An Arthropod Analysis

Teacher Instructions

Grade Level:
Middle school

Duration:
Two class periods

Subject Area:
Science

Vocabulary:
Arthropod
Biodiversity
Class Arachnida
Class Chilopoda
Class Diplopoda
Class Insecta
Crustacean
Entomologist
Exoskeleton
Habitat
Invertebrate
Leaf beating
Litter sorting
Metamorphosis
Molting
Terrestrial

Overview:
This lesson introduces students to terrestrial arthropods in our Louisiana wetland ecosystems by using observation techniques to discover and categorize them within your school's campus.

Learning Objectives:
The students will:

- Explore terrestrial ecosystems to determine types and quantities of arthropods that live there.
- Use terrestrial observation methods of collection (leaf beating and leaf litter sorting).
- Work in groups to study a microhabitat on the school's campus.

Materials List:

- Clipboards **(teacher provides)**
- Cups **(teacher provides)**
- Arthropod Field ID guides
- Paint stir sticks **(teacher provides)**
- Pencils
- Rulers
- White fabric -- a 2-foot by 2-foot piece for each group **(teacher provides)**

Grade Level Expectations:
6th grade:

1. Generate testable questions about objects, organisms and events that can be answered through scientific investigation. (SI-M-A1)
2. Select and use appropriate equipment, technology, tools and metric system units of measurement to make observations. (SI-M-A3)
3. Record observations using methods that complement investigations (e.g., journals, tables, charts). (SI-M-A3)
4. Use data and information gathered to develop an explanation of experimental results. (SI-M-A4)
5. Use relevant safety procedures and equipment to conduct scientific investigations. (SI-M-A8)
6. Provide appropriate care and follow safe practices and ethical treatment when animals are involved in scientific field and laboratory research. (SI-M-A8)

7th grade:

1. Generate testable questions about objects, organisms and events that can be answered through scientific investigation. (SI-M-A1)
2. Record observations using methods that complement investigations (e.g., journals, tables, charts). (SI-M-A3)
3. Use data and information gathered to develop an explanation of experimental results. (SI-M-A4)
4. Describe and compare the levels of organization of living things within an ecosystem. (LS-M-C3)
5. Predict the impact changes in a species' population have on an ecosystem. (LS-M-C4)
6. Describe changes that can occur in various ecosystems and relate the changes to the ability of an organism to survive. (LS-M-D2)
7. Explain how environmental factors influence survival of a population. (LS-M-D2)

8th grade:

1. Generate testable questions about objects, organisms and events that can be answered through scientific investigation. (SI-M-A1)
2. Record observations using methods that complement investigations (e.g., journals, tables, charts). (SI-M-A3)
3. Use data and information gathered to develop an explanation of experimental results. (SI-M-A4)

Common Core State Standards:
CCSS.ELA-Literacy.RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic.

Vocabulary Definitions:
Arthropod - a group of animals that have a segmented body, an exoskeleton, jointed legs and bilateral symmetry; includes insects, spiders, mites, crawfish, crabs, centipedes, millipedes and more.

Biodiversity - all the kinds of living organisms within a given area of habitat.

Class Arachnida - a group of arthropods that have eight legs, two body segments, no antennae and no wings; includes spiders, mites, ticks, scorpions and harvestmen.

Class Chilopoda - a group of arthropods commonly known as centipedes; characterized by large antennae, one pair of legs per body segment, typically flattened body, quick, carnivorous.

Class Diplopoda - a group of arthropods commonly known as millipedes; characterized by having two pairs of legs on each body segment (except the first three segments, which have one pair of legs); body is more rounded than centipedes and millipedes; mostly feed on dead plant matter.

Class Insecta - a very large group of arthropods that are characterized by a three-segment body, three pairs of legs (six legs total) and a pair of antennae.
Crustacean - a group of arthropods that are mostly aquatic; include shrimp, crawfish, lobster, crabs.

Entomologist - a scientist who studies insects.

Exoskeleton - a hard outer shell that protects an invertebrate's body.

Habitat - home environment; the natural conditions and environment in which a plant or animal lives, such as a forest, desert or wetland.

Invertebrate - animals that lacks a backbone and other bones.

Leaf beating - a sampling technique to study arthropods that live on or frequent shrub branches.

Litter sorting - a sampling technique to study arthropods that live on or frequent the ground.

Metamorphosis - a change in form from one life stage to the next.

Molting - the shedding of the exoskeleton of arthropods during life stage changes or seasons.

Terrestrial - of or relating to the Earth.

Background Information:

The term "insects" has loosely been used to describe all of the small creeping, crawling, flying and swimming critters that don't have bones. People, however, have incorrectly grouped spiders, scorpions, ticks, centipedes and "roly-poly" bugs into the insect category. All of these critters do belong to the same phylum as insects, Phylum **Arthropoda**, but they are not insects. All of these critters belong to the Animal Kingdom, and more specifically Phylum Arthropoda, named from the Greek *arthros* (= jointed) and *poda* (= foot). In addition to **insects** and **arachnids**, **crustaceans** also fall under this phylum (crabs, shrimp, lobsters, crawfish). We won't be discussing crustaceans in this lesson, so for the sake of saving time, the remaining information is centered upon insects and arachnids.

Of the estimated 1.3 million species of animals that have been identified on earth, organisms of the Phylum Arthropoda make up more than 80% of these, or around 1.2 million! Beetles alone account for around 400,000 species. Arthropods are considered the most successful of all animals to ever inhabit the Earth due to their ability to adapt and change. They currently inhabit all corners of the Earth, including land, air, freshwater and the seas. Many even live on and inside of animals and plants, including humans! Species in this phylum have been responsible for some of the most devastating plagues and famines in history. Yet, many arthropod species are directly or indirectly responsible for food, clothing, medicines and protection from other harmful organisms.

Arthropods are characterized scientifically as having jointed legs, a segmented body and an **exoskeleton**. The existence of an exoskeleton indicates that these animals do not possess bones and are thus **invertebrates**. To grow, arthropods must shed their exoskeleton through a process called **molting**. Arthropods molt several times during their lifetime to grow, and some change life forms between molts through a process called **metamorphosis**, such as a dragonfly or a butterfly. Similarly, many insects begin their life as aquatic animals, living in the water, and move to life onto land after molting and changing body forms.

Today's lesson focuses on several classes of arthropods that live on land, termed **terrestrial** arthropods. Class Insecta, one of the study groups for this lesson, is characterized by having six legs, a three-segmented body and antennae. Insects include flies, true bugs, grasshopper, beetles, roaches, butterflies, dragonflies, damselflies, bees and more. Species within class Arachnida include spiders,

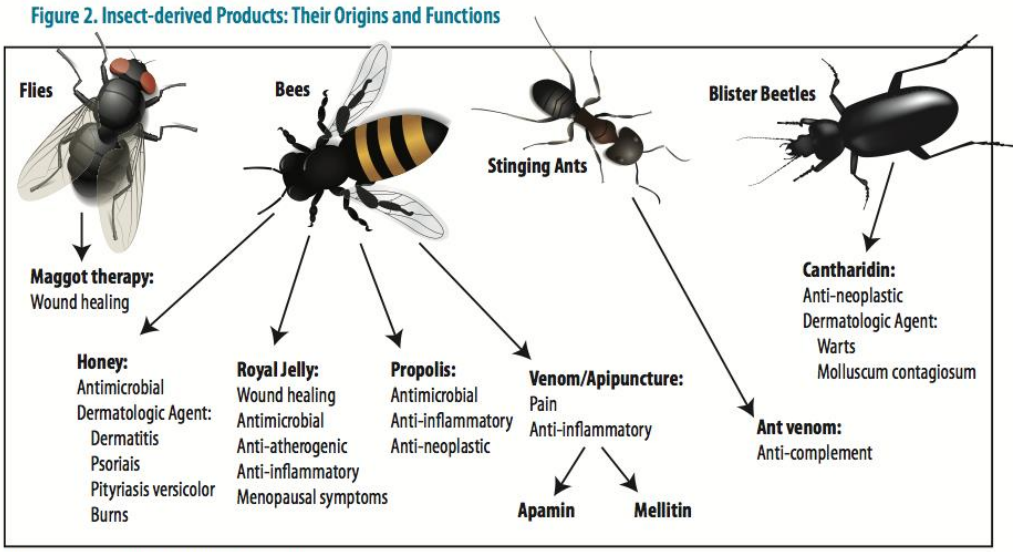
mites, ticks, daddy longlegs, scorpions and more. Arachnids are characterized as having eight legs (versus six legs in the insects). Unlike species classified in class Insecta, arachnids do not have antennae, and their body is in two sections (rather than three). Lastly, class Chilopoda (centipedes), and class Diplopoda (millipedes) will be studied during this lesson. All centipedes and millipedes are terrestrial. Centipedes have flat bodies (typically), antennae and one pair of legs on each segment. This means that for every segment along the body, one leg is coming out of each side. Millipedes differ from centipedes in two main ways: first, millipede bodies are typically cylindrical (rounded); second, millipede bodies have two pairs of legs coming out of each segment. This means that a total of four legs protrude from each segment. One major differences between centipedes and millipedes is that centipedes move quickly, while millipedes move slowly. Also, centipedes are predominately predators (carnivores), capturing and eating other arthropods and small animals, while millipedes are mostly herbivores, eating live and dead plants.

Importance of Arthropods

Scientists who study arthropods can lead to a greater understanding of environmental health by cataloging the types of arthropods that exist within a healthy and an unhealthy ecosystem. With regular observation and exploration, scientists are able to determine if the ecosystem is changing, based on the species found, and whether the ecosystem is healthy or not. Some scientists specialize in particular groups of arthropods, such as **entomologists**, who study insects. One specific field of entomology that greatly influences the lives of humans is Forensic Entomology. This field has become an extremely useful tool for solving crimes by determining time of death, where the crime took place and where the victim or suspect visited beforehand. Similarly, the entomological field of pest management is very important to human lives and works to reduce the number of harmful arthropods that could potentially threaten human or crop health.

Arthropods are an important component of almost any food web, including wetland food webs. Louisiana wetland animals, such as frogs, turtles, lizards, alligators, fish, birds and mammals prey on arthropods. Arthropods even prey on other species of arthropods. For example, dragonflies eat mosquitoes and help to keep their numbers down. Similarly, spiders capture and consume many flying arthropods, but have also been known to capture small mammals and birds in their webs! Without arthropods, many of the animals that live in our wetlands would not survive, and, thus, higher order animals would follow suit. In time, life as we know it would end on earth if arthropod species and populations were threatened.

Arthropods also play direct and indirect roles in our food, medicine and clothing. Arthropods are responsible for most of the pollination that is necessary for our food plants to survive and thrive, including vegetables, fruits and plants that are necessary for other animals to survive (e.g. oaks, magnolias, etc). Crustaceans are also a large part of some culture's diet, including crawfish, crab and shrimp in south Louisiana. In medicine, many arthropods, including flies, bees, ants and beetles contain chemicals or characteristics that are used in traditional and nontraditional medicine around the world. For example, honey is used to treat wounds, burns and gastrointestinal disorders. Similarly, venom from ants and bees are used inflammation, arthritis, muscular sclerosis and pain (see figure 1).



How to Study Arthropods

Scientists and amateur naturalists collect and study arthropods to determine the **biodiversity** of an ecosystem, as well as its health. Decreases in arthropod diversity and abundance are often the first signs that something is wrong with the ecosystem, such as pollution. Scientists study both aquatic and terrestrial arthropods to investigate system health, but in this study, we will focus on the terrestrial species.

Terrestrial arthropods are great to study in the classroom because they can be found anywhere, and you don't need a lot of tools! Different techniques for finding and observing these arthropods can lead to a discovery of different ecosystems on your school's campus. Some arthropods live in shrubs or on trees while others live on the ground. Some even spend all of their lives underground. Thus, by using different techniques to explore these different micro-**habitats**, students can observe differences in species.

In this study, we will focus on terrestrial arthropods in shrubs and on the ground. To explore arthropods that live on shrubs, students will use the **leaf beating** technique to shake loose the critters that are hiding on the leaves and branches. To do this, place a white piece of fabric (pillowcase, cut fabric) on the ground underneath some overhanging branches of a shrub. Use a stick, broom handle or something similar to beat the tops of the branches several times to release the arthropods onto the fabric. Students then can use small cups or containers to gently collect the species for closer observation. Students can use observation to determine the number of body segments, number of legs and presence/absence of antennae. They can then compare these to the characteristics of the arthropods classes as described above.

Another technique students can use to explore terrestrial arthropods is **litter sorting**. This involves finding areas of leaf and plant litter to uncover what arthropods are bustling around in there. Students should choose an area where they will explore (maybe a 10- by 10-foot area) and begin sifting through the leaf litter with their fingers and pencils. As they discover arthropods, they can temporarily capture them in cups to get a closer look. Again, using the distinguishing characteristics, students can determine which class the arthropod belongs to.

Other techniques of arthropod exploration include log busting, aerial nets, sweep nets and aquatic sampling. This study will not be focusing on these techniques, but with research, any classroom would be able to utilize them with additional materials.

Advance Preparation:
Day 1:

a. Download pictures of the following arthropods to display to the class: mosquito, snail, inchworm, grasshopper, beetle, spider, pill bug and centipede.
b. Choose several shrubs in the schoolyard that students will use to perform the leaf beating technique. Palmetto leaves work great, but other chest- and waist-high shrubs work great, too. Mark them if desired.
c. Make copies of the Habitat Observation Log (one per student).
d. Gather the following materials for each pair of students: one clipboard, two rulers, one white piece of fabric and one paint stick.

Day 2:
Reorganize study materials from Day 1 for distribution to groups.

Safety:

- Stay away from ant hills when conducting all outdoor investigations.
- Discuss the dos and don'ts of the observation and collection that will be used.
- Talk about how to observe animals with your eyes only. You don't know if it has a dangerous defense mechanism that could harm you.
- Explain how it is important to return the section of land to its original state (or as close as possible) when finished investigating.
- Stay with group members during group investigation.
- Stay within teacher-set boundaries of schoolyard habitat.

Procedure:
Guiding Questions

- What terrestrial arthropods are prevalent in our schoolyard habitat?
- How do different habitats differ with respect to types of arthropods found?
- What do arthropod species say about an ecosystem?

Day 1: Leaf Beating

1. Read the background information and vocabulary to become familiar with arthropods and the methods of exploration.
2. Tell the students that today we will be exploring arthropods. Defining characteristics of arthropods include jointed legs, a segmented body and an exoskeleton.
    a. Use the Background Information to teach the students about arthropods and interesting topics about them.
3. Tell the class: "Today, we will be acting like a scientist by observing our schoolyard habitat. We will then investigate some common groups of terrestrial arthropods that live on shrubs. This is a way for scientists to collect and identify species found in an ecosystem. We will be using the leaf beating technique of finding arthropods in today's study."

    a. Define terrestrial for students – growing on land (versus water). Thus, terrestrial invertebrates are animals that lack backbones and inhabit land.
4. Break students into groups of two.
5. Pass out one Habitat Observation Log to each student and allow them to review it.
6. Inform them they will not be using the litter sorting technique until tomorrow.
7. Based on the explanations of the two techniques, students should predict some differences that they may see.
    a. Have students write a hypothesis for questions 1 on their work sheet. Students can make more than one prediction.
    b. Guide students to consider things like where the arthropod is located (ground or plant), the color of leaves on a shrub versus the color of leaf litter, whether a bug needs to fly if on shrub or on ground, etc.
8. Explain how to fill in the Arthropod Tally Chart on their work sheet by reading the directions and giving examples.
    a. Students do not need to identify particular species; they should just mark tallies for each time they observe an arthropod in that Order.
9. Pass out the remaining materials for today's study.
    a. Each group will need three clipboards (or makeshift ones from cardboard pieces); pencils.
10. Take the whole class outside to observe a predetermined shrub and the surrounding area. Palmettos work well for this activity, if available.
11. Sit the class down as you stand near the shrub, so that they can get a good view of the process.
12. The first step that scientists take is to just observe their surroundings. *Open your eyes, ears and nose to take in your surroundings. Talk with your group members about what you see, feel and hear. Do not record anything at this time.*
13. Give students two-three minutes for this. It is important to understand where the arthropods live. Why do you think this is important? *All scientists need to understand where arthropods live to determine how they survive there and if they are healthy.*
14. Now, demonstrate the leaf beating technique to the class:
    a. Find a branching shrub.
    b. Put a white piece of fabric on the ground underneath overhanging branches.
    c. Use the paint stick to beat the leaves about four times from the top of the branch(es), dropping the arthropods onto the pillowcase.
15. Return the living organisms back to the habitat by shaking the white fabric onto the ground nearby or underneath the shrub. Don't allow any students to hurt or disrupt the arthropods.
16. Each group should now choose a shrub and talk as a group as they fill out the Habitat Observation Log for their chosen site.
    a. They should make field notes for question 2 and sketch the site for question 3.
17. They should then perform the leaf beating technique on their own study shrub and record their data on the Arthropod Tally Chart (you can continue this step on day 2 if time does not allow your class to do this step on day 1).
    a. Use the arthropod chart to help students determine the common name groupings of the arthropods. Ask questions like how many legs do you notice? Color? Body shape?, etc.
    b. Have students use the magnifying lenses to get a better view and rulers to measure the creatures.

c. Different species don't have to be correctly identified.

18. Clean up area, gather all materials and return to the classroom.

Day 2: Continuation of Leaf Beating and Litter Sorting

19. In the classroom, review what students did during the previous day's lesson.
20. Explain that in small groups, students will explore a different habitat type using a new exploration technique: litter sorting!
    a. Explain the litter sorting technique: Find an area with some leaf and plant litter on the ground (dead leaves and sticks). Using your fingers, move the litter around carefully to uncover any arthropods that are dwelling there. Use the magnifying glasses to get a closer look.
21. Note: Students can bring their materials to perform the leaf beating technique again today if you wish.
22. Distribute the tools they will need today: three clipboards per group, pencils.
    a. If students are using the leaf beating technique again today, they will need materials from yesterday as well.
23. Tell the students about how scientists go into habitats and respect their observation area. They try to leave any trace that they were there. A good rule for the students would be to explore gently. For example, you may lift up a rock, but you will need to replace it where you found it. Do not take any species from the study site, and be sure to leave the site as you found it.
24. Lead the students outside to the study area once again.
25. Dismiss the students to locate a plot where leaf litter exists.
26. Give the students about three minutes to have silent observation of their site and to fill out their Habitat Observation Log for day 2 (questions 2 and 3).
27. Allow them 20-30 minutes to explore the leaf litter.
28. Clean up area, gather all materials, and return to the classroom.
29. Upon returning to the classroom (or on the following day), students should answer the discussion questions in question 4 in their notebook or science journal.
30. As a close to the group investigation, discuss the findings based on the discussion questions:
    a. Did you find the same types of arthropods at both sites? Explain.
    b. If you found different types of arthropods at each site, what are some physical characteristics that made them adapted to the site found? (For example, think about the color of the animal based on the color of the habitat or the presence/absence of wings and what this means).
    c. From the data that you collected, can you answer your hypothesis?
    d. Is your hypothesis correct or incorrect?
    e. What could be a revised or new hypothesis based on your new found observations?
    f. What role do arthropods play in the food web? What do you think the arthropods eat? What do you think eats the arthropods in your ecosystem?
    g. What would happen to the ecosystem if the arthropods disappeared?
    h. What would happen to the arthropods if the ecosystem disappeared?
    i. What can you do at home to help arthropods thrive in your backyard?

Extension Ideas: 

- Project Noah. Turn your students into citizen scientists! Project Noah was created to provide people of all ages with a simple, easy-to-use way to share their experiences with wildlife. By

encouraging your students to share their observations and contribute to Project Noah missions, you not only help students to reconnect with nature, you provide them with real opportunities to make a difference. http://www.projectnoah.org/education

- Repeat this activity if your class participates in a field trip where students would have time to explore.
- Create a blog for your students to extend their thinking and share what they have discovered during this investigation. The blog can be accessed in school or at home. You could put the questions for the science notebook journal (day 2) on a kidsafe blog. Allow students to blog about their findings. See the link for Edublog in the technology section of this lesson plan.
- You may want to have students use their video clips and photographs to create a narrated, simple movie. Here is a link to using Windows Movie Maker in four simple steps. http://windows.microsoft.com/en-US/windows-vista/Make-a-movie-in-four-simple-steps

Blackline Masters:

- Habitat Observation Log
- Arthropod Tally Chart

Resources:

BioKIDS. Arachnids (online). Accessed September 06, 2013 at http://www.biokids.umich.edu/critters/Arachnida/

Cherniak, E.P. Bugs as drugs, part 1: insects. The "new" Alternative Medicine for the 21st Century? (online). Accessed September 6, 2013 at http://altmedrev.com/publications/15/2/124.pdf

Klappenbach, L. How many animal species inhabit our planet?" (online) Accessed September 6, 2013 at http://animals.about.com/od/zoologybasics/a/howmanyspecies.htm

Lab 5 – arthropods. Tulane University. Accessed September 6, 2013 at http://www.tulane.edu/~bfleury/diversity/labguide/arthropod.html

Myers, P. 2001. Arthropoda (online), Animal Diversity Web. Accessed September 6, 2013 at http://animaldiversity.ummz.umich.edu/accounts/Arthropoda/

National Geographic: Bioblitz. Accessed September 6, 2013 at http://education.nationalgeographic.com/education/program/bioblitz/?ar_a=1

Name _____ Date_____

Habitat Observation Log

Techniques:

Leaf Beating

1. Find a branching shrub.
2. Put a white pillowcase or other white fabric underneath overhanging branches.
3. Use a stick or broom handle to beat the leaves about four times from above.
4. Observe invertebrates that fall on the white fabric.
5. Use rulers and magnifying lenses to help you observe and identify the invertebrates.
6. As a group, complete Arthropod Tally Chart and Habitat Observation Log.
7. On the ground underneath the bush, gently shake the cloth that the invertebrates are on to return them to their habitat.

Leaf Litter Sorting

1. Locate a pile of dead leaves on the ground underneath a tree.
2. Use tweezers and magnifying lenses to sift through the leaves and pick out any invertebrates you find.
3. Collect these invertebrates in a cup.
4. Transfer the invertebrates onto a tray for closer inspection with rulers and magnifying lenses.
5. As a group, complete the Arthropod Tally Chart and Habitat Observation Log.
6. On the ground underneath the tree on top of the leaf litter, gently shake the tray that the invertebrates are on to return them to their habitat.

Hypothesis:

What do you predict will be different between the two sites with regard to the types of arthropods found there? (you can make more than one prediction)

_____

_____

_____

_____

Data Collection:

Field Notes

Day 1: Leaf beating technique	**Day 2: Litter sorting technique**
Location (be specific):	Location (be specific):
Outside temperature:	Outside temperature:
Sunshine cover:	Sunshine cover:
Food types:	Food types:
Water sources:	Water sources:
Shelter:	Shelter:

Name _____ Date_____

Arthropod Analysis

(Habitat Observation log continued)

Site Sketch (include vegetation, slope of land, water sources, etc.)

Day 1:

Day 2:

Name _____ Date_____

Arthropod Tally Chart

Directions: Make a tally mark for each species you find within the common groups below.

Phylum Arthropoda			**Number Found**	
Class	**Order**	**Common Name**	**Day 1**	**Day 2**
Insecta	Blattodea	Roaches		
Insecta	Blattodea	Termites		
Insecta	Coleoptera	Beetles		
Insecta	Dermaptera	Earwigs		
Insecta	Diptera	Flies		
Insecta	Hemiptera	Aphids		
Insecta	Hemiptera	Cicadas		
Insecta	Hemiptera	Plant Hoppers		
Insecta	Hemiptera	Stink Bugs		
Insecta	Hymenoptera	Ants		
Insecta	Hymenoptera	Bees		
Insecta	Hymenoptera	Wasps		
Insecta	Lepidoptera	Butterflies		
Insecta	Lepidoptera	Moths		
Insecta	Mantodea	Mantids		
Insecta	Neuroptera	Lacewings		
Insecta	Odonata	Dragonflies		
Insecta	Odonata	Damselflies		
Arachnida	Trombidiformes+	Mites		
Arachnida	Ixodida	Ticks		
Arachnida	Araneae	Spiders		
Arachnida	Opiliones	Daddy long-legs		
Arachnida	Pseudoscorpiones	Pseudoscorpions		
Arachnida	Scorpiones	Scorpions		
Chilopoda	Lithobiomorpha+	Centipedes		
Diplopoda	Spriobolida+	Millipedes		

+ indicates that more than one order exists for this group.

Distinguishing characteristics (how to tell them apart with sight).
Class Insecta - 3 body segments; 6 legs; 2 antennae.
Class Arachnida - 2 body segments; 8 legs; no antennae.
Class Chilopoda -many body segments; one pair of legs per segment; flat body; fast.
Class Diplopoda - many body segments; two pair of legs per segment; round body; slow.

Name _____ Date_____

Arthropod Analysis
(student activity sheet continued)

Use the Arthropod Tally Chart to count numbers for day 1 and day 2.
Answer the following discussion questions in your science journal, based on your data and observations.

a. Did you find the same types of arthropods at both sites? Explain.

b. If you found different types of arthropods at each site, what are some physical characteristics that made them adapted to the site found? (For example, think about the color of the animal based on the color of the habitat or the presence/absence of wings and what this means).

c. From the data that you collected, can you answer your hypothesis?

d. Is your hypothesis correct or incorrect?

e. What could be a revised or new hypothesis based on your new found observations?

f. What role do arthropods play in the food web? What do you think the arthropods eat? What do you think eats the arthropods in your ecosystem?

g. What would happen to the ecosystem if the arthropods disappeared?

h. What would happen to the arthropods if the ecosystem disappeared?

i. What can you do at home to help arthropods thrive in your backyard?