Lesson 1
Introducing Biodiversity

Timeframe

1 Fifty minute class period

Target Audience

Middle School (6-8) Life Science but easily adapted to Grades 4-12

Materials

- Insect biodiversity cards
- 12-oz yellow plastic bowls
- Unscented dish detergent
- A tin can or plastic cup
- Piece of wood or cardboard (to cover "pit trap")
- 2-liter bottle
- LED camp light
- Small stake and stapler (for "Research In Progress" signs)

Contact:
SMILE Program
smileprogram@oregonstate.edu
http://smile.oregonstate.edu/

Description

In this activity students will set up a variety of insect collection traps in order to spend some time thinking about biodiversity, where species are found (and why), and how scientists go about collecting and cataloguing it. Students will set insect traps in at least 3 different habitats around their school and school yard in order to compare and contrast findings.

Objectives

- Differentiate characteristics of organisms
- Record and share observations
- Explain the purpose of collecting data and why biodiversity matters

Guiding Questions

- Why is biodiversity important? How can data collection help us learn about local biodiversity?

Teacher Background

Biodiversity means the variety of life, in all its forms. It includes the variety of species and ecosystems (communities and interrelations of species) in the world, and also the variation that exists between individuals within a species.

Invertebrate animals, or animals without backbones, represent the largest and most diverse group of animal species on the planet. Representing over 35 phyla (the largest generally accepted groupings of animals with similar evolutionary traits), these include an astonishing diversity of creatures, including worms, slugs, jellyfish, corals, butterflies and sea stars, to name a few.

The Arthropods (meaning jointed foot) include the largest and best known of the invertebrates: the insects, crustaceans and spiders.

Over 1 million species of insects have been described, but current estimates of total insect diversity range from 2.6-7.8 million species. Beetles (Coleoptera) make up 40% of described insect species, but some entomologists suggest that less well-known groups, including the flies, wasps, bees and ants, could be just as diverse, if not more so.

There are many reasons why humans might value and depend on biodiversity. The pollination of domestic crops by bees and other animals is vital for agriculture. Humans also depend on a variety of undomesticated plant and animals, including insects for the development of a new medicines capable of battling incurable diseases. Beyond these ecosystem services, we can also appreciate the 'aesthetics' of biodiversity and recognize that we are one of many different creatures on Earth. People find pleasure in the natural environment and even just the sight of a butterfly can make us stop and notice 'beauty' or 'pattern' in our world.

You can collect insects from almost anywhere. The more places you look, the more types of insects you can find. The only major ecosystems where you'll find virtually no insect diversity are the world's oceans, scientific puzzle that has yet to receive a definitive answer! You can increase your chances of finding different insects by using different collecting methods.

A common collecting method is using pitfall traps. A tin can, or similar container, is sunk into the ground so the top is even with the ground. A small hole is drilled into the bottom to prevent water from accumulating. A piece of old fruit or similar bait is used to attract insects. A piece of wood is put over the top to make it more difficult for insects to escape. Insects walking on the ground fall into the container and become trapped. (Note, this is also the way that small mammal ecologists trap shrews! Shrews are insectivores and get caught when they try to catch the trapped insects.)

Yellow pan traps are a method for catching airborne insects that uses small yellow dishes filled with water mixed with a little detergent. The dishes are placed on the ground to mimic flowers, and when flying insects land on the surface of the water they rapidly sink (the dish soap reduces the surface tension of the water.) The

Next Generation Science Standards

DISCIPLINARY CORE IDEAS:

LS2.A: Interdependent Relationships in Ecosystems

PERFORMANCE EXPECTATIONS:

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

PRACTICES:

Practice 1: Asking questions and defining problems

Practice 2: Developing and using models

Practice 3: Planning and carrying out investigations

CROSSCUTTING CONCEPTS:

- Patterns
- Systems and systems models
- Structure and function

water is strained through a fine sieve to retrieve the specimens, which must then be dried to preserve them.

Another good method for collecting g insects is to go out at night around lights. You can build and use a light trap to catch them, or spend some time standing beside a light with a hand net.

Activity Introduction

1. Tell students that they will explore the diversity of life within terrestrial invertebrates (insects) and prepare for sampling within various habitats.
2. Write the word biodiversity on the board, with "bio" in a different color than "diversity." Ask students to discuss this word in pairs what we mean by biodiversity (possible response: "bio" means life, and "diversity" means different; biodiversity means the variety of life on Earth.) Explain that there is a great deal of diversity on Earth, and that diversity is all around them (estimated 7 million species on earth with only 1.7 million identified) including in the insect world. Ask:
   - How many insects live in your house? (Ants? Spiders? Mites? Flies? Fleas?)
   - How many live in a meadow? Or in a pond? A forest? A field?
   - Are there any places on earth with few or no insects? [really cold places or the ocean]
3. Let students know that they will be focusing on the biodiversity within insects. Pass out insect biodiversity cards and have students works in pairs to observe and discuss the features, characteristics, or traits, that make different species unique. Ask: What features do the insects have in common? What features make them different from the each other?

Activity

1. Explain to students that they are going to choose a familiar habitat (grass, forest, classroom/house, urban, etc.) and to select an area within it to collect insects. Ask: What can we learn by studying a single habitat and the organisms who live in it? What habitats might we expect to be more "interesting"? Why? (Is more diversity, or are more insects, necessarily better than fewer? What about the rare, but super unique species that lives all by itself in its own habitat?)

2. Tell students that they will use observation skills to select a location within a specific habitat to conduct their collection. They will then set multiple traps to help complete an inventory of the area. Let students know that insects are everywhere and are often encountered in homes, yards, around building foundations, basements, crawl spaces, flower or vegetable gardens (that are not heavily sprayed with pesticides), around lights at night, near streams and lakes, abandoned fields, parks, and forests. Many insects hide underneath things in the day – under stones, under

logs, under leaves. Let them know that many types of insects prefer to live at the borders between habitats, but that in this lesson we'll be focusing on those in the middle of the habitat. Insect collecting can be an excellent way to learn more about their incredible diversity. It can also be a good excuse to explore a variety of different habitats, even places that you might not have even noticed before you started thinking about where to find insects.

3. Go over the habitats where students will be collecting organisms and have them brainstorm some of the methods that scientists might use to collect insects from that habitat. Assign students to a sampling team (2 students per team) and let them choose from a least 3 different habitats which one to sample in.

4. Let students know that they are going to use different traps to collect organisms: "yellow pan", "pitfall", and "light" traps (feel free to use others if you, or the students, can think of any!). Go over each collection method with the students and provide a general overview of how to build each trap (see handout).

5. Have students break into their habitat teams and prepare their traps (you might only build one light trap per class and rotate it through the various habitats). Distribute materials and the "Building Insect Traps" handout.

6. Once the students have finished preparing their traps, send them to their collection sites. Make sure that they have notebooks for recording observations. Give students the following guidance:

- For about five minutes, sit silently and with minimal movement to observe your surroundings.
- In your notebooks:
    - draw a general map of the habitat;
    - draw or describe in words any things you see, hear, or smell;
    - take notes on any living organisms you notice or see.

7. Based on student observations have them choose an area of the habitat that they think would be good for collecting insects. Tell them to place their traps and note the specific locations on their maps so that they will be able to find them again. Tell students to place a "Research in Progress. Please do not disturb." sign next to each of their traps.

8. Tell students that, if possible, they should check their traps every day and preserve any specimens they trapped in rubbing alcohol. Let them know that they will compile all of the data (insects) from each habitat during their next group meeting.

Discuss

Have students share the observations they made in their different habitats. Discuss:

- What organisms do you expect to find in your habitat?
- Which habitat would you expect to have the highest diversity
- Discuss the difference between the total abundance of organisms versus the number of different species.

Extension

To introduce students to insects and the habitats they live, have them do the "Insect Tea Party" activity. You might also choose to do this at the end of the unit to get them thinking before they jump into analyzing their own data.

Resources

http://nationalgeographic.org/activity/introducing-biodiversity-and-bioblitz/

http://oregonexplorer.info/content/insects-and-invertebrates-0

https://www.amentsoc.org/insects/biodiversity/what-is-biodiversity.html

http://www.extension.umn.edu/youth/mn4-H/projects/environment/entomology/collecting-and-preserving-insects/

THANKS TO THE FOLLOWING CONTRIBUTORS:
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Dan Preston
Christopher Marshall

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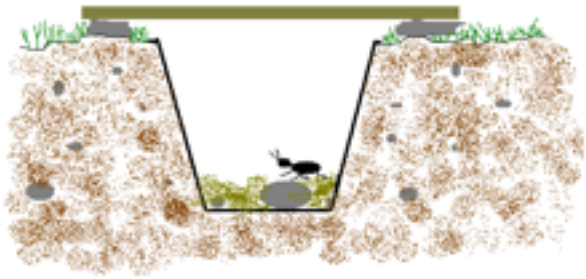
Building Insect Traps

Yellow Pan Trap

1. Prepare the solution for trap.
   - Recipe = 4 teaspoons salt and 5 drops of detergent per 1-liter bottle.
   - Place "yellow pans" in sample location and fill to ½ inch depth with solution.

Pitfall Trap



1. Dig a hole in the soil.
2. Take a tin can or a disposable plastic cup.
3. Poke a small hole in the bottom of container for drainage.
4. Dig a small hole in the ground.
5. Place container in a hole so that its rim is level with the soil surface.
6. Place a piece of old fruit in the bottom.
7. Cover the trap with a lid raised a little above the ground using a couple of stones so that the insects can crawl underneath.

Light Trap

1. Make a collection bucket using the bottom half of an empty 2 liter soda bottle.
2. Make the funnel out of a piece of poster board and reinforce the top with duct tape.
3. Attach to the funnel to the collection bucket with duct tape.
4. Attach string to funnel at 3 points and connect to LED camp light (ideally 500- 600 nm wavelengths).

Collecting Specimens

1. Check all traps daily for specimens.
2. Write labels in pencil (not ink) that include group name, date, and the trap type and location.
3. Wet specimens from "yellow pan" traps can be placed in a glass jar with a 70% alcohol (e.g., ethanol) solution.
4. Dry specimens such as moths, butterflies, mosquitoes, moth flies, and other groups with scales and long, fine hairs on the wings or body may be damaged if stored in alcohol. They should be placed in a glass jar with lid and placed into a freezer.
5. Make sure that all collection jars are labeled, both with a paper label inside and on the outside.

Research in Progress

Please do not disturb

Banded Alder Borer

(Rosalia funebris)

I am one of many kinds of bark beetles in the forest. As a larva I feed on dead, dying, or decaying wood. These activities are important for wood decomposition.

I spend most of my 1-3 years as a larva. After pupating, I emerge as an adult (my photo shown here) and feed on flowers or other plant parts for a few days to months.

Image by Susan. Banded Alder Borer. Digital image. What's That Bug? N.p., 8 Sept. 2012. Web. 26 July 2016.

Snowberry Clearwing Moth *(Hemaris diffinis)*

I am one of the large moths of the Sphinx family. Members of this family are know for their strong flying skills. These skills, along with my clear wings, long hair, and large size, cause many individuals to mistake me for a bee or even a small bird!

As a caterpillar, I am bright green and have a large horn that only looks dangerous. I feed on plants while I'm young, and once I mature I drink nectar using my proboscis.

Image by Naturally Curious with Mary Holland (https://naturallycuriouswithmaryholland.wordpress.com)

Ipsilon Dart Moth

(Agrotis ipsilon)

As a larvae, I am know as a black cutworm. I get this name due to my feeding habits. Because I tend to feed on young plants and ground level, I often cause them to topple over by consuming the base of the stem.

My life span can reach up to 67 days, depending environmental conditions. Nearly all of that time, about 34 days, is spend in larval and pupal development

Image by Dave's Garden (http://davesgarden.com/guides/bf/showimage/13647/#b)

Image by Rodale's Organic Life (http://www.rodalesorganiclife.com/garden/woolly-bear-caterpillars)

Banded Woollybear Caterpillar Moth

(Pyrrharcita isabella)

My cuddly name comes from my appearance as a caterpillar. Once I emerge as an adult, I appear as a mustard-yellow moth with black spotted wings.
I am often seen in the fall and winter, as this is when I hatch. In my caterpillar form, I can survive being frozen in the winter because of the cryoprotectant that my tissue produces. Once spring arrives, I thaw and begin to pupate.

Bald-faced Hornet

(Dolichovespula maculata)

While I am known for being extremely aggressive if disturbed, I am actually a very beneficial species. My species prey on flies and other yellowjackets, keeping these populations in check. I also like to feed on nectar and tree sap.

My home is a football-shaped hive that is grey and papery. I share this hive with anywhere from 100-400 other hornets. You can find hives like mine on low branches of trees or shrubs.

Image by Advance Pest Control (http://www.advancepestcontrolnwa.com/insect-gallery/)

Bold Jumper

(Phidippus audax)

I am the largest and most common species of jumping spider in North America. If you get the chance to look at me closely, you will notice my chelicerae (jaws) have a beautiful iridescent sheen.

They call me the bold jumper due to my ability to spring 10 to 50 times my own body length at a moment's notice.

Image by Kaldari. Adult femaie Phidippus audax jumping spider in Nashville, Tennessee. 15 May 2012. https://commons.wikimedia.org/wiki/File:Kaldari_Phidippus_audax_01.jpg

Image by Jungle Dragon (https://s3.amazonaws.com/media.jungledragon.com/)

Cross Orbweaver

(Araneus diadematus)

I get my name from my ability to create intricate orb webs. These webs are created by females of my species, and are used to collect prey. I usually hang head down in the center of my web, using my legs to detect the slightest disturbance in the silk strands.

Building webs from silk is a metabolically costly process, so I will often reuse the silk I have produced by eating my web in the mornings or evenings, depending on when I hunt.

Image by Hahn, Jeff. Squash bugs in home gardens. 2007. (http://www.extension.umn.edu/garden/insects/find/squash-bugs/)

Helmeted Squash Bug

(Euthochtha galeator)

I am one of many bugs to emit quite a stink if you bother me. I share this trait with a group of bugs known as "Leaf-Footed Bugs."

My name comes from my affinity for the juices of squash. Plants like pumpkins, gourds, and zucchini are my favorite to feed on. Because I can feed on these vegetables to the point of destruction, many farmers consider me a pest.

Image by BugGuide (http://bugguide.net/node/view/271909/bgimage)

Millipede

(Narceus americana)

I have 2 pairs of legs on each of my many, many segments except for the first (which is my head.) To protect myself, I can curl into a tight spiral or even emit a foul odor. However, I am not poisonous and I do not bite! I'm on of the bigger invertebrates on the forest floor – some millipedes are almost 1 foot long.

I live in moist environments, and I especially like soft wood in rotting logs or nurse trees. Most of my kind are either scavengers or herbivores.

Image by Folini, Franco. Armadillidium vulgare. 6 May 2006. (https://commons.wikimedia.org/wiki/File:Armadillidium_vulgare_001.jpg)

Isopod

(Armadillidium vulgare)

I am also known as a sow bug, potato bug, a pill bug, or a roly poly. I am a crustacean, meaning that lobsters, crabs, and shrimp are some of the kinds of organisms that I am most similar to. I live in moist places such as under logs and fallen leaves. This is because I breathe using gills.

When dead trees and leaves fall to the forest floor, I move in to shred them into smaller pieces so that I can eat them. By doing this I return nutrients to the soil – you could call me a master recycler in the forest!

Rindge's Moth Caterpillar

(Pero mizon)

Image by Simbana, Wilmer & Salgaje, Luis. Parasitoid-Caterpillar-Plant Interactions in the Americas. Miller, James. (http://caterpillars.myspecies.info/taxonomy/term/53746/media)

I am a young caterpillar that some call an inchworm. I'm often not even noticed as I sit on the branch of my favorite foods, but sometimes you can seem me inching along to a new leaf. I like the leaves and flowers of plants like alder, Douglas fir, and oak.

I spend months eating and growing until I'm ready to change into a moth. Some moths stay caterpillars for years, if they can avoid being eaten!

Image by U.S. Fish and Wildlife Service (https://www.fws.gov/southdakotafieldoffice/beetle.htm)

Burying Beetle

(Nicrophorus spp.)

I am an efficient recycler of the forest. I consume small, dead vertebrates in a very unique way. Bury the vertebrate, remove any feathers or hair, and lay my eggs on the carcass. When the eggs hatch, they use the carcass as a food source.

As an adult, I also feed on decaying food sources. Because I feed on dead or rotting material as an larvae and adult, I help to efficiently return nutrients back to the food web making me an essential part of ecosystem.

Image by Pest Specialist LLC (http://www.pestspecialistllc.com/library/pavement.php)

Red Pavement Ant

(Tetramorium caespitum)

I am an extremely common insect of North America, although I am native to Europe. I am known for setting up my large colonies in the cracks of pavement, which is where my common name originated from.

My presence is most notable when my colony gets into battles with nearby colonies. At these times, you may see thousands of ants swarming the pavement! Our aggressive colonization tendencies are what have led us from forest areas to the more urban habitats of pavements.

Image by PestMall Blog (http://www.pestmall.com/blog/know-how/how-to-get-rid-of-earwigs)

European Earwig

(Forficula auricularia)

Despite my name a popular stories about me, I do not crawl into human ears! In fact, I do not even bite or pinch humans. I am completely harmless to humans, spending most of my time hiding under rocks and logs.

The seemingly dangerous pincers on my posterior are actually for use against males of my own kind when fighting for females.

My kind is infamous in Portland, when in 1924 there were so many of us that the city declared a state of emergency.

Image by USDA Forest Service (http://www.fs.fed.us/wildflowers/pollinators/animals/flies.shtml)

Tachinid Fly

(Adejeania vexatrix)

While I may look hairy and scary, I only pose a threat to caterpillars. Females of my species will lay eggs on caterpillars. Larvae will then feed on the caterpillar once they have hatched.

While the feeding habits of larvae are somewhat distasteful, as an adult I feed only on nectar. My mouth consists of a proboscis that is very similar to what you would find on a moth or butterfly.

Image by Rottler (https://www.rottler.com/pests/profile/yellow-jacket)

Yellow Jacket

(Vespula spp.)

I am a highly feared member of the wasp family, easily distinguishable from my bright yellow coloring. People avoid me due to my ability to sting repeatedly without losing my stinger (as honey bees do.) My venom is also more potent than that of most bees, making my sting particularly painful.

I tend to make nests closer to than ground than other wasps, and I feed mostly on nectar. My larvae, however, enjoy insects that have been previously chewed by adult Yellow Jackets.

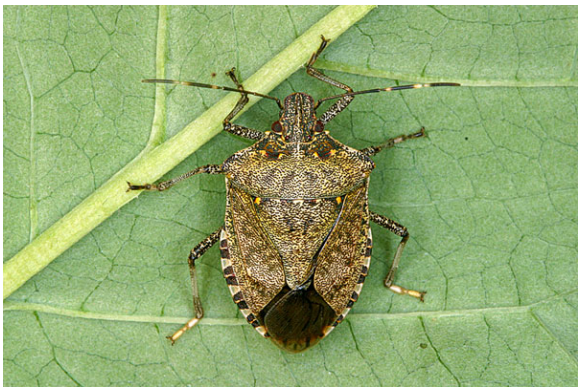


Image by Rutgers (https://njaes.rutgers.edu/stinkbug/identify.asp)

Brown Mamorated Stink Bug

(Halyomorpha halys)

I am known as a pest due to my appetite for fruit-bearing plants. While I don't actually ruin the flavor of fruit that I feed on, my proboscis creates many small dimples in the fruit. These deformities make the fruit harder to sell.

I also have the ability, like all stink bugs, to emit a foul smelling chemical from specialized stink glands. Finally, my coloring makes me incredibly hard to find among the leaves of orchard trees, demonstrating my camouflaging abilities.

Image by Proactive Pest Control (http://www.beproactivepestcontrol.com/common-pest-problems/house-centipedes-in-the-greater-sacramento-area/)

House Centipede

(Scutigera coleoptrata)

At first glance, I may look creepy crawly. Despite my appearance, I'm actually quite helpful to have around the house! I have a big appetite for cockroaches and moths, keeping these populations in check and out of your home.

My hidden skill is my speed. I actually move around with my body off the ground, using my long legs like stilts. Only when I stop moving does my body rest back on the ground.

Image by Mark J. Moran of Encyclopedia of Alabama (http://www.encyclopediaofalabama.org/article/m-7003)

Brown-Hooded Cockroach

(Cryptocercus punctulatus)

While many of my kind prefer to live in human dwellings, I actually spend my time living among decaying tree trunks.

I'm a pretty social creature, and I often live in large groups of my fellow kind. Several generations of us can be found congregating around decaying trees. We stay in such large colonies because young cockroaches, known as nymphs, rely on adults to digest the wood for them.

Image by Alexander Wild (http://www.alexanderwild.com/Ants/Taxonomic-List-of-Ant-Genera/Formica/i-pzB5PWm)

Formica Ant

(Formica spp.)

Unlike most ants, I have the ability to spray formic acid from the tip of my abdomen. This has earned me the name of Formica Ant, although I may be more commonly called a black ant or silky ant.

I love to feed on the honeydew that aphids produce. I'm a pretty clever little ant when it comes to getting food. I will often herd aphids to specific locations of plants so that I can feast on the plant juices that they extract for me.

Silverfish

(Ctenolepisma longicaudata)

Image by University of Minnesota Extension (http://www.extension.umn.edu/garden/insects/find/silverfish-and-firebrats/)

I'm a super speedy insect that loves to hide away in dark, warm places such as houses. I've earned my name by my ability to slip out of the grasp of larger insects that like to eat me, such as spiders and centipedes. My slipper nature is due to the slick scales that cover my body.

My favorite foods are starches, so it is not uncommon to find me lurking around the potatoes and flour bags stored in pantries. For this reason, many humans consider me a pest even though I am harmless.

Image by Mississauga Pest Control (http://www.mississaugapestcontrol.ca/Pests/House_Fly.html)

Small House Fly

(Fannia spp.)

I am much like your typical house fly, but much thinner and smaller. An important feature about me is my predictable life cycle. As a larvae, or maggot, I develop on decaying tissue and animal waste. The rate of my growth corresponds with the amount of time the waste or decaying matter has been present. Scientists can then use this knowledge to determine how long something has been decaying.

While I may be an annoyance when I land on your food, my life cycle is essential to understanding the process of decomposition.