rate due to a single mortality source. In other words: DIVERSITY = STABILITY.

How to Play the Food Web Game:

1. Determine the size range of your group based on the excel spreadsheet.
2. Calculate the right number of owls, toads, ladybugs, aphids and plants by using the spreadsheet and print or draw these on paper or cardstock. If the group is small, the aphids and plants can be manipulated by the students without anyone wearing them.
3. Students should put one hole punch on either side of the pictures and string yarn through these so that they can wear the pictures around their necks.
4. Designate individuals to be the plants and animals in the *Initial population*.
5. --- If you have fewer participants than the total number of plants and animals in the *Initial population*, represent some animals or plants with pictures or other objects (e.g. toy toads).
6. --- If you have more participants than the total number of plants and animals in the *Initial population*, allow some to be observers in the first round of predation. They can join in during the first round of reproduction.
7. --- Note that you should start with equal numbers of two species of ladybugs.
8. OBSERVATION: What do you observe about the shape of the web and the numbers in each level? Why do you think the web has this particular shape?
9. Starting with the highest trophic level (an owl in our example), let predation begin. In our example the owl starts by "eating" the number of toads specified in the predation rate column (for example, two for the small group size). Toads that are eaten should stand off to the side and surrender their roles to any observers that have not yet been part of the web.
 - The uneaten toads then prey on ladybugs and the game continues on through to the lowest predation level (e.g. aphids eating plants).

Lost Ladybug Project: Food Webs & Biodiversity

10. Surviving individuals then "recruit" new members. Note that recruitment can occur through either reproduction or immigration into the area. Observers from the first round should be the first recruits for the next round.
11. Repeat for two to three generations.
12. OBSERVATION: What is happening to this food web? Is this food web stable and "sustainable"? Why would a stable food web be a good thing?
13. Begin Round Two. Simulate a sudden disappearance of all ladybugs by having them all exit the web. Begin the predation and recruitment with the ladybugs absent. (Check the spreadsheet to make sure you have enough prey and recruits.)
14. OBSERVATION: Did the toads have enough to eat? What happened to the aphids and plants? Is this food web stable?
15. This time, assume that only one species of ladybug was effected by whatever caused the disappearance and other plants and animals are at initial levels. Begin predation and recruitment again. (Repeat observation above.)
16. Begin Round Three. Now start again with half the ladybugs (e.g. one species) and all other plants and animals at initial levels but with the adjusted rates provided?
17. OBSERVATION: How did the rates of predations and recruitment change? Why might they have changed like that? Compare numbers after recruitment to initial population numbers. Is this food web headed back to stability? What does this imply about having multiple ladybug species (or species at any trophic level) instead of just one?

Science Checkup - Questions to ask to evaluate what was learned

(note that there are answers in the intro to this series if needed)

- What do ladybugs eat?
- What eats ladybugs?
- How many different species are there in the US? In the world?
- Can you think of some other "predators" and other "prey"?

Extensions

For a demonstration of the importance of density dependence for stable population regulation check this flash graph made by John Losey in his teaching at Cornell University: (http://instruct1.cit.cornell.edu/Courses/ipm444/movies/pred_pre_y_curves.html).

Vocabulary

- **Predator:** An animal that eats other animals in order to survive.
- **Prey:** An animal caught, killed and eaten by another animal as food.
- **Herbivore:** An animal that feeds only or mainly on grass and other plants.
- **Trophic Level:** A stage the a food chain that reflects the number of times energy has been transferred through feeding. For example, plants are on the first level and predators are on higher levels.
- **Ecological Stability:** When conditions are appropriate so that a habitat can support a number of species.

Background Resources

- www.lostladybug.org

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Lost Ladybug Project: Ladybug Sampling

Activity Series:
Lost Ladybug
Grade: 3-6
Time: 45 min.

Main Idea

Ladybugs can be found all over the world and can move between continents. But introducing new species can affect natives. We will learn about and sample the ladybugs in our habitats.

Motivator

There are more than 4,500 species of ladybugs in the world and more than 500 identified in the U.S. Only about 70 of these are the cute red, yellow and black ones we think of most.

Pre-Activity Questions

Before you start the activity, ask the students:

- Do you think you will find ALL of the ladybugs in your habitats in only ½ hour?
- About how many different kinds do you think you might find in one place?
- How many of these will be natives?
- How many of the total number of ladybugs your group finds will be natives?

Activity 1: Bead Game “Sampling”

- 3 big bowls
- About 30 each of several different colored beads
- Paper and pencil for data collection

Scientists go out and count the different kinds of insects. This is called sampling. This is done to understand species richness and how the role of each insect fits into the bigger picture. Many non-native lady beetle species have been introduced to the United States by scientists as an attempt to control crop-damaging aphids, or they could have hitched a ride with vegetation that was brought over from Europe, Africa, or Asia. They serve a unique role, perform a special “job”. We are going to take a sample to figure out how diverse our beetle (bead) population is.

1. Explain the game: We have different color beads in each bowl. We can pretend each color is a different kind of insect. We can take a scoop or sample from a bowl and find out if the bowl has enough different kinds of pretend-insects.
2. Each group’s bowl will have a very different ratio of colors, one with equal numbers of all colors (Bowl A), one with lots of one color and very few of the other three colors (Bowl B), one with only two colors (Bowl C).

Supplies

Objectives

- To understand how sampling can show biodiversity
- To understand the impacts of introducing non-native species

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Lost Ladybug Project: Ladybug Sampling

3. Divide children about equally next to bowls of beads and have each child take one spoonful of beads and put it on their plate.
4. Have each child divide their beads by color and count each color.
5. Leader or small group reports their data to the blackboard or large paper. (Put bowls as columns and colors as rows.) Direct entire group to look at results as they are being put up. "What do you notice about these numbers? How many different kinds of insects are in bowl A? bowl B? bowl C?"
6. Discuss how the numbers of different kinds of pretend -insects differed between the bowls, adding that different kinds of insects have different jobs. A ladybug, for example, eats aphids, but a bee pollinates plants, so it's important to have a mixture of insects of equal numbers.
7. Discuss how you could improve the populations of bowls B and bowl C so that they would have a mixture of insects?

Activity 2: Lost Ladybug Bingo

Supplies

- Lost Ladybug Bingo cards (downloaded from the lostladybug.org Web site)
- Chips or markers

1. Learn the common varieties of ladybugs and prepare for the sweep net survey by playing a game or two of lost ladybug bingo.

Science Checkup - Questions to ask to evaluate what was learned

- Why is it important to have a variety of insects in a sample?
 - What would happen in a habitat if one kind of insect wasn't present?
- How does sampling help you to understand population health?

Extensions

Visit lostladybug.org and print out the Lost Ladybug Field Guide (under Lost Ladybug pdfs). This will help students identify eight types of ladybugs. There's also a ladybug matching game at this site.

Vocabulary

- **Common versus rare:** Common items are widely found; rare are less likely to be found.
- **Native versus introduced:** Native species were original to a specific place, while introduced species were brought into a new habitat.
- **Biodiversity:** The range of organisms present in a particular ecological community or system.
- **Conservation:** The preservation, management, and care of natural and cultural resources.

Background Resources

- www.lostladybug.org

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Lost Ladybug Project: Nothing but Net

Activity Series:
Lost Ladybug
Grade: 3-6
Time: 45 min.

Main Idea

Prepare a ladybug collection chart and make a good strong sweep net for collecting in the next unit.

Motivator

If ladybugs fall from a plant or fall into your net, they may play dead! Watch them closely!

Pre-Activity Questions

Before you start the activity, ask the students:

- What are the differences between a butterfly net and a sweep net?
- How many different kinds of ladybugs do you think you will find?

Supplies

Activity:

Making a homemade sweep net

- Ladybug Field Guides (from www.lostladybug.org)
- Pillowcases
- Two wire coat hangers per pillowcase
- A piece of wood or dowel 2-3 feet long for handle
- Scissors
- Duct tape
- Pliers
- A piece of poster board
- Crayons or markers



1. Turn your two wire hangars into similar circles.
2. Then tape them together in several places, leaving the open end opened.
3. Now cut holes on either side of the seam where there are two layers of pillowcase fabric. Feed the wire through the pillowcase hem.
4. Straighten out the ends that are left so that they can be taped to the handle. Heavily tape the four wire pieces that are out of the pillowcase to the handle. Make sure it is sturdy because it's going to bump into thick grass, alfalfa, clover and other plants!
5. Set up a poster board chart like this, with different ladybug species at the top.

Species	Species draw pic here				
Date, location	#	#	#	#	#

Objectives

- To create a sweep net to be used in collecting.
- To learn how to organize sample data in a chart.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Lost Ladybug Project: Nothing but Net

6. Students can draw the different species of ladybugs again or cut them out from either the bingo game boards or field guides they have seen before. (Either can be downloaded from www.lostladybug.org).
7. After each collection (next two units) the students will record the dates, habitats and numbers of each type of ladybug they found. At the end of the fifth unit, or during the sixth unit, these can be compared.

Science Checkup - Questions to ask to evaluate what was learned

(note that there are answers in the intro to this series if needed)

- Recall species richness and species evenness. Do you think you will find the same number of different species or the same evenness of species in the two habitats you will visit?
- How many species will be natives? Will you find more natives or introduced species?

Extensions

Check out the Minnesota Dept. of Agriculture's Web page, www.mda.state.mn.us/kids/actionkit.htm, for cool activities, including a sweep net safari you could do with your students.

Vocabulary

Sweep net: A strong net without holes for collecting insects.

Species: A basic biological classification containing individuals that resemble one another and may interbreed.

Background Resources

- www.lostladybug.org

Lost Ladybug Project: Collecting

Activity Series:
Lost Ladybug
Grade: 3-6
Time: 45 min.

Main Idea

Go outside and collect ladybugs to see what kinds you find and how many. All ladybugs are important to the Lost Ladybug Project and help scientists figure out where different species are – both rare and common varieties. The children become citizen scientists themselves!

Motivator

Some ladybugs are found alone while others are found in huge groups of thousands. Some are swept out of the air and wash ashore beside large lakes!

Pre-Activity Questions

Before you start the activity, ask the students:

- What makes a good habitat for ladybugs? (answers below)
- What kind of weather or what time of day do you think would be best for collecting ladybugs?
- How many different species do you think you will find?

Activity

- Your own sweep nets
- Your poster board chart
- Large plain cloth or sheet
- High-sided wash basin or box
- Jars, vials or ziplock bags
- Cooler w/ cold pack or ice

First, locate a collecting site(s). In general, the best sites will be areas of more than 100 square meters (120 yards) that contain herbaceous (not woody or tough) plants that are at least 20 cm (8 in) high. Plants that are too tough cannot easily be swept through and plants that are too short do not host many of the prey insects that ladybugs need, so they don't usually support very large populations of ladybugs.

Collecting sites could include:

- Any area that has not been mowed recently, preferably with some weeds;
- Plants at the edge of a wooded area, mowed area or field (e.g. a hedgerow);
- Orchards, if not too recently mowed; trees themselves are excellent habitat for ladybugs, and while they clearly cannot be swept, lower branches can be shaken or beaten vigorously onto sheets. Note that many orchards are treated frequently with insecticides, so be sure to check on the treatment schedule.

Supplies

Objectives

- Learn to efficiently collect a sample from the field
- Learn to identify ladybugs

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
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- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Lost Ladybug Project: Collecting

- Many agricultural fields including alfalfa, clover, small grains (e.g. wheat), potatoes and soybeans can make fruitful collecting sites. As with orchards, be sure to check with the grower first.
1. If you will be comparing ladybugs from two different habitats (two consecutive units), you should know that keeping ladybugs in a refrigerator for more than one week is not great for their health. If your group meets once each week, the best plan would be to search for the same length of time, say ½ hour, each time and allow time for photographing the ladybugs on the second week. So, if one habitat is farther from headquarters, that would be the place to go during this unit!
 2. Demonstrate back and forth motion of the net, sweeping low enough to knock insects into the net but not hit the ground, or show video clip from the lostladybug.org Web site. In addition to the insects that will be knocked off the plant, many insects leap for the ground when disturbed and will hopefully land in your nets.
 3. Let everyone go out and sweep, search and beat for a defined period of time.
 4. Empty sweep nets onto open sheets or into wash basins and boxes.
 5. Collect all ladybugs into jars, vials or bags.
 6. Try to identify which species have been found!
 7. Put the ladybugs into a cooler until you reach a refrigerator. Keep them with a small bit of damp paper towel or cotton until they can be photographed (next unit). Cooling slows insects down and makes it easier for them to go without food.

Science Checkup - Questions to ask to evaluate what was learned

(note that there are answers in the intro to this series if needed)

- How many ladybugs did you find?
- How many different species did you find?
- How many different ladybug species did you recognize?
- Did you find them all in the same kind of habitat?

Extensions

Find out more about the ladybugs you have found so far at www.lostladybug.org

Vocabulary

Habitat: The natural conditions and environment in which a plant or animal lives, e.g. forest, desert, or wetlands

Microclimate: the climate of a confined space or small geographic area

Sampling: Taking a small part, number, or quantity of something as a sample and using it to make observations about the whole group or area.

Collecting "Effort" A way of measuring the number of people and time put into collecting so that densities (of ladybugs can be compared between different trips.

Background Resources

- www.lostladybug.org

Lost Ladybug Project: Collecting-Part 2

Activity Series:

Lost Ladybug

Grade: 3-6

Time: 45 min.

Main Idea

Go outside and collect ladybugs again and compare results from two different habitats. For the Lost Ladybug, having repeat collections from nearby locations and by the same "spotters" is especially valuable. The children become SUPER citizen scientists themselves!

Motivator

We still don't know why certain ladybugs live on certain plants and in certain areas. Let's try to learn more about this.

Pre-Activity Questions

Before you start the activity, ask the students:

- How and why do you think your second ladybug collection may be different from your first?
- How many different species do you think you will find?

Activity

- Your own sweep nets
- Your poster board chart
- Large plain cloth or sheet
- High-sided wash basin or box
- Jars, vials, or ziplock bags
- Cooler w/ cold pack or ice
- Camera (preferably digital with a close-up function.
- Printed page of "the perfect grey" (downloaded from www.lostladybug.org)

Locate a second collecting site, somehow different in habitat than the first. The difference could be related to what surrounds the fields (surrounding vegetation versus neighborhood housing) or differences in the fields themselves (types of plants, etc.). Note recommendations from "Collecting."

1. If you will be comparing ladybugs in two different habitats (two consecutive units), this time you should plan to go out fast and come back with time to take photographs.
2. Gather your sweep nets, cloths, wash basins, jars and cooler.
3. Go out and sweep, search and beat for a defined period of time.
4. Empty sweep nets onto open sheets or into wash basins and boxes.
5. Collect all ladybugs into jars, vials or bags.
6. Put the second collection of ladybugs into a chilled cooler. Cooling will slow them down and make them easier to photograph.

Supplies

Objectives

- Learn differences between habitats
- Learn to store and photograph insects

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Lost Ladybug Project: Collecting-Part 2

7. Once back at headquarters, while the second group of ladybugs cools down, you can photograph the first (pre-cooled) collection of ladybugs. To do this, bring out your print of "the perfect grey." This grey background will help avoid the glare that can come off shiny ladybug elytra and make identification more difficult. Glare or reflection off the beetle is often more of a problem than not having enough light.
8. Place one chilled ladybug at a time on the grey background and take the largest photograph you can, while maintaining focus. Shield the beetle from bright light and use the flash only if there is very little light.
9. As this is happening, someone in the group should be recording the group's "best guess" as to the species of each ladybug being photographed.
10. Repeat the process with the now chilled newer group of ladybugs and record the "best guesses" separately.
11. Once all the ladybugs have been photographed, you are ready to fill in your poster board chart and have an interesting discussion! In the upper half, note the date, time, number of "spotters," habitat and numbers of each ladybug species found, as well as "kinds" you may not know the names of yet. You may recognize them as all belonging to the same species even if you don't yet know the name. (This is fine! You do not need to determine the species you find. The Lost Ladybug Project will receive the photo and determine the species.)
12. Fill in the lower half of the chart with similar data from this day's collection. Discuss how and why your collections from two different habitats may have been similar or different.

Science Checkup - Questions to ask to evaluate what was learned

(note that there are answers in the intro to this series if needed)

- On which day did you find more ladybugs?
- On which day did you find more species of ladybugs?
- If you found differences, do you think they may be due to habitat, date or weather?
- How many different ladybug species did you NOT recognize?

Extensions

- Think of all the ways your two collecting expeditions differed. Do you have any hypotheses about where or when you can expect to find more ladybugs?
- Find out more about the ladybugs you have found so far at www.lostladybug.org.

Vocabulary

Habitat: The natural conditions, environment where a plant or animal lives, e.g. forest, desert, wetlands

Microclimate: The climate of a confined space or small geographic area.

Sampling: Taking a small part or quantity of something as a sample and using it to make observations about the whole group or area.

Collecting "Effort": A way to calculate the effort spent collecting insects. For example, one person collecting for four hours equals a collecting effort of 4 (1x4). Four people collecting for one hour also equals a collecting effort of 4 (4x1). It's important to know if the 10 ladybugs were found by one person in one hour (an effort of 1, which means the ladybugs were relatively easy to find) or by five people searching for two hours (an effort of 10, or relatively difficult to find).

Species Richness: The number of different species in a given area.

Species Evenness: A way to quantify how equal the community is numerically. So if there are 10 two-spotted ladybugs, and 1,000 convergent ladybugs, the community is not very even. But if there are 10 two-spotted ladybugs and 12 convergent ladybugs, the community is quite even.

Background Resources

- www.lostladybug.org

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Lost Ladybug Project: Submitting your Data

Activity Series:
Lost Ladybug
Grade: 3-6
Time: 45 min.

Main Idea

Complete the process of giving your ladybug images to the Lost Ladybug Project and begin to explore how your data relates to all the other data collected for the Lost Ladybug Project.

Motivator

Lost Ladybug project received more than 1,000 ladybug photo submissions in 2008. We would love to receive 10 times that many in 2009 and 100 times that many in 2010! Your data is important to us!

Pre-Activity Questions

Before you start the activity, ask the students:

- How and why do you think your two ladybug collections were or were not different?
- Do you think your collections were similar or different from collections in other parts of North America?

Activity

Note: This activity involves the computer and is best suited for only a few members to submit data at a time. The rest of the group could move on to #3.)

- A computer with online access
- The camera with the ladybug photos in it
- Your data from the two collection times

1. Download your ladybug photos from your camera and submit them online through www.lostladybug.org by following instructions. You will be asked for the names and ages and number of "spotters." You will be asked for date, time, habitat data as well as the length of time spent searching, etc.
2. Congratulations citizen scientists!
3. If you have time, you can access the currently submitted data to the Lost Ladybug Project through www.lostladybug.org. You can ask and even map questions like:
Where have all the _____ species been found so far?
Where have all the native ladybugs been found so far?
Where have all the exotic ladybugs been found so far?
In what month of 2008 were the most _____ specie found?
In what habitats were _____ species found in 2008?

Supplies

Objectives

- Learn how to submit data to the project
- See the bigger picture of ladybug diversity across the U.S.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Construct
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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The Lost Ladybug Project
www.lostladybug.org

Lost Ladybug Project: Submitting your Data

Science Checkup - Questions to ask to evaluate what was learned

- How did your collections compare with the ladybugs already submitted to the Lost Ladybug Project?
- Did you find about the same proportion of native and introduced species?
- Did you find any of the newly rare species? Can you tell from the data in the Lost Ladybug Project where you might expect to find them?
- Be sure to keep in mind that all ladybugs provide good information to scientists. Without pictures of all the ladybugs you find they will not be able to tell how common the common species are or, in turn, how rare the rare ones are.
- Which of your collections had greater species richness?
- Which of your collections had greater species evenness?

Extensions

Test your own ladybug hypotheses using the mapping and graphing features found at www.lostladybug.org.

Vocabulary

Native species: Native species are plants or animals that were original to a specific place

Introduced species: Introduced species are brought into a new habitat from another location. They are not original to the area.

Background Resources

- www.lostladybug.org

Lost Ladybugs

About the 4-H Science Toolkit Series: Lost Ladybugs

Some species of native ladybugs in North America are disappearing. In just the last 20 years, these beneficial predators of farm and garden pests have become extremely rare. This rapid decline is of great concern.

In completing this series of units, both age groups will learn about:

- Insect life cycles and the food web
- Biological control of insect pests
- The importance of biodiversity and the process of sampling
- Building their own sweep net
- Searching for, capturing, cataloguing and storing insects
- Submitting data to the Lost Ladybug Project

Students from both age groups will contribute to real scientific inquiry, and begin to explore their own scientific research questions.

All of these adventures call on students to predict what will happen, test their theories, then share their results. They'll be introduced to ladybug vocabulary, gain an understanding of the life cycles of ladybugs and their importance in the food web and collect bugs themselves to identify, observe and report about to the Lost Ladybug Project.

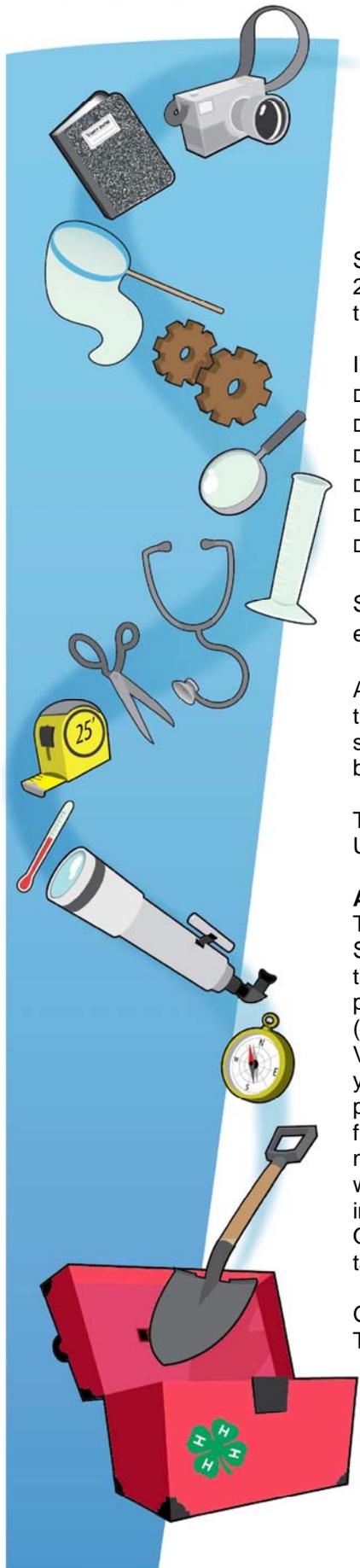
The lessons in this unit were developed by the Lost Ladybug Project based at Cornell University in the Department of Entomology.

About the project:

The Lost Ladybug Project was set in motion at a small number of schools in New York State in 2004. Now it is active in many states in the U.S. It is a citizen science project that asks anyone of any age to look for any ladybugs they can find, and then send in pictures of each one. One of the first major discoveries came in 2006 when Jilene (age 11) and Jonathan (age 10) Penhale found a rare nine-spotted ladybug near their Virginia home. This was the first nine spotted ladybug seen in the eastern U.S. in 14 years. Their finding confirmed that the species was not extinct and that with enough people working together we can find even these rare species. With recent funding from the National Science Foundation the Lost Ladybug Project has expanded and now anyone in North America can participate. Both common and rare ladybugs, whether native or introduced, are important to find. They all contribute to understanding where different species of ladybugs can be found and how rare they really are. Once we know where the rare ladybugs can be found, we can try to protect their habitat and save them!

General information about ladybugs and their life cycle are on the following pages. This information may be useful for the activities as well.

To find out more about the Lost Ladybug Project, visit www.lostladybug.org. To find numerous resources related to the insects, outdoor exploration and the environment, check out the 4-H Resource Directory at www.cerp.cornell.edu/4h.



All About Ladybugs

What are ladybugs?

Ladybugs are insects in the Coccinellidae family of the beetle order, Coleoptera. They are characterized by their oval-shaped body and distinctive coloring.

Is there a difference between lady beetles and ladybugs?

Although these insects are commonly called “ladybugs,” they are members of the beetle order, Coleoptera. The Coleoptera are unique from other orders in that they undergo complete metamorphosis (that is, have larva and pupa stages in their life cycle), and their forewings have modified into a hardened cover (elytra) that protects the insect. “True” bugs belong to the order Hemiptera, and include boxelder bugs, plant bugs, and squash bugs.



Immature True Bug

Though taxonomically incorrect, lady beetles are still commonly referred to as ladybugs. Other frequently used common names are ladybirds or ladybird beetles.

How did ladybugs get their name?

The most common legend as to how ladybugs got their name is that during the middle ages in Europe, swarms of aphids were destroying crops. The farmers prayed to the Virgin Mary for help – and help came in the form of ladybugs that devoured the plant-destroying pests and saved the crops! The grateful farmers named these insects “Our Lady’s beetles,” a name which had endured to present day.

What do ladybugs eat?

Both adult and larval ladybugs are known primarily as predators of aphids but they also prey on many other soft-bodied insects and insect eggs. Many of these are agricultural pest such as scale insects, mealybugs, spider mites and eggs of the Colorado Potato Beetle and European Corn Borer. A few ladybugs feed on plant and pollen mildews and many ladybugs supplement their meat diet with pollen.

What eats ladybugs?

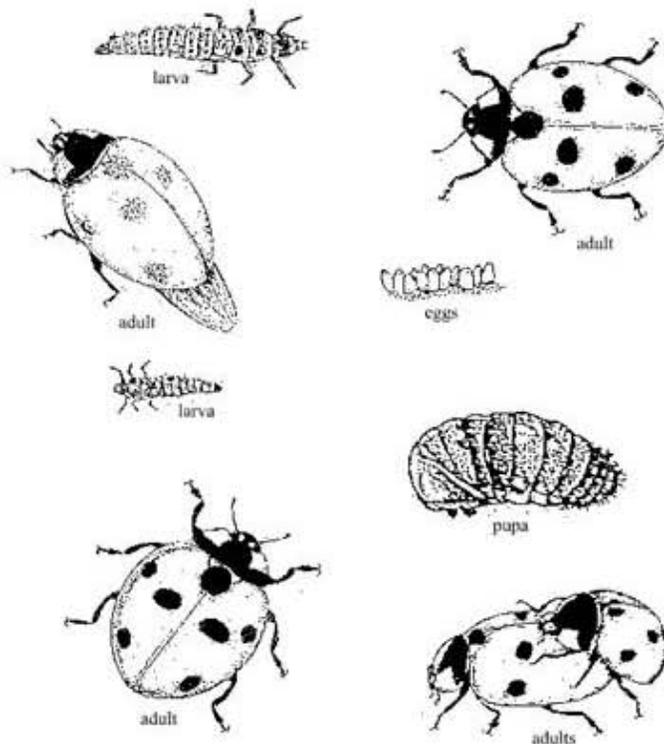
Ladybugs are not commonly eaten by birds or other vertebrates, who avoid them because they exude a distasteful fluid and commonly play dead to avoid being preyed upon. However, several insects, such as assassin bugs and stink bugs, as well as spiders and toads may commonly kill lady beetles.

How many different species are there in the US? In the world?

There have been over 500 species of ladybugs identified in the United States, and over 4500 in the entire world.

How long do they live?

After a female lays her eggs, they will hatch in between three and ten days, depending on ambient temperature. The larva will live and grow for about a month before it enters the pupal stage, which lasts about 15 days. After the pupal stage, the adult ladybug will live up to one year.



What do the different stages of the life cycle look like?

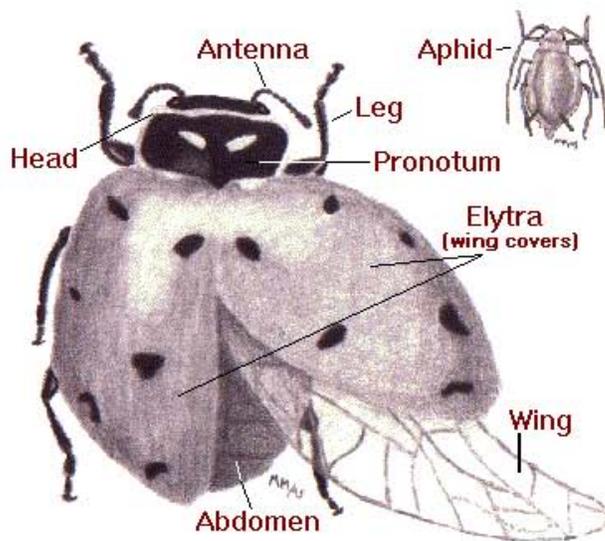
Life Cycle Stages

Eggs are tiny, spindle-shaped, and arranged in clusters.

Larvae are usually elongated, "alligator" shaped, slightly pointed at the rear, and their body is covered in tiny bristles.

Pupae are slightly round and dark colored. You can find them attached to a surface by their hind ends.

Adults are sphere-shaped, smooth, and have easily recognizable colors and markings.



What about ladybug anatomy?

Ladybug Anatomy

Ladybug in Flight
 Photo by Alex Wild, Champaign, Illinois, 2008



Why are they so brightly colored?

Ladybugs bright colors serve as a warning – they indicate any potential predators of the distasteful repellents the beetle will release if attacked. Ladybug spots are part of the bright warning pattern discussed in the previous question.

What's with them in my house during winter?

During the winter months, ladybugs seek out a warm place to hibernate. Many seek out cracks around buildings, including people's homes. They mass together to stay warm throughout the winter. Don't worry, they will not harm you or any part of your home, and they will be gone by spring.

How did non-native species get here?

Non-native ladybug species may have been introduced to the United States by scientists as an attempt to control crop-damaging aphids, or they could have hitched a ride with any vegetation that was brought over from Europe, Africa, or Asia.

Lost Ladybug Project: Ladybug Life Cycle

Activity Series:

Lost Ladybug

Grade: K-2

Time: 45 min.

Main Idea

Ladybugs, like all beetles, undergo complete metamorphosis. The four life stages of beetles look extremely different. Both immature and mature ladybugs prey on small soft-bodied insect prey, which are often agricultural pests.

Motivator

A single ladybug larva will eat about 400 medium-size aphids during its development to the pupal stage. An adult female will eat about 300 medium-size aphids before she lays eggs. She can eat about 75 aphids in a day and may consume more than 5,000 aphids in her lifetime!

Pre-Activity Questions

Before you start the activity, ask the students:

- Have you all seen ladybugs? Did you know that they are beetles?
- Do you know what ladybug babies look like?
- Did you know that ladybugs use their antennae to touch, smell, and taste?

Activity: Create ladybugs

- Green felt or construction paper
- Packing peanuts
- Toilet paper rolls
- Black pipe cleaners
- Empty egg cartons
- Masking tape
- Scissors
- Stapler
- Yellow paint
- Red and black markers or paint
- Hole punch
- Glue
- Printed photos of real ladybug eggs, larvae, pupae and adults from www.lostladybug.org

To make ladybug EGGS:

1. Cut the green felt or construction paper into the shapes of leaves.
2. Cut the rounded ends off of the packing peanuts and glue the flat sides of these (approximately 10 - 20) close together on the leaves.
3. Paint the rounded eggs yellow.

Objectives

- Learn about the ladybug life cycle.
- Understand what ladybugs eat

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Lost Ladybug Project: Ladybug Life Cycle

To make ladybug LARVAE:

1. Make slits half way up from one end of the toilet paper rolls.
2. Make ½ inch slits in the other side of the toilet paper rolls.
3. Shape the slit ends into cones and fasten with masking tape.
4. Make six legs by feeding three black pipe cleaners through holes punched in the uncut portion of the toilet paper rolls.
5. Use markers or paint to make eyes on the blunt end and color the entire form dark.

To make ladybug PUPAE

1. Cut green felt or construction paper into the shapes of leaves.
2. Separate individual cups from an egg carton.
3. Using markers or paint, children can paint the egg carton cups yellow and black or a muddy mixture like brown.
4. With tape, attach the cups, open part down, to the leaves. If the artists have designed one end of the cup to be more like a head, then the pupae should be attached opposite to this.

To make ADULT LADYBUGS

1. Separate individual cups from an egg carton.
2. Using markers or paint, children can paint the egg carton cups red or yellow or orange. Then, using black paint, color about a quarter of the outside of the cup. This will be the ladybug pronotum. The true ladybug head would hardly be visible but can be envisioned at the very front of this. Children can draw a vertical line down the ladybug body (abdomen) and make symmetrical spots on either side of that line.
3. Using the point of a scissors or a hole punch, an adult should make six small holes (three on each side) at the base of the cup near along the front half of the cup. These will be for the legs. Make two small holes (for antennae) at the very front where the head will be.
4. Insert a black pipe cleaner into each side hole and out the other side for the legs. Use half a pipe cleaner for the antennae.

Science Checkup - Questions to ask to evaluate what was learned

(note: there are answers in the intro to this series if needed)

- Are ladybugs "bugs" or "beetles"?
- Ladybug larvae and adults have legs. What about the pupae?
- Do ladybug larvae and ladybug adults eat the same things?
- Can you think of some other "predators" and other "prey"?

Extensions

Play the game "Plant, Plant, Ladybug!" (Duck, Duck, Goose!)

This game reinforces the roles of ladybugs as predators and aphids as likely prey and was invented by a 9-year-old student in one of the first groups collaborating with the Lost Ladybug Project in 2008. Everyone sits in a circle except for one aphid who walks around designating "plant, plant, plant" until she calls someone a ladybug! The ladybug gets up and the chase is on! If the ladybug catches the aphid, the aphid must sit in the middle and the ladybug becomes the next aphid, and so on until the ladybugs have

Lost Ladybug Project: Ladybug Life Cycle

Vocabulary

Ladybug: A small round flying beetle that has red or orange outer wings with black spots

Lady beetle: Another name for a ladybug.

Egg: A large cell produced by birds, fish, insects, reptiles and amphibians that includes a fertilized embryo that continues to develop outside the mother's body until it hatches.

Larva: The wingless immature worm-shaped form of many insects.

Pupa: An insect at the stage between a larva and an adult in complete metamorphosis.

Complete metamorphosis: A stage during which the insect is in a cocoon or case stops feeding, and undergoes internal changes

Predator: An animal that eats other animals in order to survive.

Prey: An animal caught, killed and eaten by another animal as food.

Background Resources

- www.lostladybug.org

Lost Ladybug Project: Ladybug Diversity

Activity Series:
Lost Ladybug
Grade: K-2
Time: 45 min.

Main Idea

Ladybugs can be found all over the world and there are many different species. Learn to recognize important characteristics.

Motivator

There are more than 4,500 species of ladybugs in the world and more than 500 identified in the U.S. Only about 70 of these are the cute red, yellow and black ones we think of most.

Pre-Activity Questions

Before you start the activity, ask the students:

- Do all ladybugs look alike?
- What colors do they come in?
- About how many kinds do you think you might find in one place?

Activity 1: Drawing, modeling ladybugs

- Large ladybug poster (download from www.lostladybug.org) (optional)
- Ladybug field guides (download from www.lostladybug.org)
- Blank paper or ladybug outlines (download from www.lostladybug.org)
- Crayons, markers, or paints

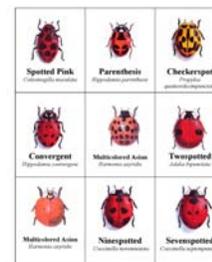
1. Have children pick a ladybug from the poster or Field Guide to draw freehand, fill in on a ladybug outline sheets or model with clay or play dough.
2. Talk about how ladybugs look: identify body parts; colors of wings, head, antenna; color, size, shape, number and placement of spots. Then compare to other ladybugs.

Activity 2: Ladybug Bingo

- Ladybug bingo chips (can be made of paper, felt, or anything)
- Up to 30 different ladybug bingo game boards (download from www.lostladybug.org)

1. Give each child a ladybug bingo game board and discuss the differences and names of the ladybugs.

Ladybug Bingo Card



Objectives

- Learn to identify ladybugs
- See why insect variety is important

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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2. Cut up a few other game boards for pieces to pull out of the hat, and cut up something for chips.
3. Have a great game and learn about ladybugs at the same time!

Science Checkup - Questions to ask to evaluate what was learned

(note: there are answers in the intro to this series if needed)

- Are all ladybugs red?
- Do the patterns of both the wings (or elytra) and the pronotum vary?
- Where do introduced ladybugs come from?

Extensions

Ways to demonstrate that a variety of insects do a variety of jobs

- Gather a toolbox or bag containing different tools. "Here are different tools that people use to do different jobs. Here's a hammer for hammering nails, here's a screwdriver for screwing into wood, a measuring tape for making accurate measurements. "(Hold up a hammer) So the hammer is good for pounding nails. Why don't we just have lots of hammers? Why don't we fill our toolbox with just hammers? Why do we need all these different tools? Each tool does a different job. We need all the tools in order to do lots of different things. Each insect also does a different job, so we need different kinds of insects, not just bees or just beetles."
- Ask participants to think of different jobs that people do in their community.

Each ladybug species lives best, and eats the most pests, in specific circumstances. One way of expressing this is that they each have their own "job" like tools in a toolbox. This understanding will help students make sense of biodiversity and conservation.

Vocabulary

Elytra: A tough front wing, occurring in pairs on beetles and some other insects, that acts as a protective covering for the rear wing.

Rare: Rare plants and animals are not commonly found.

Common: Common plants and animals can be easily found.

Native species: Native species are plants or animals that were original to a specific place

Introduced species: Introduced species are brought into a new habitat from another location. They are not original to the area.

Biodiversity: The range of organisms present in a particular ecological community or system.

Conservation: The preservation, management, and care of natural and cultural resources.

Background Resources

- www.lostladybug.org

Lost Ladybug Project: Getting Ready to Collect

Activity Series:
Lost Ladybug
Grade: K-2
Time: 45 min.

Main Idea

Prepare a ladybug collection chart and make a good strong sweep net for collecting in the next unit.

Motivator

If ladybugs fall from a plant or fall into your net, they may play dead! Watch them closely!

Pre-Activity Questions

Before you start the activity, ask the students:

- What are the differences between a butterfly net and a sweep net?
- How many different kinds of ladybugs do you think you will find?

Activity: Making a homemade sweep net

- Pillow cases
- Two wire coat hangers / pillow case
- One piece of wood or dowel approx 2 - 3 feet long for a handle
- Scissors
- Duct tape
- Pliers
- One piece of poster board
- Crayons or markers

1. Turn your two wire hangers into similar circles. Then tape them together in several places, leaving the open end opened.
2. Now cut holes on either side of the seam where there are two layers of pillowcase fabric. Feed the wire through the pillowcase hem. Straighten out the ends that are left so that they can be taped to the handle
3. Heavily tape the four wire pieces that are out of the pillowcase to the handle. Make sure it is sturdy because it's going to bump into thick grass, alfalfa, clover and other plants!
4. Set up a poster board chart like this, with different ladybug species at the top.

Species	Species A				
Date, location	#	#	#	#	#

Objectives

- Create a sweep net
- Learn to organize ladybug data

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Lost Ladybug Project: Getting Ready to Collect

5. The students can draw the different species of ladybugs again or cut them out from either the bingo game boards or field guides they have seen before. (Either can be downloaded from www.lostladybug.org)
6. After each collection (next two units) the students will record the dates and habitats and numbers of each type of ladybug they found. At the end of the fifth unit, or during the sixth unit, these can be compared!

Science Checkup - Questions to ask to evaluate what was learned

- Now that you have looked at several different kinds of ladybugs, is it getting easier to identify them?
- Are you ready to go outside and find them?

Extensions

Check out the Lost Ladybug Coloring Book on the www.lostladybug.org Web site for a great story of the project, with pictures for children to color.

Vocabulary

Sweep net: A strong net without holes for collecting insects.

Species: A basic biological classification and containing individuals that resemble one another and may interbreed

Background Resources

- www.lostladybug.org

Lost Ladybug Project: Collecting

Activity Series:
Lost Ladybug
Grade: K-2
Time: 45 min.

Main Idea

Go outside and collect ladybugs to see what kinds you find and how many. All ladybugs are important to the Lost Ladybug Project and help scientists figure out where different species are – both rare and common varieties. The children become citizen scientists themselves!

Motivator

Some ladybugs are found alone while others are found in huge groups of thousands. Some are swept out of the air and wash ashore beside large lakes!

Pre-Activity Questions

Before you start the activity, ask the students:

- What do you think makes a good habitat for ladybugs?
- What kind of weather or what time of day do you think would be best for collecting ladybugs?
- How many different species do you think you will find? (some answers to the first question can be found below)

Activity: Collecting

- Your own sweep nets
- Your poster board chart
- Large plain cloth or sheet
- High-sided wash basin or box
- Jars, vials, or ziplock bags
- Cooler w/ cold pack or ice

First, locate a collecting site(s). In general, the best sites will be areas of more than 100 square meters (120 yards) that contain herbaceous (not woody or tough) plants that are at least 20 cm (8 in) high. Plants that are too tough cannot easily be swept through and plants that are too short do not host many of the prey insects that ladybugs need, so they don't usually support very large populations of ladybugs.

Collecting sites could include: any area that has not been mowed recently, preferably with some weeds, plants at the edge of a wooded area, mowed area or field (e.g. a hedgerow). Or orchards are also a possibility. Sweeping is possible if not too recently mowed.

Trees themselves are excellent habitat for ladybugs, and while they clearly cannot be swept, lower branches can be shaken or

Objectives

- Learn to efficiently collect a sample from the field
- Learn to identify ladybugs

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
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- Collaborate
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Lost Ladybug Project: Collecting

beaten vigorously onto sheets. Note that many orchards are treated frequently with insecticides, so be sure to check on the treatment schedule.

Agricultural fields such as alfalfa, clover, small grains like wheat, potatoes and soybeans can make fruitful collecting sites. As with orchards, be sure to check with the grower first.

1. If you will be comparing ladybugs from two different habitats (two consecutive units), you should know that keeping ladybugs in a refrigerator for more than one week is not great for their health. If your group meets once each week, the best plan would be to search for the same length of time, say ½ hour, each time and allow time for photographing the ladybugs on the second week. So, if one habitat is farther from headquarters, that would be the place to go during this unit!
2. Demonstrate back and forth motion of the net, sweeping low enough to knock insects into the net but not hit the ground, or show video clip from the lostladybug.org Web site. In addition to the insects that will be knocked off the plant, many insects leap for the ground when disturbed and will hopefully land in your nets.
3. Let everyone go out and sweep, search and beat for a defined period of time.
4. Empty sweep nets onto open sheets or into wash basins and boxes.
5. Collect all ladybugs into jars, vials or bags.
6. Try to identify which species have been found!
7. Put the ladybugs into a cooler until you reach a refrigerator. Keep them with a small bit of damp paper towel or cotton until they can be photographed (next unit). Cooling slows insects down and makes it easier for them to go without food.

Science Checkup - Questions to ask to evaluate what was learned

(note that there are answers in the intro to this series if needed)

- How many ladybugs did you find?
- How many different species did you find?
- How many different ladybug species did you recognize?
- Did you find them all in the same kind of habitat?

Extensions

Find out more about the ladybugs you have found so far at www.lostladybug.org

Vocabulary

Habitat: The natural conditions and environment in which a plant or animal lives, e.g. forest, desert, or wetlands

Microclimate: the climate of a confined space or small geographic area

Sampling: Taking a small part, number, or quantity of something as a sample and using it to make observations about the whole group or area.

Background Resources

- www.lostladybug.org

Lost Ladybug Project: Collecting-Part 2

Activity Series:
Lost Ladybug
Grade: 3-6
Time: 45 min.

Main Idea

Go outside and collect ladybugs again and compare results from two different habitats. For the Lost Ladybug project, having repeat collections from nearby locations and by the same "spotters" is especially valuable. The children become SUPER citizen scientists themselves!

Motivator

We still don't know why certain ladybugs live on certain plants and in certain areas. Let's try to learn more about this.

Pre-Activity Questions

Before you start the activity, ask the students:

- How and why do you think your second ladybug collection may be different from your first?
- How many different species do you think you will find?

Activity: Collecting at a new site

- Your own sweep nets
- Your poster board chart
- Large plain cloth or sheet
- High-sided wash basin or box
- Jars, vials, or ziplock bags
- Cooler w/ cold pack or ice
- Camera (preferably digital with a close-up function.
- Printed page of "the perfect grey" (downloaded from www.lostladybug.org)

Locate a second collecting site, somehow different in habitat than the first. The difference could be related to what surrounds the fields (surrounding vegetation versus neighborhood housing) or differences in the fields themselves (types of plants, etc.). Note recommendations from "Collecting."

1. If you will be comparing ladybugs in two different habitats (two consecutive units), this time you should plan to go out fast and come back with time to take photographs.
2. Gather your sweep nets, cloths, wash basins, jars and cooler. Go out and sweep, search and beat for a defined period of time.
3. Empty sweep nets onto open sheets or into wash basins and boxes.
4. Collect all ladybugs into jars, vials or bags.
5. Put the second collection of ladybugs into a chilled cooler. Cooling will slow them down and make them easier to photograph.
6. Once back at headquarters, while the second group of ladybugs cools down, you can photograph the first (pre-cooled)

Objectives

- Learn differences between habitats
- Learn to store and photograph insects

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

The Lost Ladybug Project
www.lostladybug.org

Lost Ladybug Project: Collecting-Part 2

collection of ladybugs. To do this, bring out your print of "the perfect grey." This grey background will help avoid the glare that can come off shiny ladybug elytra and make identification more difficult. Glare or reflection off the beetle is often more of a problem than not having enough light.

7. Place one chilled ladybug at a time on the grey background and take the largest photograph you can, while maintaining focus. Shield the beetle from bright light and use the flash only if there is very little light.
8. As this is happening, someone in the group should be recording the group's "best guess" as to the species of each ladybug being photographed.
9. Repeat the process with the now chilled newer group of ladybugs and record the "best guesses" separately.
10. Once all the ladybugs have been photographed, you are ready to fill in your poster board chart and have an interesting discussion! In the upper half, note the date, time, number of "spotters," habitat and numbers of each ladybug species found, as well as "kinds" you may not know the names of yet. You may recognize them as all belonging to the same species even if you don't yet know the name. (This is fine! You do not need to determine the species you find. The Lost Ladybug Project will receive the photo and determine the species.)
11. Fill in the lower half of the chart with similar data from this day's collection. Discuss how and why your collections from two different habitats may have been similar or different.
12. Return the ladybugs to where you found them or to another great ladybug habitat.

Science Checkup - Questions to ask to evaluate what was learned

(note that there are answers in the intro to this series if needed)

- On which day did you find more ladybugs?
- On which day did you find more species of ladybugs?
- If you found differences, do you think they may be due to habitat, date or weather?
- How many different ladybug species did you NOT recognize?

Extensions

- Think of all the ways your two collecting expeditions differed. Do you have any ideas about where or when you can expect to find more ladybugs?
- Find out more about the ladybugs you have found so far at www.lostladybug.org.

Vocabulary

Habitat: The natural conditions and environment in which a plant or animal lives, e.g. forest, desert, or wetlands

Microclimate: the climate of a confined space or small geographic area

Sampling: Taking a small part, number, or quantity of something as a sample and using it to make observations about the whole group or area.

Background Resources

- www.lostladybug.org

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Lost Ladybug Project: Submitting your Data

Activity Series:
Lost Ladybug
Grade: K-2
Time: 45 min.

Main Idea

Complete the process of giving your ladybug images to the Lost Ladybug Project and begin to explore how your data relates to all the other data collected for the Lost Ladybug Project.

Motivator

Lost Ladybug project received more than 1,000 ladybug photo submissions in 2008. We would love to receive 10 times that many in 2009 and 100 times that many in 2010! Your data is important to us!

Pre-Activity Questions

Before you start the activity, ask the students:

- How and why do you think your two ladybug collections were or were not different?
- Do you think your collections were similar or different from collections in other parts of North America?

Activity

Note: This activity involves one person at a computer and may be best suited for a few members to submit data at a time.

- A computer with online access
- The camera with the ladybug photos in it
- Your data from the two collection times

1. Download your ladybug photos from your camera and submit them online through www.lostladybug.org by following instructions. You will be asked for the names and ages and number of "spotters." You will be asked for date, time, habitat data as well as the length of time spent searching, etc.
2. Congratulations citizen scientists!
3. If you have time, you can access the currently submitted data to the Lost Ladybug Project through www.lostladybug.org. You can ask and even map questions like:
 - Where have all the _____ species been found so far?
 - Where have all the native ladybugs been found so far?
 - Where have all the exotic ladybugs been found so far?
 - In what month of 2008 were the most _____ species found?
 - In what habitats were _____ species found in 2008?

Supplies

Objectives

- Learn how to submit data to the project
- See the bigger picture of ladybug diversity across the U.S.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

Contributed By

The Lost Ladybug Project

www.lostladybug.org

Lost Ladybug Project: Submitting your Data

Science Checkup - Questions to ask to evaluate what was learned

- How did your collections compare with the ladybugs already submitted to the Lost Ladybug Project?
- Did you find about the same proportion of native and introduced species?
- Did you find any of the newly rare species? Can you tell from the data in the Lost Ladybug Project where you might expect to find them?
- Be sure to keep in mind that all ladybugs provide good information to scientists. Without pictures of all the ladybugs you find they will not be able to tell how common the common species are or, in turn, how rare the rare ones are.
- Which of your collections had greater species richness?
- Which of your collections had greater species evenness?

Extensions

Test your own ladybug hypotheses using the mapping and graphing features found at www.lostladybug.org.

Vocabulary

Native species: Native species are plants or animals that were original to a specific place

Introduced species: Introduced species are brought into a new habitat from another location. They are not original to the area.

Background Resources

- www.lostladybug.org

Plant Science

About the 4-H Science Toolkit Series: Plant Science

In this Toolkit series, students will use all of their senses to learn more about the amazing world of plants. They'll become keen observers and notice small details in the plant world; conduct experiments to learn how plants respond to light; discover how plants adapt to changing climate conditions; explore chlorophyll and gain an understanding of how plant color relates to nutritional value. They'll even conduct some taste tests on vegetables, hoping to find a new one to add to their list of favorites.

They can take their activity even further in one unit — by planning, designing, planting and eating a garden of their own creation.

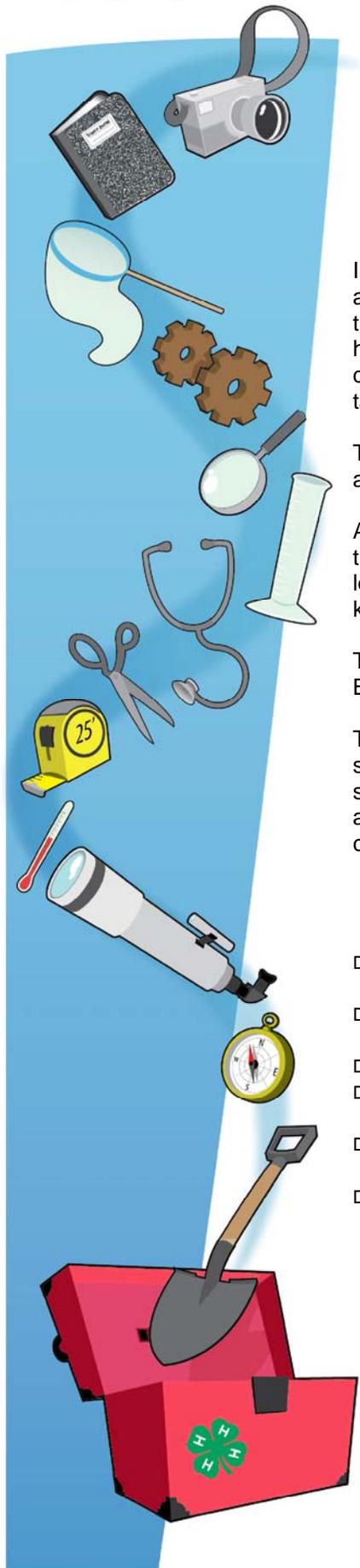
All of the plant science activities call on students to predict what will happen, test their theories, then share their results. They'll be introduced to plant science vocabulary, learn how plants gain and produce energy for other living things and expand their knowledge of vegetable varieties and their taste.

The lessons in this unit were developed by, and are connected to, Cornell Garden-Based Learning, in the Department of Horticulture at Cornell University.

To find out more about plant science and garden-related activities, visit the It should say, to find out more about plant science and garden-related activities and program support, visit Cornell Garden-Based Learning at: <http://blogs.cornell.edu/garden> and to find numerous resources related to gardening, nutrition and plant activities, check out the 4-H Resource Directory at www.cerp.cornell.edu/4h.

Plant Science Table of Contents

- Be a Human Camera:** Explore the world of plants up close to notice details you don't see from far away.
- Making Chlorophyll Prints:** Learn more about chlorophyll and how it is a key to life — producing energy for animals and human beings.
- Patterns in the Grass:** Discover how light affects the color of grass.
- Climate Change Superhero:** Explore plant adaptation as it relates to climate change.
- Plan a Rainbow Garden:** Learn how color reveals information about a plant's nutritional and biological properties and work together to plan a colorful garden.
- Veggie Taste Test:** Learn about different varieties of vegetables, while thinning out a garden.



Plant Science: Be a Human Camera!

Activity Series:
Plant Science
Grade: 3-6
Time: 30-60 min.

Main Idea

Great science begins with keen observation.

Motivator

You may think you're just looking at a garden. You've seen plants before. But take a closer look. Really see what's happening right before you. What's that? That leaf is moving? It's a camouflaged praying mantis! Peering inside a tulip reveals a whole world of color and pattern. What do we see when we really look closely? How does our observation change when we are intentional? After we learn to "see," how can that info be useful in a diversity of ways?

Pre-Activity Questions

Before you start the activity, ask the students:

- Do you see everything that is front of you?
- Do you think that there is important information that you may miss?
- Are you up for a challenge to see just what you may be missing?

Activity

- Paper and pencil for each participant
- Flowers, houseplants, an outdoor garden, indoor garden or any other available plants.

Begin by preparing the group to go outdoors to the garden or schoolyard. Alternatively, you could move to an indoor space where students can explore flowers and other plants up close.

1. Gather together near the garden and discuss initial observations. Ask the group about the difference between casual looking and careful observation. You might begin with an example, such as the way people in the Northeast eagerly await the return of robins. Those first few robins you see are exciting, and are often pointed out – "It's a robin, it must really be spring!" Within a week or two, robins are everywhere, become a part of the outdoor background and many people stop "seeing" them.
2. Another example is how we tune out familiar information that we simply do not need. You may ask the group to describe details of very familiar settings, such as the school hallway, places in their homes, the after school program or the community center that they walk through daily. Although they may recall the bigger parts of the scene, they may forget details. Subtle patterns on the wall, accumulated dirt or papers in corners, what may be written on a chalkboard, and other elements may disappear from our conscious minds.

Supplies

Objectives

- Learn to sharpen observation skills
- Write descriptively and then creatively
- Work in collaborative teams

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

Contributed By

Marcia Eames-Sheavly, Cornell Garden-Based Learning. Adapted from an activity by Christine Hadekel

Plant Science: Be a Human Camera!

3. Generate a discussion. Ask students for examples of situations where we have a great deal of visual information around us that we miss. Why do we tune it out? In which occupations would keen observation be a critical part of the work? What are some examples of how a scientist in particular relies on observation?
4. Have students pair up. Ask for two volunteers to demonstrate how one student will be the “photographer” while the other is the “camera.” The camera will have his/her eyes closed, while the photographer positions him/her close to a beautiful flowering bulb or intricately veined leaf, for example, at an angle that will offer a unique and perhaps unexpected perspective. Positioning could be from above, from below or up very close. When cued, the camera will open his/her eyes for 10 seconds, record a visual memory of what s/he has observed, then close their eyes again. Move the camera to a new location and repeat two more times. Have the camera record her/his observations in as much detail as possible, then switch roles.
5. Before the pairs begin, ask them to consider: What questions would they like to answer as “cameras?” Make a note of these.
6. Gather together to discuss the process. What did students notice when they were the camera that they might not have otherwise? Often, young people will describe intricate details of texture, color variation, delicate drops of dew, flower structures, insect visitors and other details they may never have seen before.
7. From this discussion, generate a list of the things a good artist or scientist observes: lines, shapes, forms, shadows, shades, tones, perspectives and size in relation to other items, etc.
8. After discussing, students are ready to use their observations to write poetry about the plants they observed. The 5-7-5 syllable structure of a haiku is a good place to begin.
 - Pale butter petals
 - Early morning dew still clings
 - Nodding, soft breezes
9. You might encourage students to take the same subject and play around with different versions of it. Which of their poems do they prefer and why?
 - Vivid markings steer
 - Honey bee heavy laden
 - With golden pollen
 - Vivid markings guide
 - Heavy laden gold miner
 - Bee exits, stage right
10. Seek student input as to how they want to go further with this flexible activity. It can lead to exploring indoors or outdoors, really anywhere there are plants or a garden.

Science Checkup - Questions to ask to evaluate what was learned

- During this activity, you generated some questions you wanted to answer as “cameras.” Did you find what you were seeking?
- How did your focused observation compare to your initial (or overall) impression of the garden (or plants, etc.)?
- What surprised you about your “up close” observations?
- Students often enjoy working in pairs. Let’s hear about that part of the experience.
- Would you please share evidence of your observation by reading aloud your description and/or poetry?

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Plant Science: Be a Human Camera!

Extensions

- Write about the experience, and other outdoor experiences, in a garden or nature journal.
- Repeat the activity with other outdoor elements as a focus – for example, observe trees during the winter months and compare with observations and writings from the spring.
- Use this activity before another science activity that requires careful observation.
- Host a nature-based poetry slam on Earth Day, Arbor Day or any other time that seems appropriate. Feature these and other creative writings or artwork from young people. Explicitly talk about the link between keen scientific observation and how that informs a creative experience.
- An interesting twist is to explicitly notice — and write about— pollution, garbage, trash and other waste elements of the environment that we may be tuning out. What are the impacts of “not seeing” the waste we generate?
- Try this activity on a micro-scale. Look through a microscope or hand lens and describe in detail the color, textures and other elements of the subject.

Vocabulary

Observation: A very specific way of noting information of the outside world using all the senses.

Background Resources

- For more exciting activities like this one, visit Dig Art! Cultivating Creativity in the Garden: <http://blogs.cornell.edu/garden/get-activities/signature-projects/dig-art/activities/>
- National Gardening Association’s Human Camera Activity: <http://www.nationalgardenmonth.org/index.php?page=camera>
- Visit Cornell Garden-Based Learning for more plant-based activities: <http://blogs.cornell.edu/garden>

Plant Science: Making Chlorophyll Prints

Activity Series:
Plant Science
Grade: 3-6
Time: 60-90 min.

Main Idea

Photosynthesis is said to be the most important biological process on earth, and chlorophyll pigment is vital to the process. We simply could not survive without it! And yet, sometimes the topic can be dull, given the way in which it is typically presented, which usually emphasizes memorizing the components. In this activity, while discussing the value of plants to all of life on earth, students will extract chlorophyll from a plant part and create a beautiful chlorophyll print.

Motivator

So you think plants are amazing, cool and they're all you want to talk about, right? And on top of that, don't you love memorizing intricate details of cycles in nature, and then listing all the elements on tests? Wait, before you run in the other direction: Plants really are amazing, and we can't live without them. Our entire lives on this planet are dependent on them. But instead of force marching you through memorization of minutia, we're going to consider plants through a creative activity that celebrates life's most important pigment: chlorophyll. We hope that it helps provide the pause to ponder just how remarkable plants really are.

Pre-Activity Questions

Before you start the activity, ask the students:

- What is absolutely essential to life on earth?
- What do we get from plants?
- Why do plants matter?
- How can we learn about the most important pigment on earth in a unique way?
- When it comes to plants and plant pigments, is there anything in particular that you are curious about?

Activity

- Green leaves (vegetables like kale and spinach; herbs like basil and mint; green leaves from trees and shrubs)
- Pieces of white fabric or watercolor paper
- Metal spoons
- Masking tape

1. Begin by generating a lively and spirited discussion about life on Earth. What do we need to live? What things do we consume that we *really* could do without? What is the impact of consuming more than we need? What do we get from plants?
2. Check in with concepts of photosynthesis and chlorophyll. What do we know about these? Let's make a list of what we

Supplies

Objectives

- Engage in science concepts behind photosynthesis and chlorophyll
- Extract chlorophyll from a plant and create a print

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

Contributed By
Marcia Eames-Sheavly, Cornell Garden-Based Learning. Adapted from an activity by Christine Hadekel.

Plant Science: Making Chlorophyll Prints

already know. Help to fill in the blanks with what young people do not understand. (Light is a form of energy. Plants need energy to develop and grow. Humans and animals get their energy from plants. Plants get their energy from the sun, which works to combine water and carbon dioxide to produce sugar. Plants contain chlorophyll, a green pigment that traps the sun's energy. Plants use the sun's energy to combine water and carbon dioxide together to make sugar. Every green part of a plant has chlorophyll and makes sugar).

3. Usually in school, we focus on the details, memorizing elements of this process. While these are important to know about, sometimes we get so wrapped up in things like the Krebs cycle that we forget the "big picture" of the remarkable, awe-inspiring way in which this process supports all of life on earth. What are your thoughts about that?
4. Let's explore chlorophyll close up, in a unique way. Begin by folding a piece of paper or fabric in half and open it up again. Place a leaf face down on half of the paper/fabric, and fold the other half over it. Tape the paper/fabric to the table so that it stays in one place.
5. Use the bottom of a spoon to press firmly and rub it across the paper/fabric.
6. Rub the spoon over the entire leaf area so that all of the leaf's chlorophyll will be transferred to paper or fabric. The chlorophyll print will be more prominent on the paper because it is thinner and will absorb the chlorophyll more easily than fabric.
7. Repeat this process as many times as you like, trying different leaves and paper or fabric materials. Try to describe the green – what shades do you see, how vivid are the colors? What do you think about the pigment on this simple leaf print holding the key to life on earth as we know it?
8. Bind the finished prints together in a garden journal or class book, laminate and frame or hang them as special flags around the room.

Science Checkup - Questions to ask to evaluate what was learned

- Often we focus on chlorophyll and photosynthesis as the memorization of facts, without acknowledging the wonder. What did this activity cause you to ponder from the perspective of what is "awe-some" about plants?
- What do you think of your leaf print?
- Did you get answers to other questions you were curious about?

Extensions

- Check out Dig Art! for ideas for other print making projects: <http://blogs.cornell.edu/garden/get-activities/signature-projects/dig-art/activities/printmaking/>
- Move from this activity to the Plant Science toolkit activity: Patterns in the Grass, which also builds on learning about light and chlorophyll.

Vocabulary

Chlorophyll: The green pigment found in most plants, algae, and cyanobacteria.

Photosynthesis: A process that converts carbon dioxide into organic compounds (especially sugars), using the energy from sunlight.

Carbon dioxide: A chemical compound used by plants during photosynthesis to make sugars.

Background Resources

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Plant Science: Making Chlorophyll Prints

- For more exciting activities like this one, visit Dig Art! Cultivating Creativity in the Garden: <http://blogs.cornell.edu/garden/get-activities/signature-projects/dig-art/activities/>
- How to Paint with Chlorophyll from Leaves: http://www.ehow.com/how_4535975_paint-chlorophyll-from-leaves.html
- Vietnamese artist Binh Danh has developed a process for printing photographs on leaves through using the natural process of photosynthesis. Check out his chlorophyll leaf prints here: <http://neaat.wordpress.com/category/photographer-binh-danh/>
- Visit Cornell Garden-Based Learning for more plant-based activities: <http://blogs.cornell.edu/garden>

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Plant Science: Patterns in the Grass

Activity Series:
Plant Science
Grade: 3-6
Time: 60 min.
total, spread over
three weeks

Main Idea

This activity uses plants' response to lack of light to create images or patterns. When deprived of light, chlorophyll, which gives leaves their green color, fails to function. As a result, the leaves lose or don't produce chlorophyll, and turn yellow, or sometimes even white. This technique can be carried out on a large scale on lawn, creating fantastic patterns. In this activity, we are simulating the process on a small scale indoors.

Motivator

Did you know that by using light, you can create a "picture" in grass? Imagine creating a secret message, and revealing it publicly – on a lawn! You may know about chlorophyll, a pigment responsible for the green color in plants. In this activity, we'll mess around with chlorophyll to create a grass image, by robbing the grass of light in certain places.

Pre-Activity Questions

Before you start the activity, ask the students:

- What is chlorophyll?
- What color is it associated with in plants?
- What do you think happens if you cover it up, not letting light get to it?
- How can we take advantage of this to create an image?
- What other questions related to this topic are you curious about?

Activity

- A shallow, rectangular container
A shallow tub-like container at least 8 x 10 inches long, or a long, shallow window box. The bigger the container, the larger the items you can use, and the more dramatic your results will be.
- Tray to rest container on, so that water does not run out onto surface.
- Potting soil
- Grass seed
- Quarters, nickels, dimes, and half dollar coins

1. Begin by checking in about chlorophyll. What do we already know to begin with, and what can we learn about it? Light is a form of energy. Plants need energy to develop and grow. Humans and animals get their energy from plants. Plants get their energy from the sun, which works to combine water and carbon dioxide to produce sugar. Plants contain chlorophyll, a green pigment that traps the sun's energy. Chlorophyll is vital for photosynthesis, which allows plants to get energy from light. Chlorophyll absorbs light most strongly in the red, some in the blue, and poorly in the green portions of the electromagnetic spectrum. Robbing plants of light prevents photosynthesis from taking place, resulting in the bleaching out of pigment, turning plant parts

Supplies

Objectives

- Learn how light affects the color of grass.
- Try creating a large-scale grass pattern outdoors.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

Contributed By

Marcia Eames-Sheavly, Cornell Garden-Based Learning. Adapted from "Living Sculpture."

Plant Science: Patterns in the Grass

first yellow, then eventually, white. Permanently blocking the light results in plant death.

2. Generate some ideas as to what might happen if we prevented light from reaching the plant in a very specific way -- that is, blocking it in the form of a pattern. How long might it take to create an image that appeared yellow against the green? How would you know when it has been just the right period of time to see the image without killing the plants?
3. Setting up the "lawn:" be sure that your container has drainage holes – punch several if there are none. Fill the container with dampened potting soil, and then place the container on a tray.
4. Thickly sow the grass seed over the soil. Place in a location that gets ample sunlight or under grow lights. Water as needed until grass is established.

Roughly 10 – 14 days later: Creating the pattern

1. As a group, generate ideas for a pattern you want to create. Determine if using coins will meet your needs. If not, seek out other items. As long as they are heavy and dense, most items will work. You want to make sure that the items will not shift on the surface and that they are dense enough not to allow any light to penetrate.
2. Arrange your items in the desired pattern. How will you know when your pattern is "just right?" Although our best guess is that you can reveal your pattern in 5 – 7 days, you may want to place several coins at the edge of the tray, and remove them day by day until you have the ideal degree of yellowing to show a vivid pattern.
3. Return the experiment to its light source. Continue to water as needed (keep moist, but not wet).

Revealing the Pattern

1. If you have coins along the edge, remove them day by day until you think you have the right degree of yellow you desire. Or, wait 5-7 days before removing the items and revealing your pattern. Depending on your growing conditions, it may take less than 5 days, or more than 7, to express your pattern. Voila! How does it look?

Science Checkup - Questions to ask to evaluate what was learned

- What is chlorophyll?
- What happens if you block the light from reaching plants?
- How can we take advantage of this to do something unique and creative?
- What answers did you find to other questions you had?

Extensions

- Using the same method outlined above you can create giant patterns on lawns and fields outdoors. No need to wait for the grass to grow if you're working with an existing lawn – and, your shapes can be much bigger and more dramatic! Check out the [Playing with Light: Temporary Lawn Patterns](http://www.hort.cornell.edu/livingsculpture/mowing_cropt/lawn_patterns.htm) site (http://www.hort.cornell.edu/livingsculpture/mowing_cropt/lawn_patterns.htm) for more project ideas.

Vocabulary

Chlorophyll: The green pigment found in most plants, algae, and cyanobacteria.

Background Resources

- For more exciting activities like this one, visit Living Sculpture: <http://www.hort.cornell.edu/livingsculpture/>
- Visit Cornell Garden-Based Learning for more plant-based activities: <http://blogs.cornell.edu/garden>

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Plant Science: Climate Change Superhero

Activity Series:
Plant Science
Grade: 3-6
Time: 30-60 min.

Main Idea

Young people often feel overwhelmed with environmental concerns. They have inherited some of the most challenging tasks of the ages. Many resources and activities focus on faraway places, such as rainforests, and as a result, they can give a false notion of climate change as a “faraway” problem. Fighting climate change can begin in the backyard. In this activity, young people will learn how plants are affected by the climate and how they adapt to climatic changes. They will then design and create a “Plant Superhero” that has all of the characteristics of an adaptable plant for their local region. They will design, illustrate, name and describe it.

Motivator

Climate change is a confusing and challenging topic. Not surprisingly, many of us are bewildered about where to begin, since there is so much to learn! In this activity, we’ll get started on a path to understanding climate change together that is just the beginning. You will have a chance to design a plant superhero that can adapt to global climate change, based on what you learn.

Pre-Activity Questions

Before you start the activity, ask the students:

- What is climate change?
- Why is it relative to our lives?
- What can we do to learn more about it?
- What steps can we take to alleviate it?
- What aspects of climate change are you most curious about, related to the plant world?

Activity

- Flipchart and marker
- Art supplies (construction paper, markers, glue, scissors, and anything else that could be used in designing and creating a plant superhero)
- Updated garden zone map from the National Arbor Day Foundation. Available at <http://www.arborday.org/media/zones.cfm> It can be printed or viewed online.

1. Before you begin, print the garden zone map or locate the map online. The online version is preferable since it shows the transition of zones from 1990 to 2006. This transition of colors will help to illustrate the phenomenon of global warming to the youth.
2. Explore background concepts such as what a plant needs to survive and how climate zones are shifting. Use a flip-chart and markers to brainstorm with the students the types

Objectives

- Explore plant adaptation as it relates to climate change
- Provide forum for a discussion about climate change.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

Contributed By

Marcia Eames-Sheavly, Cornell Garden-Based Learning. Adapted from an activity by Christine Hadekel

Plant Science: Climate Change Superhero

of needs that a plant has: sun, water, soil nutrients, space to grow, pollinators, etc... If they reach a stumbling block, ask them what they need as human beings, and then suggest that plants need some of the same things.

2. Generate a discussion of how different plants have adapted to different climates. Some thrive without summer rain, while others need to be constantly replenished with water. Still others are especially adaptable to a range of conditions. In this way, plants are very similar to humans. Some of us love the hot weather and full sun; some of us prefer cooler weather and rain. Some of us could live in the hot Sahara desert and others in the freezing cold Arctic. We have adapted to our local climates, just like plants.
3. Show the updated garden zone map to youth and talk about the implications of changing zones on plants and gardens. Explain that as global warming increases, these zones will shift even more. What are the implications of this shift?
4. Engage them in a discussion by prompting them with questions such as: Can palm trees grow here? Why not? What would happen if our current garden zone became warmer, like that of Florida? Could we grow palm trees then? If those palm trees grew here, what other plant species would those trees replace? Provide some examples of plants that thrive in both cooler and warmer climates and talk about the threat of invasive species encroachment with the rise in global temperatures.
5. How are plants connected to the cycle of animals? What is an example of an animal that might rely on plants at key times of the year? Did you know that some bird species change their dietary needs based on the time of the year, and what is available to them? How might the changing climate affect, for example, a songbird reliant on a tree species? Ditto the cycle of insects, which are accustomed to pollinate the plants at a certain time of year?
6. Ask youth to design their own "plant superhero" that would have important qualities and characteristics that help it adapt to a changing climate. For example, the superhero plant might have a special protective shield (like an umbrella!) for heavy rain spells. Or it might have a special inner storage unit (like camels!) to store extra water for weeks, in case of a heavy drought. Or it might have an extra thick lining (like a sweater!) to put on if there was a spontaneous frost in early summer.
7. Encourage them to think creatively: The key is to understand how plants are affected by the climate and how certain plants have developed qualities that help them to withstand spontaneous or erratic climatic changes.
8. Ask them to illustrate their plant superhero with the art supplies provided, and then to name it. After they are done illustrating their superhero, give each child a chance to show and describe their superhero to the group.

Science Checkup - Questions to ask to evaluate what was learned

- What is one thing about this activity that surprised you about climate change – something you had not thought about before?
- What were some of the most exciting adaptations you saw in people's superheros?
- Were there some questions you were curious about that you found an answer to? What were they?

Extensions

- Based on each young person's super hero adaptations, research whether there are indeed plants with those adaptations. Share your findings.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Plant Science: Climate Change Superhero

- Go further with other One Seed at a Time: Fighting Climate Change in the Garden resources and activities. <http://blogs.cornell.edu/garden/get-activities/signature-projects/climate-change-in-the-garden/>

Vocabulary

Climate Change: A change in the distribution of weather and weather events over periods of time. This change can occur from decades to millions of years. Climate change may be noted in a specific region, or may occur across the whole Earth.

Zone map: A hardiness zone map is a geographic area that outlines regions where plants are capable of growing. These zones are defined by climatic conditions, and are often associated with minimum temperatures.

Background Resources

- For the USDA zone map, please see: <http://www.arboday.org/media/zones.cfm>
- Visit Cornell Garden-Based Learning for more plant-based activities: <http://blogs.cornell.edu/garden>

Plant Science: Plan a Rainbow Garden

Activity Series:
Plant Science
Grade: 3-6
Time: 60-90 min.

Main Idea

Collaboration, an important element of science, can yield an approach that is typically more robust than an idea generated from one. The spirit of collaboration is more intentional than just “group work:” it ensures that each group member has a voice and contributes their best thinking.

Motivator

Collaboration, an important element of science, can yield an approach that is typically more robust than an idea generated from one. The spirit of collaboration is more intentional than just “group work:” it ensures that each group member has a voice and contributes their best thinking.

Pre-Activity Questions

Before you start the activity, ask the students:

- What are the colors of a rainbow?
- Why do flowers come in different colors anyway?
- What is the most appealing way to lay out a rainbow garden?
- How can we work together to use different ideas in a way that will yield the best result for *our* garden?

Activity

- Seed catalogues
- Scissors
- Paper
- Glue
- Seeds and seedlings
- Planting a Rainbow* by Lois Ehlert

1. Begin by asking students about the colors of a rainbow. Together, generate a list of them on the board or on newsprint (ROYGBIV: red, orange, yellow, green, blue, indigo and violet). Discuss vegetables, fruits, and flowers that could be planted to have all the colors of a rainbow represented in their garden. Add these to your list next to their corresponding color.
2. Read Lois Ehlert's book *Planting a Rainbow* as a group. Begin a discussion using some of these guiding questions as starters:
 - Why are flowers different colors? What is a pigment?
 - Why is being colorful beneficial to flowers?
 - What are the benefits of plant diversity in a garden?
 - What is the importance of biodiversity?
 - Why are fruits and vegetables different colors?
 - What nutritional properties are associated with colors?
 - Why is it healthy to eat a rainbow of colors of fruits and vegetables?
3. Ask which questions are interesting to the students as they begin the process of planning a rainbow garden.

Supplies

Objectives

- Learn concepts of color
- Connect plant colors to nutritional properties
- Work collaboratively to create a garden

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

Contributed By

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Plant Science: Plan a Rainbow Garden

4. Introduce the idea of collaboration, and how it differs from competition. With collaboration, people contribute their ideas, and through a group process, those ideas are considered, modified and finally, adopted. Each person has unique attributes, a special perspective, and without each person, something would be lost. With competition, there are “winners” and “losers.”
5. Explain that each group will be working in a collaborative team format. With collaboration, we begin with ground rules. The first ground rules are as follows:
 - Every idea is a good idea.
 - No put-downs.
 - Students will take about equal time listening and talking.
 - We will listen to all ideas.
 - If things get uncomfortable, we will pause to process what is happening, and consider how to best move past the tension.
6. Ask students if there are there other ground rules to add?
7. Hand out old seed catalogues, paper, scissors, and glue. Divide students into small groups, with only 3 – 4 per group. Ask each group to think about how to design a rainbow garden. All colors need to be represented, but the design is up to the group. Typically, rainbow gardens are planted in the order of ROYGBIV. Does this make the most sense for our garden, or could there be unique alternatives? Is there a different way to present the color spectrum?
8. Ask students to practice discussing and listening to different options. Have them list ideas.
9. If you overhear heated discussions about different options, help students to pause, take a deep breath, and consider: What will be easiest to plant and maintain? How will other people respond to the design? How can everyone be heard? How can we move past this challenge?
10. Process point #1: Sometimes in a group, the person who speaks the most “wins” or gets their desired outcome. How can we use this activity to consider ways to include all voices? What might be the benefit of understanding the point of view of someone who often isn’t heard?
11. Process point #2: Sometimes we think of tension as “bad” but it is part of the collaborative process. The trick is to slow things down, give everyone the opportunity to share, and consider alternatives, before moving on in the process.
12. After groups have explored options, ask them to draw a design on their piece of paper. Encourage each group member to work on the drawing. Ask groups to denote each color, which may be a stripe, block, etc., with photos of different vegetables, fruits, and flowers in the corresponding color cut out from the seed catalogues. *Note: When planting a food garden, the colors of the rainbow, because of the nutrients associated, are typically grouped as pink/red, blue/purple, brown or tan/white, yellow/orange, and green.*
13. After each group has completed their rainbow collages, ask them to share their rainbow garden design and talk about the process that they followed. You may want to ask each student to speak about his or her perspective, rather than ask for a reporter.
14. Next, each group will work together to select the vegetables, fruits and flowers they would like to plant in their color section of the garden. At this stage of the planning process, be sure to consider when each of the plants will be blooming and which part of the plant (fruit, leaf or flower) the students have chosen for their representation of color. Coordinating these things appropriately will ensure that there is a wide spectrum of plants in full bloom and in the appropriate color, so as to create a real rainbow effect. (This portion of the activity could develop into an extension if you are limited with time. You may want to set aside seed catalogs for this.)
15. Gather the groups together to review their work. At this point, you could: 1) Ask each group to create a master plan of the rainbow garden to scale; 2) Vote on one approach, and create a master plan collectively; 3) Post all designs and ask others to assist in voting with sticky dots, going with the design with the most votes or 4) Review all designs, and create a new plan that incorporates elements from each.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Plant Science: Plan a Rainbow Garden

Science Checkup - Questions to ask to evaluate what was learned

- What are the steps in the collaborative process?
- How do we ensure that every voice is heard?
- What is the link between collaboration and disciplines such as science and art?
- What are one or two interesting things you learned in designing a rainbow garden, from the plant perspective?

Extensions

- The most important extension is actually planting the garden!
- Gather and organize all the materials needed for planting the garden, such as the seeds and seedlings needed for planting each section of color. In addition to the nuts and bolts of gardening, as a group, you may need to do some organizing as well, writing donation letters, seeking specific plants from a diversity of sources, and so forth.
- Students can collect rocks to use as a border for the garden. Each group can paint their collection of rocks in their groups corresponding color. Before planting the rainbow garden with the students, have them place the painted rocks as a border for each section. This way, they will know where to plant and where to expect each color after the garden is beginning to bloom.
- Students can create an informational brochure or garden signage that tells about the nutritional benefits of the colors represented in the garden.
- Arrange a meeting with a local landscape architect to learn about how garden design, collaboration, and sharing master plans with the community are important parts of their job.

Vocabulary

Color (or visible) spectrum: The portion of the electromagnetic spectrum visible to the human eye. Electromagnetic radiation in this range of wavelengths is called visible light.

Collaboration: A creative process in which people work together toward a common goal. It usually involves leadership, learning and opportunities to build consensus.

Background Resources

- For more exciting activities like this one, visit Dig Art! Cultivating Creativity in the Garden: <http://blogs.cornell.edu/garden/get-activities/signature-projects/dig-art/activities/>
- What Color is Your Food? Taste a rainbow of fruits and vegetables for Better Health. North Dakota State University Agriculture and University Extension: <http://www.ag.ndsu.edu/pubs/yf/foods/fn595w.htm> and <http://www.ag.ndsu.edu/pubs/yf/foods/fn595.pdf>
- Visit Cornell Garden-Based Learning for more plant-based activities: <http://blogs.cornell.edu/garden>

Plant Science: Veggie Taste Test

Activity Series:
Plant Science
Grade: 3-6
Time: 30-60 min.

Main Idea

Gardens for young people often include salad greens, since they are easy to grow, and fit into short seasons, such as the school calendar. Broadcasting many tiny seeds usually creates too many seedlings in a small space. Removing the excess seedlings, called thinning, allows enough room for the remaining plants to grow. Rather than tossing the thinned seedlings on the compost pile, run a taste test to check out the flavors and other qualities of the lettuces and greens.

Motivator

"You should eat your vegetables!" If your first reaction to this command is *"Eww – they all taste bad!"* we have a surprise in store for you. Doing a taste test of young seedlings often reveals surprisingly subtle differences in flavors – and you might just like some of them! In addition, you can use a time honored garden practice called thinning as a way to help your garden thrive *and* yield bigger, fatter, tasty produce.

Pre-Activity Questions

Before you start the activity, ask the students:

- Who loves vegetables? Who thinks that they don't?
- Have you ever tasted different varieties of the same vegetable?
- Have you ever wondered how different varieties are developed?
- As you taste-test, what questions are you curious about?

Activity

- Greens
- Charts
- Pencils to record responses
- Glasses of water

1. First, assess the gardens to determine which lettuces and greens need thinning. (Although you will also need to eventually thin root vegetables like carrots and radishes, the thinning may not be large enough to eat at mid-season).
2. Demonstrate how to thin plants by removing individual seedlings according to packet instructions. Ask: why might the plants need this extra room? What is the big deal about thinning, why might this be a helpful practice from a growing perspective?
3. Begin the tasting by asking the group some of the pre-activity questions above.
4. Introduce the idea of plant breeding as an important science career. Imagine being responsible for having created the juiciest strawberry, the sweetest apple, or the biggest pumpkin! An important part of the breeding process is taste testing. At universities like Cornell, researchers may even pay people to participate in the tasting process.
5. Make a chart that lists all the variety names, as well as the

Objectives

- Learn about variety uniqueness
- Learn a garden technique called thinning
- Cultivate an interest in healthy food

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

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Plant Science: Veggie Taste Test

names of the youth in the group.

6. Decide on a rating system. You can rate each on a scale of 1 to 5, give a thumbs-up or thumbs-down, use different versions of smiley faces, or use an “ick,” “ok,” or “yum” rating. We offer an example below, and a blank chart.
7. Set a few ground rules for tasting so that everyone feels comfortable sharing their honest opinions. For example, try to keep the dramatic “Yuck” sounds to a minimum as this may make participants who do in fact like the variety feel “weird” or otherwise uncomfortable. A good basic rule is “Don’t yuck my yum.”
8. Rate greens one variety at a time. Taste, share your ratings one by one, and record on the chart.
9. Have water on hand to drink in between tastes.
10. Save your ratings chart and repeat the taste test at harvest time. Has anyone’s opinion changed? Has the taste of some greens improved or declined with time?

Sample Ratings Chart:

Name/Variety	Freckles	Red Sails	Spinach	Swiss Chard	Tango
Victor	yum	ok	yum	ok	ick
Anna	yum	ok	yum	yum	Ok
Terry	ok	ick	ok	yum	ok
Audrey	yum	yum	ick	yum	yum
Bruce	ick	yum	ok	yum	ick
Gia	ok	ick	yum	yum	ok
Yolore	yum	ok	yum	yum	ok
Hannah	yum	ick	yum	yum	ick
Yuuki	yum	ok	ok	yum	ok

Blank Ratings Chart:

Varieties to the right and names below:					

Find this activity and more at: <http://nvs4h.cce.cornell.edu>

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Plant Science: Veggie Taste Test

Science Checkup - Questions to ask to evaluate what was learned

- Why is it important to thin crops such as lettuce?
- Did you detect differences in flavor? Can you describe them?
- What connections did you make between this activity and a career?
- Did you get some answers to questions you were interested in?

Extensions

- Try taste tests of other vegetables and fruits. A strawberry tasting at the height of strawberry season is delicious, and very informative, since the differences in aroma, flavor, and acidity are very noticeable.
- Investigate other differences in crops, in addition to taste. Are there subtle (or not so subtle) differences in yield, color, height, and so forth?
- Contribute what you learn to <http://vegvariety.cce.cornell.edu/>

Vocabulary

Thinning: Removing the excess seedlings to allow enough room for the remaining plants to grow.

Background Resources

- For a project that includes this and many more activities like it, visit Seed to Salad at: <http://blogs.cornell.edu/garden/get-activities/signature-projects/seed-to-salad/>
- Visit Cornell Garden-Based Learning for more plant-based activities: <http://blogs.cornell.edu/garden>

Canaries of the Pond and Stream

Activity Series:
Water
Grade: 3-6
Time: 20-60 min.

Main Idea

Youth will explore ponds and/or streams to collect and identify the various species living there. The diversity of organisms found in an aquatic environment is an indicator of habitat quality and overall environmental quality. The presence or absence of certain macroinvertebrates (large organisms that don't have backbones, such as insects) tells us something about the health of the aquatic ecosystem.

Motivator

Because canaries are more sensitive than humans to dangerous gases in the air, coal miners used to take them into mines to measure air quality. Their death indicated when the air was not safe to breathe. Aquatic organisms can play a similar role because the absence or presence of certain species can indicate water quality.

Pre-Activity Questions

Before you start the activity, ask the students:

- What is biological diversity?
- What might a high or low diversity of life suggest about a habitat?
- What environmental conditions are important for organisms to survive in an aquatic environment?
- How can you minimize your impact on the environment (stream banks, spawning sites, vegetation) when collecting?

Activity

For Each Team:

- Ice-cube trays or shallow white-bottomed pans
- D-nets
- Plastic spoons
- Magnifying glasses or bug boxes
- Identification charts

1. Head to a pond or stream. Divide your group into pairs and provide each pair with some collection gear and identification books or charts.
2. Demonstrate collection techniques with the D-net or scoop nets.
2. Allow pairs to collect their own samples and observe collected specimens. How many different kinds of specimens did each group collect?
3. Record findings and discuss what everyone found.
4. Combine everyone's observations and decide how you would rate the quality of the ecosystem.
5. Demonstrate how to return the contents of a pan to the pond or stream and have everyone do the same with their collections.
6. Travel to another location and collect again. Compare results.

Supplies

Objectives

- Learn how to safely observe and collect aquatic macro-invertebrates
- Use diversity indexes to classify the health of aquatic ecosystems

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Water: Canaries of the Pond and Stream

Science Checkup - Questions to ask to evaluate what was learned

- What does biodiversity mean?
- How does biodiversity relate to the health of the water?
- Explain how water quality can be good for one creature and bad for another.

Extensions

- Conduct some chemical or physical tests to measure water quality (pH, dissolved oxygen, speed, temperature, depth, etc.).
- Visit your pond or stream several times throughout the year to discover changes in the stream. Be sure to use physical and biological tests in your investigations. What changes do you notice?
- Keep written records of your work so that your group (or a different one) can compare results in the future.

Vocabulary

Aquatic: Pertaining to water.

Biological Diversity: Variety of different species.

Biomonitoring: Determining the health of an aquatic ecosystem by taking a count of the number of different types of living organisms and their tolerance to pollutants.

Macroinvertebrates: Organisms, without a backbone, large enough to be seen without a microscope.

Water Quality: A measure of the health of a water body. This can be measured with chemical, biological or physical parameters.

Background Resources

- [Water Project Unit 3: Water Quality Matters](#), Joy R. Drohan, William E. Sharpe, Sanford S. Smith, Penn State University, 2004
- [Water Worlds](#), Experience 4-H Natural Resources Series, Janet E. Hawkes, Kurt Jirka, Marianne Krasny, Diane Held Phillips, Cornell Cooperative Extension, 1988
- [Pond and Stream Safari](#), Experience 4-H Natural Resources Series, Karen Edelstein, Cornell Cooperative Extension, 1993
- The Stream Study, <http://people.virginia.edu/~sos-iwla/Stream-Study/Key/MacroKeyIntro.HTML>, A very nice key to identifying macroinvertebrates can be found on this Web site. Very useful if you can take pictures of your organisms or if you can bring a laptop into the field, Website Manager Rick Webb, Department of Environmental Sciences, University of Virginia, Charlottesville, Va.

Water: Fishy Food Chains

Activity Series:
Water
Grade: 3-6
Time: 20-60 min.

Main Idea

Pollutants can be transferred through food chains, eventually ending up in the food that people eat. At each level of the food chain, the concentration of chemical pollutants gets higher. Scientists call this biological amplification. Youth will simulate the transfer of chemicals through a food chain and discuss the impacts of pollutants on the health of organisms.

Motivator

Cut and separate the two fish advisory signs from the New York State Department of Health at the end of this packet. Show youth the signs. These signs make it clear where you can and cannot fish. What if there were no signs? How could you tell if a place was safe to fish? How could you know if a fish you caught was safe to eat?

Pre-Activity Questions

Before you start the activity, ask the students:

- Who catches fish? Who eats fish?
- How do you know it is safe to fish at a location? (There are signs that say you can fish, the water looks good, others are fishing there)
- When might you choose not to fish at a location? (The water looks bad, there's a bad smell, a sign says not to)
- Can you think of reasons why you might not eat a fish you caught? (If it was deformed, diseased, already dead, etc.)

Activity

- 250 feet of yellow nylon rope
- 100 feet of white nylon rope
- Five fishing hats or vests
- 40 copies of sunfish handout (attached)
- Whistle
- Copies of the most recent New York State Department of Health publication "Health Advisories for Chemicals in Sportfish and Game." Available at <http://www.health.state.ny.us/environmental/outdoors/fish/fish.htm>

1. On the back side of five sunfish, write "I ate mercury." On another five, write "I ate pesticide." On another five, write "I ate PCBs." On the other five, write "I ate dioxin." Leave the remaining sunfish blank. If your group is larger than 15, copy extra fish, with half being "contaminated".
2. Fold the fish in half so the words are hidden inside. Secure with tape or hook and loop fastener to seal.
3. Divide the class into two groups depending on size of group. In each group, two to five students should be fisherpersons (who will wear vests or hats), the rest of the students will be bass.

Supplies

Objectives

- Learn how pollutants are concentrated as they move through the food chain
- Discover that some pollutants are not easily detected, but can still be present

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
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- Summarize
- Invent
- Interpret
- Categorize
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- Troubleshoot
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- Optimize
- Collaborate

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Water: Fishy Food Chains

4. Rope off a large area with the yellow rope. This will represent the lake in which the bass will feed. Scatter the paper sunfish around in this area.
5. Rope off another section with the white rope inside the boundary made by the yellow rope. This area will represent a boat and must be large enough to accommodate five fisherpersons and at least 10 bass.
6. Blow the whistle to tell the bass to start feeding. They are to gather (“eat”) as many of the paper sunfish as possible.
7. After approximately 30 seconds, blow the whistle again. The fisherpersons are now allowed to start fishing for the bass (the bass may continue feeding on the sunfish while trying not to get caught).
8. The fisherpersons must tag one bass at a time and bring it back to the boat for storage before they head back into the lake to catch another bass. Each fisherperson can catch only two bass so that some bass will remain in the lake at the end.
9. When the fisherpersons have caught their limit, blow the whistle to stop the game.
10. At this point, have the bass and fisherpersons open the sunfish that they have “eaten” / caught to see if they were healthy or contaminated. If more than half of the sunfish are contaminated, the bass are not safe to eat.
11. Any bass that were not caught should look at their sunfish. If more than half of their sunfish are contaminated, the bass are now considered dead.
12. Talk with the group about what they experienced.

Science Checkup - Questions to ask to evaluate what was learned

- How does a food chain work?
- How might chemicals enter and affect food chains?
- What precautions should you take when consuming fish? (Clean and cook properly, read guidelines for how many to eat safely.)
- What factors might determine if chemicals harm an organism? (size, age, overall health, pregnancy, etc.)

Extensions

- Examine the New York State Department of Health publication “Health Advisories for Chemicals in Sportfish and Game.” Discuss why this publication is important and what information it contains.
- Have the youth research the story of how PCBs affected the health of bald eagles. PCB’s had a terrible effect on these birds that led to the banning of this chemical. Are there other chemicals or toxins that are now banned from use? (Fishing weights are now made of zinc. Why?)

Vocabulary

Bioaccumulation: The build-up of chemicals that don’t break down or break down very slowly in the body.

Biological Amplification: The increase in concentrations of chemicals in organisms at successively higher levels of a food chain.

Dioxin: A highly toxic chemical formed as an unintentional by-product of many industrial processes involving chlorine, such as waste incineration, chemical and pesticide manufacturing and pulp and paper bleaching. Dioxin was the primary toxic component of Agent Orange, a herbicide that made many Vietnam War veterans sick.

Food Chain: A series of organisms that survives by eating the preceding one.

Mercury: A naturally occurring but toxic metal that can be absorbed directly from the water or from eating

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Water: Fishy Food Chains

other organisms that have absorbed it.

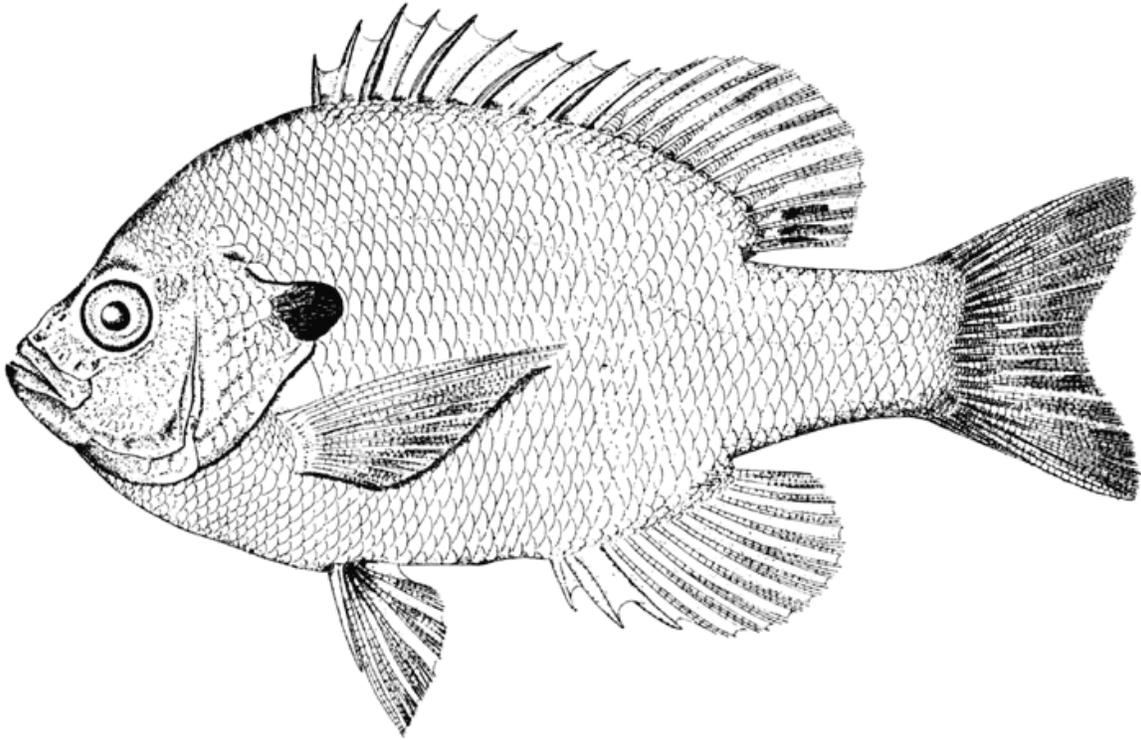
PCBs: Man-made chemicals that were used in electrical products until banned in the mid-1970's. These chemicals accumulate in the fatty tissues of organisms.

Pesticide: Any chemical designed to kill or slow the growth of an organism that people consider to be undesirable.

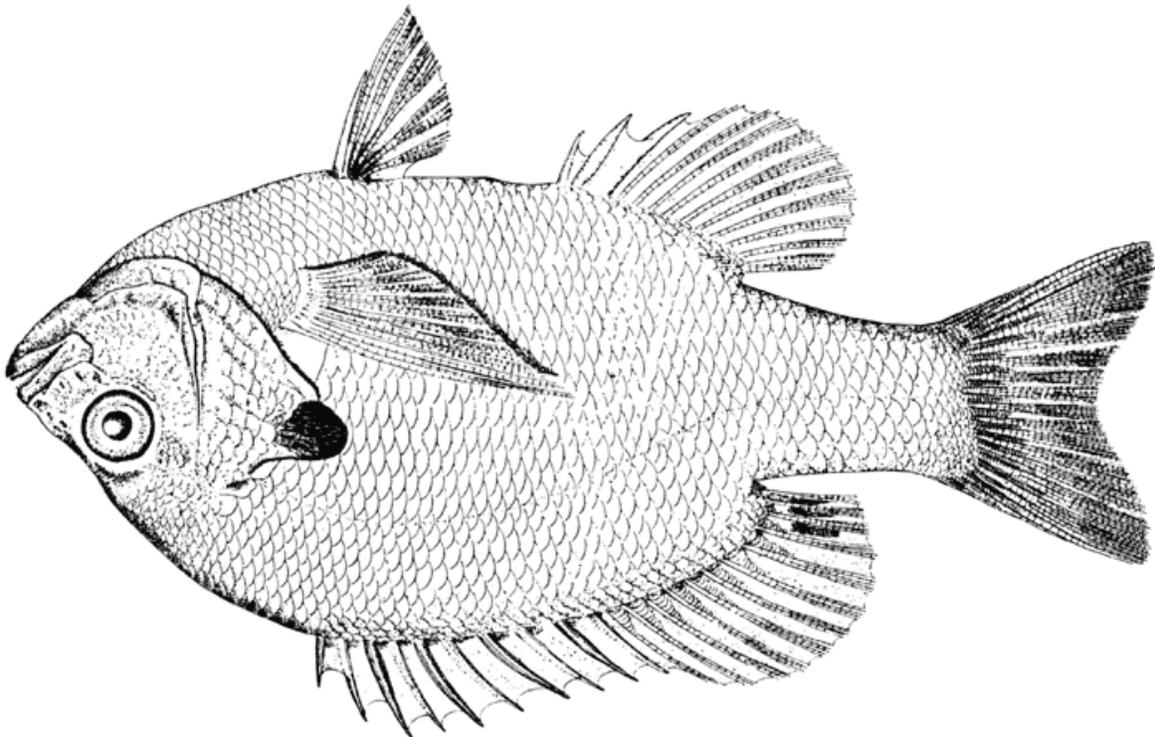
Background Resources

- Signs can tell us where a location is safe to fish. Signs don't always tell us if the fish themselves are safe to eat. Some fish may take in contaminants from the water where they live and/or the food that they eat.
- Chemical pollution, such as pesticides and heavy metals, enter food chains at the level of plants and microorganisms. Over time, the chemicals can become concentrated in the bodies of wildlife and people that consume them because the chemicals do not pass out of their bodies but accumulate in them.
- These chemicals are passed on through the food chain in a process called biological amplification. Moving up the food chain, higher order organisms accumulate greater amounts of the pollutants in their bodies because they eat more. The greater the number of contaminated organisms they eat, the more chemicals their bodies are collecting and storing. These chemicals may make organisms – including people – sick.
- Water from rivers and lakes are tested each year to determine the amount of harmful chemicals and pollution present. Fish are also tested, to determine the quantity of chemicals their bodies contain. A guide is then written to help people know how many fish can be safely eaten from the water that was tested.
- **This activity is not mean to scare people from eating fish.** Be sure to discuss the health benefits of eating fish and the means of reducing exposure to unwanted contaminants by following guidelines in annual fish advisories.

Water:
Fishy Food Chains



Fold paper here

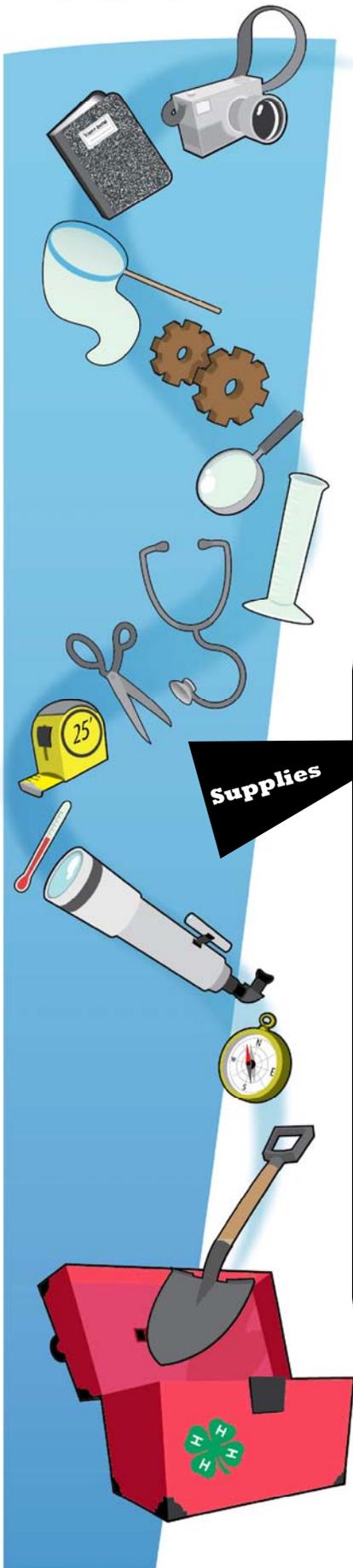


Water:
Fishy Food Chains



Water: Take a Water Vacation

Activity Series:
Water
Grade: 3-6
Time: 60 min.



Main Idea

All the water on the Earth has been here since the beginning of time. Students will gain an understanding of the water cycle and how water flows from place to place on the Earth.

Motivator

Hold up a glass of water. Tell the students that the water in the glass is the same water that a dinosaur once drank and then urinated onto the ground. Then drink the water.

Pre-Activity Questions

Before you start the activity, ask the students:

- Where does water come from?
- Where on Earth can you find water?
- What forms does water come in?
- Is it possible to destroy water?

Supplies

Activity

- A sign for each of the seven water stations
- Seven empty wide-mouth plastic jars or large envelopes, one for each station
- Copies of water station cards

For each Team:

- Clipboard
- Paper
- Pencil

1. Create a poster or sign for each of the seven water stations: cloud, glacier, groundwater, ocean, animal, plant and river.
2. Cut the station cards into strips and place them in the jars or envelopes at the stations set up around the area.
3. Divide the students into no more than seven teams. Explain that during the following activity they will become a water drop and travel around the earth on a vacation. Each group may start at any place they wish.
4. Since every drop will take a different trip, students need to record the places they visited. First, each group chooses a station card strip from the container at their station. Record that information on their clipboard then return the strip to the container. The strip will tell them which station to visit next. Move to that station.
5. Repeat step 4 at 10 to 12 stations.
6. When the activity is finished, compare the stations the students visited. You may want to make a large chart so students may see where other groups went and compare paths.

Objectives

- To simulate the motion of a water drop through the water cycle
- To gain an understanding of the way water moves across the Earth

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate
- Compare

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Water: Take a Water Vacation

Science Checkup - Questions to ask to evaluate what was learned

- What three phases does water exist in on Earth?
- Explain the water cycle and the three parts.
- Can water leave the water cycle?
- Why doesn't the ocean dry up like puddles do?

Extensions

- Have the students write a water story that follows their journey through the water cycle. Use the first-person narrative from the point of view of a water drop. For example "There I was, just bobbing in the ocean when I began to feel funny. I evaporated up into the sky and then joined thousands of other drops in a huge cloud..." The students can each read their stories and others can identify the ways water has moved through their story, through evaporation, precipitation, etc.
- Do some research to find the percentage of the world's water that is found in the ocean, clouds, ground-water, ice, etc. Try to reduce the ratio down to a 5-gallon bucket. How much of the world's water is available for us to use for drinking?
- Have the students fill out the interactive diagram at this Web site: http://education.jlab.org/reading/water_cycle.html

Vocabulary

Condensation: The phase change of water from vapor to liquid.

Evaporation: The phase change from liquid to gas.

Liquid: The phase of water when its temperature is between 32°F (0°C) and 212°F (100°C).

Precipitation: The condensing of water from a cloud. Rain, snow, hail.

Solid: The phase of water when its temperature is below 32°F (0°C).

Sublimation: The phase change from solid to vapor, without becoming liquid.

Transpiration: The evaporation of water from the surfaces of plants or animals.

Vapor: The phase of water when its temperature is above 212°F (100°C).

Water Cycle: The pathway of water through its environment.

Water Phases: The form of water based upon its temperature — liquid, solid or vapor.

Background Resources

- Water Wise, Lessons in Water Resources, Elizabeth C. Moran and Marianne Krasny, Illus. Steve Sierigk, Cornell Cooperative Extension, 1989.
- Water Project Unit 2: Incredible Water, Joy R. Drohan, William E. Sharpe, Sanford S. Smith, Penn State University, 2002.
- Jefferson Lab Reading Comprehension Passages, Thomas Jefferson National Accelerator Facility, 10/01/08, http://education.jlab.org/reading/water_cycle.html
- Project Learning Tree Environmental Education Activity Guide "Water Wonders," American Forest Foundation, 1995.
- Project WET Curriculum and Activity Guide, "The Incredible Journey," The Watercourse and the Council for Environmental Education, 1995

Water:
Take a Water Vacation

Water vacation station cards

Cut apart, fold in half and place in each station's container.

Station 1- Glacier

Go to Groundwater

Go to Ocean

Go to Ocean

Go to Cloud

Go to River

Stay at Glacier

Stay at Glacier

Station 2- Ocean

Go to Cloud

Go to Cloud

Go to Cloud

Stay at Ocean

Stay at Ocean

Stay at Ocean

Station 3- River

Go to Ocean

Go to Groundwater

Go to Animal

Go to Cloud

Go to Ocean

Stay at River

Station 4- Cloud

Go to Ocean

Go to Ocean

Stay at Cloud

Stay at Cloud

Go to River

Go to Groundwater

Water:
Take a Water Vacation

Water vacation station cards

Cut apart, fold in half and place in each station's container.

Station 5- Groundwater

Go to River

Go to Plant

Go to Plant

Go to Ocean

Go to Ocean

Stay at Groundwater

Station 6- Plant

Go to Cloud

Go to Cloud

Go to Cloud

Go to Animal

Go to Animal

Stay at Plant

Station 7- Animal

Go to Cloud

Go to Cloud

Go to Groundwater

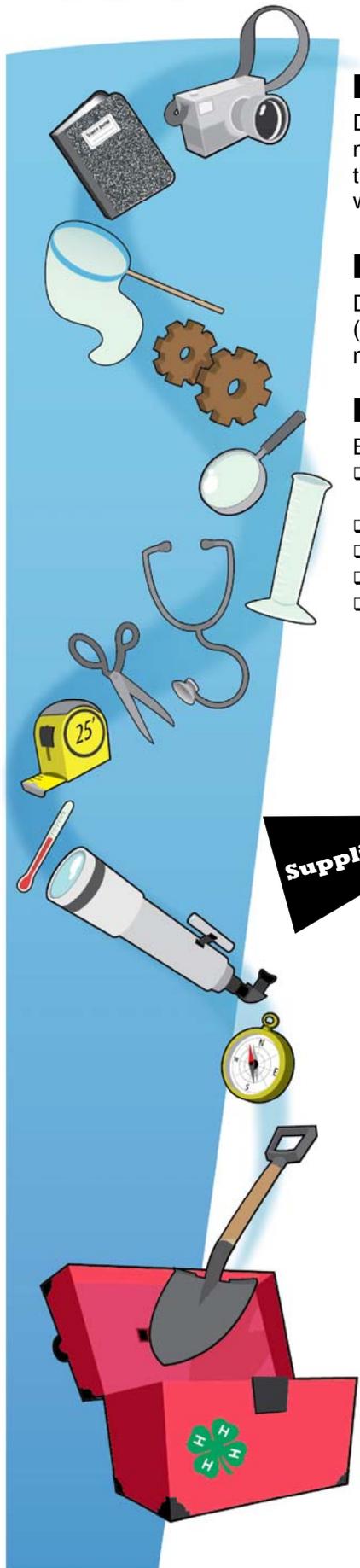
Go to Groundwater

Go to River

Go to River

Water: Won't you be my Neighbor?

Activity Series:
Water
Grade: 3-6
Time: 45 min.



Main Idea

During this activity, youth will help to clean up a water supply contaminated with a variety of non-point source pollutants. They will experience the many steps, challenges and expenses involved in the purification of water, then discuss pollution prevention and alternatives to pollutants.

Motivator

Drink a glass of clean water and talk about how refreshing it is. (Aaaahhh!) Then introduce yourself as Iggy, their new next-door neighbor.

Pre-Activity Questions

Before you start the activity, ask the students:

- What is the difference between point and non-point source pollution? Give examples.
- What substances can pollute our surface and ground water?
- How is the water that we drink purified?
- What does a water treatment device do?
- How many of you have water treatment devices at home?

Activity

- A five-gallon bucket for every four-five students.

Pollutants:

- ½ cup vegetable oil
- 1-5 drops food coloring
- 2 teaspoons sand/gravel
- 5 drops dish detergent
- One handful of leaf litter
- 1 teaspoon salt
- Trash (bottle caps, Styrofoam, etc.)

Clean-up Apparatus:

- One piece of screen (15cm square)
- Cotton facial pads
- Funnel
- Eye dropper/turkey baster
- Paper towels
- Empty plastic or metal pan

1. Divide youth into groups of four or five.
2. Provide each group with a 5-gallon bucket about half full of water and explain that the bucket contains their drinking water supply.
3. Introduce yourself as a new neighbor who is just moving into town and act out the following scenarios.
4. "My house is still under construction. I notice that there seems to be a lot of soil in the street around it." (Walk around and dump a load of sand or gravel into each

Supplies

Objectives

- Learn about non-point source pollution and how to prevent it
- Learn how different materials can help remove water contaminants

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

- Predict
- Hypothesize
- Evaluate
- State a Problem
- Research Problem
- Test
- Problem Solve
- Design Solutions
- Develop Solutions
- Measure
- Collect Data
- Draw/Design
- Build/Construct
- Use tools
- Observe
- Communicate
- Organize
- Infer
- Question
- Plan Investigation
- Summarize
- Invent
- Interpret
- Categorize
- Model/Graph
- Troubleshoot
- Redesign
- Optimize
- Collaborate

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Revised by

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Water: Won't you be my Neighbor?

- bucket.)
5. "Now that my house is finished, I am putting in my lawn. I am using extra fertilizer so that my grass grows very fast and is very green." (Walk around and squirt green food coloring into each bucket.)
 6. "When I do my yard work I simply blow my grass and leaves into the street." (Walk around and dump leaves and organic debris into each bucket.)
 7. "My lawn mower is in need of an oil change. I am not sure what to do with the used oil. I usually just pour it in the gutter." (Walk around and squirt some oil into each bucket.)
 8. "My car needs to be washed. This soap produces so many bubbles. I am glad that they just run down the driveway." (Walk around and squirt dish detergent into each bucket.)
 9. "In the wintertime, I like to salt my sidewalks and the driveway so that I don't slip and fall." (Walk around and dump some salt into each bucket.)
 10. "I lost the lid for my garbage can. On windy days garbage tends to blow away." (Walk around and drop small pieces of trash in the buckets.)
 11. "It looks like rain today. I am glad because my yard sure could use the water." (Walk around and stir each bucket with a spoon.)
 12. Ask each individual how they feel about their new neighbor and what they think about their water.
 13. Ask each group to begin the clean-up process. Here are some hints:
 - Use the screen as a filter for the large objects.
 - Put the facial pads or paper towel in the funnel and pour the water through to filter out the smaller particles and some of the non-soluble liquid contaminants.
 - Dab the surface of the water with the cotton or paper towels to absorb some contaminants.
 - Dump the contaminants into the empty jar or pan.
 - Suck out oil particles and small bits with the eye dropper.
 - The pint of water is to illustrate/demonstrate dilution, and can also be used as a control.
 14. Bring all of the groups back together and ask how clean they think their water is. Discuss how there are still pollutants in it that you cannot see. Ask them if they would want to drink, swim in or fill their fish aquariums with this water.

Science Checkup - Questions to ask to evaluate what was learned

- How clean is the water?
- Which pollutants were the easiest to remove? (Solids)
- Which were the most difficult to remove? (The substances that dissolved in the water — food coloring, salt, soap — pose the greatest problems for clean-up).
- How long did it take to pollute the water?
- How long did it take to clean it up?
- What could Iggy do to prevent his pollution problems?

Extensions

- Keep track of the materials each group needs to clean their water. Use play money to charge groups for materials. Judge the cleanliness of the water and factor in how costly the clean-up was for each group.
- Try the activity "Soil as a Filter" on page 49 of "Water Wise: Lessons in Water Resources" listed in the Background Resources section.
- Demonstrate the use of charcoal as a filter. Place two coffee filters in a funnel and fill it with well-rinsed charcoal (available where aquarium supplies are sold). Take one of the group's "purified" water supplies and slowly pour the water through the charcoal filter. The charcoal will absorb some of the dissolved pollutants.

Find this activity and more at: <http://nys4h.cce.cornell.edu>

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Water: Won't you be my Neighbor?

Vocabulary

Dissolve: Mixing particles into a liquid to the point that no individual particles are left.

Non-point source: Large or widespread areas such as parking lots and croplands that discharge pollutants into the environment.

Purification: The process of removing impurities.

Background Resources

- Water can easily become polluted by human activities. Unfortunately, it is not as easy to purify the water. Care must be taken to protect water quality. Some pollutants enter water from a localized, identifiable source, or **point source**, such as discharge from a factory. **Non-point sources** of pollution are those that come from large, dispersed land areas such as parking lots or lawns.
- The science of treating water to remove pollutants is continually evolving with the invention of new methods and technologies. Today's processes are costly, complicated and imperfect, yet necessary as humans continue to rely on pollution clean-up instead of pollution prevention.

Evaluation

So, What did you think?

Our motto in 4-H is “to make the best better”. In order to do that, we need your feedback and thoughts. Please take a moment to complete the following for each activity you have tried. This form can be completed by using this form or the on-line version.

Which Activity did you try? _____

Please tell us about what you thought: (Circle a number for each statement).

	Strongly Disagree		No Opinion		Strongly Agree
I was interested in this activity	1	2	3	4	5
I learned something from this activity.	1	2	3	4	5
The materials were easy to use.	1	2	3	4	5
It was clear what I was supposed to do.	1	2	3	4	5
I would tell a friend that they would like it.	1	2	3	4	5

What did you like the most?

What didn't you like?

Other comments:

Please return this form to:

Conell Cooperative Extension 4-H Youth Development
340 Roberts Hall
Ithaca, NY 13118

Or complete it on-line at:

