beetles
Science and Teaching for Field Instructors

Student Activity Guide

Indoor Field Observations

Observing live organisms can be a highlight of students' time in outdoor science programs. *Indoor Field Observations* is designed to follow an outdoor science experience by giving students time to practice observation skills they learned and and get a closer look at organisms they may have only seen briefly in the outdoors. In *Indoor Field Observations*, students reflect on the skills they gained during an outdoor science experience and then make observations, ask questions, make connections, and construct explanations as they watch a nature video with the narration turned off. Next, students record their observations and thinking in journals, discuss their observations and ideas as a class, and make connections to science ideas (such as structure and function). Finally, students reflect on the learning experience. This simple activity can build on the excitement for learning about nature that students developed during an outdoor science experience. This activity should be completed after students have had an outdoor science experience in which they participated in the BEETLES Activity *I Notice, I Wonder, It Reminds Me Of*.

Students will...

- **Reflect on the skills they developed for exploring and learning about the natural world.**
- **Apply those skills by observing a nature video (with the sound off) and discussing observations and explanations with peers.**
- **Discuss observations and explanations as a class and make connections to other science ideas.**

Grade Level:
Grades 2–8. (Can be adapted for younger or older students.)

Timing:
40–65 minutes

Related Activities:
Field: *I Notice, I Wonder, It Reminds Me Of*; *NSI: Nature Scene Investigators*; *Interivew an Organism*; *What Scientists Do*; Classroom: *Evaluating Evidence*

Materials:
See Materials and Preparation on page 3 for details.

Tips:
To ensure a successful experience, review the teaching tips found on page 2 and throughout this guide.

NEXT GENERATION SCIENCE STANDARDS

FEATURED PRACTICE
Constructing Explanations

FEATURED CROSSCUTTING CONCEPT
Structure & Function

DISCIPLINARY CORE IDEAS
DCI's will vary, depending on video and prompts you chose

For additional information about NGSS, go to page 12 of this guide.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Indoor Field Observations

ACTIVITY OVERVIEW

Indoor Field Observations	Learning Cycle Stages	Estimated Time
Reflecting on Skills Learned in Outdoor Science Experiences	Invitation	5–10 minutes
Watching the Video	Exploration, Concept Invention	20–30 minutes
Discussing Observations and Making Explanations	Concept Invention, Application	10–20 minutes
Reflecting and Wrapping Up	Reflection	5 minutes
TOTAL:		40–65 minutes

TEACHING TIPS

Read the Instructor Support section. Beginning on page 9, you'll find more information about pedagogy, student misconceptions, science background, and standards.

***I Notice, I Wonder, It Reminds Me Of* activity is a prerequisite.** This activity is meant as a follow-up to an outdoor science experience in which students used the activity *I Notice, I Wonder, It Reminds Me Of*. Make sure your students have had a thorough experience with this activity before doing *Indoor Field Observations*. If you think your students didn't have enough experience with the routine, or were taught a version that shortcut the full activity, or did not all get to participate in the activity, lead *I Notice, I Wonder, It Reminds Me Of* before doing *Indoor Field Observations*: http://beetlesproject.org/resources/for-field-instructors/notice-wonder-reminds/

Why the silent movie approach? This activity won't work if the narration is on. The goal of the activity is for students to pay close attention, discuss observations of organisms, and to use the skills of a field scientist to think about what they see. Video narration tends to be a delivery of information, which puts viewers in a passive role as receivers of information. With the sound off, students can discuss the events of the video with their peers and become engaged with observing organisms. Information delivery through videos can be useful in other instances, but not for the goals of this exercise.

Crosscutting Concepts. This activity is written to engage students in using the Crosscutting Concept of *Structure and Function* as a lens to think about how organisms' structures and behaviors help them survive in their habitats. To reach other learning goals, such as thinking about the human impact on organisms and the environment or interactions between organisms, you could choose to use a different Crosscutting Concept such as *Cause and Effect*.

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Find the latest activities and information at http://beetlesproject.org.

MATERIALS AND PREPARATION

MATERIALS

For the class

- short video showing organisms

For each student

- student's journal (or paper)
- pencil

PREPARATION

1. **Choose a 5–10 minute (or shorter) nature video to watch with the sound turned off.** Nature videos tend to be very popular with students and often capture events and phenomena that are hard to observe during brief outdoor excursions. You can probably find a short and interesting video (or a short section of a longer video) about one of the organisms in which your students are interested. There's a list of videos to choose from on page 9, and there are many more on the Internet. You might also choose any of the following: a video of something that students can't observe directly (e.g., a slow-motion video of spores coming out of a fungi, an organism hard to find in the wild, a close-up video of pollination), a nature video that applies to a nature-related science idea you want students to spend more time thinking about, any video that shows something in nature that is deeply intriguing. (Note: Videos with interspersed footage of talking heads don't work very well for this activity—the footage should be of the organisms themselves.)
2. **Preview the video.** Watch the video at least once all the way through with the sound off to make sure students will be able to make observations that help them understand how the organism's/organisms' structures and behaviors function to help it/them survive. Or think about another science idea that might interest your students. Decide which section(s) of the video you want students to watch (the whole video, one or more sections). If you have a concept other than structures and behaviors on which you want students to focus, watch the video with an eye toward the kinds of observations that could help students make inferences about that concept.
3. **Plan questions you will ask about the video.** Read through the suggested prompts and questions in the "Watching the Video" and "Discussing Observations and Making Explanations" sections. The questions are meant to guide students to focus on particular aspects of the video and will affect the learning that happens for them during the activity. Think about whether you want to have students concentrate on a particular science concept, or perhaps you want to tie the activity to another topic your class is studying and come up with appropriate guiding questions. To make sure the discussion is engaging for students, balance these planned questions with a flexibility and a willingness to improvise and follow the group's interests.

TEACHING NOTES

TEACHING NOTES

Using journals as a reminder. If students used field journals during their outdoor science experience (particularly to make sketches or record observations), give them a chance to read and reflect on some of their experiences they recorded in their journals.

Including students who didn't attend an outdoor science program. If some students in your class were not able to attend an outdoor science experience, it's important to include them in this phase of the activity. Instead of suggesting that they have a completely quiet reflection, pair students who didn't get to attend the outdoor science experience with those who did, prompting them to ask questions of each other and to engage in dialogue.

Students may have had different experiences during their outdoor science experience. If students in your class were in separate groups for activities during their outdoor science experience, their exposure to using field science practices and learning about the natural world may have been different. Listen to your students' discussion to get a sense of what they learned, which transferable skills they might have gained, and whether there are large differences in their experiences.

Reflecting on Skills Learned in Outdoor Science Experiences

1. **Give students a minute or two to discuss or quietly reflect on their outdoor science experience.**
   a. Students could reflect on their favorite memories, impactful experiences, cool organisms or things they saw in nature, skills they got better at, or whatever else is meaningful to them.
2. **Give students another minute or so to discuss or quietly reflect specifically on skills they used for learning during their outdoor science experience.**
   a. What are some skills you used to learn about science and nature during your outdoor science experience?
   b. These skills could include making observations, participating in science discussions, asking questions, and so on.
3. **Ask a few students to describe a skill they learned and tell how it helped them learn about the natural world.**
   a. If students say things such as recycling or hiking, redirect them to think about experiences specific to learning about organisms or exploring science ideas.

Watching the Video

1. **Remind students of the observation skills they learned in their outdoor science experience and then introduce the video. Explain:**
   a. During your outdoor science experience, you learned how to make observations and ask questions about your surroundings.
   b. You'll get to use some of your observation skills while we watch a video of [name the organism or ecosystem on which the video focuses].
   c. We'll watch the video with the sound off so you can later talk quietly with a partner about what you observed.
2. **Explain that students' goal is to act like field scientists and learn as much as possible about the organism(s) in the video by making observations:**
   a. You'll be making observations out loud with a partner.
   b. Observations are things you notice with your senses.
   c. *It's pretty* or *It's gross* are not observations. They are opinions. Observations often start with *I notice*….
   d. If you run out of observations, say, "I notice…" and see what comes out of your mouth after it.
   e. You can also be inspired by what you hear others say.
3. **Explain that students will also ask questions about the organism(s) in the video:**
   a. You'll also be asking questions out loud.
   b. Any kind of question is fine, but questions that are scientific and can be answered through observations are most useful now.

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c. If you run out of questions, say, "I wonder..." and see what comes out after it.
d. Or, make an observation and see if you can come up with a question about that observation.

4. **Explain that students will also make connections about the organism(s) in the video:**
   a. You'll also be coming up with connections out loud.
   b. Connections are things you are reminded of. This could be a memory, something else like it that you've seen or heard about before, or some information you know.
   c. You can focus on what a part of the organism looks like or reminds you of (e.g., *That claw reminds me of a pair of pliers.* or *The feathers remind me of a fan.*).
   d. If you run out of comments, say, "It reminds me of..." and hear what comes out of your mouth next.
   e. You can also go back to making observations and see if any of them remind you of anything.

5. **Play the video, pausing at one or more intervals to hear students' observations.**
   a. Don't tell students the title of the video, but tell them the general topic (e.g., dragonflies).
   b. Make sure the video is muted and then press PLAY.
   c. If students are watching quietly, remind them to say their observations, questions, and connections out loud.
   d. Pause a little way into the video and ask a few students to share observations and ideas with the whole class.
   e. Highlight any interesting questions the group comes up with and record them on a whiteboard or sheet of chart paper.
   f. If students seem excited about discussing a certain question or observation, give them a moment to do so, but move on before they lose interest.
   g. Then, press PLAY again.
   h. Repeat as you see fit. If students seem excited to share their observations and ideas as a group, pause a few times, but don't let the video drag on too long.

6. **During the video, pay attention to what students are saying and try to find something they are interested in on which to focus later in the activity.**
   a. Move around the room, listening to what students are saying, asking follow-up questions, and encouraging discussion when appropriate.
   b. Notice interesting questions students come up with and pay attention to their curiosity and what excites them.
   c. Follow your students' interests and see if you can find something that gets them excitedly observing and discussing what they observed.
   d. Think about what prompt(s) you can use during their third viewing (in Step 9) to tap into their interests while deepening their learning.

TEACHING NOTES

Modeling for students. If your students need more support, model how to make detailed observations, ask questions, and make connections as you play the first part of the video. Modeling what it will look like to follow instructions is particularly helpful for language learners, younger students, and students who struggle with auditory processing.

Formative assessment opportunity. As students share what they notice, pay attention to the quality of their observations and provide support as needed. Are they describing what they see in detail or instead sharing vague statements about the organisms? Are they sticking to describing what's observable, or are they extrapolating and making inferences about why the organism is doing what it's doing or why it has particular structures? Being able to make careful observations is foundational to engaging in the science and engineering practices called for in the Next Generation Science Standards. For example:

- **Asking Questions:** To ask useful questions about a phenomenon, students must first make careful observations of it.
- **Planning and Carrying Out Investigations:** To plan and carry out an investigation, students must make and record systematic observations.
- **Constructing Explanations:** To construct an explanation, students must use evidence gathered from careful observations.

TEACHING NOTES

More support with journaling. If your students are newer to nature journaling (drawing and writing to record observations of nature) or are younger, consider offering a bit more structure for this phase of the activity. This could include a model journal page you show to students, illustrating the kind of entry they could create, or a chart to add to their paper with prompts such as *I Notice, I Wonder, It Reminds Me Of.* Avoid fill-in-the-blank worksheets, as they won't encourage students to make their own observations.

About field journaling. For more information on how to use field journaling to support student learning, see *Opening the World Through Nature Journaling*, a free curriculum written by John Muir Laws and Emilie Lygren (access at www.johnmuirlaws.com).

Watching the video more than once. Watching the video a second and even a third time gives students an opportunity to notice things they may not pick up on during their first viewing. This engages them more deeply in making sense of what they see, just as reading a text a second time enables deeper understanding. If your students seem interested, consider offering the option of watching the video a final time with narration on. One teacher said, "At the end, students wanted to watch the video with the sound on. They were excited to compare their observations, questions, and connections with what the narrator said."

7. **Distribute journals and tell students they will watch the video again. They will continue to discuss ideas and use words, drawings, and numbers to record their observations and questions whenever you pause the video.**
   a. Distribute students' journals and pencils.
   b. If students don't have journals, distribute sheets of paper instead.
   c. Tell students they will record their observations, questions, and connections by using words, drawings, and numbers to show what they see.
   d. Emphasize that students don't need to make a pretty picture—they just need to record accurate observations.
   e. Encourage students to rely more on whichever mode of recording information (i.e., writing, drawing, using numbers) is most comfortable for them, but they should use all three.

8. **Play the video again and ask students to record their observations and questions in a journal.**
   a. Play the video once more, this time pausing throughout the video to give students a few minutes to record their observations and questions, using sketching and writing.
   b. If students start coming up with explanations for what they see, ask them to stay focused on observations and questions and hold their explanations to share a little later in the lesson.

9. **Explain: Students will watch the video a third time, and this time they'll focus on particular things.**
   a. Choose one or more of the prompts below, or your own prompt, to focus students on certain kinds of observations as they watch the video again:
      - *Focus on [whatever unanswered question your students have come up with that they are interested in].*
      - *Focus on how the [squid, seals, etc.] interact with each other.*
      - *Focus on how the [squid, seals, etc.] interact with the environment.*
      - *Try to observe as much as you can about the structures of the [squid, etc.].*
      - *Compare how these organisms are similar to or different from one another.*
      - *Focus on observing behaviors.*
      - *Start counting—numbers of individuals, numbers of behaviors of organisms, numbers of certain structures, etc.*

10. **Play the video again, this time with students focusing on your prompt or prompts.**
    a. Play the video again, reminding students of the prompt(s) when appropriate.
    b. If there's a particularly intriguing sequence that students are discussing, you may want to replay it a few times, if that seems interesting and helpful.

Discussing Observations and Making Explanations

1. **Ask students: "What did you observe? What did you wonder?"**
   a. Ask a few students to share their observations or questions.

b. If there was a particularly interesting or rich moment in the video, ask other students to share what they noticed during that moment. Try to stimulate discussion.
c. Consider replaying that part of the video so they can deepen their observations.

2. **Lead students in discussing explanations about some events in the video, encouraging them to use the language of uncertainty and also to cite evidence.**
   a. Ask students to come up with explanations about certain aspects of the video.
   b. If some interesting explanations have already come up, bring them up again.
   c. Ask students to use the language of uncertainty when offering explanations, such as I think..., *I wonder if...*, *Maybe...*, and so on.
   d. Ask them to cite evidence that supports their explanations as well as any evidence that doesn't.
   e. Encourage discussion by asking questions such as: *Does anyone else agree? Disagree? Why?*

3. **During the discussion, use some of the following questions to relate students' observations to specific science concepts:**
   - *How did the organism's structures help it survive in its habitat?*
   - *How did the organism's behaviors help it survive in its habitat?*
   - *How did the organism rely on other organisms in the environment to survive?*
   - *How did the organism rely on its physical environment to survive?*
   - *If some aspect of the environment changed or was impacted by human activity, how might these organisms be affected?*

4. **Explain: Scientists use the connection between structures and their functions as a powerful tool for gaining understanding.**
   a. Remind students of a few examples in which they made connections between structure and function during their discussion (e.g., the structures of the dragonfly larva—the joints that keep its lower jaw folded under its head and its two claws on the jaw—function to help it grab and trap mosquitoes by quickly lunging forward, grabbing prey with a claw on either side, and pulling prey back in toward the mouth where it can be eaten).
   b. Explain that scientists use the connection between structure and function to understand organisms and objects in all types of science.
   c. Encourage students to use the idea of structure and function as a tool when they're observing other organisms, parts of nature, or even things in the human-built world.

5. **Ask students to discuss the function of structures of organisms they observed during their outdoor science experience. Ask the following questions:**
   - *What's a specific organism you saw during your outdoor science experience?*
   - *How did the structures of that organism function to help it survive in its environment?*

TEACHING NOTES

Choose questions to match your learning goals for students. This discussion is an opportunity to connect students' observations during the video to actual science ideas. Ask questions that will prompt students to think about science ideas that are relevant to your learning goals. The suggested questions emphasize the connection between structure and function, organisms' adaptations, interdependence of organisms, and human impacts on ecosystems. Consider tailoring the questions to the specific video you watched. For example, rather than asking, "If some aspect of the environment changed..." use a specific possible change to the environment in the video (i.e., "If the sea level got higher..."). If you want to focus on adaptations, you can introduce adaptations such as *inheritable structures or behaviors that help a group of organisms survive in their habitat* and ask:

- *Which organisms in the video might be more likely to survive and which might be less likely to survive after [change to the environment]?*
- *Which adaptations, or inheritable structures or behaviors, would help certain organisms survive?*

Using journals to review organisms' structures. If students recorded observations of organisms at their outdoor science experience, have them refer to their drawings or writing as they visualize an organism.

TEACHING NOTES

Dealing with anthropomorphic statements. When observing animals, students (and people in general) tend to make anthropomorphic statements (e.g., *That crab is scared. The lizard likes that rock.*). Dealing with anthropomorphic statements can be tricky. While such statements aren't true observations, anthropomorphism has been shown to be a useful way (especially for younger students) to develop empathy for organisms. This is most true for organisms very different from humans (such as barnacles). However, making assumptions that other organisms perceive the world in the way that humans do limits the extent to which students can make accurate scientific observations of what is actually going on. Don't directly shut down students' anthropomorphic statements—doing so can come across as insensitive to students whose cultural identities value anthropomorphism. Instead, try a *Yes, and...* approach, encouraging students to share the observations behind their statements (e.g., *What makes you say that the crab is scared? What are the observations that make you think that?*) or building on what the student said by adding accurate information or observations (e.g., *Yes, I see that the crab is backing up with its claws in the air. What else can you observe about it?*).

Additional activities to strengthen and apply observation skills. See the Instructor Support/Ideas for Additional Activities section for ideas on how to further engage students in the observation skills they developed during their outdoor science experience.

Reflecting and Wrapping Up

1. **Ask: "How is it different observing organisms in nature and on video?"**
   - **a.** Ask students one or more of the following questions about their experiences:
     - *What kind of information can't you find out by only watching a video of organisms?*
     - *Could scientists do thorough studies of organisms just by watching videos? Why or why not?*
     - *If you could see these organisms in the wild, what are things you might observe that you couldn't observe while watching the video?*
     - *How could we answer some of the questions our group came up with about these organisms?*

2. **Use some of the following questions to prompt students' discussion and reflection:**
   - *Which observations surprised you?*
   - *What were some of your observations about these organisms' interactions with the environment?*
   - *What do we now know about these organisms, and what would we like to know about them?*

3. **Optional: If you want your students to do research to answer any remaining questions, give them support and guidelines.**
   - **a.** If your students' curiosity is piqued, you may want to guide them in pursuing their interests by doing some research.
   - **b.** Research may involve observing actual organisms or doing online and book research.
   - **c.** Let them know about the resources and the amount of time they'll have to do research. Suggest what they should do with what they learn.

4. **Ask: "Which organisms might you want to explore and observe in the future?"**

5. **Ask: "What helped you to learn, and where else might you use these curiosity/observation skills in the future?"**
   - **a.** What helped you to learn during this activity?
   - **b.** The skills you've used in this lesson are really curiosity tools that can be used to explore different things, such as other organisms, parts of nature, or anything around you!
   - **c.** If you are ever feeling bored or not engaged with something and you want to become more curious about it, you can use these tools.
   - **d.** Where else might you want to use these tools?

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Instructor Support

Teaching Knowledge

Possible Videos

The BBC Earth YouTube channel has a lot of 3–5 minute videos of different organisms. PBS Deep Look videos are another rich source. YouTube also has clips of nature videos. Some links to such videos are listed below, along with videos from other sources. Look through these for more options or choose a short clip from a longer nature documentary to which you have access. It's usually best if students aren't given the title of the video they're about to watch (the general topic, such as dragonflies, is fine) so their experience will be more similar to open-mindedly watching something they find in nature and then making discoveries for themselves.

- Hermit Crab Shell Switching: https://www.youtube.com/watch?v=f1dnocPQXDQ
- A Baby Dragonfly's Mouth Will Give You Nightmares: https://www.youtube.com/watch?v=EHo_9wnnUTE
- Grebe Courtship: https://www.youtube.com/watch?v=ZbRrxw-H6xA
- Grizzlies Catch Salmon: https://www.youtube.com/watch?v=TSSPDwAQLXs
- The Ladybug Love-in: A Valentine's Special: https://www.youtube.com/watch?v=c-Z6xRexbIU
- Newt Sex: Buff Males! Writhing Females! Cannibalism!: https://www.youtube.com/watch?v=5m37QR_4XNY
- The Fantastic Fur of Sea Otters: https://www.youtube.com/watch?v=Zxqg_um1TXI
- Daddy Longlegs Risk Life...and Especially Limb...to Survive: https://www.youtube.com/watch?v=tjDmH8zhp6o
- This Is Why Water Striders Make Terrible Lifeguards: https://www.youtube.com/watch?v=E2unnSK7WTE
- Gliding Leaf Frogs: https://www.youtube.com/watch?v=tf1bytsDDho
- Beetles Brawl for Female Attention: https://www.youtube.com/watch?v=JFsw-vyWS5E
- Antlion Cone Death Trap: https://www.youtube.com/watch?v=QSYpWaFsIRY
- 17-Year Periodical Cicadas - Planet Earth: https://www.youtube.com/watch?v=EWr8fzUz-Yw
- Spider Shoots a Web: https://www.youtube.com/watch?v=nIRkwuAcUd4

The following videos don't work well if your focus is structure and function, but they're great for observing the process of decomposition:

- Bioturbation with and without Soil Fauna: https://www.youtube.com/watch?v=Mxp1nnrUG0Q
- Decaying Animal Time Lapse: https://www.youtube.com/watch?v=WYzBUYYu9Cw

TEACHING NOTES

TEACHING NOTES

Introducing Content

Avoid telling students information about the video before they watch it, otherwise you might discourage them from observing closely to figure out what's going on. The goals of the activity are for students to make observations, ask questions, come up with connections, and talk with one another to make explanations about what they observe. Make sure students have a chance to observe freely first, waiting to share information until after they have watched the video once or even twice. If you share a bit of information at the right time, you can incite more curiosity and allow students to apply their thinking in a new way. For example, during the phase of the activity when students are coming up with explanations for what they observed in the video, you could offer a small piece of information and then give students the chance to discuss further and revise their explanations based on the new information.

Ideas for Additional Activities

Here are some suggestions for how to build on students' experience in *Indoor Field Observations*:

- **Watch another nature video.** To deepen students' understanding of how organisms' unique structures help them survive in their habitat, repeat this activity with another nature video featuring different organisms in a different ecosystem. Consider allowing students to choose which organism they want to watch a video about. Then ask students to compare the structures of the organisms in the two videos and make possible explanations for how the structures were uniquely suited to help the organisms survive in their habitats. This will give students a chance to hone their observation skills even more and to understand the idea of adaptations more deeply.
- **Discuss students' questions.** To deepen students' experience in this activity, give them an opportunity to discuss how they might research the questions the class came up with. Decide which questions are scientific and which questions are not. Scientific questions can be further sorted into questions that students could investigate themselves in a short period of time and questions that would require longer study or special tools. Students can investigate questions that they come up with.
- **Organism study groups.** If students want to learn more about the organisms they watched in the video, consider placing them in groups to study varying aspects of the organisms. Examples of study topics could include adaptations of the organisms, feeding behaviors, organisms' habitat distribution, etc.
- **Active reading.** The three prompts—*I notice, I wonder, It reminds me of*—can be used to engage students with text! Give students a reading, either photocopied or in a book. If it's photocopied, you can tell them to write directly on the document. If it's a book, they can write on sticky notes. Tell them to underline what they think are important points in the text (*I notice*), write questions they have in the margins (*I wonder*), and write connections they think of in the margins (*It reminds me of*). After reading,

tell them to work with a partner to discuss their notes and together to try answering questions they still have.

- **Engage students in using observation skills in other disciplines.** The sentence starters *I notice..., I wonder...,* and *It reminds me of...* can be used as prompts in other contexts, too. They are essentially curiosity tools that can be applied to a wide variety of topics to help students actively engage with the subject matter. For example, students can use these tools when reading dramatic scripts in their English class to better understand characters and interactions. They can use them in an art or science class to examine a work of art or a historical artifact. They can also employ them when watching videos about topics other than nature. For more information on how to use these sentence starters to support science learning, see the BEETLES field activity *I Notice, I Wonder, It Reminds Me Of.*
- **Make a class field guide to organisms found at the outdoor science site.** Give students a chance to continue applying the knowledge they gained by making a class field guide to organisms found during their outdoor science experience. Combining their observations and knowledge from their field experiences and other research from books and the Internet, each student can create a page of drawings and text focused on one organism.

Content Knowledge

The concepts students discuss will vary, depending on the video you choose and the discussion prompts you share. Focusing on structure and function as described in the write-up will guide students toward observations and inferences that help them understand how organisms are adapted to their environments. Below is some useful background information on adaptations.

Adaptations are inheritable traits that improve the fitness of a population of organisms. Fitness refers to an organism's reproductive success. Evolution happens because some individuals in a population are more reproductively successful than others. Evolution is the process of change that occurs in populations over generations. Traits that improve fitness will be passed on to more offspring than traits that do not improve an organism's fitness, and these traits will become more prevalent in a population. This is how a population of organisms changes over time. If a population becomes so different from other members of the same species that it can no longer reproduce with them, then this population is considered a new species. This process is called speciation. While we often think of evolution and adaptation in terms of observable external changes in a population (e.g., a bird's beak size), it's important to remember that inheritable traits are the result of genetics. It's through DNA that these traits are passed on from one generation to the next.

Common Relevant Misconceptions

Misconception. An individual organism can adapt.

More accurate information. This is the most prevalent misconception about adaptations. In common English usage, the word *adapt* can refer to something an individual does. For example, *I moved to a new school, and I adapted by making new friends.* However, in scientific usage, populations of organisms adapt over

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More on scientific/nonscientific questions. "Science is a tool for studying observable experiences and phenomena—the stuff you can see, hear, taste, feel, or measure. *How many holes are in this tree? What time do moths begin to fly in the evening? How long is this earthworm?* These questions can be explored and, in some cases, answered through observation and experimentation. Some things cannot be observed, measured, or tested. *What is God? What is kindness? How do trees feel about the wind? Does the Gray Wolf have a soul?* These questions are outside the realm of science. It's an important part of the human experience to consider them, and you can use disciplines such as poetry, theology, and philosophy to do so."—John Muir Laws and Emilie Lygren, *The Laws Guide to Nature Drawing and Journaling*

Connecting to the Outdoor Science School experience. Outdoor science school experiences tend to be very memorable and can even be life changing for students. Thoughtful educators pay attention to how to connect an outdoor science experience to the classroom. The more opportunities students have to connect what they are learning in the classroom to what they experience at outdoor science school, the more meaningful their outdoor experiences will be and the more lasting students' academic impact will likely be. This activity presents one way to connect classroom and outdoor learning through engaging in science practices. Think of other ways you can connect what students are learning at school to what they experienced in outdoor science school, including taking students outside to observe plants, ants, birds, or clouds from your schoolyard or building on concepts they studied in outdoor science school.

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generations, but individuals don't. Adaptations are inherited structures or behaviors; they aren't acquired during an organism's lifetime. If a person works out a lot and develops big muscles, that person's children will not inherit big muscles, so big muscles are not an adaptation. If you dye your hair, and it makes you superbly successful, this trait will not be passed on to your children—so your chic coif is not an adaptation. An adaptation must be something an organism is born with, such as long legs. If longer legs help organisms run faster, survive, and have more offspring than those with shorter legs, then longer legs may eventually become an adaptation and spread throughout the population.

Misconception. All behaviors are adaptations.

More accurate information. Behavioral adaptations are beneficial behaviors inherited from one generation to the next. They are instinctual behaviors, like when mosquito larvae dive below the water's surface in response to a shadow passing over, or when ants follow a trail of formic acid. The organisms aren't thinking about the situation and choosing a behavior, and they didn't learn it from their parents or other individuals. They are instinctively reacting. It's a bit more difficult to think of human behaviors that are adaptations since our brains are complex and most of our behaviors are acquired. Shivering in response to cold is an adaptation, but putting on a jacket is a learned response.

Misconception. If a population or organism tries hard enough, it will adapt to its environment.

More accurate information. Adaptations originate in random genetic mutations. While most genetic mutations are harmful to organisms, every once in a while a mutation will help an organism have a survival advantage and thus produce more offspring. The offspring that inherit the beneficial trait will also have more offspring. Evolution does not occur because an organism wants an adaptation. Instead, evolution works through random trial and error. Genetic mutations occur randomly, and beneficial mutations are passed on to the next generation.

Connections to Next Generation Science Standards (NGSS)

BEETLES student activities are designed to incorporate the three-dimensional learning that is called for in the Next Generation Science Standards (NGSS). Three-dimensional learning weaves together Science and Engineering Practices (what scientists do), Crosscutting Concepts (thinking tools scientists use), and Disciplinary Core Ideas (what scientists know). Students should be exploring and investigating rich phenomena and figuring out how the natural world works. The abilities involved in using Science and Engineering Practices and Crosscutting Concepts—looking at nature and figuring things out, using certain lenses to guide thinking, and understanding ecosystems more deeply—are mindsets and tools students can take with them and apply anywhere to deepen their understanding of nature, and they're interesting and fun to do!

This activity gives students the opportunity to apply skills for exploring the natural world learned during their time in outdoor science, which supports

their ability to engage in the following Science and Engineering Practices: *Asking Questions*; *Constructing Explanations*; *Engaging in Argument from Evidence*; and *Obtaining, Evaluating, and Communicating Information*. It also supports students' understanding of the Crosscutting Concept of *Structure and Function*. The Disciplinary Core Ideas help students understand the videos and the prompts that you as the instructor choose to focus on, but they could also include *Structure and Function*, *Interdependent Relationships in Ecosystems*, or *Adaptation*.

Featured Science and Engineering Practice

Engaging students in Constructing Explanations. According to the NRC's publication *A Framework for K–12 Science Education*, a major goal of science is to deepen human understanding of the world through making explanations about it. Students should develop their understanding of science concepts through making their own explanations about what they observe.

- The video students watch in *Indoor Field Observations* provides an engaging topic for students to figure out (e.g., hermit crabs switching shells, leaf frogs leaping through the air).
- As students discuss how the structures and behaviors of the organism(s) in the video help it survive or how a change to the environment would impact the organism(s), students begin to construct their own explanations of what they observed.
- You can engage students more deeply in this practice by giving them repeated opportunities to make explanations in different situations, by encouraging them to consciously use tentative language (*I think that...*), to base their explanations on evidence, and to consider alternative explanations based on that evidence.
- At the end of science activities and experiences, ask students to reflect on how making explanations affected their thinking and learning so they could begin to recognize the value of making explanations as a scientific way of thinking about the natural world.

Featured Crosscutting Concept

Learning science through the lens of Structure and Function. The idea that structure and function complement each other is a useful tool for explaining things in science. In the human-designed world as well as in any natural system, the shape and material of a structure are related to what it does, and vice versa.

- In *Indoor Field Observations*, students observe an organism's structures and make possible explanations for how those structures help the organism survive in its specific environment.
- Initially, students focus on making observations, asking questions, and making connections. Focusing on making careful observations of structures is an important science skill, as it leads students to gain accurate and more in-depth information about structures when they begin to think about functions.
- Toward the end of the activity, students are introduced to the specific language and lens of structure and function when they reflect on the function of structures they observed during an outdoor science experience.

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About the Next Generation Science Standards (NGSS). The development of the NGSS followed closely on the movement to adopt nationwide English language arts and mathematics Common Core standards. In the case of the science standards, the National Research Council (NRC) first wrote *A Framework for K-12 Science Education* that beautifully describes an updated and comprehensive vision for proficiency in science across our nation. The *Framework*–validated by science researchers, educators and cognitive scientists–was then the basis for the development of the NGSS. As our understanding of how children learn has grown dramatically since the last science standards were published, the NGSS has pushed the science education community further toward engaging students in the practices used by scientists and engineers and using the "big ideas" of science to actively learn about the natural world. Research shows that teaching science as a process of inquiry and explanation helps students to form a deeper understanding of science concepts and better recognize how science applies to everyday life. In order to emphasize these important aspects of science, the NGSS are organized into three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas (DCI's). The DCI's are divided into four disciplines: Life Science (LS); Physical Science (PS); Earth and Space Science (ESS); and Engineering, Technology, and Applied Science (ETS).

Read more about the Next Generation Science Standards at http://www.nextgenscience.org/ and http://ngss.nsta.org/

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- Using this specific language and pointing out this lens as a learning tool are a key part of students' experience. If students don't get the chance to think about how the idea of structure and function connects to the explanations they're making, they miss the opportunity to recognize the idea of structure and function as an important way of looking at the natural world. This also gives students an opportunity to think about how the idea of structure and function also applies in other scenarios, such as looking at a certain model of car or computer and thinking about what it was designed to do.
- Make sure to emphasize this with students and to provide additional opportunities to apply the idea of structure and function in various contexts.

Featured Disciplinary Core Ideas

Building a foundation for understanding Disciplinary Core Ideas. The NGSS make it clear that students need multiple learning experiences to build their understanding of Disciplinary Core Ideas. Depending on the video and the line of questions you choose, *Indoor Field Observations* may provide students with an opportunity to develop an understanding of the life science core ideas related to LS1.A Structure and Function, LS2.A Interdependent Relationships in Ecosystems, and/or LS4.C Adaptation.

- Specifically, if students make explanations about how particular structures of organisms might help the organisms survive, students will develop some understanding of the core idea that organisms have characteristic structures that serve functions in growth, survival, behavior, and reproduction. (LS1.A)
- If students focus on how an organism's structures and behaviors help it survive within the context of its habitat, students will build some foundational knowledge of how the organisms depend on and interact with both the living and the nonliving parts of the environment. (LS2.A)
- If students consider how a change to the environment might allow some organisms to survive better than others, students will develop some foundational understanding of how the environment influences populations of organisms over generations. (LS4.C)
- You can informally assess student understanding of these concepts by listening carefully as students make explanations after the video is shown. This information can help you determine which ideas to focus on in future lessons so appropriate follow-up activities or discussions can be used to further student understanding.

Performance Expectations to Work Toward

No single activity can adequately prepare students for an NGSS Performance Expectation. Performance Expectations are designed as examples of things that students should be able to do to demonstrate their understanding of content and big ideas in science after engaging in multiple learning experiences and instruction over time. They are *not* the curriculum to

Translating the codes for the NGSS Performance Expectations. Each standard in the NGSS is organized as a collection of Performance Expectations (PE's) for a particular science topic. Each PE has a specific code, which is provided here so they can be easily referenced in the NGSS documents. The first number or initial refers to the grade level: K = kindergarten, 1 = first grade, 2 = second grade, MS = middle school, and HS = high school. The next letters in the code refer to the science discipline for the standard: LS, PS, ESS, ETS. The number following the discipline denotes the specific core idea within the discipline that is addressed by the PE, and the last digit identifies the number of the PE itself. So, 3-LS4-3 means the Performance Expectation is part of a third-grade standard (3) for life science (LS), addressing the fourth core idea (4), Biological Evolution: Unity and Diversity, within the life science standards, which deals with Adaptation. It's also the third Performance Expectation (3) that makes up the complete LS4 standard at this grade level.

be taught to students. Following are some of the performance expectations this activity can help students work toward.

- **3-LS4-3.** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- **4-LS1-1.** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Activity Connections

This activity is designed to follow students' experiences in outdoor science, particularly at an outdoor science school and specifically after students have experienced the *I Notice, I Wonder, It Reminds Me Of* routine. Other BEETLES activities focus on these sorts of skills, such as *NSI: Nature Scene Investigators*, *Interview an Organism*, and *What Scientists Do*. The classroom activity *Evaluating Evidence* focuses on using different evidence when making explanations. Many other BEETLES activities support students in making observations and constructing explanations. Participation in BEETLES adaptation-focused activities could allow students to go deeper in their explanations of phenomena in the video or videos they have viewed.

Learning Cycle: *Indoor Field Observations* completes a full learning cycle. Within a sequence of activities done in outdoor science, this activity serves as both an Application and a Reflection of science observation skills. Within a sequence of many activities focused on developing student understanding of adaptations, this activity could serve as an Exploration or a Concept Invention activity.

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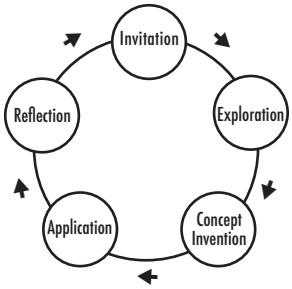

Within a longer sequence of activities, *Indoor Field Observations* functions as an Exploration or a Concept Invention activity.

ABOUT BEETLES™

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