



# Vital Links

**Grade:** 6

**Subject Areas:**  
Life Science, Social Science

**Skills:** modeling,  
identifying, observing,  
predicting, reading

**Duration:** 1 hour

**Connections:**  
ecology, forestry, natural  
resource planning

## Vocabulary

ecosystem

community

competition

predation

niche

carnivore

herbivore

keystone species

decomposition

## Objective:

**Students will understand certain species are vital to the overall integrity of an ecosystem and are referred to as keystone species.**

## Materials

- rectangular wooden blocks
- cavities
- picture(s) of an old growth forest
- description cards
- pictures of pileated woodpeckers with nest

## Standards

**Strands: Excellence in Environmental Education Guidelines**

**Strand 1 — Questioning and Analysis: E) Organizing Information:** Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation. **F) Working with models and simulations:** Learners understand many of the uses and limitations of models. **G) Developing explanations:** Learners are to synthesize their observations and findings into coherent explanations.

**Strand 2 — Env. Processes and Systems: 2.2 The Living Environment: C) Systems and connections:** Learners understand major kinds of interactions among organisms or populations of organisms.

**Strand 3 — Skills for Understanding and Addressing Environmental Issues: 3.1 Skills for Analyzing and Investigating Environmental Issues: B) Sorting out the consequences of issues:** Learners are able to apply their knowledge of ecological and human processes and systems to identify the consequences of specific environmental issues.

## California State Educational Standards:

**Life Sciences (Ecology) 5b:** Students know matter is transferred over time from one organism to others in the food web and between organisms and the physical environment

**5c.** Students know populations of organisms can be categorized by the functions they serve in an ecosystem.

**5d.** Students know different kinds of organisms may play similar ecological roles in similar biomes.

**5e.** Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

# Background

## Adapting for Peace

An **ecosystem** is defined by both the living and non-living things in an environment and how they interact with each other. Many interactions happen between living and non-living things. For instance, trees are woody plants. They are the dominant species in a forest and grow above the plants living below them producing much shade. Many flowering plants that grow in the shade of larger trees time their peak growing and blooming periods according to high light levels. Others plants may grow up the trunks of trees using them as a sort of scaffold to get to necessary light. The amount of light received is a non-living (abiotic) factor. The growth patterns of plants are living (biotic) factors.

An ecological **community** is all of the plants and animals living within a particular ecosystem. Many relationships exist between species within the same community like **competition** and **predation**. Competition influences a community the most and occurs between species when a shared resource limits the growth, survival or reproduction of each species.

There are many adaptations that reduce competition. For instance, a variety of birds hunt for insects in trees. As they search for insects, some birds move up the tree, and other birds move down the tree. As they peck around looking for tasty morsels to eat, they can lessen competition between each other by searching in opposite directions. Other birds have strong, sharp bills, like woodpeckers, that can reach insect larvae living below the top layer of bark. Still

other birds will forage in the tree tops looking for food in the canopy while others search in the lower branches of trees. All of these birds may be hunting for insects and their larvae, but their behaviors and collection methods differ. The different ways plants and animals survive is referred to as their **niche**.

## Keystone Species

In a given ecosystem, there are animals that have an above average role, these are called **keystone species**. Compared to their relative abundance, these particular species have a disproportionately large impact on their community and/or ecosystem in their function or structure. For instance, if top **carnivores** are removed from an ecosystem, like mountain lions, the populations of the **herbivores** preyed upon increases, such as deer. If deer populations soar because their main predator has been eliminated, they will overgraze an area. Overgrazing by deer of young trees, shrubs and other vegetation leaves less food for other animals. Many animals that depend on vegetation such as insects and rodents may begin to disappear; and the entire ecosystem gets out of balance and may even collapse as a result of the disappearance of a top predator.

Keystone species get their name from an architectural term. A keystone is the wedge-shaped stone at the crown of an arch that holds the other stones in place. When applied to ecological principles, **keystone species** can be categorized by predators, prey, mutualists, hosts and habitat modifiers. The mountain lion scenario

given above is an example of a keystone predator.

In the preserved forests of the King Range National Conservation Area, lives the largest species of woodpecker in North America, the pileated woodpecker. The pileated woodpecker is a keystone species. It is a habitat modifier for old growth and secondary growth forests in the Pacific Northwest. The overall range of this woodpecker species extends beyond the Pacific Northwest region, but studies done here, show many species are dependent on the cavities these birds create as they hunt and nest. Hollow chambers that occur naturally in trees are important to many species for nesting, roosting, and resting. Pileated Woodpeckers excavate both dead and living wood while looking for appropriate nest sites several feet above ground. Because this species of woodpecker is large, it can make a nest cavity that is thick walled and deeper compared to cavities made by other birds and natural processes like decay. In turn, these bigger cavities once abandoned, provide habitat for secondary users which include squirrels, bats and other birds. In addition to making cavities for nests, pileated woodpeckers also excavate while foraging. They eat insects and prefer carpenter ants and bark beetle larvae. They dig deep into heartwood searching for these insects and inadvertently help the forest by reducing bark beetle damage. As they use their chisel-shaped bills to find food, they make new habitat for secondary users. It is the only species that excavates extensively into sapwood and heartwood looking for food. In addition, as it probes into wood, it makes available invertebrates for other bird species to eat. Some

birds are known to follow foraging pileated woodpeckers looking for a meal they may have left behind. One study done by the US Forest Service has revealed that these nests provide extra protection against predators as well.

Lastly, pileated woodpeckers speed up the process of **decomposition** as they break apart wood. They expose wood to insect attack and fungal infections quicker than normal decay would allow. Wood softened by heart-rot fungus is essential for the production of certain nests. Both birds and bats have been known to use large cavities inside living trees that were originally started by pileated woodpeckers. (see attached species list of species known to use pileated woodpecker cavities)

As people modify the environment, proper land management is necessary. In order to maintain and restore forests and other habitats to the desired structure and function, monitoring and assessment of key species is sometimes used. By maintaining the needs of keystone species, many other species are benefited. The management of indicator species (MIS) is becoming controversial, however. It is difficult to identify all variables affecting a change in a population of a single species because of the complexities interconnectedness of living things.

Pileated woodpeckers are primary cavity builders. Because of their large size they correspondingly choose large cavities in snags and living trees for nesting and roosting. Without these birds, the structure of the forest would not provide the deep strong-sided cavities many species depend on for their optimal habitat. They are only one example of a keystone species living in the forests of Pacific Northwest.

# Local Connection

## Humboldt Bay National Wildlife Refuge

The Humboldt Bay National Wildlife Refuge (HBNWR) is located on the west side of Highway 101 just south of the city of Eureka. It has two main purposes. To protect and enhance wetlands and bay habitats visited by migratory birds, and to protect endangered species and their habitats. Over 100 species of migratory birds use Humboldt Bay as a stop over point during their annual migration along the Pacific Flyway. Four bird species found there are considered sensitive including two species of geese. The Aleutian goose use to be considered a subspecies of the Canadian goose and prefers open pasture land. During the spring, flocks of several hundred geese dot the landscape. The black brant is a rare small sea goose that visits areas rich with eelgrass before flying to their Arctic breeding grounds. Humboldt Bay is an important source of eelgrass and the HBNWR continues to enhance and monitor this vital resource.

The most popular part of the refuge has two easily accessible trails open seven days a week. The 1.5 mile Hookton Slough trail stretches along the levy bordering the slough and provides an expansive view of this productive ecosystem. Next to the Richard J. Guadagno Visitor Center is the Shorebird Loop Trail . This 1.75 walk takes one through multiple habitats including, open fields, willow thickets and ponds. Thousands of ducks, geese, shorebirds, and swans can be viewed from both trails during the wet season, especially spring. The visitor center offers information, guided walks and other environmental education opportunities and is a great place for a field trip.

# Activity 1: Keystone Tower

## Procedure

1. Introduce different ecological terms that will be applied to the understanding of keystone species (ecosystem, community, habitat, niche, predation, etc.). Find out what students already know about local ecosystems by asking them some questions. As students give feedback, write down key words on the board that will be used throughout this lesson. An option is to have students take notes.

2. Give an example of a keystone species (not a pileated woodpecker) such as the sea otter. Sea otters became endangered because they were hunted for their beautiful pelts (fur). Fishermen noticed that the amount of fish had declined in places where sea otters were removed. It turns out that sea otters keep the amount of sea urchins in check because they are a favorite food. Sea urchins graze on kelp which many other animals, especially fish, depend on for food and protection. When the sea otters were removed, the population of sea urchins increased so dramatically that beds of kelp began to disappear along with the numbers of fish. The result of removing sea otters had an affect on the entire food chain.

3. Using an example such as this one, have the students pick out which animal has a disproportionate role compared to the rest. (more significant role compared to others). In the above example, you could give the students a choice: sea otter, sea urchin, bottom fish, or kelp.

## Materials

- rectangular wooden blocks

4. To model a keystone, the students will set up a stack of blocks three blocks wide and five blocks high alternating the direction they face. They should figure out which block or blocks are more significant to holding up the overall structure compared to the rest. One by one, the students should remove any blocks that are not vital while maintaining the height of the tower. In other words, they are to make a model of a tower and identify the “keystone”. There may be more than one block that is crucial to the integrity of

the tower, but that is okay. The students can assess the accuracy of using a model like this. After all groups have predicted the keystone species, the papers should be collected and announced. Write down all predicted species on the board with tallies behind the name. (Hopefully, most will have picked the pileated woodpecker). Give the correct answer and explain why. At this time, show them a few pictures of pileated woodpeckers and the cavities that they make.

- *What kind of local habitats have you observed?*
- *What does a habitat provide for the wildlife that lives there (food, water, shelter, space)?*
- *What do you suppose is meant by conservation area? Who knows where the King Range NCA is?*
- *What are other examples of protected land?*
- *Who thinks they know the difference between a conservation area and a wilderness area?*
- *What activities are allowed in a wilderness area?*
- *Why do you think it is important to protect certain lands?*
- *Does anyone know of a local animal that is considered endangered? (coho salmon, gray wolf, California condor, sea otter)*
- *Do you think certain lands are managed based on the species that live there?*
- *What do you think the word keystone means?*
- *Why do you think some animals are referred to as keystone species?*

## Activity 2: Identifying a Keystone Species

### Procedure

**1.** Students will work in groups to identify a keystone species by comparing description cards. Before breaking them up into groups of 4-6 people, show them pictures of a forest. Discuss sources of food, shelter, water, and space that a forest provides. Explain to them that they will use clues provided on description cards to assess what one species has a more significant role compared to all the rest. In other words, they are to find the one species that has an above average roll because the other species depend on it in some way. You may want to suggest a few ways for them to identify the keystone species. For instance, you may want them to underline common words found on each card. Another possibility is to have the students list requirements (needs) given for each species versus behaviors or preferences. Perhaps by listing requirements, the students can find a need that is dependent upon the actions or behaviors of another species.

**2.** Since there are six cards, groups of six work well. Break the students up into groups. Each student should read one card to the rest of the members in their group. Together they should discuss the information given on their description cards in hopes of identifying which one affects the others.

**3.** Have each group write down the predicted keystone species. In this example (pileated woodpeckers as keystone species), the role of the

### Materials

- picture(s) of an old growth forest
- pictures of pileated woodpeckers with nest cavities
- description cards

woodpecker is one of a keystone architect. The pileated woodpecker makes suitable homes for the rest of the species.

**4.** During the group activity, wander the classroom to assess and assist where necessary. After every group has had time to make a prediction (10-15 minutes), have each group share their answer.

Write the answers on the board even if some are incorrect.

**5.** In conclusion, show them a picture of a pileated woodpecker. Explain the reasons why the pileated woodpecker is a keystone species. You may also want to go over each description card in hopes of improving their critical thinking skills.

- *What was difficult about this assignment?*
- *Do you think the field observations scientists typically make are usually easy or straight forward?*
- *Can anyone give me an example of an animal that is making a comeback after being scarce? (bald eagle, California condor, Roosevelt elk)*
- *Did these populations come back naturally or did humans assist in their recovery?*
- *What tests might one do in order to identify a keystone species?*

## Extensions

- Have students research keystone species in tropical rainforests or other ecosystems.
- Introduce the concept of endangered and extinct animals and plants, and how their absence affects a particular environment.
- Have students role play different characters involved in resource management given a hypothetical situation.
- Encourage local stewardship by having students remove non-native invasive species.
- Find population statistics for certain species and have students graph the numbers.

## References

- Aubry, Keith B., Raley, Catherine M., The Pileated Woodpecker as a Keystone Habitat Modifier in the Pacific Northwest, USDA Forest Service Gen. Tech. Rep, 2002
- Humboldt Bay National Wildlife Refuge, <http://www.fws.gov/refuges/profiles/index.cfm?id=81590>, 2011
- Keystone species, <http://darwin.eeb.uconn.edu/eeb310/lecture-notes/interactions/node2.html>, 2010
- Information cards edited using information from: <http://animaldiversity.ummz.umich.edu>, 2010
- Pileated Woodpecker, Management Indicator Species for the New Plan, [http://www.fs.usda.gov/Internet/FSE\\_DOCUMENTS/fsm9\\_030575.pdf](http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_030575.pdf), 2010
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## FOSS Connection

Grades 5-6: Life Science  
Environments  
Grades 5-6: Alternative Module  
Living Systems

**WOOD DUCK**

Wood ducks live in a variety of places including lakes, rivers, creeks, beaver and farm ponds and various other freshwater sources. Wood ducks are cavity nesters. They need to have a nest within one mile of water that can fit a family of wood ducks. When it is time for the chicks to leave the nest, they jump!

**COMMON GOLDENEYE**

Common goldeneyes are a type of duck. They nest in tree cavities, but will accept nest boxes that people make for them. Naturally, a female will find a nest cavity and then proceed to line it with materials like downy feathers. Preferred nesting sites seem to be those that have been used before with success, instead of using choosing a nesting site closer to food resources.

**PILEATED WOODPECKER**

This large woodpecker may have an important role in controlling insect outbreaks especially in forest habitats. Because of its size and strong chisel-shaped bill, the pileated woodpecker is good at excavating (hollowing out) dead and living trees. It makes large cavities in order to make nests and roost cavities and to find food.

**WESTERN SCREECH OWL**

Throughout its range, the western screech owl will nest in tree cavities, most commonly those made by other species (examples include: fox squirrels, northern flickers, gilded flickers, and the pileated woodpecker). Western screech owls add no new material to their nest sites. Instead, these owls will use whatever materials are already present. Their preferred tree is the cottonwood.

**NORTHERN FLICKER**

Northern flickers help to control the populations of insects, especially ants which are their chief food. They also eat grasshoppers, crickets, termites, wasps, aphids, beetles, caterpillars, and spiders. They sometimes follow pileated woodpeckers because their bills are not as big and can not drill into wood as far. Aggressive displays such as “bill directing” or “bill poking” are used by flickers especially between males.

**VAUX’S SWIFT**

Vaux’s swifts can be found in old-growth forests consisting of mixed vegetation. During the breeding season, Vaux’s swifts occupy forests of coast redwood and Douglas firs. Very important to swifts’ nesting grounds are hollow trees or large cavities that are either dead or alive. They look for food in naturally occurring openings in forests and along streams as well as high above in the tops of trees.

*Written by Melinda Bailey*



*Below is a list of bird and mammal species know to use the cavities and entrance and foraging holes excavated by Pileated Woodpeckers in coniferous forests of the western U.S. and Canada.*

### **Birds**

Wood duck  
Common goldeneye  
Bufflehead  
Hooded merganser  
Common merganser  
American kestrel  
Flammulated Owl  
Western screech-owl  
Northern pygmy-owl  
Boreal owl  
Northern saw-whet-owl  
Vaux's swift  
Hairy woodpecker  
Northern flicker  
Brown creeper

### **Mammals**

Silver-haired bat  
Big-brown bat  
Douglas' squirrel  
Red squirrel  
Northern flying squirrel  
Bushy-tailed woodrat  
Ringtail  
American marten  
Fisher