and then there were none
survival of species (here: animals)

△ FRAMEWORKS

SCIENCE
- **LS 4.6.1** Identify environmental conditions that can affect the survival of individual organisms and entire species.
- **LS 4.6.4** Analyze natural selection.
- **LS 4.7.1** Explain the role of reproduction in the continuation of a species.
- **LS 3.8.13** Identify basic ideas related to biological evolution: diversity of species, variations within species, adaptations, natural selection and extinction of a species.
- **LS 4.8.1** Analyze the effect of changes in environmental conditions on the survival of individual organisms and entire species.

LANGUAGE ARTS
- **W 5.6.10** Write across the curriculum.
- **W 5.7.10** Write across the curriculum.
- **W 5.8.10** Write across the curriculum.

△ OBJECTIVES

The students will learn:

**OBJECTIVE #1** To describe the relationship between environmental factors and a species’ survival and reproduction rate.

**OBJECTIVE #2** To define extinction.

**OBJECTIVE #3** To explain natural and man-made extinction.

**OBJECTIVE #4** To appropriately use verbal speaking skills in class discussion with the teacher and Garden Program Specialist.
Planting bumblebee-friendly gardens helps conserve this species, which is vital to the pollination of most flowering plants.

**OVERVIEW**

Environmental changes to biotic and abiotic factors can affect a species’ ability to survive and reproduce. Species capable of adaption will survive; others will become extinct. There are natural and man-made causes for extinction.

**GARDEN ACTIVITIES**

- Planting bumblebee-friendly plants
- Hoeing and hand-pulling weeds
- Plant, harvest and work in the garden following the Garden Guide
- Recipes and Taste tests as time permits (refer to Delta Garden Study Recipe Book)
## TIPS FOR THE CLASSROOM

**Pre-lesson preparation:**

1. Check with the Garden Program Specialist to determine if there are any bee-friendly plants to plant or work with in the garden.

## LESSON OUTLINE

<table>
<thead>
<tr>
<th>activities</th>
<th>estimated duration</th>
<th>actual duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>in the classroom</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲ Offer the icebreaker</td>
<td>5 minutes</td>
<td>10 minutes</td>
</tr>
<tr>
<td>▲ Explain how environmental changes can affect a species’ survival and reproduction rate; define extinction and its natural or man-made causes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>in the garden</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲ Plant bumblebee-friendly plants</td>
<td>15 minutes</td>
<td></td>
</tr>
<tr>
<td>▲ Hoe and hand-pull weeds</td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td>▲ Plant, harvest and work in the garden following the Garden Guide Schedule.</td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td>▲ Implement recipes and taste tests as time permits (refer to the Delta Garden Recipe book).</td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td><strong>back in the classroom</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲ Hand out Student Workbooks, review and assign “Take it Home Activity” as homework</td>
<td>5 minutes</td>
<td></td>
</tr>
</tbody>
</table>

## TIPS FOR THE GARDEN

**Pre-lesson preparation:**

1. Set up supplies to seed, transplant or work with bee-friendly plants.
2. Prepare to discuss the role and importance of bees in the garden, as well as the possible impact of their diminishing numbers.
3. Set up a garden work activity weeding the garden.
## LESSON PLAN

### I. Start in the classroom

#### A. Icebreaker

Ask students: “How fast can bees fly in mph?”  

**Answer:** Bees can fly about 13–15 mph.”  

Tell students: “Honeybees are the only insects that make food for humans.”

#### B. Present Main Topic

- Discuss how animal and plant species depend on the right environment in order to survive and reproduce. Review definition of extinction.
- Describe how environmental changes affect a species’ survival and reproduction capabilities and cite examples (temperature changes, volcanic eruptions, rising and falling sea levels, diseases, etc.).
- Distinguish between natural and man-made extinction.

### II. Take class to the garden

- If appropriate, plant a bumblebee garden or bumblebee-friendly plants. Explain how maintaining/restoring natural habitat contributes to the conservation of a species.
- Hoe or hand-pull weeds. Explain how the use of toxic herbicides can change biotic and abiotic factors, possibly threatening a species’ survival.
- Plant, harvest and work in the garden, following the Garden Guide.
- Implement recipes and taste tests as time permits (refer to Delta Garden Recipe book).

### III. Take class back to classroom

- Hand out the Student Learning Workbook as reference material and class assignment. Review take it home activities and encourage students to do them.
SUPPORTING INFORMATION FOR TEACHERS

BACKGROUND

Very little research exists on bumblebees in Arkansas, but anecdotal evidence suggests that their populations, and those of all bees, are declining. An intensive, nationwide survey in the United Kingdom showed that half of that country’s bumblebee species might face extinction. Factors contributing to their demise include intensive agriculture, use of pesticides and herbicides, habitat loss and urban development. Why is that reason for concern?

Bees, as a group, hold terrestrial ecosystems together. Most flowering plants in North America depend on pollinators for fertilization and seed production. Without pollinators, many plants would not reproduce and possibly become extinct. Of all pollinating insects, bees are the most important ones. That’s because they have special characteristics:

They deliberately collect pollen to feed their offspring, so they are particularly determined foragers. No other insect group does this. Over the course of a single day, a female bee might seek out several hundred flowers, depositing pollen at each stop.

They tend to select only specific flower species during a foraging trip. As a result, the pollen stays in the family, instead of being wasted on different species.

In Arkansas, bumblebees have been identified as vital pollinators of several native plants, including species of special concern. They are also the most effective pollinators of food crops such as tomatoes, melons, blueberries and raspberries. To thrive and reproduce as a species, bumblebees have two essential needs: nectar and pollen for food and suitable nesting sites. Yet their habitat has greatly diminished as natural environments have been converted for residential and commercial use. Many herbicides and pesticides are either toxic to bees or they destroy the flowers the bees depend on for food.

To help conserve existing local bumblebee populations or increase them, home and school landscapes can be designed to include bumblebee gardens. Here are a few basic guidelines that are easy to follow:

▲ Aim for full sun. Even a small garden provides valuable resources for bees as long as it receives at least 6 hours of daily sunlight. Plants that grow in plenty of sunshine produce more nectar than those in shady areas.

▲ Native plants are the best choice. Once established, they are adapted (here is that concept again) to Arkansas’s hot and humid summers and require much less care than non-native species. Horticultural varieties and double-flowered hybrids (roses, marigolds) should be avoided. They have been bred to produce showy flowers rather than the structures that produce pollen; they also have less nectar.

▲ Ensure successive blooms. Choose plants that will bloom at different times from spring through early fall so bees will find food throughout the season.

▲ Plant in groups. Arrange for clusters of the same plant species (3-5) rather than scattering single plants here and there. Bees prefer groups of the same plant, rather than soloists.

▲ Skip the poison. Avoid the use of commercial insecticides or pesticides. Weeds can be controlled by applying a heavy layer of mulch or pulling by hand.

The following plants are ideally suited for an Arkansas bumblebee garden:

Columbine (Aquilegia canadensis)
Purple milkweed (Asclepias purpurascens)
White-flowered milkweed (Asclepias variegata)
Spider milkweed (Asclepias viridis)
Yellow wild indigo (Baptisia sphaerocarpa)
Pale purple coneflower (Echinacea pallida)
Purple coneflower (Echinacea purpurea)
Joe pye weed (Eupatorium fistulosum)
Narrow-leaved sunflower (Helianthus angustifolia)
Common sunflower (Helianthus annus)
Woodland sunflower (Helianthus divaricatus)
Ashy sunflower (Helianthus mollis)
Jewelweed (Impatiens capensis)
Rough blazing star (Liatris aspera)
Blazing star (Liatris elegans)
Prairie gayfeather (Liatris pycnostachya)
Evening primrose (Oenothera biennis)
Sundrops (Oenothera fruticosa)
Showy evening primrose (Oenothera speciosa)
Passionflower (Passiflora incarnata)
Arkansas beard-tongue (Penstemon arkansana)
Foxglove beard-tongue (Penstemon digitalis)
Obedient plant (Physostegia virginiana)
Gray-head coneflower (Ratibida pinnata)
Black-eyed susan (Rudbeckia hirta)
Compass plant (Silphium laciniatum)
Cup plant (Silphium perfoliatum)
Canada goldenrod (Solidago canadensis)
Three-lobed violet (Viola palmata var. triloba)
Bird's-foot violet (Viola pedata)


Bumblebees are typically larger than honey or native bees with fuzzy, yellow-and-black bodies. They are less likely to sting than honeybees.

**ACTIVITIES**

▲ Plant a small bumblebee garden to compliment the vegetable garden. If that's impractical, plant several specimen of bumblebee-friendly ornamentals in the vegetable beds. Explain to the students the importance of preserving/restoring the habitats of endangered species.

▲ Hoe or hand-pull any pesky weeds. Explain that the use of herbicides can be toxic to bees and could contribute to a further decline of their population. Herbicides change biotic factors (plants that serve as food source) as well as abiotic factors (air, water, soil), dramatically altering a natural environment and putting a species' survival at risk.

▲ To collect and interpret data on Arkansas bumblebee populations, the Arkansas Natural Heritage Commission in 2005/06 conducted a citizen science survey. It asked Arkansas residents to count bumblebees spotted in their front and back yards and report the figures to the Commission.

▲ Optional Enrichment Activity:

Time and circumstances permitting, set up a small-scale citizen science survey with the students. Starting in spring, instruct students to count the bumblebees they observe in the school garden. Keep a data table and note changes from garden visit to garden visit.

Bumblebees aren't the only ones in Arkansas that are declining in numbers. Some of you may have heard about the Ivory-billed Woodpecker.

The demise of the Ivory-billed Woodpecker was brought on by man-made activity: the clear-cutting of forest took away the bird's nesting grounds and food source.

Disease can also diminish a species population to the point of endangerment and extinction. This is happening right now to many bats in caves found in an area stretching from New York State to Canada in the north and Oklahoma in the west.

A fungus has killed more than one million bats since it was first discovered in early 2006. Already, it has infected the endangered gray bats in Missouri. No cure or treatment is known to date. The fungus leads to White-nose Syndrome (WNS), named for a white substance that forms on the bats’ muzzles and wings. It may kill the bats directly or indirectly by disrupting the bats’ hibernating cycle. Infected bats wake during hibernation in the winter, which causes them to lose their required fat reserves. They end up starving. The fungus is transmitted from bat to bat and from other animals, even from humans, who enter the caves and transmit the fungus spores to other caves. Many caves have been closed to human visitors and explorers as a precaution, while research continues for treatment or a cure.
**Sources**

*Master Gardener Arkansas Handbook*
University of Arkansas, Division of Agriculture, Cooperative Extension Service

*Science, See learning in a whole new light*
Scott Foresman, Pearson Education Inc., 2007

*Ehow.com*

*Bumblebees are Friendly Pollinators*
http://suite101.com/article/bumblebees-are-friendly-pollinators-a114605

*Guide to Bee-Friendly Gardens*
http://nature.berkeley.edu/urbanbeegardens.index.html

*Mercola.com*

*US Fish & Wildlife*
http://naamlp.net/documents/white-nosefaqs.pdf
and then there were none
survival of species (here: animals)

study guide for students

Mention “extinct species” and everybody thinks dinosaurs. True, but you don’t have to go that far back in history to study how changes in the natural environment affect a species’ ability to survive and reproduce. Right here at home, you find evidence of species that were plentiful in Arkansas until just a few years ago, but have disappeared forever or are in danger of doing so.

One example, involves the Ivory-billed Woodpecker. The colonial naturalists who explored the New World considered this bird a king among woodpeckers because of its magnificent appearance. It lived in the forests of the southeastern United States, especially the swamps of the Mississippi Delta.

Almost 70 years later, in 2004, local birdwatchers claimed to have spotted the bird in eastern Arkansas, a sign that the species had survived. However, despite intense searches conducted by some of the world’s most noted scientists, no further sightings have been confirmed. It remains doubtful whether or not the Ivory-billed Woodpecker still exists.

The demise of the Ivory-billed Woodpecker is a probable example of extinction brought on by man-made activity: the clear-cutting (cutting down all of the trees) of forests took away the bird’s nesting grounds and food sources. Extinction caused by human activities, such as destroying habitat, pollution and over-harvesting, is called man-made extinction.

Disease can also diminish a species population to the point of endangerment and extinction. That is happening right now to many bats in caves found in an area stretching from New York State to Canada in the north and Oklahoma in the west. A fungus has killed more than one million bats since it was first discovered in early 2006. Already, it has infected the endangered gray bats in Missouri. No cure or treatment is known to date. The fungus leads to White-nose Syndrome (WNS), named for a white substance that forms on the bats’ muzzles and wings. It may kill the bats directly or indirectly by disrupting the bats’ hibernating cycle. Infected bats wake during hibernation in the winter, which causes them to lose their required fat reserves. They end up starving.

The fungus is transmitted from bat to bat and from other animals, even from humans, who enter the caves and transmit the fungus spores to other caves. Many caves have been closed to human visitors and explorers as a precaution, while research continues for treatment or a cure.
Extinction caused by factors such as disease, changes in climate or increased pediatric populations, is called *natural-made extinction*. Another example here in Arkansas is the bee population. Very little research exists on bumblebees in Arkansas, but what little research does exist suggests that bees are declining. Factors contributing to their demise include intensive agriculture, use of pesticides and herbicides, habitat loss and urban development. You have learned how important bees are for pollination, which is why it is very important to plant bumblebee-friendly plants and try to keep their environment free of pesticides. Choose plants that will bloom at different times from spring through early fall so bees will find food throughout the season.

Another interesting fact is that bumblebees are the largest of the bees!

Once the last individual of a species is dead, the species is considered extinct. Species with very low population levels are considered endangered. They exist in such limited numbers, they might not reproduce enough offspring to sustain their kind. But it is sometimes possible to reverse the trend and bolster the birthrate by restoring the appropriate habitat.

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**natural-made extinction** reasons for extinction that are not caused by humans. things like climate change, diseases among animals and large predator populations are examples.

**man-made extinction** extinction caused by human activities, such as destroying habitats, pollution, over harvesting etc.

**extinction** the dying out of an entire species

**habitat** the place in an ecosystem where an organism lives
LS 4.6.1 Identify environmental conditions that can affect the survival of individual organisms and entire species.

1. **Describe the difference between man-made extinction and natural-made extinction.**

2. **Why is it important to prevent the extinction of an organism like the bee?**

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*Take it Home*

*If you haven’t tried soccer yet, kick some balls today. Just-for-fun soccer requires no special equipment, just the ball. Play some soccer today.*
1. **Describe the difference between man-made extinction and natural-made extinction.**

   *Man-made extinction is caused by human activity, such as destroying habitats, pollution, over-harvesting etc. Natural-made extinction is caused by non-human activity, such as changes in climate, diseases, increased predators, natural disasters, etc.*

2. **Why is it important to prevent the extinction of an organism like the bee?**

   *Answers may vary.*
and then there were none

POPULATION & ECOSYSTEMS

1. Compare and contrast man-made and natural made extinction.

2. Why is it important to prevent the extinction of an organism like the bee?

3. How can humans help rebuild declining plant and animal species?

Take it Home
If you haven’t tried soccer yet, kick some balls today. Just-for-fun soccer requires no special equipment, just the ball. Play some soccer today.
1. **Compare and contrast man-made and natural made extinction.**

   *Man made extinction is extinction caused by human activities such as destroying habitats, pollution, over harvesting etc. Natural made extinction is not caused by humans and are things like climate change, diseases among animals and large predator populations. In both instances though the animal or plant population diminishes.*

2. **Why is it important to prevent the extinction of an organism like the bee?**

   *Answers may vary.*

3. **How can humans help rebuild declining plant and animal species?**

   *Answers may vary. Humans can plant and grow declining plant species, as well as plant specific types of plants that certain animals eat. They can make safe habitats for declining animal species.*
LS 4.8.1 Analyze the effect of changes in environmental conditions on the survival of individual organisms and entire species.

1. Compare and contrast man-made and natural made extinction.

2. Describe why bees are important to our food system.

3. How did humans contribute to the extinction of the Ivory-billed Woodpecker?

4. How can humans help rebuild declining plant and animal species?

Take it Home
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1. **Compare and contrast man-made and natural made extinction.**
   
   Man made extinction is extinction caused by human activities such as destroying habitats, pollution, over harvesting etc. Natural made extinction is not caused by humans and are things like climate change, diseases among animals and large predator populations. In both instances though the animal or plant population diminishes.

2. **Describe why bees are important to our food system.**
   
   Bees help to pollinate flowers and plants, which helps them to grow. These plants can feed the animals that eat them. We in turn can eat the produce from the plants that have been pollinated. Also, some bees provide honey.

3. **How did humans contribute to the extinction of the Ivory-billed Woodpecker?**
   
   Humans cut down their habitats (clear cutting) and destroyed their habitat.

4. **How can humans help rebuild declining plant and animal species?**
   
   Answers may vary. Humans can plant and grow declining plant species, as well as plant specific types of plants that certain animals eat. They can make safe habitats for declining animal species.