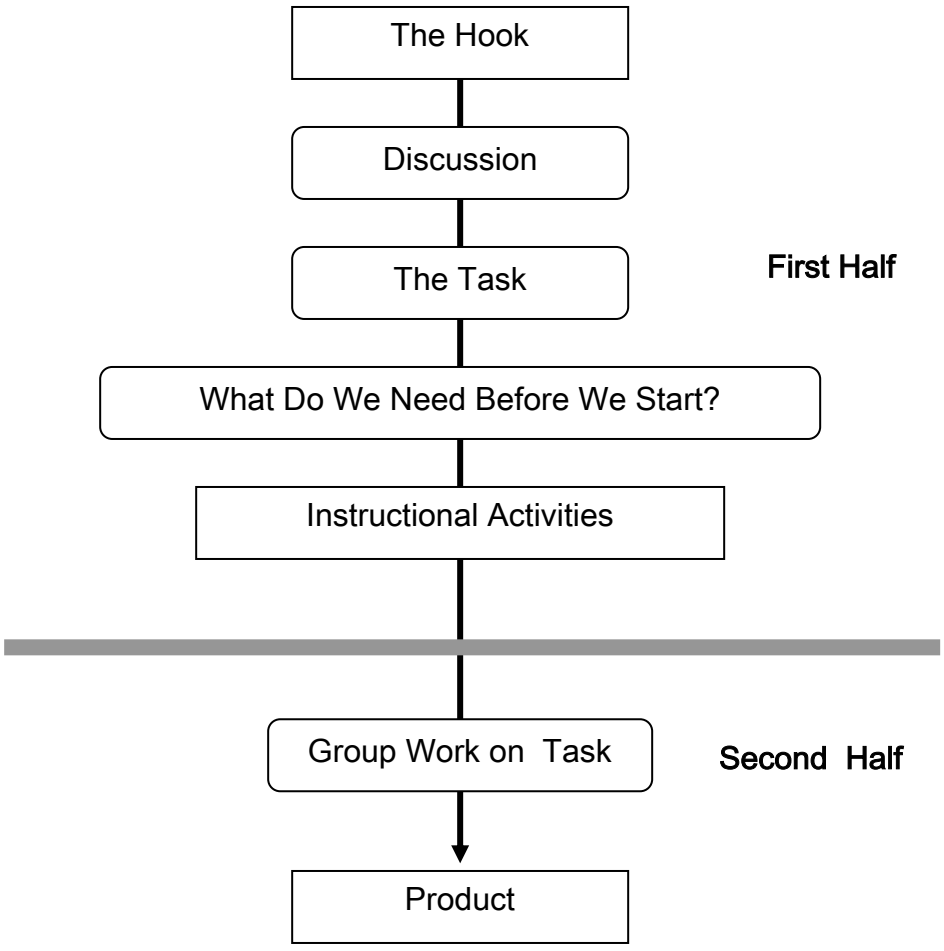
The Event-Based Science Model

This life science module follows the Event-Based Science (EBS) Instructional Model, as developed by Dr. Russell Wright. All EBS modules begin by having students watch television coverage of an actual event of scientific importance, and read newspaper and other media reports. This first step is called the "hook," because it catches students and holds their interest just as a hook catches and holds a fish. Discussion of the event reveals your students' prior knowledge of related science concepts. An authentic Task creates a need for teams of students to refine their knowledge and explore new concepts and processes. Student demands for needed information are met with hands-on instructional activities that prepare them to complete the Task. The Task leads to a final product that allows students to apply the science they have learned and to be assessed on the quality of their work.

Today, literate citizens must know how to analyze problems, ask critical questions, evaluate competing claims, and formulate and test tentative explanations of events. They also need to acquire scientific knowledge and apply it to new situations. An EBS model allows students to accomplish this by placing science in a meaningful context in which they see the role that science plays in the lives of ordinary people.



The schematic at left shows how each part of an EBS module leads to the next.

As a constructivist learning tool, EBS leads us to a new instructional paradigm: the students are the workers and the product is knowledge. In this framework, teachers are coaches, guides, and advisors who support students as they (the students) construct and test their knowledge.

Assessment in this paradigm consists of students exhibiting their knowledge through projects, reports, essays, and problem solving.

Continued on next page...

The Event-Based Science module includes a broad range of activities and strategies. Cooperative learning structures, open-ended laboratory investigations, guided discussions, statistical analysis, and performance assessments are included.

The take home message is this: Be careful not to succumb to the natural desire to pre-teach. Save your augmentation of the module for the discussions that will naturally follow EBS activities. Please note that this doesn't mean you may not help your students as they engage in their discoveries. Of course, you may use all the tricks of the science teaching trade, supplementing the words and activities of the text with your own insights, experiences, explanations, and demonstrations. The key to an Event-Based Science module is that whole-class instruction should be kept to a minimum. Once all EBS activities have been completed, and students are busy working on the Task, encourage them to find information from sources other than you. They can - and should - utilize all relevant media, from the Internet (using scientifically accurate websites) to daily newspapers. Other textbooks, encyclopedias, public health pamphlets, magazine and newspaper articles, maps and atlases are all fair game in their search. It is vital to the preparation of scientifically literate citizens that they become accustomed to finding information on their own.

Adapted from the Preface to Event-Based Science, by Russell Wright, Ed.D.

INVADERS!

Impacts of Invasive Species on Food Webs and Ecosystems

An event-based science mini-unit to support Connecticut State Science Standard 6.2 - *An ecosystem is composed of all the populations that are living in a certain space and the physical factors with which they interact.*

Developed by the following teachers and museum educators in the Yale Peabody Museum's Event-Based Teacher Collaborative, July 2010 to June 2011:

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The Event-Based Teacher Collaborative was made possible by a National Leadership Grant from the Institute of Museum and Library Services

INVADERS!

Impacts of Invasive Species on Food Webs and Ecosystems

The Hook

- Monk parakeet news footage (see web link below and accompanying files)

http://www.wtnh.com/dpp/news/new_haven_cty/court-rules-for-utility-against-monk-parakeet-nests

- Snakehead fish documentary footage (optional, see web link below)

http://channel.nationalgeographic.com/channel/videos/fishzilla-snakehead-invasion/

Discussion Questions

- What do you think an invasive species is?
- Do you think invasive species are a problem?
- How are our lives affected by invasive species?
- How are other living organisms affected by invasive species?
- What impact do humans have on an ecosystem when they move into an area?
- How do invasive species get into our ecosystem?

The Task: On the Chopping Block (page 3)

- Each group of students will give expert testimony on an invasive species before the State Assembly.
- Class Forum will be held where students will ask questions and groups will try to convince the State Assembly to prioritize their funding.
- The State Assembly will vote on what issues will receive priority funding to control or manage problems.

Activities – what do we need before we start?

- Abiotic and Biotic Walk-about (page 5)
- Modeling Food Chains and Food Webs (includes Peabody specimens) (page 7)
- How Did I Get Here? Creative writing about how invasive species came to Connecticut (page 10)
- Oh Deer! (page 11)
- Structured visit to the Yale Peabody Museum to learn about biomes
- Research on invasive species

THE TASK

Invaders on the Chopping Block

Local authorities have reported there are several areas in the state where invaders are changing the local ecosystems. Government officials are trying to decide how to appropriate funding they received from the EPA (Environmental Protection Agency) to manage or eradicate the invaders.

These invaders are not the ones you read about in science fiction stories, but producers and consumers not regularly found in our area. Doesn't sound too alarming you say? You may feel differently once you hear the testimony from various experts on the topic and residents who live in the area. Government officials need to collectively determine which invaders to control first and determine future planning for those whose effect on the environment is not critical.

Your Task

Each group of students will become an expert and give testimony on an invasive species. The class will have a forum to ask questions, clarify the presented materials, and persuade state officials of where funding should go. An assembly votes on which invasive species needs the most state funding to control or manage. The assembly can be made up of the class or a subset of the class, or can include other classes, other adults at the school, etc. They will also decide how much of the remaining funding the other species control plans will receive.

The Roles

Each team will research one invasive species. This can be chosen from the following list, or students can be encouraged to find others:

- Asian Longhorned Beetle
- Emerald Ash Borer
- Zebra Mussel
- Gypsy Moth
- Monk Parakeet
- *Phragmites* (common reed)
- Asian Shore Crab
- Northern Snakehead Fish
- Japanese Knotweed

There will be five members in each team. Each team member has a different job to perform. The roles are: State DEP official, Federal EPA Representative, community representative, botanist (plant scientist), and a zoologist (animal scientist).

Decide which individual will perform each job and submit the list to your teacher. Also discuss what information is needed before you begin. Are you familiar with the species you will be addressing?

Job Descriptions

State Department of Environmental protection (DEP) official will:

1. Write a letter stating the nature of the invading species.
2. Identify where the organism is located within the state.
3. Discuss the impact the organism is having on the ecosystems in the state and within the Northeast region.

Federal EPA official will:

1. Report where the organism is found nationally.
2. Discuss how other states are addressing the invading species.

Botanist will:

1. If it's a plant, report on the life cycle of the species, its mode of transmission, and its habitat.
2. Discuss how the organism impacts other plants.

Zoologist will:

1. If it's an animal, report the life cycle of the species, its migration, and its habitat.
2. Discuss how the organism impacts other animals.

Community Representative will:

1. Talk about the impact the organism has had on the local community.
2. Voice concern of the community regarding the economic and environmental impact of the species and/or proposed solutions.

The Presentation

Students will address the task utilizing posters, pamphlets, PowerPoint, and/or videos. The presentation should be between 10 – 15 minutes.

Good Luck!!

Activities

Activity 1: Abiotic and Biotic Walkabout

Purpose: At the end of the activity, students will be able to distinguish between biotic and abiotic factors within their nearby ecosystem.

Objective: Identify five abiotic and five biotic examples outside the school.

Materials:

- Notebook
- Pen/pencil
- Graph paper
- Markers

Story: All of the organisms in our environment can be classified into two categories: abiotic (non-living) and biotic (living). Today, you will take a walk around a park to see how many items fall into these categories.

Procedure:

1. Teacher will guide students outside.
2. Teacher will instruct students that they have 5-7 minutes to write down as many observations they can about their environment.
3. Upon returning to the classroom, students will work in groups of 4 to compile their lists, creating a master list of their observations.
4. Students will read the Discovery File "Abiotic/Biotic Factors."
5. Students will classify the items from their group's master list into two groups: abiotic and biotic**.**
6. Students will create a bar graph to compare the number of abiotic vs. biotic examples they observed, taking care to correctly label axes.
7. Upon completion, each group will share their findings.

Conclusion:

Take a look at your master list.

a. Were you surprised at any objects that were considered to be abiotic?
b. Look at your biotic list. Classify each of members according to its kingdom/major taxonomic group (ex. animal, plant, fungus).
c. Choose two items from your abiotic list and explain their role in the environment.
d. Choose two items from your biotic list and explain their role in the environment.

Extensions:

- Students can complete a similar activity at an area near their home.
- Students can chose five of their organisms and create a PowerPoint presentation explaining their habitat and diet.

Activity 2: What's For Dinner?

Purpose: Compare and contrast food webs and food chains.

Materials:

- Species flash cards – contact peabody.education@yale.edu for a set of cards
    - Six biomes: tundra, taiga/boreal forest/coniferous forest, deciduous forest, tropical rainforest, grassland, desert
    - Each card will have a photo next to the species name.
    - On the front of each card, the species will be identified as "producer," "herbivore," "carnivore," "omnivore," or "decomposer."
    - Each consumer card will also indicate what the animal eats.
    - Each set will also include a sunlight flash card.
    - Each biome set will also include one invasive species.

- Connecticut freshwater biome flash cards – contact peabody.education@yale.edu for a set
    - The biome set will have up to 30 cards.
    - Each card will have a photo next to the species name.
    - On the front of each card, the species will be identified as "producer," "herbivore," "carnivore," "omnivore," or "decomposer."
    - Each consumer card will also indicate what the animal eats.

- One ball of yarn
- 100 pipe cleaners
- Assortment of museum specimens for each biome set
- Museum specimens of Connecticut invasive species
- One diagram of a model of a food chain and food web – see related Discovery File

Story: Each biome has its own unique set of food chains and food web. What would happen if a species were removed from the biome? What would happen if an invasive species were introduced into the environment?

Procedure:

Day 1:

1. Students will receive and read the "Food Chain and Food Web" Discovery File. Students will have five minutes to read, but they are encouraged to refer to the discovery file throughout the lesson.
2. Students are broken up into six teams (one for each biome).

3. Sample specimens will be grouped into biome stations.
4. Each group is issued one set of biome cards (Note: the invasive species card is NOT given out at this time).
5. After examining the specimens and cards, groups will be tasked to sort the cards into a food chain. At least five cards must be used in the food chain. Groups will have ten minutes to complete the task. They can use pipe cleaners to **make the arrows that show the direction of energy flow**, or do the activity on top of large sheets of paper that they can draw the arrows on, or reusable plastic tablecloths that they can draw arrows on using dry-erase markers.
6. After ten minutes, groups will present their chain, explaining the dynamics of their biome.
7. Students will create a food web using their cards. Groups will have 15 minutes to create their food web, **with arrows**. At least 10 cards must be used in the food web.
8. Each group will present their food webs.
9. Each group will be given the invasive species card for their biome, and they should put it into their food web and discuss how it will affect the rest of the organisms. This could be written or oral, but they must mention disruption of the system.
10. As a closing activity, the teacher will facilitate a class discussion comparing food chains and food webs. Students will be encouraged to use the food webs and food chains they created as evidence for their comparison.

Day 2:

1. Teacher will facilitate a brief review of food chains and food webs in the form of a Venn diagram with students providing input for the diagram.
2. Teacher will pre-select from the freshwater biome set cards that would create a food web based on the number of students in the classroom.
3. Teacher will pass out freshwater biome set of cards with one card per student. Students will attach their card (using tape or clothespins) so that they can be hands-free and the card is visible to all students.
4. Teacher will have the sunlight card, and explain the purpose of the yarn in the activity (i.e. the yarn replicates the energy flow in the food web).
5. Teacher will pass off the ball of yarn to one student who has a producer card (e.g. duckweed). Teacher will explain why the string of yarn is connected to the student who has the producer card.

6. That student will then pass along the ball of yarn to the next person, whose card is connected to theirs. This will continue until all students are connected (potentially multiple times).
7. Teacher will introduce an invasive species card and connect it to the web of yarn. Students will then be asked to explain how it will impact the food web.
8. Species cards that are removed from the ecosystem will drop the yarn and explain what the dropped yarn symbolizes.
9. Students will also be referred to the invasive species specimens courtesy of the Yale Peabody Museum. These specimens will later be the focus of the mini-unit task.
10. As a closing activity students will orally, or in a free-write, assess the impact invasive species have on an ecosystem. Teacher will collect written work as a formative assessment.

Extensions:

- Optional Game: Teacher will post biomes around the room and mix all the biome sets of flashcards (will need to cover biome names at the top of each card). Students will then be given the task to match all of the cards to the correct biome.
- Interactive Food Web Activity: Teacher will open up the following website: http://www.gould.edu.au/foodwebs/kids_web.htm. Students may then work individually or as a group, matching individual species to their food web category (e.g. producer, consumer).
- Teacher will introduce Rachel Carson's book *Silent Spring* as a guide for DDT's tracing on food web. Teacher can modify reading for grade-level.

Teacher Notes:

- The biome set cards could be laminated for longevity and multiple uses.
- Attaching Velcro on the back of cards could be used for easier logistics instead of tape or other adhesives.
- Depending on class sizes, it is important to pre-select the species cards so that food chains and food webs can include all the necessary categories (e.g. producer, secondary consumer). This is specific to each biome.

Activity 3: How Did I Get Here?

Purpose: Students will research how an invasive species entered an ecosystem. Using the narrative writing process, the students will write a first person fiction essay explaining how they, in the role of an individual invasive plant or animal, entered Connecticut.

Materials:

- Science Journal, Notebook
- Invasive Species Cards
- Computers (if possible for research and publishing)
- Books, Magazines, Videos, etc. for research
- Emerald Ash Borer video clips from the Don't Move Firewood DVD

Story: Connecticut is being invaded by species that are not indigenous to the area. As scientists, the students need to research how an organism got here and how it affects the biome. The students will write a story explaining how the organism found its way to the Connecticut area and the perceived effect on the ecosystem.

Procedure:

1. The teacher will introduce the writing activity and explain that they will play the role of an author by writing a fiction piece explaining how their organism got to their biome. The teacher can show them one or two video clips of the Emerald Ash Borer (try "The Interview") and discuss its history, etc.
2. The students will research their invasive species to learn about them.
3. The students will write a story, in accordance with their grade standard, with this information to prepare a story about how they got here.

Conclusion: The students will use the writing process to revise, edit, and publish their writing piece to share with the class.

Extensions:

- Publish a class/team book to share with others about the invaders of Connecticut.
- Publish on class/team webpage.

Useful websites for invasive species research:

- http://www.invasivespeciesinfo.gov/animals/faq.shtml
- http://www.mass.gov/dcr/watersupply/lakepond/downloads/aquatic_species.pdf

Activity 4: Oh Deer!

This activity cleverly teaches population dynamics, carrying capacity, and habitat requirements. It was originally a Project WILD activity, part of the Western Regional Environmental Education Council. The Yale Peabody Museum does not have permission to re-publish this activity, but you can find it through Project WILD and in a few other places on the internet.

Be sure to have someone (could be the teacher) collect the number of deer at the end of each round so that you can have the students make a line graph of it later, that you then ask them to interpret, with round/year on the x-axis and number of deer on the y-axis.

Try adding an invasive species to the mix and see what happens. But discuss it first. For instance, if you added the Asian Longhorned Beetle, you might tell the entire habitat line that because the beetle was introduced and killed lots of hardwood trees, and the deer had nothing to eat during the fall and winter (there are places where 50% of a deer's year-round diet is acorns, which of course come from oak trees, and many deer get through the winter by eating "browse" – the buds and twigs of trees and other woody plants), that they have to choose either water or shelter only for that round. In the following round, you could argue that the beetle's long-term impact would also be to reduce the amount of shelter for the deer, so you could have them all be water. Or try to get the students to think through these sorts of effects that invasive species can have on an ecosystem.

The Event-Based Teacher Collaborative was made possible by a National Leadership Grant from the Institute of Museum and Library Services

INVADERS!

Impacts of Invasive Species on Food Webs and Ecosystems

Discovery Files: Relationships in Nature

http://coe.mse.ac.in/images/biodiversity.jpg

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Yale Peabody Museum of Natural History, Event-Based Teacher Collaborative, October 2010

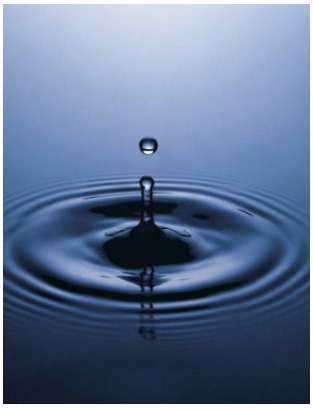
The Event-Based Teacher Collaborative was made possible by a National Leadership Grant from the Institute of Museum and Library Services

DISCOVERY FILE 1: Abiotic and Biotic Factors

Many factors influence every part of our environment: things like how tall trees grow, where animals and plants are found, and why birds migrate. There are two categories of these factors: abiotic and biotic.

Abiotic factors are influences on living organisms that come from the physical environment. Abiotic factors include water, sunlight, oxygen, soil and temperature.

Water is a very important abiotic factor – it is often said that "water is life". All living organisms need water. Without water, animals become weak, disoriented, and can die if they do not rehydrate. Think of how you feel after you take a long run. Do you feel thirsty? This is your body signaling to you that you must rehydrate. Now, consider camels in the hot desert. Unlike you, camels do not have direct, constant access to water, so they must store it inside their bodies for long periods of time so they do not become dehydrated. This cool adaptation allows ca environments.



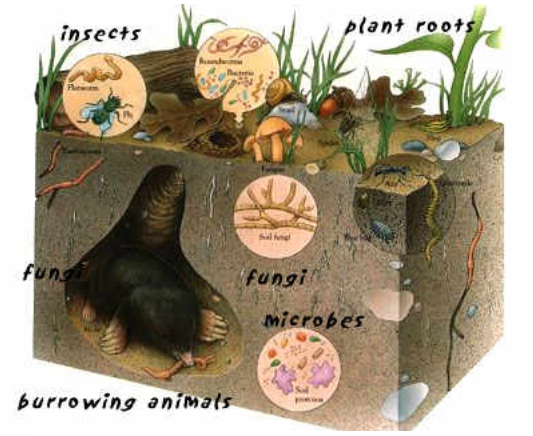
http://www.wsi.nrcs.usda.gov/products/images/wq_drop.jpg

Sunlight is the main source of energy on Earth, which makes it an extremely important abiotic factor. It is necessary for photosynthesis, the process by which plants convert carbon dioxide (CO_2 gas) and water to oxygen (O_2) and sugar – food for the plants that later becomes food for animals. Sunlight excites electrons (tiny negatively charged particles) within the leaves of plants and starts the

photosynthesis process. At night, plants do not photosynthesize because sunlight is not available to excite the electrons. Without the sun, plants could not live, and without plants, animals could not live!

Like water, **oxygen** is another important abiotic factor for many living organisms. Without oxygen, humans would not be able to live! This is true for the many other living organisms that use oxygen. Oxygen is directly linked to sunlight, because its production on Earth is controlled by plants.

Soil is often considered an abiotic factor since it is mostly made up of small particles of rock (sand, clay) mixed with decomposed plants and animals. Plants use their roots to get water and nutrients from the soil. Soils are different from place to place – this can be a big factor in which plants and animals live in a certain area.



http://www.organicgardeninfo.com/images/soil-life.jpg

Temperature is an abiotic factor strongly influenced by sunlight, another abiotic factor. Temperature plays an important role for animals that cannot regulate their own body temperature, such as reptiles. Unlike humans, reptiles (such as snakes, lizards, and frogs) cannot maintain a constant body temperature (for example: our body temperature is usually around 98.6°F). Reptiles are usually found in warm zones around the planet, such as in tropical forests or areas near the equator. To regulate their body temperatures, reptiles will sun themselves on rocks, which absorb heat from sunlight and radiate heat back into the environment. While doing this, reptiles can also absorb heat produced by the sun (known as infrared radiation).

Biotic factors are the living things that influence an ecosystem. Biotic factors include all the living things, such as plants and animals, that influence each other by their eating habits, where they live, and who they interact with. Biotic factors and their interactions can be broken down into three groups:

1. **Producers**. These organisms absorb the sun's energy and convert the energy into food for consumers. An example of a producer is a plant, such as grass.

2. **Consumers**: These organisms eat producers and other organisms. Two examples of consumers are cows (eat grass) and wolves (eat smaller animals).
3. **Decomposers**. These organisms break down dead material (such as a fallen tree) into soil and return nutrients (such as carbon or nitrogen) to the soil so they can be re-used by producers to create food. An example of a decomposer is an earthworm.

DISCOVERY FILE 2: What Makes Up an Ecosystem?

http://static.guim.co.uk/sys-images/Environment/Pix/pictures/2008/03/10/polarbear_alaska_276.jpg

Each living species, or kind of organism, has certain environments where it lives and grows best. For example, polar bears have thick fur, which allows them to live in cold climates. Unlike polar bears, African elephants have very little hair and can also beat the heat by spraying themselves with water. These species live in very different **habitats**, which are places where species can live and grow best depending on their unique needs. Think of your favorite animal. Where would you find it? And where *wouldn't* you find it? This defines its habitat.

Many individuals of a species (for example: 10 leopard frogs) can live in a single habitat (such as a pond in a forest). These individuals of the species are known as a **population** because they are all living in the same place at the same time. Within the same habitat there will also be populations of other species. For instance, in the pond with the 10 leopard frogs, we may also find six water snakes, 19 rainbow fish, and 30 water beetles.

Even though the frogs, snakes, fish, and beetles all live in the same habitat, they are not related to each other because they are different species. Instead, they make up a **community**, which is a group of many different kinds of species living in the same habitat. These populations of species will interact with each other. For instance, one of the water snakes may eat one of the frogs, or one of the frogs may eat one of the water beetles.

An **ecosystem** is made up of these species, their surrounding environment (such as the temperature, their location in the world, and other abiotic factors), and how these living things interact with each other. An ecosystem contains all the processes involved in an organism's life from birth to death, including eating, reproducing, creating shelter, and raising young (depending on the species). As we will read in the future, populations interact with each other in different ways. These interactions are responsible for the functioning of all ecosystems on Earth.

DISCOVERY FILE 3: Predation

Predation is an interaction between a predator and its prey. Any animal that eat other animals when it is hungry is called a **predator**. The animals that are eaten by the predators are called **prey**.

http://www.africacalls.com/Images/cheetah_zebra.gif

Predators have special abilities to hunt their prey. Some predators are very fast, such as cheetahs, which can run up to 60 miles per hour when they are chasing their prey. Other predators have a very good sense of smell and can sense their prey from far away. For example, sharks can smell blood from over one mile away in the ocean. And finally, some predators have remarkable eyesight that helps them see prey in the dark or from far away. Owls can easily catch mice on a dark night, and a hawk sitting in the top of a tall tree can see an ant moving on the ground!

Because predators have these unique skills to catch prey, prey have equally special characteristics to help them avoid being eaten. Some prey travel in packs, such as gazelles and zebras, because their predators, such as cheetahs, have difficulty attacking one individual in a large group; although they may be fast, cheetahs do not have very good eyesight, so a group of zebras looks confusing to it. Similarly, prey have developed advanced body coloring – **camouflage** – that allows them to blend into their environments. Certain types of octopi can change their outer coloring to match their surroundings

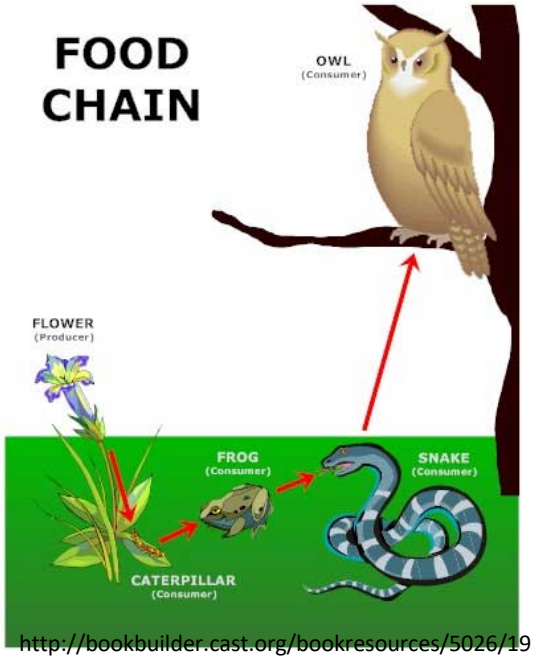
http://i.telegraph.co.uk/telegraph/multimedia/archive/01014/Mimic-Octopus_1014146i.jpg

in the ocean. Can you spot an octopus in the picture to the right? This octopus has blended into the sand on the ocean's bottom!

DISCOVERY FILE 4: The Food Web vs. The Food Chain

All animals need energy to run, breathe, and hunt, and they get this energy by consuming food. Think about what you ate today: that is helping you walk, think, and read! The food web and the food chain are similar to each other, but they are not the same. We will explore the differences here.

A food chain shows a single, connected path of energy flow through an ecosystem. Some animals only eat plants while other animals eat other animals. A food chain shows all the levels of eating within an ecosystem. The arrows show the flow of energy from one organism to the next. Let's examine the example on the right.



http://bookbuilder.cast.org/bookresources/5026/19324_1.jpg

There are six types of organisms in a food chain:

1. **Producers**. These organisms absorb the sun's energy and convert the energy into food for consumers. An example of a producer is a plant, such as the flower in the picture.

2. **Primary consumers**: These organisms eat producers and the food they provide. These consumers only eat plants, so they are called **herbivores**. The primary consumer in the picture is the caterpillar.

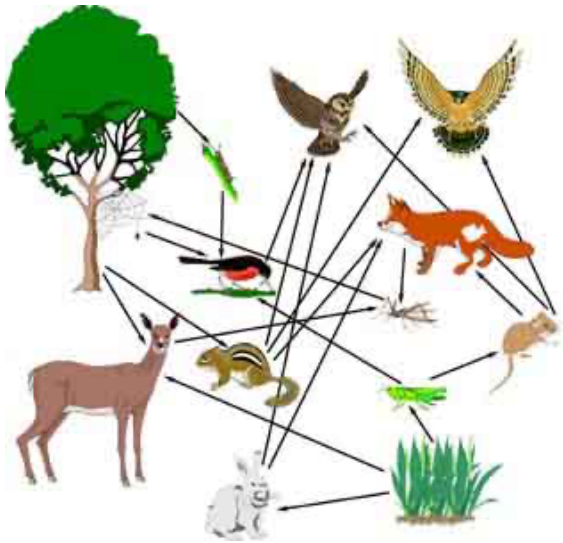
3. **Secondary consumers**: These organisms eat primary consumers (herbivores). Secondary consumers are either **omnivores** (meat and plant-eaters) **or carnivores** (meat-eaters). The secondary consumer in the picture is the frog.

4. **Tertiary consumers**: These organisms eat the secondary consumers and are usually **carnivores**. The tertiary consumer in the picture is the snake.

5. **Quaternary consumers**: These organisms eat the tertiary consumers and are **carnivores**. The quaternary consumer in the picture is the owl. In this picture, the food chain ends with the owl, which claims the title as the top predator.

6. **Decomposers**. These organisms turn dead material (such as a fallen tree) into soil and recycle nutrients (such as carbon or nitrogen) so they can be re-used by producers to create food. The decomposers are not shown in this picture, but they live underground where the flower's roots are. Decomposers include earthworms, small soil beetles, fungi, and bacteria.

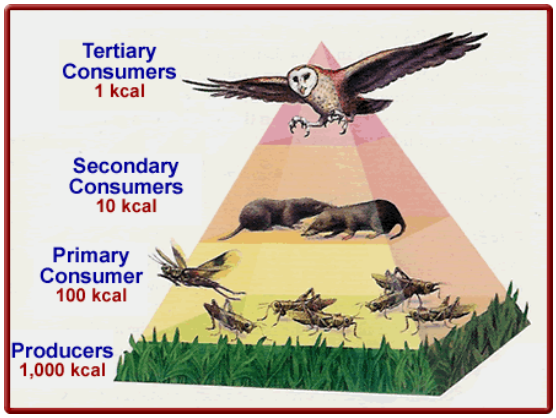
A food web shows how food chains overlap. We can get a very good idea of how plants and animals are related by looking at and constructing a food web. How is the picture at the right different from the food chain picture above?



http://www.bigelow.org/edhab/images/food_web.jpg

In the picture to the right, there are multiple lines from one organism to another. We see that the grass in the bottom right hand corner is eaten by more than just the grasshopper; it is also a food source for the rabbit and the deer. How are the top predators in this food web different from the top predator, the owl, in the food chain? In this food web, we see that there are many top predators, not just one. We can identify three: the owl, the hawk and the fox. We can also note the owl, the hawk, and the fox are all shown as secondary consumers in this food web. The deer is a primary consumer because it only feeds on plants, which makes it an herbivore.

An energy pyramid shows how energy from the sun moves throughout an ecosystem. As we move up the pyramid levels, approximately 90% of the food's original energy is lost from level to level because animals must use their own energy to consume and digest food. The consumers at the top of the pyramid do not have as much energy available to them because their food, another animal, is simply not very good at converting the food it eats into energy in its body.



http://www.mlms.logan.k12.ut.us/~mlowe/EnergyPyramid.gif

In the picture above, we can see that calories (shown here as kilocalories) are lost as we move up the pyramid from producer to consumer. This diagram also shows how plentiful the producers must be to support the predators at the top of the pyramid, such as this owl.

DISCOVERY FILE 5: The Different Kinds of Symbiosis

Symbiosis occurs when two species have a close, long-term interaction that is beneficial to one or both of the species. There are three kinds of symbiosis that we'll discuss today: mutualism, commensalism, and parasitism.

Mutualism is an interaction that takes place between two different species that is beneficial for both of the species. In extreme cases of this kind of mutualism, called **obligate** symbiosis, the two species cannot survive unless they are together – this is the case with many lichens, which are combinations of an algae and a fungus. Most mutualisms are **facultative**, where the species will be OK if they are apart but do much better if they are together! The Disney film *Finding Nemo* demonstrated one of the greatest mutualisms in the natural world between clownfish and the sea anemone. In the picture to the right, we can see that a clownfish is interacting with a sea anemone. Sea anemones have stinging tentacles, but a layer of mucus on the clownfish protects it, and it uses the anemone as a habitat. In return, the clownfish protects the sea anemone from other animals that may want to eat the anemone. As we see here, both the clownfish and the sea anemone benefit from each other in this relationship.

http://www.tommyschultz.com/photos/album/philippines/clown-fish-apo-island/clown-fish-apo-island-3.jpg

Commensalism is a relationship between two species where one species benefits from the other species but does not harm or help it in return. For example, a spider may spin its web on a plant, as shown in the picture to the right. The spider receives the benefit of spinning its web in an environment that has many potential prey (such as flying or crawling insects), but the plant is neither helped nor hurt by the spider doing this.

http://www.inkity.com/shirtdesigner/prints/clipArt1/WR924110.JPG

Parasitism is a relationship between two species where one species (the parasite) benefits from the interaction and harms the other species (the host). A parasitic relationship exists between ticks and warm-blooded animals, such as cats, dogs, deer, and humans. Ticks are a parasite and they feed on warm-blooded animals (hosts) for their blood; the ticks use the blood to produce more ticks. Ticks also carry a variety of diseases with them, and they can infect their hosts with these diseases (such as Lyme disease) when they bite them.

DISCOVERY FILE 6: Competition

Competition is an interaction between different organisms where each plant or animal is working to get the resources that it needs to live and grow, such as sunlight (for a plant) and the best mate (for an animal). Competition is an important factor that shapes ecosystems because plants and animals are constantly competing against organisms similar to themselves to make sure that their own families live on.

Competition happens locally: plants and animals compete with other organisms in their own environments for food and mates. Because plants and animals are so different from each other, they do not compete with one another; plants will only compete with nearby plants, and animals will only compete with other animals in their territory. Additionally, because plants and animals are very different, they compete in different ways.

Plants and animals both compete with organisms in their environments for access to food. Plants are especially good at competing for sunlight, an essential abiotic factor that controls their growth. Let's look at the picture on the right. What do you see the plant doing to out-compete its neighboring plants? This invasive plant species, named kudzu, grows over the other plants surrounding it. By blocking the surrounding plants' direct sunlight, the kudzu is able to out-compete its neighbors and take over. It will kill the plants it grows over, including trees. In this picture, the plant has actually grown entirely over a house!

http://writersforensicsblog.files.wordpress.com/2009/09/kudzu-covered-house.jpg

Unlike plants, animals directly compete with each other for the attention of a mate. Several kinds of male animals, such as lions, bears, and beetles, will fight each other to determine which male is stronger and more suitable to be mate for a female. Deer do this in very impressive ways. Throughout the fall and winter, male deer grow sets of antlers on top of their heads. In early spring, these deer will select a female deer with whom to mate. If another male deer has also selected the same mate or enters another male deer's territory, the deer will fight each other using their antlers to determine which male is stronger. The stronger male in the fight will win access to the territory

and can mate with the female deer. If not killed during the fight, the weaker male deer will move into a new territory and select a new female deer who may or may not have a mate.

DISCOVERY FILE 7: Niche, Natural Selection, and Adaptation

A **niche** is the specialized role that an organism plays in an ecosystem. For instance, a niche could be "large herbivore." A deer properly fits this particular description, but a rabbit does not because it is a small animal.

Natural selection is one of the ways in which evolution works. It occurs when certain members of a species are better adapted for their environment than other members of that species. The organisms that are better adapted are not necessarily bigger, better, or stronger than others, they are just better at surviving or getting the resources they need, and are therefore more likely to have babies and pass on their genes to the next generation. For example, a particularly good camouflage pattern has nothing to do with being stronger, but it could make an animal more likely to survive than others of that species which can't blend into the surroundings as well. Note that this is not a series of "improvements" resulting in a better animal. The key is that the animal does well in a specific environment, not that it is "better" than another.

Adaptation is the process by which a population changes over time to be better suited to its environment. Also, you can say that the individual plants or animals in a population have adaptations that make them well-suited to survive. Natural selection (see above) is the main driving force behind the process of adaptation.

Similar to a niche, **keystone species** are plants or animals that have a very large effect on their ecosystem despite their population size (which is often small). Keystone species are extremely important because they fill a vital niche and interact with a variety of other organisms while they participate in their ecological role.

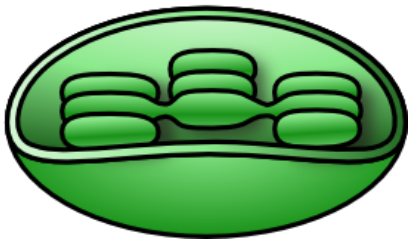
http://www.pc.gc.ca/~/media/pn-np/bc/pacificrim/s/Specie1.ashx

An example of a keystone species is the sea otter, which is found off the west coast of the US. Sea otters eat sea urchins, which primarily eat algae in the form of kelp. Because sea otters keep sea urchin populations low, kelp flourishes in the ocean and decreases the populations of barnacles, mussels, and chitons. Kelp also provides shelter for fish and other sea organisms. Because of this, areas with sea otters also have increased populations of harbor seals and bald eagles who feed on these fish. In an experiment that removed sea otters from these areas, scientists noted that sea urchin and

other herbivore populations increased, which caused a huge decrease in kelp and an increase in barnacles and mussels.

DISCOVERY FILE 8: Abiotic Factors of Plants for Photosynthesis

Photosynthesis is a process in which carbon dioxide (CO_2) and water is changed into sugar and oxygen (O_2) by plants. Plants use the carbon from the carbon dioxide to make the sugar and release oxygen in return. The process of photosynthesis takes place in chloroplasts, which are tiny structures in plants' leaves (see image to the right). The ovals within the chloroplasts are called chlorophyll, which are even tinier structures that are very sensitive to light. Because of this, photosynthesis is controlled by sunlight, the amount of carbon dioxide in the air, and the temperature. The formula for photosynthesis is:



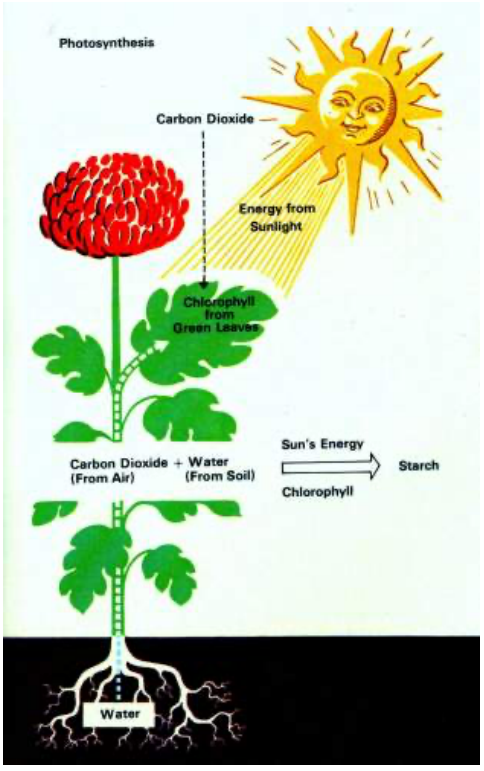
http://www.clker.com/clipart-16397.html

$$\mathbf{6CO_2 + 6H_2O + Energy \rightarrow C_6H_{12}O_6 + 6O_2}$$

There are two stages of photosynthesis: the reactions that require sunlight (light reactions) and the reactions that take place in the dark (dark reactions).

In the light reactions, sunlight shines onto leaves and enters the chloroplasts. The sun's energy is very powerful and beams into the chlorophyll structures. Because chlorophyll is very sensitive to sunlight, it immediately reacts to the sun's energy by transferring this new energy to electrons, which are remarkably tiny particles, inside the chlorophyll. These tiny particles become excited and start a process that makes energy for the plant. This is when carbon dioxide is converted to oxygen. Photosynthesis only occurs during the day.

While the plant is in the sunlight, it stores up energy that it will use during the night. When it is dark, the plant uses this stored energy to condense carbon that it has gained from carbon dioxide in the air while it was light out. This carbon is food for the plant, which allows it to grow taller or make bigger leaves. This process that occurs at night is known as the Calvin Cycle.



http://www.chrysanthemums.info/Photosynth/photosynth.jpg

Plants do not only produce oxygen! At night, plants produce some carbon dioxide, just like humans. This happens because the plant is using energy to condense the carbon it stored up during the day. Plant respiration only happens at night or on very cloudy days.

Species List for Biome cards in Food Chain/Food Web Modeling Activity (* indicates accompanying specimen(s))

Tropical Rainforest Biome:

- Cane Toad (invasive)
- Golden Lion Tamarin
- Giant Anteater
- Jaguar
- Red-eyed Tree frog* (plastic model)
- Toco Toucan
- Anaconda
- Banyan Tree
- Bamboo*
- Vanilla Orchid
- Leaf-Cutter Ants*
- Greenwing Macaw* (feather)
- Amazon Parrot* (feather)
- Goliath Bird-Eating Spider
- Fly
- Mushroom

Tundra Biome:

- Japanese knotweed (invasive)* (see invasive species box)
- Snowy Owl

- Salmon
- Arctic Tern
- Cotton Grass
- Gyrfalcon
- Mosquito
- Caribou
- Moss
- Tundra Swan
- Arctic Hare
- Arctic Fox
- Musk Ox
- Lichens*
- Dwarf Birch trees
- Polar Bear

Grassland Biome

- Axis Deer (non-native) eats grass, other plants
- Blue stem grass
- Indian grass
- Prairie Dog
- Coyote* (skull)
- Silver maple tree
- Bison
- Western meadowlark
- Rabbit

- Ant
- Mosquito
- Smooth aster plant*
- Red-tailed hawk* (talon replica)
- Mouse* (skull)
- Dung beetle*

Desert Biome

- Cactus moth (invasive)
- Desert tortoise
- Kangaroo rat
- Prickly-pear Cactus
- Texas Horned Lizard*
- Scorpion*
- Grasshopper*
- Annual Flowers
- Rabbit
- Rattlesnake
- Tarantula*
- Kit Fox
- Vulture
- Burrowing Owl
- Mountain Lion
- Centipede*

Deciduous Forest Biome

- Asian Longhorned Beetle (invasive)* (see invasive species box)
- Wood Frog
- American Black Bear
- Raccoon
- Least Weasel
- Mosquitoes
- Eastern Chipmunk
- Cooper's Hawk
- Red Fox* (skull)
- Carpet Moss
- Milk Cap Mushroom
- American Beech
- White-footed mouse* (skull)
- White-tailed deer* (skull and fur)
- Hayscented Fern*
- Wild Turkey* (feather)

Boreal Forest/Taiga/Coniferous Forest

- Octagonal-tailed worm (invasive)
- Black fly
- Lichen*
- Grizzly bear* (front claw replica)

- Wolf* (track replica)
- Great horned owl
- Mushrooms
- Jack pine tree
- Aspen tree
- Black huckleberry
- Porcupine* (quills)
- Snowshoe hare
- Moose
- Beaver* (skull)
- Red squirrel
- Grouse

Sunlight cards

CT Freshwater Aquatic

- Zooplankton
- Algae
- Mosquito larvae
- Duckweed
- Water lily
- Eurasian watermilfoil (invasive)
- Water striders
- Whirligig beetles

- Dragonflies
- Snails
- Omnivorous crayfish
- Freshwater mussels *(Anodonta)*
- Banded sunfish eats aquatic insects
- White sucker (bottom feeder) eats aquatic insects, crayfish, snails, freshwater mussels
- Bluegill when young feeds on zooplankton; later aquatic insects and other invertebrates
- Tessalated darter eats aquatic insects, small crustaceans
- Pumpkinseed eats aquatic insects and snails
- Brown Bullhead (only native catfish) bottom feeder
- Native Yellow Perch(most colorful and most common lake and pond fish)
- Large Mouth Bass (introduced species) eats other fish (most popular freshwater fish)
- Northern Water snake
- Painted turtle
- Wood frog tadpoles
- Red spotted newt

- Green frog
- American toad
- Spotted salamander
- Osprey
- Bald eagle (seasonal)
- Mallard (herbivore)
- Great Blue Heron

POTENTIAL INVASIVE SPECIES: Northern snakehead fish – not in CT at this time

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Court rules against Monk Parakeet nests

Updated: Thursday, 04 Nov 2010, 12:37 PM EDT
Published : Thursday, 04 Nov 2010, 9:05 AM EDT

By: Matt Scott

West Haven, Conn. (WTNH) - In a decision that some people may say isn't for the birds, an appeals court has ruled in favor of United Illuminating in a court case filed by an animal protection group trying to protect Monk parakeets.

The birds have been nesting here for years. More than 100 are nests on top of utility poles overlooking shoreline communities including Milford and West Haven. UI claims the Monk parakeet population has been causing power outages and they want the nests gone.

The group Friends of Animals got their feathers all riled up and filed lawsuit to protect the Monk parakeets. But in a decision released Wednesday the Connecticut Appellate Court ruled that parakeets causing health and safety hazards are not protected by state regulations that apply to wild birds.

- *Read The Opinion Here*

The birds will be captured alive and then turned over to the US Department of Agriculture. The USDA will decide what to do with the birds -- which will likely result in euthanizing.

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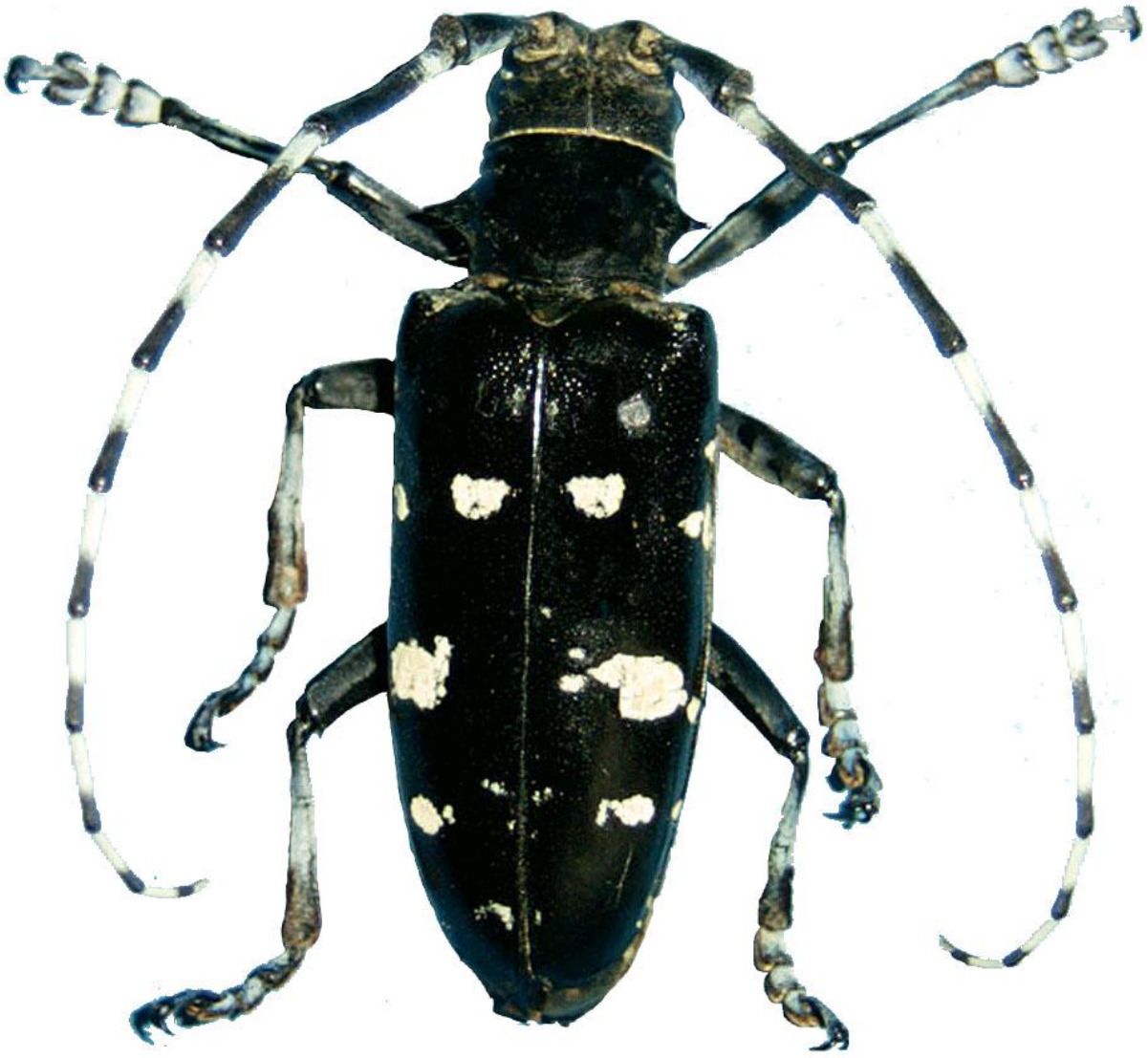
Asian Longhorned Beetle

Anoplophora glabripennis

(actual size: 2.5 – 4 cm)



Photograph by Michael Bohne

INVASIVE SPECIES

Emerald Ash Borer

Agrilus planipennis

(actual size: 10 – 13 mm)

Photo: National Park Service

INVASIVE SPECIES

additional units, no links?:

Animal Olympics (CT Science Standard 10.5)

Thirst! (CT Science Standard 9.8)

Rude Crude (CT Science Standard 9.8)