



Ecology and Energy Flow

9th - 12th Grade

Duration

Pre-Visit: 45 minutes

Visit: 1 hour

Post-Visit: 30 minutes

Location

Nature Gardens

Supplies

- Worksheets
- Pencils
- Clipboards
- Optional: Camera

Standards

[NGSS HS-LS2.B](#)

[Science and Engineering Practices 2: Developing and using models](#)

[Crosscutting Concepts 4: Systems and system models](#)

Vocabulary

Ecosystem

Interdependent

Ecological Model

Inventory

Species

Producer

Consumer

Feeding Strategy

Concepts

- Plants convert energy from the sun into biomass, making it available to other members of an ecosystem.
- Energy is a dynamic property that makes organisms in an ecosystem interdependent.
- Models help describe interrelationships of organisms in ecosystems
- Different models have different purposes and “tell different stories.”

Objectives

- Students will observe and inventory organisms found in the Nature Gardens.
- Students will describe and classify organisms by trophic level and feeding strategies.
- Students will interpret the energy flow between organisms in the by using collected data.
- Students will compare what is observed in the Nature Gardens to what the models say should be here.

Outline

1. In one classroom session before visiting the Museum, introduce the idea that members of an ecosystem or habitat are interdependent, and classify organisms into trophic levels and feeding strategies.
2. At the Museum, inventory species in an area of the Nature Gardens, then organize data into two ecological models.
3. Back in the classroom, compare species inventories. Reflect on observations of the habitat and the use of the different ecological models and the anticipated members of the ecosystem.

References & Resources

Urban patterns and ecosystem function

http://link.springer.com/chapter/10.1007/978-0-387-75510-6_3

Energy Flow Through Trophic Levels

<http://www.pdesas.org/module/content/resources/16339/view.ashx>

Habitat Preferences and Distribution of Mammals in Chaparral California

http://www.fs.fed.us/psw/publications/documents/psw_rp202/psw_rp202.pdf

Living with Mountain Lions

http://www.azgfd.gov/w_c/urban_lion.shtml

<http://articles.glendalenevnewspress.com/keyword/mountain-lion>

Fire Effects Information System, Species Entry, Mountain Lion

<http://www.fs.fed.us/database/feis/animals/mammal/puco/all.html>

Postfire Biological Assessment in Southern California

<http://www.dfg.ca.gov/rap/socal-fire.html>

New Cougar Sighted, Captured New Hollywood

<http://www.werc.usgs.gov/outreach.aspx?RecordID=130>

Mammals of North America Database, Mountain Lion

http://www.mnh.si.edu/mna/image_info.cfm?species_id=287

Keep Me Wild, Mountain Lion

<http://www.dfg.ca.gov/keepmewild/lion.html>

Mountain Lions Vs. Outdoor Enthusiasts?

<http://www.nationalgeographic.com/adventure/survival/mountain-lion-attack.html>

Vertical Food Web Example from United States Geological Survey

http://en.wikipedia.org/wiki/File:Chesapeake_Waterbird_Food_Web.jpg#filelinks

Horizontal Food Web Example from United States Department of Agriculture

http://en.wikipedia.org/wiki/File:Soil_food_webUSDA.jpg

Energy Pyramid Example from Mark David Thomson

<http://en.wikipedia.org/wiki/File:TrophicWeb.jpg>

Pre-Visit

In the classroom, explain that we are going to look at energy movement through an ecosystem. Organisms are interdependent on each other because all living things need energy to live. Distribute *Mountain Lions and Wildfires* narrative to open the discussion and provide a local example of organism interdependence.

After reading, list the organisms in the narrative (or use *Trophic Level Cards*). Add any to make the example accessible to students. Discuss the interdependence of these organisms. Questions might include:

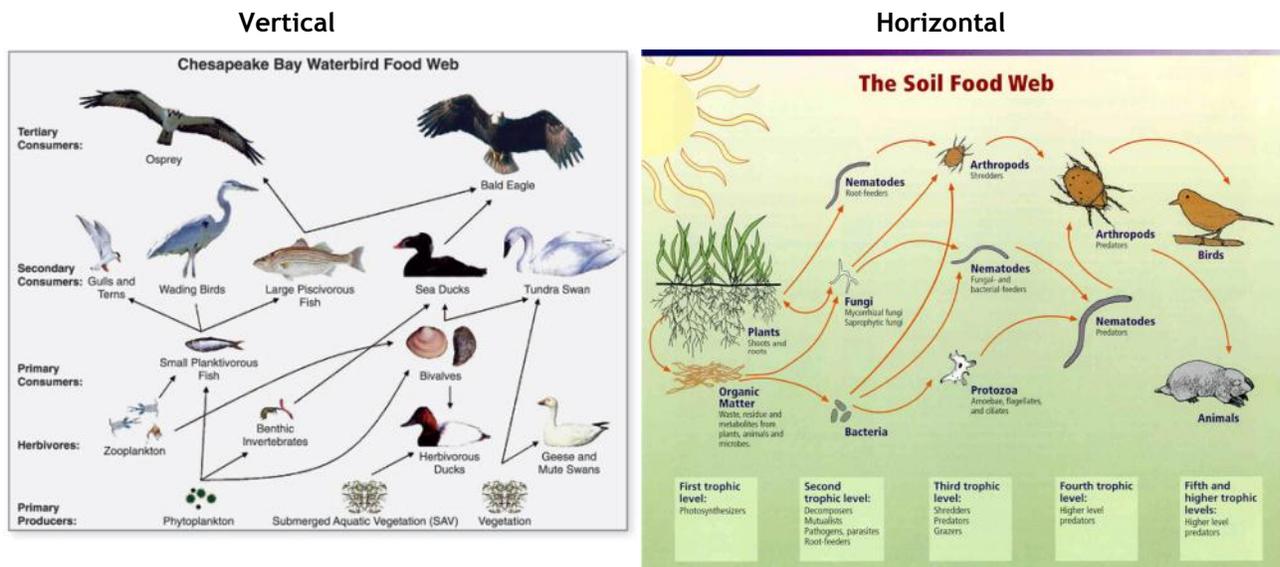
- What features (parts) of the habitat did the fire damage?
- What is the connection between the fire and the changes in population in the deer following it?
- How do the increased deer population affect the mountain lion population?
- How might this demonstrate the general predator-prey relationships?

Teacher's Note: Depending on fire frequency, intensity and longevity, some plants survive fires and regenerate their soft tissues in spring, or prepare for germination by the fire.

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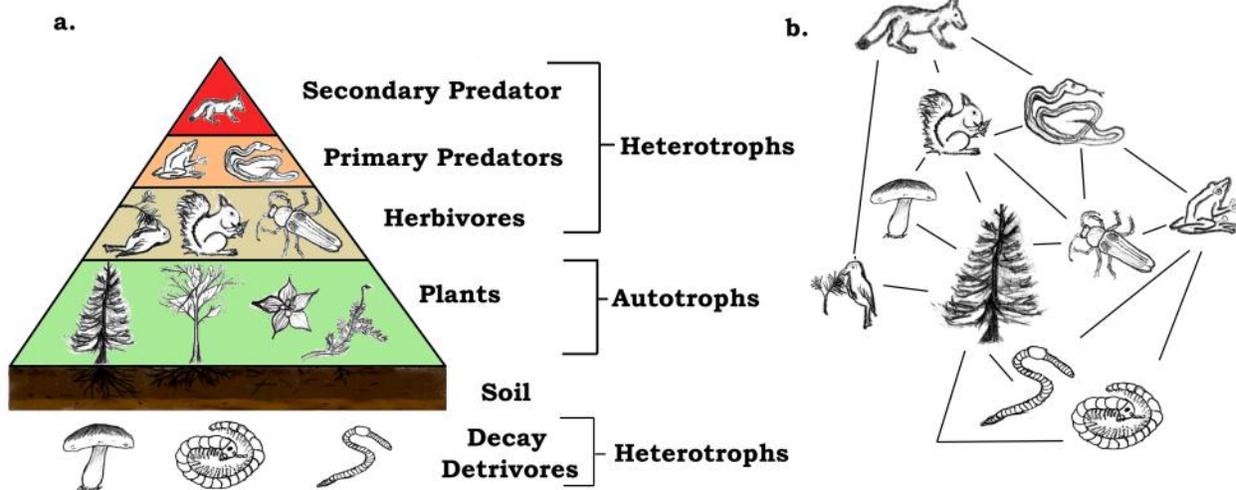
Now introduce vocabulary: producer, consumer, herbivore and carnivore. As a class, use the *Trophic Level Cards* and identify each organism's feeding strategy. Arrange the cards in a vertical food web to indicate their trophic levels and interactions with each other. Explain that vertical food webs are one model that helps us see how energy flows between organisms in an ecosystem, another is an energy pyramid. Draw an energy pyramid on the board, and together place organisms into the model.

Teacher's Note: Examples of food webs organized by trophic levels, followed by an energy pyramid



Energy Pyramid

Image courtesy Mark David Thompson



Tell students they are going to create these kinds of models using their own data from the Nature Garden's at the Natural History Museum.

To do this, they will record organisms they find in the Nature Gardens. Pass out the *Species Inventory List* and go through it. At the Museum, they will make observations of at least ten kinds of organisms, including: it's type (insect, mammal, bird, plant - species if available), number of individuals of that species, the trophic level (consider feeding strategy), size, and any identifying characteristics that distinguish the organism from others around it.

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Include observations about feeding strategy when possible. They may not see active feeding, but can infer an organisms diet using other evidence; such as munch marks on plants, insects trapped in webs or from further research from a valid resource. Additionally, they will document contextual data such as location, time (including date and time of day) weather (including temperature and conditions) and any other information they feel is relevant and might be impacting their observations.

Students do not need to identify down to species. The purpose is to make careful observations that indicate trophic level. Encourage students to record distinguishing characteristics for future identification and research. One helpful prompt is “Could I find this specific plant by using your description?” In addition to drawing or writing, students may choose to photograph their specimens.

Organize students into small groups for the field trip and choose or assign their specific area in the Nature Gardens for data collection. Tell them each part of the Nature Gardens represents a unique habitat, and they will have better data if their research applies to a specific section of the garden.

Teacher’s Note: To ensure groups are distributed throughout the Nature Gardens, pre-assign sections using the map on the downloadable [Chaperone Guide](#). If you would like students to have their own copy please print and photocopy it for them before your visit.

Museum Visit

Gather students in the Nature Garden and remind them of the objective. Help navigate students to research areas. Give them 20 minutes to work, then assess progress and give more time if necessary. To provide incentive to finish, they need a teacher’s signature after ten documented specimens.

Next, direct students to use data from their *Species Inventory List* to build a vertical food web using the provided worksheet *Model Data: Vertical Food Web*, then an energy pyramid using the *Model Data: Energy Pyramid*. This may also be completed as homework or back in the classroom if time or attention is short.

Teacher’s Note: Pending student experience and prior knowledge, you may need to talk through some specimens natural history, or give homework or classroom time to complete research before modeling.

Post-Visit

Back in the classroom, have students in each group compare their models and discuss why there might or might not be differences. Repeat this exercise with the classroom to compare and contrast different areas within the Nature Gardens.

General reflection questions might include:

- Are there differences between different areas of the Nature Gardens based on the models? What are they, and why might we be seeing them?
- These two models use the same data, they communicate different information. What might the food web tell us that the energy pyramid doesn’t, and vice versa?
- Which type of model best described and demonstrated all of the different feeding relationships?
- Which type of model reflected the appearance of the habitat/ecosystem best?
- Why might looking at both of them might be more valuable than just using one of the other? (For example, the web shows specific relationships between individuals in the ecosystem, but lacks describing their relative abundance. However, the pyramid shows us abundance, but does little to explain the interrelationships between species.)
- Were certain habitats in the Nature Gardens more productive based on the number of consumers, total species, biomass?
- Regarding top predators, what do these kinds of models predict *should* be there?
- Why might they be minimally represented, or even absent from our results?
- How might the contextual data collected inform our results? (For example, crowds might cause organisms to change behavior, the time of day or year might impact when organisms are more or less active, weather might bring out or discourage certain kinds of organisms)

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Variations & Extensions

- Have students complete a *Species Inventory List* at their school campus and compare the habitats of the Nature Gardens with the school campus. Why might there be differences or similarities?
- Based on their models, ask students if they would consider the ecosystem “healthy”. Why or why not? Then, consider the biodiversity of the Nature Gardens represented in their *Species Inventory List*. How might biodiversity inform their models? How might it inform their understanding of “healthy”?
- Students can investigate energy pyramids by counting individual members of the ecosystem in addition to the species inventory list. Using that data, students can assess if their energy pyramids with the number of individuals matches the predictions established by the “Rule of Ten” concept.
- Contribute student observations at the Museum and schoolyard into to an iNaturalist project (or create your own classroom project). Or, use the iNaturalist platform as a place to collect student observations to later download for the modeling activity. For more visit www.inaturalist.org

Mountain Lions and Wildfires

Here in Southern California, mountain lions indicate the health of our wild habitat. By looking at their presence at the wildland/urban interface, we can see the interconnectedness of the organisms in our local environment.

Mountain lions are large solitary carnivores, that maintain expansive territories ranging from 10 -150 square miles. As young mountain lions mature, they separate from their mother to look for mates and find territory, and food, to call their own. When impacts to the natural habitat occur, such as wildfires, mountain lions are displaced from their territories and into surrounding areas until their food base returns to their normal range.



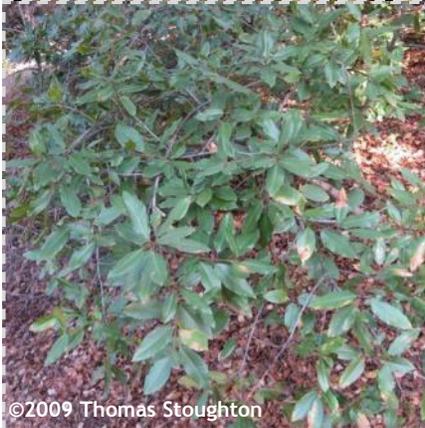
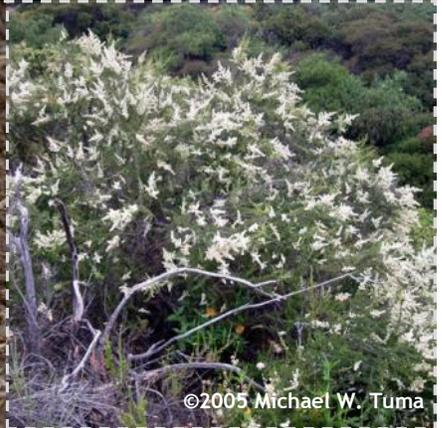
After the Station Fire in 2009, there were many reports of mountain lions in Glendale, La Crescenta and La Canadathe, areas around the Verdugo and San Gabriel mountains. These sightings increased throughout 2010, as mountain lions moved into surrounding urban areas looking for new territory and food.

Though wildfires have a negative impact on mountain lions, after a couple years there is some benefit from the after effects of fire.



The natural regeneration of plants (primary producers), soil organisms, and small rodents and insects (primary consumers) is followed by an increase of their prey populations (deer) that are attracted to the new plant material (forage) that is more succulent, abundant and easier to find after a fire. This increase in food results in a temporary expansion of mountain lion populations after wildfires.

Ecology and Energy Flow: Trophic Level Cards





Ecology and Energy Flow

Collect Data: Species Inventory List

In the Nature Gardens, complete the table below for at least 10 organisms.

Location:

Other Observations:

Time:

Weather:

Organism	Number of Individuals	Approximate Size <i>Use your body as a reference</i>	Distinguishing features or behavior	Trophic Level
Eg. Hummingbird		About 1/2 the size of the palm of my hand	Bright red iridescent neck, feeding at nectar stations and nearby flowers	Herbivore/Nectarvore— Primary consumer
1				
2				
3				
4				
5				



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Species Inventory List Continued

	Organism	Number of Individuals	Approximate Size <i>Use your body as a reference</i>	Distinguishing features or behavior	Trophic Level
6					
7					
8					
9					
10					

Teacher Signature: _____

Model Data: Vertical Food Web

Using your *Species Inventory List*, place organisms into their trophic levels and use arrows to indicate how energy flows from one organism to another.

_____ *Garden Location*

Tertiary Consumers	
Secondary Consumers	
Primary Consumers	
Decomposers	
Primary Producers	

Model Data: Energy Pyramid

Using observations from the *Species Inventory List*, place organisms into the energy pyramid below:

_____ *Garden Location*

